Transforming University-Industry-Government Relations in Ethiopia

Proceedings

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INTRODUCTION

1.1 Foreword

Many individuals made contributions that were crucial for the successful organization of the Triple Helix Conference on Transforming University-Industry-Government Relations in Ethiopia. In particular, we would like to thank Dr. Duri Mohammed, former Minister of Planning and Ethiopian Ambassador to United Nations, who first broached the idea of creating the Ethiopian Triple Helix Association as a platform for developing more effective cooperation between various actors in Ethiopia according to the Triple Helix concept with Henry Etzkowitz (then of State University of New York and who established the concept in the early 1990s), and Mr. Per Eriksson, Director General of the Swedish Agency Responsible for Innovation Systems (VINNOVA).

The project evolved with the help of the International Organisation for Knowledge Economy and Enterprise Development (IKED), Malmö, Sweden and, in Addis Ababa, Ethiopia, the staff of the Ethiopian Triple Helix Association with Mr. Abdurrahman Ame and other colleagues and volunteers.

The Swedish International Development Agency (SIDA), as well as the Brazil Infodev Project, the German Technical Development Agency (GTZ) and MIDROC Ethiopia are thanked for financial support.

The event was hosted by the Ethiopian Ministry of Education and UNECA, the United Nations Economic Commission for Africa, generously made its spacious conference facilities in Addis Ababa freely available as the event venue. We also thank Matthieu Roest at IKED for his coordination and administration of the conference in Addis Ababa on 29th-31st May 2006, and for holding together the process of producing these proceedings. It is our hope that the book will serve as a source of inspiration in Ethiopia as well as for other countries looking for new ways and means to dynamise the relations between universities, industry and government.

Thomas Andersson

1.2 Introduction

Better means for developing and using technology and knowledge have become critical for basically any country in the world. This includes developing countries which can ill afford to try and advance or survive merely by exploiting cheap labour and simple production technologies. Whereas the means and the potential of technology to make a difference in any kind of societal situation keep expanding at high pace, however, so does the need of speeding the upgrading of competencies and skills that are needed for supporting the task. The needs cut deeply through society. In developing countries, there are hordes of children and young people who need education, not merely many hours in school, but teaching and training communicated in ways that can inspire, allow for active learning and for creativity. Grown-ups and even the elderly need to let go of outdated practices and embrace new means and new tools. Experts, officials, bureaucrats, and the like, all need to come to grips with the new opportunities and what they require.

In this situation, it is becoming obvious that government alone cannot lead the way towards progress and needed societal change. Different key stakeholders must be able to assume a very active and productive role, and they need to interact in constructive ways. The concept that captured this notion ahead of others is that of Triple Helix. By identifying and examining ways in which government, private sector and university can act in unison and engage in complex interwoven processes of mutual adaptation and change, and thereby create important synergies and new capacities in society, the need is revealed of a new paradigm for growth in developed countries, as well as for generating development in the developing world.

Embarking on a series of reforms and efforts to strengthen the triple helix can be a difficult and painful task. Each society needs to come to grips with its own specific issues. At the same time, any country can learn from the experience of others. It will not be sufficient to study just any individual case, however. In fact, there is a need of a template of alternative and perhaps complementary stories and collections of experience. For developing countries, it may sometimes be most fruitful to ponder and learn from the experience of other developing countries, which may in some respects display those structures and trajectories of societal transformation that yield the most productive lessons.

A problem is, however, that most academic and other studies of triple helix and related aspects such as industrial structures, clusters and innovation processes, have concerned themselves with the United States or other developed countries. For this reason there is a great need of collecting and systemizing developments in the developing world. This work need to be pursued in such a way as to be meaningful and relevant to the many actors involved in these issues, i.e. not only academic and policy planners.

For this reason, a number of actors got together in the first few years of the new millennium and started to contemplate the potential benefits of organising a conference on the Triple Helix to take place in a major developing country that displays both the need of tangible reforms, and the potential for progress, and with a strong presence of participants from other developing countries. Ethiopia was from early on selected as the country. The conference eventually took place at the United Nations Conference Centre in Addis Ababa on 29th - 31st May 2006.

An important part of the preparations had to do with investigating how university can encompass a third mission of economic development in addition to research and teaching, with a particular view to the situation in developing countries and in Ethiopia. Further, to analyze the concept of the “entrepreneurial university” and its relevance to this institutional set-up, and how to adapt and reorient existing institutions of higher education to take a more active role in society, especially in fostering an innovation culture and practice. Lastly, there was the task of designing strategies to facilitate collaboration and modalities for an effective networking amongst the University, industry and government in connection with the conference itself.

Various actors and resources engaged in the process. Expatriate resource persons included technology transfer practitioners from U.S and India; Entrepreneurial education experts from Sweden and Brazil; Incubator directors from Brazil and U.S.; Academicians with experience in adapting the entrepreneurial university model to Africa from Zambia and Kenya; S&T policy analysts and "Triple helix" researchers from Brazil, Canada, China, Israel, Madagascar, Mexico, South Africa, Tanzania, Turkey the US and Sweden; Policymakers from Brazil and Sweden. Policymakers as well as industrialists and academics in Ethiopia participated enthusiastically in the event.

An important objective was to help set in motion a participatory process. Resource Persons from Latin America, Europe and Asia offered their country experiences, which others were set to compare with, comment on and debate. Models for organizational innovation from abroad were investigated for utilization in Ethiopia. Case studies of the triple helix model adopted in Brazil and the Swedish Innovation Agency were presented. Active participation from within Ethiopia included that drawn from Addis Ababa University and several new regional universities: (i) Arbaminch University, (ii) Bahirdar University, (iii) Debub University, (iv) Jimma University and (v) Mekele University.

We shared the organisational responsibility for preparing and carrying out the conference with the International Organisation for Knowledge Economy and Enterprise Development (IKED), an independent think-tank located in Sweden and specialised in comparative studies of multiple countries in the realms of the cross-disciplinary issues affecting the economic transition of societies at our time. IKED also assumed the task of putting together a substantive review of the relevant economic and institutional context of Ethiopia, and has coordinated the work of putting together these proceedings.

The content of this publication addresses a range of issues. The contributions highlight the varying nature of changes and processes under way in the Triple Helix and wider society. The overview piece of Ethiopia shows the range of challenges confronting this society, and several other contributions add further observations and conclusions on efforts that Ethiopia may need to embark upon to enable more affirmative progress in this area. The book goes much beyond the Ethiopian context, however. Hopefully it provides observations, comparisons and lessons that should be useful to contemplate by various actors engaged in these kinds of issues in various societies around the world.

Henry Etzkowitz   Thomas Andersson

1.3 Executive Summary / Overview

The Triple Helix of Innovation and Cluster Creation

A new role for government has arisen in increasingly knowledge-based societies, transcending procurement of individual technologies and support of the science and technology base. Innovation is considered here as the process of developing an institutional infrastructure that helps create new industries and growth firms. Such "innovation in innovation" guides the specific process of generating new products or processes that traditionally goes under the heading of innovation.

In order to pursue such tasks, government needs to move away from traditional approaches, build new competencies, and operate so as to foster initiatives by other actors. There are great differences between countries when it comes to government's preparedness and ability to do so. However, changes are under way, in many places. The state increasingly introduces measures to promote innovation and accompanying processes of industrial and societal renewal in collaboration with industry and university. We call this higher order of innovation, comprising bottom up, top down and lateral initiatives, from university, industry and government, individually and collectively, "meta-innovation," and inquire into the conditions under which it is produced.

The role of government in innovation in the classic sense is long-standing: to carry out traditional state functions, such as defense and enumeration of the population, as well as new tasks such as cure of diseases and industrial advance. Government has employed various means to induce innovation such as offering prizes for results, for example, a method to calculate longitude to improve navigation of ships and reduce the risk of shipwreck in 18th century Britain.[1] Government has also established laboratories to achieve specific objectives such as improvement in weapons, sanitation and farming practices in 19th century U.S.[2] It has purchased equipment such as the Hollerith card sorter to speed analysis of census data in the early 20th century and, especially since the second half of the 20th century, granted funds on a large scale to support basic research that scientists predict will have both theoretical and practical significance.

Different trajectories of meta-innovation can be identified depending upon the configuration of the triple helix and of governmental levels in relation to each other. The interaction between national and regional levels of government is a strategic research site to examine the emergence of meta- innovation. Conflict, as well as coordination, among the levels of government may be identified as a driving force of meta-innovation. A meta-innovation system has been created in the US, since World War II, and in Brazil since the downfall of the military regime in the 1980's. Welfare state societies, such as Sweden, and post-Socialist societies, such as Hungary, as well as developing countries such as Brazil and Ethiopia, are moving in this direction from various starting points.

The Triple Helix of Innovation

The triple helix of innovation is emerging in widely different societies, with previous traditions of strong and weak levels of state activity. In statist societies, the relaxation of the total state, based upon central planning, to a more modest role of incentivizing innovation, without going all the way to inaction, was also a difficult transition. A triple helix coordinated entirely by the state only

[1] Sobel, Dawa Longitude Penguin.

[2] Rossiter, Margaret 1976. The Emergence of Agricultural Research, New Haven: Yale University Press.

provides a limited source of ideas and initiatives. Under these circumstances government may take initiatives without consulting others; indeed it may subsume the other institutional spheres and direct their activities. Although large projects may be accomplished it is not the most productive form of triple helix relationships since ideas are coming only from one source, the central government.

Of course, top-down models have been highly successful in organizing large military and space projects in both socialist and capitalist regimes and in promoting economic development in authoritarian regimes. The Singapore government organized the transition to high-tech manufacturing and then to knowledge-based economic development. However, too strong human capital focus on formation of employees for manufacturing enterprises left a relatively narrow base to draw upon when it became apparent that transition to a knowledge economy was indicated.

Conceptualizing the role of the state in innovation thus should take into account multiple levels of state activity, from the local to the multi-national. If the role of the state in innovation is presumed to be primarily at the national level, policies may be too broad to deal with local or regional needs. Too great focus on the national level also may result in policies and practices targeted at large national firms rather than start-ups which typically have local origins. Most importantly, encouraging different levels of state activity has the advantage of allowing various sources of program experimentation to arise.

Interaction among university-industry-government, as relatively independent, yet inter-dependent, institutional spheres, is the key to improving the conditions for innovation in a knowledge-based society. The change in the role of the state from public partner in dual relationships, with either industry or university, to one of three participants in triple helix relationships increases government involvement in innovation issues, irrespective of the political system or development level. For the triple helix to operate fully there must also be initiatives rising from the bottom up and from the other institutional spheres. The precise challenge varies between countries. In many parts of the developing world, government has drastically subsumed other players, and bureaucrats at various levels keep interfering with university and private sector activities in ways that divert much energy and resources from anything that resembles productive innovation. Thus, it is very important that governments put strong emphasis on increasing their ability to roll back public action in unproductive modes, and to grow the ability to shift attention to capacity-building and fruitful interface in the triple helix.

Cluster Creation

Civil Society and the Triple Helix

Beyond the question of activation of multiple levels of government is the issue of the societal base to support innovation. Civil society is the foundation stone of the triple helix and the relationship between science policy and democracy. Although a limited triple helix can exist under authoritarian conditions, a full triple helix occurs in a democratic society where initiatives can be freely formulated.

As the state incentivizes university and industry to enhance their technology transfer and firm formation capabilities, it does not necessarily imply that the government increases its control over these spheres. Indeed precisely the opposite course of action may be indicated in societies where government has dominated the industrial and academic spheres. On the other hand, in societies where government has been relatively inactive; it may mean playing a greater role in society. The ideal triple helix configuration is one in which the three spheres interact and take the role of the other, with initiatives arising sideways as well as bottom up and top down.

A flourishing civil society of individuals and groups freely organizing, debating and taking initiatives, encourages diverse sources of innovation. The basis for a triple helix including bottom-up as well as top-down initiatives can be seen most clearly in countries that are just emerging from military dictatorships. The first academic revolution, the incorporation of research as a broad university mission, took place in Brazil in the 1970's, expanding the role of the university in society from a traditional support structure to one directly linked to national priorities. This transformation took place under a military regime where the university had relative autonomy. University discussion groups became a place where some internal opposition was tolerated even as many other academics were removed from their jobs and forced out of the country.

When the military gave up control in the early 1980's, a space opened up for university science and technology researchers to introduce the concept of the incubator from the U.S. At the same time a financial crisis led large scale technology programs to be downsized, making smaller scale initiatives, such as incubators to encourage the creation of start-ups, a necessity. At a later point, the national government built upon these programs and made them national policy. However, it was not until the re-creation of civil society that these local initiatives became possible. In succeeding years, various levels of government as well as industry and civil associations took up the incubator concept and spread it throughout Brazilian society, applying to a variety of problems from raising the level of low tech industry to creating jobs for the poor.[3]

Thus, one path to the Innovation State is from a top-down model of bureaucratic control, with the state devolving its authority to various degrees. The other is from a standpoint of modest participation by central government in which case the pathway is to increased activity. The two different starting points intersect at some mid-point, where government, industry and university assume relatively equal status as interdependent institutional spheres.

Government is either taking a more or less active role in knowledge-based economic development, as the case may be. Direct and indirect innovation polices are formulated in former statist and laissez-faire regimes, utilizing the university as an intermediary between government and industry. In countries that followed a linear model, there has been a shift to an assisted linear model, with intermediate mechanisms introduced to move research into use. An indirect and decentralized innovation policy, across the institutional spheres, may be more effective than traditional direct approaches since it is better able to take regional differences into account and incorporate bottom-up initiatives.

If the regional and local levels are active and with input from universities and industry as well, there is a much broader base to develop creative ideas for innovation as well as better base for implementation, especially at the regional and local level. The resulting dynamic of initiatives from different levels of government and from joint initiatives among the institutional spheres is the hallmark of an innovative society.

Any country in the world can move in this direction. A country such as Ethiopia, with its proud history and many talented experts and citizens, can gain tremendously by moving away from interventionist and destructive bureaucratic procedures, and by putting emphasis on capacity-

[3] Etzkowitz, Henry, Jose Mello and Mariza Almeida.2005. Towards 'meta-innovation' in Brazil: The evolution of the incubator and the emergence of a triple helix Research Policy.

building through participatory processes engaging major stakeholders. The journey is not straightforward though and any society can benefit from studying and drawing lessons from the experience of others. There is a compelling case for embracing this task. The journey must start through the establishment of new partnerships and constructive collaboration and engagement between the key societal players.

Henry Etzkowitz

Academia, Business, Government: A Partnership to Promote Development

H.E. Staffan Tillander, Swedish Ambassador to Ethiopia

Keynote Address delivered at the
Ethiopia Triple Helix Conference on
TRANSFORMING UNIVERSITY-INDUSTRY-GOVERNMENT RELATIONS IN ETHIOPIA
Addis Ababa, 29th May, 2006

His Excellency, President Girma Wolde Giorgis,

Ministers,

Guests,

Academics,

Businessmen:

It is an honour for me to be asked to say a few words at the opening of this Conference.

This country has produced some of the most amazing historical and religious places. It has also produced some of the most amazing athletes.

A few years ago there was a poster all over Addis Ababa, with a picture of Haile Gebre Selassie, one of the greatest individuals and athletes of our time. On the poster it said, "Yishalal". It is possible.

The Great Ethiopian Run, with 25000 participants, shows that it can be done. Yishalal. If you run, or take a walk around Meskel Square early in the morning, you see hundreds of young people, and some middle aged as well, showing the same thing. When they run at full speed up the hill passing ECA and Hilton and the Foreign Ministry, they show that it is possible - Yishalal.

But the message from Haile Gebre Selassie is not confined to sports only. It says that it can be done also in other sectors. Ethiopia Yishalal!

The incredible thing with long distance running, which is a highly individualistic effort, is that it also requires cooperation. Different efforts must pull in the same direction. Team work is necessary. Haile and Kenenisa together winning Olympic Games is a fantastic illustration of this.

And this is true also in politics and economics. It is true if one wants to achieve growth and development. Different actors need to work together, to pull in the same direction, to make the individual efforts possible. To enable the best to win.

Perhaps that is the key message from this Conference. Government, the private sector, academia must work together, in a partnership.

Each one in the team has a crucial role. That is true for sports, and it is true in the area of development.

Government does not create growth. Businesses do. The aims of this Conference - to achieve improved economic and social development – will not be achieved by people like me. Development and growth will only be possible if businesses can grow and prosper. If individuals and investors, workers and business women and men, farmers and entrepreneurs, feel that investing their efforts, time and money is useful and profitable. If so they may produce, sell, buy, trade.

The private sector is the key.

But it is not enough. From where do businesses get their ideas? Their research and development? Their trained people?

Some of this will come out of the family, the village, the businesses. But as businesses grow, prosper and develop, as they interact and compete with other businesses, as they move beyond the local and national market, then the challenges grow, the need for information increases. They need new ideas, they need specialists, researchers.

In Ethiopia, the manufacturing sector is characterized by low productivity and weak competitiveness due to low skills, shortage of capital and lack of modern technology. Yet this sector could be a major source of export led growth if these constraints are removed. To realize this potential, the GOE needs to create an enabling environment for more investment in manufacturing, both foreign and local and improve the skills base for higher labour productivity.

Universities are a breeding ground for ideas, free thinking, development. Some of it may succeed. Some may not. Out of hundreds of ideas and thoughts and theories and studies, only a few will prove to be crucial and useful for further development. But all will contribute to the creation of a vibrant intellectual climate that is so necessary for ideas to flourish.

Universities are not the only institutions that contribute to such an intellectual climate. Also think tanks, independent organizations, the free press, people participating in debates – they all play an important role in creating a climate that breeds innovations and a spirit that it is possible - Yishalal.

The free flow of ideas and information is a key to economic and social development and to democracy.

The task of government is to create the general framework for such a climate. A spirit of openness, respect for freedom of thought and expression, the means through which information can flow, internally but also externally creating a flow of information and ideas between the national and the global market. In today's world the global market creates enormous opportunities. To take advantage of those opportunities, the connection to them, the awareness of them and the accessibility to them must be in place.

Perhaps the most important task of government is to remove obstacles to business growth. To know what those obstacles are, the business community as well as research institutions and others must be encouraged to participate and voice there demands and criticism. Government must listen. It must encourage dialogue.

Networks among different actors are key to the success of such a dialogue. One aspect of this is the networking between government, businesses and universities. A big and important step in the right direction can be taken through this conference.

SECTION 2

PROCEEDINGS

Transforming University-Industry-Government Relations in Ethiopia
Addis Ababa, May 29 - 31, 2006

Special Acknowledgement:

This section of the document, which records the Proceedings of the Conference, was originally prepared largely by the Ethiopian Triple Helix Association under the supervision of Mr. Abdurahman Ame.

Introduction

Recent years have witnessed growing interest among scholars, the private sector and policymakers in the importance of the university - industry - government relationship (UIG) in fostering regional growth. A number of questions have been raised as a result. For example, how to adapt, reorient existing institutions of higher education to take a more active role in society, especially in fostering an innovation culture and practice? How to get the universities to better contribute to the innovation process at the regional level?

An international conference was convened in Addis Ababa at the United Nations Conference Center, from May 29 to 31, 2006, under the theme of "Launching a Program to Transform University - Industry - Government Relations in Ethiopia". Over 150 participants representing academia, business leaders, researchers, policy-makers, NGOs, the donor community, ambassadors, and regional and international organizations from various countries participated.

The Ethiopia Triple Helix Conference was unique because for the first time the concept of "Triple helix" is introduced in Africa. The focus of this policy-oriented conference is on issues and challenges associated with the "triple helix" strategy for promoting innovation and learning societies in developing countries through co-operation and exchange of best practice. The conference is a response to the growing awareness about the need for policy shift from the traditional technology transfer practice, involving little or no learning of innovation consequence, to a policy position that is capable of providing a sustainable basis for innovation and technological progress in African countries.

This report attempts to summarize the key issues that transpired in the discussion and in a number of papers presented at the conference that focused on the opportunities and the challenges of African universities in general and those of Ethiopia in particular as these universities are expected to carry out a third mission of economic development in addition to research and teaching. In addition, the experience of Latin America particularly Mexico and Brazil in creating wealth from knowledge and lessons drawn from the experience is included in the report. The papers presented at the conference are published as an integral part of the proceedings of the conference.

Opening Session

1. In his opening address to the conference, H.E. Girma Wolde Giorgis, President of the Federal Democratic Republic of Ethiopia, stated the importance of the conference as its main objective of transforming university-industry-government relations by identifying common issues through well-designed strategies. According to the President, the Ethiopian Government has set out the goal of reducing extreme poverty by 2015. Universities have a special role in promoting economic growth through enhancing production efficiency and effectiveness. In this regard, the conference has an immense advantage in defining the role of university-industry-government relations by synthesizing the local and international experience. It also helps to establish how Ethiopian universities can encompass a third mission of economic development in addition to research and teaching through well-designed strategies that facilitate collaboration and modalities for an effective networking amongst university, industry and government in the interest of furthering the Ethiopian economy.

2. In his keynote speech to the conference, H.E. Dr. Sintayehu Woldemichael, Minister of Education, said that the capacity-building strategy of the Federal Democratic Republic of Ethiopia (FDRE) underscores the developmental role of universities. The strategy of the

government also recognizes that universities can be used to adapt advanced technologies to solve local problems. The Industrial Development Strategy of the FDRE also recognizes the integration of economic and social development with teaching and research. He also noted that the FDRE was rapidly diversifying and expanding tertiary education and training opportunities. New universities have been founded and old ones have been re-oriented to this end so as to increasingly become sources of regional economic development.

The Minister pointed out that it was a common agenda for the establishment of the new universities that they would strengthen the local economic conditions. All are located in regions that are broadly characterized as outer regions. The main reason behind the foundation was clearly that the new universities should lift the regions by having a direct economic impact in terms of a Keynesian multiplier effect. The attraction of students and academic personnel consuming and paying taxes in the cities was one side of the economics effect.

He also indicated that universities must play a pivotal role in expediting the country's effort to bring about sustainable progress and rapid socioeconomic development through employing research activities and generating knowledge. What is needed is to develop strong research capacity in fields with conjoint practical and theoretical relevance, faculties and administrators interested in using these capabilities to develop local economies and collaborative efforts among university-industry-government to implement these.

He argued that we have to focus on the adoption of new technology since generation of new technology need a vast resource that is quite expensive to developing countries.

He declared that "developing countries shouldn't borrow technology. Africans should also think to create knowledge, in this era of globalization, to be free from dependence knowledge should be generated from the land of Africa".

He noted that for some time it was believed that new knowledge is generated exogenously. He stressed that "it is known that generation of new knowledge is endogenous i.e., it is a deliberate, human, motivated action".

He said that when industry engages in research with the objective of profit maximization as long as we don't protect new knowledge it is not possible for industry to fully benefit from new knowledge. As the market mechanism alone will not enable the generation of new knowledge, he suggested the need to forge strong university, industry and government interaction to enhance generation and diffusion of new knowledge. The government has to protect new knowledge through the special mechanism. When the three actors, UIG, work together new technology can be generated and solve social problem.

The Minister also raised concern over the mismatches between university capability and private sector needs and the lack of support for innovation.

Finally he said the education and training offered in higher education institutions should be expanded with no compromise to its quality and standard. To maintain the quality and standard of higher education, it is mandatory to improve the efficiency of universities through capacity building programs.

3. The third speaker H.E. Mr. Staffan Tillander, Ambassador of Sweden, underlined the significance of the topics addressed and the conference for Ethiopia - a diverse country with a federal system - where universities as well as businesses are being established and are evolving.

According to him, federalism has the potential of creating power centres at different levels of government and in different parts of the country. A well-functioning federal system builds on and encourages pluralism, diversity of views, new ideas and innovation. Indeed, federalism should be designed so as to acknowledge diversity while maintaining unity. In his address, Sweden's Ambassador further noted the need of pull-back by government of red tape and interventionist policies that impede the functioning of the private sector. It is important for a country to provide an environment where a great number of people are willing to make the effort to become entrepreneurs. "Not all of them will be successful, but eventually some will become a household name at the global level", he said.

4. Thomas Anderson, of the International Organization for Knowledge Economy and Enterprise Development, focused on the growth potential of countries in the present situation, marked by globalization and the advance in information and communications technology (ICT). He argued that several enabling conditions need to be in place if the potential of growth is to be fulfilled. The population must also encounter conditions that enable people to be creative and to drive the knowledge-based economic development. Professor Andersson emphasized that all countries are in a learning mode regarding how to accept in full and exploit the existing opportunities. Progress with respect to new technology and knowledge cannot be commanded from the top. The key formula for success must critically include the adoption of instruments that allow each society to advance from within. He mentioned two important factors for growth: the first aspect is the speed at which the new information becomes available and used in the development process. The second emanates from the combination of specialisation and collaboration among individuals and organizations.

With regard to Ethiopia, he noted the critical challenges of raising the quality of education, improving health conditions, providing better infrastructure, increasing the use of technology especially information and communication technology (ICT), reducing barriers to entrepreneurship and improving the investment climate, and addressing the acute weaknesses in the governance system.

Finally, he suggested the direction for reform to overcome these challenges in fostering science and technology and innovation in low-income countries. "Here, the centrepiece of collaboration is between university and societies. In order for universities to operate successfully, funding mechanisms need to encourage specialization and strive for quality improvement. Universities need to be encouraged to deliver quality education, research and build relations with societies. In addition, there must be better conditions for individuals to take on risk to start firms, to invest in training and research and to turn informal into formal companies. In this collaboration process, the government must assume a role of developing infrastructure and protective regulatory frameworks".

5. Professor Augustin Fosu, representative for the United Nation Economic Commission for Africa (UNECA) made opening remarks. The representative's remarks focused on the concern of "the challenges of Employment" and "the challenges of meeting the Millennium Development Goals in Africa". He further mentioned that the meeting of African Ministers of Finance and Economic Development, held in Ouagadougou, Burkina Faso, during 14-15 May 2006 emphasized on creating employment in Africa.

The UNECA representative paid special tribute to the universities and the private sector in employment creation. In the learning process, the individual students pass through school with the expectation of getting the reward, eventually, of being employed. In this respect, the universities should be aware of societies' needs and establish an environment for development.

What the universities deliver has to match with what the society needs. The universities should deliver the quality services that are required for development.

The UNECA representative also expressed his organisation's opinion that the kind of ideas promoted by the Triple Helix Association are of great value, and its certitude that the international expertise provided at this meeting, in particular, will serve to advance the partnerships being sown here between university, private sector and government. He also noted the particular relevance to UNECA of the conference, given the focus of the Commission on issues of employment on the African continent.

Prof. Fosu said that UNECA's research indicates that to improve employment perspectives with a consequent impact on African economies, it is necessary to invest in an integrated capacity building strategy for development. More than providing training and technical assistance, building capacity entails the ability of individuals, organizations and institutions to deliver tasks and mandates.

A capable society is able to build and sustain knowledge systems that enable countries to do the work for themselves, reducing dependency on outside assistance at the level of the individual, organizations, and in the institutional context.

To achieve this, Prof. Fosu said, "a society must develop a tripartite arrangement between government, the private sector and the university. This partnership will ensure that the university not only delivers professionals of a high calibre that are relevant to employment in the private and public sectors, but also will assist - particularly through research and development - a country in building a sound and innovative economic basis".

Finally, the UNECA representative reiterated the need for partnership among universities, the private sector and government in every country to produce the thinking and research that are crucial in building progressive and inclusive societies, where the individual is not only encouraged, but allowed to contribute to make his or her country a better place for him or herself, and for future generations, and UNECA's commitment to assist such kinds of partnership.

6. Prof. Henry Etzkowitz, Chairman of the department of Management of Innovation, Creativity and Enterprise at the University of Newcastle upon Tyne Business School, introduced the Triple Helix concept. Triple Helix acknowledges (1) the enhanced role of university in the innovation system of knowledge-based society; (2) a movement toward collaborative relationship among universities, industry and government and (3) in addition to fulfilling their traditional functions, each institutional sphere also takes the role of others, like universities establishing firms.

Beyond the development of new products, innovation is the creation of new configurations among the institutional spheres. These organizational innovations are as important as technical innovation in regional development. University - Industry - Government interactions are increasingly the basis of economic and social development strategy in both developed and developing societies. The Triple Helix thesis underscores the possibility of developing capacity to generate science-based innovation locally rather than relying on turn-key technology-transfer/ traditional technology-transfer mechanisms. The interaction among the three institutional spheres is the source of sustainable generation of innovation/institutional arrangements especially in developing countries where a university has traditionally had limited R&D capacity and industries are not innovating.

The transition to a "Triple Helix", characterized by inter-dependence among relatively autonomous institutional spheres, takes place from divergent starting points of "statist" and "laisser-faire" regimes (Etzkowitz, 2005). Professor Etzkowitz discussed how the three actors operate under each model, starting with the statist Triple Helix model in which the government dominates other spheres, with top down bureaucratic coordination, and the laisser-faire Triple Helix model where the role of government is limited to addressing market failures. He stressed that too much, or too little, government is not conducive for innovation. For a country like Ethiopia a challenge is that UIG relations are still in transition from a system in which the state was heavily involved in almost all production and distribution activities.

He also introduced the concept of the Entrepreneurial University and the key role it plays in the transition to a Triple Helix model of regional innovation and economic development. In the movement from knowledge and consensus to innovation spaces, the university provides the knowledge space by generating knowledge with economic and social relevance and providing the leadership in initiation of collaboration with government and private sector to generate ideas/strategies and also the innovation space where the new organizational mechanisms or socioeconomic policies are initiated to transform ideas/projects conceived in the consensus space.

7. Dr. Arega Yirdaw, Chief Executive Officer of MIDROC-Ethiopia, addressed the conference on "Innovation and Its Contributions to the Growth of the Private Sector and the Country". He started his presentation with the nature and importance of the private sector in economic development as follows:

- To be part of the global market, the private sector is required to innovate,
- The private sector needs to compete and be successful in the international market,
- The private sector should provide products of high quality for domestic markets,
- Introduce innovation for national economic growth, and pay taxes,
- Leaders in the private sector are required to double their production while enhancing the quality.

He also outlined the role of the private sector, universities and policymakers in fostering innovation. The private sector can engage with government and university in the following areas:

- Curricula development,
- To make industry leaders "available" (e.g. to support university development in some way),
- Sponsorship to enhance innovation,
- Participate in studies conducted by the universities.

He further noted that the private sector - government collaboration should:

- Ensure healthy development of the economy,
- Promote the country to attract foreign investment,
- Engage and facilitate to improve investment proclamation,
- Assist policymakers by providing relevant data (information),

- The universities are the main sources of for the private sector in providing human resources,
- The three development actors need to join hands to contribute to development.

On the other hand, he argues that the Government should:

- Ensure that enabling conditions are in place,
- Provide incentive to encourage innovation,
- Encourage dialogue between private sector and universities.

He also stared that the private sector on its part expects universities:

- To provide quality and marketable skills,
- To initiate and promote innovation,
- To reengineer the courses where the private sector is interested to do so,
- To take the advantage of market economy.

It was reflected that, traditionally, in Ethiopia everybody waits for any initiative to come from government. In the discussion that followed, a major challenge to create a network between the three actors to work together and use the output was noted by Dr. Yirdaw. He argued that government must not be too dominating and that the three helixes have to recognize each other and should work together to achieve long-term growth and development in Ethiopia. On behalf of the private sector, he praised the initiative of the Ethiopian Triple Helix Association for bringing the three actors together and encouraged them to promise to implement the conference's output.

8. The critical importance of maintaining trust in cross-institutional relations calls for focused opening of dialogue and communication from multiple perspectives. Ms. Genet Fresenbet from the private sector suggested the strong need for continuous dialogue among the three actors through the available communication media such as radio, TV, and electronic and print media so as to enhance university-industry-government relations in Ethiopia. The current Triple Helix initiative in Ethiopia should be consolidated to create a similar forum for such a decisive dialogue.

9. Mr. Mulugeta Amaha, the then Director of the Science and Technology Agency of Ethiopia addressed the conference on "A preliminary review of the Science and Technology Policy of Ethiopia in the framework of National System of Innovation". He said that the Ethiopian Government launched the National Science and Technology Policy in 1993 as part of the national endeavour to develop (industrialize/modernize, etc.). The Policy was issued with due consideration to the existing realities and knowledge spectrum of policy during that time. The review of the S&T policy indicates the successes in the areas of Internet in schools, expanding higher education enrolments etc. What makes the Ethiopian Science and Technology Agency unique is that it has been led by the National Science and Technology committee chaired by the Prime Minister. However, having a high profile chair, who has multiple and urgent demands on his time, definitely has practical drawbacks. Moreover insufficient funds and the imposition of taxes on imported technology goods have not augured well for its success.

He further stated enhancing the role of university in socio-economic development is an arduous task for which there is no blueprint. Mr. Amaha stated that the legal basis that defines the relationship between the various elements of the national S&T system constitutes another important gap. The responsibilities, roles, relationships and accountabilities of the elements of the system have not been legally defined and established. The functional relationships between all the elements are, in fact, based on their willingness to collaborate and implement the policy.

Finally, he suggested the importance of reviewing the national Science and Technology policy taking into consideration the functions and interactions of the stakeholders of the national system of innovation and to put in place the necessary legal, organizational, operational and financial instruments to make the national system of innovation more relevant, effective, efficient and sustainable.

10. Presentations from Professor Etzkowitz opened up a wide range of debates among the panellists and the audience.

The role of government in Innovation

11. Mr. Asrat Bulbula, former Science and Technology Commissioner, raised the role of government in the Triple Helix model. Why do we need the government in the model, i.e., is it not possible to directly link industries to universities?

Prof. Etzkowitz in response to the question said that when the resources needed to develop research and infrastructure in US although the role of government in innovation is not visible, there is enormous support for innovation. This takes the form of direct and indirect government support for innovation: universities both private and public get grants from government for bridging research to commercialization. In this case government becomes a public venture capitalist although the term is never used.

"Universities in Ethiopia need resources to train PhD students for research and teaching. In this case the role of the government is important as contributions from the private sector are not sufficient to support these. The government is needed to speed up and strengthen the linkage."

As a follow-up to the question Mr. Bulbula, asked "what if the private university is linked to the private industry where there is no government, leaving aside the existing public university-industry linkage?"

12. Prof Eyob Tadese, from the private sector, raised the issue of vested interest and conflict of interest and how to resolve it. Does conflict of interest hinder collaboration between UIG?

Prof. Etzkowitz, in his response to Prof. Tadese's question, underscores that the question of conflict of interest also leads to the confluence of interest. He started with an analysis of conflict of interest, playing roles in two or more institutional spheres simultaneously "as the university engages in consultancy besides teaching, and research can enhance the role of teaching and research role." Conflict of interest is a sign that some change is taking place in the organisation. It is a signal for change that could be positive or negative. To manage conflict, first look at the conflict carefully and resolve it.

Prof. Etzkowitz discussed the role of government in the TH model by elaborating the difference between the two-actor model and the three-actor model. He said that the disadvantage of the two actors is that when one element gets weak, the second element has to wait until the other actor grows fully. But in the Triple Helix if one element gets weak, the second element takes the role of the other. Here, the good example is when the industry is not active and is not playing its role, the university takes the responsibility and establishes firms. When both industry and university are weak the government can also lead the interaction between the three.

13. Dr. Francisco J. Cantú-Ortiz presented a paper on "Creating a Network of Research Centers in a Developing Country". Dr. Cantú started his presentation with an economic and social background of Mexico. In the economic sphere, the Mexican Economy in terms of Gross Domestic Income per capita has not shown growth in comparison to other countries and poverty is a serious problem in the southern part of Mexico with the skewed nature of wealth distribution in general. In addition, most Mexican industries are producing products with less value (price), and the issue is how to increase value. In other words, the current challenge is how to create value and wealth from knowledge.

In creating a knowledge economy, the university has an immense role. Dr. Cantú has the used Monterrey Tech University experience to show the role of Mexican Universities in wealth creation. In this regard, Monterrey Tech has contributed a lot. Through time Monterrey Tech has introduced the entrepreneur university concept changing from the earlier mission of education to research and development. As a result, Monterrey Tech helps to remove some of the challenges of the Mexican economy through enhancing competitiveness based on the knowledge economy, job creation, strengthening public administration and public policy, and reduction of the education gap.

To address the challenges, Monterrey Tech has established Science and Technology parks/ innovation centres in the context of a "knowledge city". The science park has a research and development centre for knowledge and innovation generation, and viable project ideas are taken to incubators (technology transfer centres) for conversion of technology into wealth (business), again at a third stage some of the project ideas that can be marketable are taken to commercial centres for industrial design and production, and finally, industrial designs and production go to manufacturing companies. He concluded his presentation with remarks on centre for innovation and technology transfer.

Participants of the conference raised a number of questions including (1) which research centres first started establishing a Technology Park? (2) What is the interest of the university in linkage with industry? (3) What can Ethiopia learn from Mexico? (4) For a country like Ethiopia where industries do not have research capacity, what recommendations are there?

In response to these questions, Dr. Cantú said that the reasons for Universities to establish Technology (Science) Parks in Mexico are:

- The university graduates can easily get employment (jobs in the science park),
- Venture capital can easily be attracted to the science park because of the potential for innovations, new skills and knowledge,
- Technology Parks are being designed for the automotive industry and biotechnology,
- Finally, for Ethiopia he suggested the need for looking into the opportunities and to exploit those opportunities.

Dr. Cantú shared experience on how entrepreneurship is a skill that can be taught and that institutions can be more or less entrepreneurial. Prof. Andersson asked what Ethiopia can learn from Mexico. Dr. Cantú-Ortiz responded by saying that first of all by identifying niches in which Ethiopia has in terms of human capacity and competitive advantages is important. Once, the national resources are identified there should be intellectual property rights. So, if you work on the opportunities and protect innovations, there is room to grow.

14. Prof. Andersson commented on the role of government in the Triple Helix model.

On the positive side government is important in creating conditions that can enable effective roles for other actors. Government can also play the role of the facilitator by creating rules and regulations. At the same time, it can play a negative role by making it difficult for other actors to fulfil their respective roles.

It was observed that universities and the private sector presently do not have an adequate mandate to fulfil their roles, e.g., in terms of specializing for unique conditions at regional level. In this regard, he suggested the government should take a step back in some respects, lower taxes so as to facilitate for actors in the informal sector to form real businesses and provide incentives for research and development needed for universities to integrate with industry.

The Swedish experience in linking small companies to university through mentoring:

Prof. Andersson further noted the importance of the Triple Helix concept as a framework for analyzing the potential and problems inherent in the national innovation system. The Triple Helix Model provides important building blocks for understanding what roles can be played by the various key societal actors to enable effective implementation of reforms needed for a successful innovation system.

He elaborated by providing examples of Jönköping University in Sweden, which has pioneered in the development of a mentorship program through which students are connected to enterprises. The scheme was in part facilitated by the relatively large freedom of the institution to mature, following from its standing as one of the few private universities in Sweden, and thus less constrained by the law by which public universities have to abide. It took time to establish collaboration, to build a basis for speaking the same kind of language and to bridge the gap especially between small- and medium-sized companies and the university. He emphasized the need for training and using specially-adapted people in or around the university to communicate with the private sector.

He also made a remark on the need for a high-level support for Innovation (S & T policy) in Ethiopia. What is needed is the shift from top-down planning to more dynamism for experimentation from below. In order to make this tradition he stressed the need for a signal from the top to address the conflict of interest in constructive way. Otherwise a lot of bureaucracy that remains in the system can become an obstacle.

Some countries succeeded by putting this system in practice, in transforming the top-down approach, like Finland when it lost its export revenue from Russia, and became interested in addressing the problem. For other countries he suggested the need to make constructive dialogue at high level and that innovation is central in every policy making today. It needs a change of mentality. The role of government is strong but also the private sector and university have to play their respective roles.

It also reflected that the organizational structure of the national S&T system is of a centralized type; it does not take into consideration the existing Federal Government structure. In this context the need to ensure the participation of all stakeholders in the science and technology policymaking is stressed.

Prof. Andersson noted that Ethiopia has built a federal system of government, and devolved authority and responsibility to local and regional governments. Federalism is based on the basic principal that decision-making should be devolved to levels of governance close to the people affected by the decisions. In this regard, the need to ensure the participation of all stakeholders in the science and technology making is important.

The African Experience

The conference explored the relevance of the triple helix model of innovation in the creation, dissemination and sharing of knowledge in Africa. A special feature of the conference was the presentation of African countries' experiences from Cameroon, Tanzania, South Africa and Zambia with sharing of experiences in triple helix transition. These presentations gave rise to a debate on whether the triple helix model is relevant for developing countries, where universities are not producing enough research; industries don't exist or are not innovating. Several papers (e.g., by Dr. Félix-Marie Affa'a from Cameroon, and Dr. Victor Konde from Zambia and Dr. Tadele Teffera from Ethiopia) presented in diagrammatic representations the suggestion to reinterpret of the concept of Triple Helix to make it more relevant to local realities.

These included the need to expand to include a fourth helix. For instance, Félix-Marie Affa'a proposed the addition of the informal systems, which are distinct from industry in Cameroon. While Dr. Victor Konde suggested the modified Triple Helix model where donors replace industry as this is largely lacking in Africa. Dr. Tadele Teffera from Haromaya University also came up with the multiple actors/stakeholders alternative: researchers, farmers, local government and NGOs.

15. Mr. Dereje Alemu from UNDP and Mr. Abdurahman Ame from ETHA said that an expanded model may affect creative dynamics of the university-industry-government interaction. In responding to the issues, Prof. Etzkowitz appreciated the attempt to modify the analytical model to meet the realities of developing countries. As the Triple Helix illustrates dynamic interaction among different spheres that can enhance their contributions to the economy by interacting in a complementary, mutually-reinforcing manner, adding additional spheres may cause the model to lose its creative dynamics.

The presentation from South Africa was unique as it demonstrated how in South Africa a so called White Paper from 1995 outlines *A National Strategy for the Development and Promotion of Small Business in South Africa* where the Triple Helix concept is indirectly called for.

Dr. Chris Friedrich of the University of the Western Cape, Cape Town, South Africa said the concept of Triple Helix and its way of working have received great attention in the Western World, even if we still have little theoretical understanding. In the developed countries in general – and as in our case here, in South Africa – the concept has received less attention and an espoused rhetoric about Triple Helix does not exist. Even so, a so-called White Paper from 1995 outlines *A National Strategy for the Development and Promotion of Small Business in South Africa* where the Triple Helix concept is indirectly called for.

His presentation dealt with entrepreneurship and growth in the Western Cape region of South Africa through the perspective of Triple Helix. In this area at least two universities have business outreach programs – the University of the Western Cape and the University of Cape Town. His paper examined how academia, business firms and local authorities in the Western Cape region, through cooperation, are working for fostering entrepreneurship and growth. He also identified impediments for working according to the model and discusses its possible outcome in the South African context.

Finally, he suggested elaboration of the Triple Helix model and the need incorporate the dimensions of donors and non-governmental organizations, and above all – a proactive entrepreneur in the model.

16. Dr. Abraham K. Temu from the College of Engineering and Technology CoET), University of Dar es Salaam, presented a paper on the Academia-Industry-Government Relationship: Experience of the College of Engineering and Technology, University of Dar es Salaam Tanzania.

He said in Tanzania, whereas academia-industry relationship looks reasonably strong, the government-industry or government-academia relationship has not been equally strong. Government involvement in the Triple Helix is, however, improving as a result of a series of awareness campaign, spearheaded by CoET, through workshops, conferences, exhibitions, publications and direct interaction with responsible officials. The CoET awareness campaign is now directed to the financial institutions to ensure SMEs are funded in order to be competitive.

He suggested the need for tripartite relations between university, industry and government to enhance the competitiveness of small and medium enterprise in the Innovation Systems and Clusters Programme in Eastern Africa, which CoET has spearheaded since 2003, with a view to fast-tracking socio-economic development in this region.

Among other things, the Triple Helix model illustrates how the interactions among government, university and business are becoming more important in transferring research and technology to users. The emergence of organizational mechanisms linking U-I is one of the most discussed issues. Participants noted that African universities exhibit entrepreneurship traits that, if harnessed, can meet the development aspirations of their people. Universities in Africa are oriented towards interaction with government or the private sector; however, variations abound in terms of comparisons between African countries. Issues raised were how directly should an academic institution involve itself in for-profit activities? If it establishes its own businesses, or supports those founded by its members, does the university risk undermining its traditional independence and commitment to open intellectual exchange?

Moreover, interactions among these institutions have had the effect of generating new structures within each of them, such as the establishment of research centres in universities or spin-off companies. These organizational innovations are as important as technical innovation in regional development. For example, Viktor Konde presents an interesting model of how universities could mobilize their intellectual and social capital to create and support businesses. It is not clear whether the enterprise is university run spin-off. It is becoming increasingly common for African universities to establish consulting firm.

17. One panellist noted that academic institutions have themselves taken the initiative to reorganize their resources in their pursuit to become profit-makers. Besides the traditional approaches of linking research to development through seminars, annual symposia, journals, and short-term trainings, university-industry relations have been a priority for regional universities with a focus on regional development (Dr. Ayana from Arba Minch University and Dr. Teffera and Mr. Zergaw from Haromaya University).

However, in Ethiopia, Dr. Teffera noted, on the basis of case studies from the Eastern Ethiopian region, the challenges of institutionalizing the UIG linkage. Mr. Ambachew Maru and Mr. Tesfaye Mulu identified the challenges of building bridges with the Ethiopian textile and garment industry: (i) The industry is reluctant to involve intellectuals in its day-to-day problems; and (ii) A co-operative effort to enhance the industry as a whole is missing.

Panellists from Ethiopian universities, private sector and policy makers were also active in presenting a wide range of examples of cooperation between academia and industry (including agriculture) to improve the effectiveness of knowledge transfer to the surrounding communities:

18. Mr. Bekele Tsegaye, Manager of Bekas Chemicals PLC, presented a paper on the Potential Benefit of University - Industry Linkage. Bekas Chemicals PLC is one of the companies established in the mid-1990s. The company's establishment and growth history justifies the potential importance of university-industry linkage to bring a difference in this country. Although the initial start up, seed money, was about Birr 1,000, the current registered capital of the company is about Birr 2.5 million. This remarkable record is the result of the transformation of knowledge from the university into capital.

The company's success was attributed to the early 1980's programme for institutionalization of university-industry cooperation. Within the framework of that programme, Mr. Tsegaye got a chance (in 1984) to work as chemist on a project for the utilization of Endod (Phytolacca Dodecandra) as a detergent, or people soap. He joined the program from Reppi Soap Factory to carry out routine tests on detergent parts, under the supervision of one of the department staff, Niguise Retta. (of the Chemistry department of AAU). Coming back to the university after graduation and working in the industry gave him an appreciation for Research & Development.

He was asked whether Ethiopia's higher education system provides opportunities for staff progression and mobility. A strategic and more immediate challenge for Ethiopia will be to enhance the network and create fast mobility between different actors in the innovation system through complementary mechanisms and institutions. This implies working towards a system where academic researchers can become entrepreneurs, where entrepreneurs can work in universities, where there are forums for academic and industrial researchers to meet, and where government institutions can take on a variety of roles in providing the interface between policymakers, private sector and the academia.

The role of universities in regional innovation systems

Higher education in Ethiopia has been under transformation both in size and composition from public and private domains. Until a few years back, Ethiopia had only two public universities. There are now nine such universities. A major campaign is currently underway to establish another 16 universities at a cost of about 2 billion US dollars.

While primary and secondary education has been in the focus of the international policymaking community's attention for decades, the issue raised was the reason behind the attention given to higher education more recent years.

The common agenda for the establishment of the present universities is that they would strengthen the local economic conditions. All new universities are located in regions that are broadly characterized as outer regions. This, combined with considerable local political pressure, was the main reasons behind the foundation. The new universities should lift the regions by having a direct economic impact in terms of a multiplier effect. The issue has catalyzed the transition of what may be described as a “top down” to a “bottom up” innovation system with universities playing an active role in society.

19. Dr. Daniel Kitaw, from the Faculty of Technology, AAU, informed the participants about the current campaign to establish the Technology Faculty–Industry Linkage Unit (TFILU) to strengthen the university efforts to promote relationships with industry since 2000. Currently, there is a Technology Faculty-Industry Linkage Unit led by the committee composed of members from:

- Ministry of Trade and Industry,
- Ethiopian Science and Technology Commission,
- Public Enterprises Monitoring Authority,
- Chamber of commerce,
- Private companies, and
- Addis Ababa University - Technology Faculty.

Dr. Kitaw mentioned different initiatives like the recent development between the manufacturing industry association and Addis Ababa University that have signed a memorandum of understanding. As a way forward, he suggested the coordination of different efforts to link and establish university-industry-government relations in Ethiopia. It was reflected that the participation of the private sector in such a top-down initiative was weak.

20. An attempt has also been made to link university and industry through special schemes associated with the regional universities. Universities are reorganizing their existing resources into new combinations in order to market services and gain income: research and consultancy services for regions, developed conference centres and short courses for industry.

21. It was reported that Haromaya University performs a quasi-governmental role as a regional or local innovation organizer. Dr. Teffera from Haromaya University indicated the concentration of the university’s research activities in the areas of livestock- and crop-improvement, natural resources conservation and post-harvest technology and food sciences, improving farm mechanization, and research in the socioeconomic area. Multiple stakeholders: farmers, input suppliers, processing and marketing enterprises, research and education institutions, credit institutions, extension and information units, the private sector, international development agencies and the government have been involved in regional innovation/development.

The university has established a research extension-farmer linkages advisory council in 2002. The council consists of farmers, researchers, investors, input suppliers, credit institution, extension or development agents, GOs and NGOs. The council serves as the meeting place for the stakeholders to identify, prioritize and plan the functional and structural linkages between research extensions and farmers.

Challenges identified in organizational mechanisms to link university research to users are the lack of commitment by some actors, limited area coverage, and absence of accountability.

Mr. Daniel Zergaw presented experience from Faculty of Sciences at Haromaya University where the university’s established linkage with government to generate and disseminate knowledge in the health sector. The University’s Faculty of Science designed community-based practical education programmes. These are a drought mitigation project and a reproductive health programme. This is an integrated approach - involving students and staff, with government bodies and in-service training in collaboration with partners. Students are evaluated on the contribution made to the programmes. There are 709 final-year students in 15 attachment areas in Eastern Ethiopia.

Mr. Abnet from Adama University presented the university's long-term objective to become a centre of excellence in technical teacher education. To realize its objectives, the University has drawn up its research strategic plans and planned reforms. The reforms include the preparation of teaching material through the active learning methods. He argued that the Tripartite networking among the university, government and industries can be realized if Adama's research reform strategy works out well.

He noted that curriculum reforms are underway so that the University can respond to demand of the technical vocational education training needs. Moreover he noted that management reforms like out sourcing non-academic student's services are implemented.

He also questioned the achievement of the university's objectives because of the high tensions between teaching and research activity of the university as the result of the high teaching load. Critical shortage of facilities and innovative lecturers and stiff competition with the private higher education providers were also mentioned as impediments.

22. Dr. Mulu Bayray from Mekelle University explained the practical attachment programme of Mekelle University. This indicates the university's transition to entrepreneurial university is introduced through the teaching mission in the form of extension of entrepreneurial training throughout the university. Practical Attachment Program is designed as part of the curriculum that all students should fulfil before graduation. The questions to be addressed here include (1) Are there any innovative projects coming from the practical attachment program? (2) How students be evaluated?

23. Dr. Mokonnen Ayana of Arba Minch University, presented the Arba Minch Water Technology Institute's main objective since its inception in 1986 to produce skilled and qualified manpower, which is vital for effective utilization and exploitation of the country water resources for various aspects of development. Research activities include the development of water-related innovation like a simple low-cost drip-irrigation system. The drip-irrigation system is developed from pot (pot is a simple and locally-made and available product) to increase water application. A filter is developed to clear out micro-course to enhance effectiveness of water usage. The drip irrigation system has shown tremendous increase in fresh potato production. Following the innovation, the technology has been adapted and the surrounding communities were given training on its use.

The second innovation of the Arba Minch University presented at the conference was a manually operated fibre-winding machine. The machine has the possibility of winding 32 spindles at a time and offers an enormous increase in productivity compared to the traditional methods of winding.

Finally, Dr. Ayana concluded his presentation with the present experience of water harvesting at household level to enhance food self-sufficiency and to enhance its productivity. He suggested wide implementation of a low-cost drip-irrigation system as it can save and supply water to plants more efficiently and be afforded by poor farmers.

25. Mr. Tewodros Tefera, from Hawassa University, presented a paper on operational Research for Food Security and Sustainable Livelihoods, a Case Study on Participatory Research through the Triple Helix Model.

He started by presenting a series of measures that have been taken by the Government of Ethiopian and non-governmental organization to reorient agricultural research and innovation to support the on-going development endeavours of the country.

As a part of this commitment, Hawassa University, in collaboration with the Regional research institute and Bureau of Agriculture and Rural Development, has designed the Operational Research Programme for Food Security and Sustainable Livelihood. The programme was developed through the Triple Helix model that links university-regional government development-oriented institutions and the farmers (the farming industry). This model has promoted participation through farmers' centred organization, consortium-based management, and development-oriented research approach, which contributes towards comprehensive poverty reduction, food security and sustainable livelihoods of the targeted watershed communities.

Within the framework of Triple Helix, the programme has used Participatory Varietal Selection (PVS) methodology. It was employed in order to ensure the involvement of different actors who have a stake in research and development. Since April 2003, in the Participatory Crop Improvement component five varieties of haricot bean, three varieties of soybean, five varieties of teff, and four varieties of wheat were tested with the participation of 1,158 farmers. Out of the new varieties introduced, farmers selected two varieties of haricot bean, teff, wheat and three varieties of soybean. A seed multiplication work has been completed and a community-based seed production scheme established for mass production. Currently the programme has undertaking a market analysis research to link farmers with exporters, food industry and consumers.

26. Dr. Nele Wasmuth and Dr. Michael Nebelung presented a paper on The Triple Helix Paradigm for Development: Strategies for Cooperation and Exchange of Good Practice, Contribution of the Engineering Capacity Building Programme (ECBP).[4]

Dr. Wasmuth and Dr. Nebelung said the Triple Helix Model focused on innovation through the establishment of new networks within a region, with universities, the private sector and the government as major players to be interwoven in order to contribute to the emergence or renewal of high-tech complexes and the creation and organization of new industrial sectors. Academic-industry-government cooperation is to be shaped in accordance with the demand and the challenges of the global knowledge economy.

With respect to international development cooperation and its overall goal to alleviate poverty, knowledge and its proper management – on the one hand – is the main key, which also has led to a new paradigm of cooperation. On the other hand, technology transfer can only be successful on the basis of respective capacity development. In this context, between the scope of the Triple Helix concept and the major challenge of sustainable development, particularly in the African continent, there still seems to be quite a gap that needs to be bridged.

The "Engineering Capacity Building Program" (ECBP) contribution aims to introduce in particular the German Technical Cooperation Agency (GTZ) knowledge management approach, some best practices of GTZ in the field of "Promotion of technology and innovation" in a

[4] See the supporting slide presentation on the ECBP by GTZ following this section.

developmental context, as well as the ongoing development cooperation of ECBP in Ethiopia, which may be considered as a multi-sectoral approach combining university, the private sector and the Government of Ethiopia, and thus be an example of translating the spirit of Triple Helix into concrete efforts towards sustainable development.

The two speakers described the relationship between knowledge generating institutions and industry as the most important factor for sustainable development. Knowledge, and herewith innovative technologies, is generated - to a large extent - in higher education. Appropriate transfer, including qualified graduates, to the industry together with respective partnerships between higher education and the industry sector increases employment opportunities and thus contributes to economic growth, which is an essential factor for social and political stability. There is a clear impact on the improvement of the living conditions of the poor, which is the utmost goal of development cooperation.

The two speakers also said that the ECBP contribution aims to introduce the particular GTZ knowledge management approach, some best practices of the German Technical Cooperation Agency (GTZ) in the field of "Promotion of technology and innovation" in a developmental context, as well as the ongoing development cooperation "Engineering Capacity Building Program" (ECBP) in Ethiopia, which may be considered as a multisectoral approach combining university, the private sector and the Government of Ethiopia, and thus be an example of translating the spirit of Triple Helix into concrete efforts towards sustainable development.

Finally, they said successful collaboration among higher education, industry and government creates the positive frame conditions that are needed for sustainable development. The process itself involves a permanent generation and application of new knowledge that needs to be protected and further developed.

27. Mr. Getahun Gebru, from the World Bank Ethiopia, presented a paper on the Development Innovation Fund (DIF), a sub-project of the Post-Secondary Education Project (PSEP), aimed at encouraging innovation in Tertiary Education in Ethiopia. He indicated that under the previous International Development Association (IDA) Credits, funds were mainly used for expanding physical facilities to increase access, mainly for primary education in Ethiopia. Over the last 4 to 5 years, according to Getahun, the government of Ethiopia has been investing heavily in infrastructure and access to higher education institution has been expanding substantially. IDA's support under the PSEP with the IDA credit of US$ 35 million was aimed at helping the higher education reforms that are under way to taking root, contributing to the development of better quality of instruction and management.

The DIF contains the bulk of the resources - originally $16 million and now $20 million - designed to stimulate innovation, promote modernization changes, and reward quality-enhancing efforts within the universities. Resources will be distributed on the basis of approved proposals, evaluated against criteria that place emphasis on performance, improvements in strategically-selected areas of teaching, learning and management. Considerable effort has been invested by university faculty to develop and get approved 46 Level 1 and 37 Level 2 proposals in Round One which have a total project disbursement value of US$ 4.3 million, and an additional 121 Level Two proposals in Round Two were submitted. Analysis of 83 DIF project proposals and performance contracts from Round 1 shows that three out of every ten DIF proposals contain inadequate plans for procurement. This indicates that implementation problems can be expected in the future. It seems that little attention is devoted to the relationship of the institutional spheres of university, industry and government in the process of evaluating the projects under DIF.

The response reflects the enthusiasm university faculty members have expressed for the opportunities presented by the DIF. It was observed that Addis Ababa University as one of the oldest universities in the country benefits the least of the fund. This can raise a question whether benefits are related to capacities.

28. Mr. Zelalem Begashaw from the Ethiopian Information and Communication Technology Development Agency (EICTDA) presented the Information and communication technology (ICT) incubator assisted by EICTDA aimed at fostering innovation and advanced use of ICT business ideas (in setting up operations by the private sector). The objectives are to boost entrepreneurship in the ICT sector and to provide start-ups with the necessary infrastructure, professional and business-advisory services and financial support.

It was reflected that business incubators play major roles in the creation and facilitation of small- and medium-sized businesses. Their roles range from providing affordable space to providing core business-support functions, such as business development, financing, marketing, and legal services. In general, several factors that are considered important to determining business incubator success include: public policy to facilitate venture capital creation and provide business infrastructure; private sector partnerships for mentoring and marketing; community involvement; a knowledge base of university and research facilities; and professional networking.

It was also reflected that the benefits of the new technologies are the result of not only an increase in connectivity or broader access to ICT facilities per se but also the facilitation of new types of development solutions and economic opportunities that ICT deployment makes possible. When strategically deployed and integrated into the design of development interventions, ICT can enable development resources to go that much further by facilitating the development of cost-effective and scalable solutions.

There is considerable interest in identifying ways of measuring the socioeconomic impacts of ICT and its potential contributions to the implementation of the Millennium Development Goals. Much of the information available on this subject has not received substantial policy attention, and as a result, popular claims about the impact of the ICTs on development continue to lack strong conceptual and methodological foundations.

Another significant problem in developing countries like Ethiopia is the absence of demand for value-added and more sophisticated technological activity. One of these technological activities is research and development relates to enterprises' collective learning functions - that is, their organizational path is assimilating and implementing innovative technologies. If this important function is left unattended, enterprises remain largely dependent on imported technologies that are expensive and are not suitably adapted for local conditions. If demand for future high-level technological activity is not transmitted to enterprises through appropriate policies, countries run the risk of only importing equipment without the complementary generation of domestic innovations. It was observed that the proposed business incubator's link with university is weak.

29. Dr. Yohannes Woldetensae from the Higher Education Relevance & Quality Agency (HERQA) addressed the conference with "University-Industry linkage for promoting Quality of Higher Education in Ethiopia". In his paper, he underlined, among other things, the rationale for university-industry partnership:

- Enhances the relevance of university research to national development needs,
- Promotes applied research for investigating national and regional industrial problems,

- Enhances innovative capacity of the nation improves the relevance of curricula,
- Facilitates industrial placement/training,
- Increases opportunities of employability,
- Promotes the quality and relevance of HE.

Finally, he put forward the following recommendations:

- Create networks and initiate discussion among stakeholders,
- Review current practices,
- Identify opportunities and activities for collaboration,
- Commit financial resources,
- Prepare joint proposals and develop a national policy for University-Industry linkage.

30. Reflection from Mrs. Frehiwot Worku, Executive officer of Ethiopian Airlines, the leading African airline, which celebrated its sixty years of existence in business in June 2006 shows that the company uses, as much as possible, in-house expertise. The company used to have foreigners doing training but the decision was taken to do training of pilots, technicians and managers within the company.

The airline used to recruit high school students for in-house training based on their high school performance. As the quality of education had declined in high schools, the airline started recruiting diploma and degree-level students though many of them didn't yet fulfil the required standard. Besides, the airline could not find the right institution to provide relevant courses for the staff.

The speaker found the Triple Helix concept useful for her industry. The airline industry is unique but it welcomed the government initiatives to develop the concept and associated curriculum and provision of training.

The company could take a bigger role not only within Ethiopia but also in a number of African countries by training more pilots and technicians than needed – but this would require a subsidy from government as it is expensive to run such courses.

It was reflected that in the discussion that the basic issue is either that the quality of education has declined or that attitudes towards quality have changed. If that is the case, why has it changed? Moreover, the measure of quality of education is the key issue. He also highlighted that there are differences between urban and rural areas.

A comment made by a participant was that Ethiopian Airlines have not delivered this broader role of applying skills to the nation – training has been given by ex-pats, and external experts have been brought in.

The speaker from Ethiopian Airlines, who underlined the competition from the Far East as a major challenge, supported this.

31. Mr. Ishac Diwan, World Bank Country Director for Ethiopia, noted that the World Bank will internalize the triple helix model and provide support but he questioned the root causes of difficulties – why has it not been done before? Do laws discourage academics being involved in such delivery and being entrepreneurial? Is there a brain drain? Does IP legislation inhibit such

activities? Are the causes historical? Are there more structural issues to be dealt with? He pointed out the huge brain drain of doctors and pilots as a major problem for Ethiopia as the government has failed to pay competitive salaries.

32. Dr. Kasirim Nwuke, Senior Economic Affairs Officer at UNECA, argued that the private provision of higher education in Ethiopia has confronted the twin challenges of quality assurance and improved access. The private higher education sector in Ethiopia is growing at an impressive rate. The sector, although young, is vibrant and making a demonstrable contribution to the expansion of access and provision of industry-relevant skills. The sector provides an offering of programmes (social sciences and humanities, business studies) that do not require substantial investment outlays. To the extent that there is very limited research activity in these institutions, their contribution to the production of new knowledge is at best modest.

Dr. Nwuke also agued that the increase in the number of private providers could result in the fall in the average quality of higher education graduates. He also argued that if participation in higher education is a function of household income, then expansion of the sector through private provision is unlikely to result in improved access for the poor.

33. Mr. Redwan Hussain, head of the Education Bureau of Southern Ethiopia Nation Nationalities and Peoples Region, argued, in historical context, that Ethiopia is a country of diversified nations, nationalities and peoples with varieties of language, cultural and historical heritage. As a result, the diversity goes to economic variations manifested not only in individual life but also in a societal form. But the founders of our higher education system were those regimes that denied even the existence of nationalities; hence, education was not meant for all citizens.

Policy recommendations were made in order to overcome the challenges of the trade-off between low-cost provision and quality assurance and the challenge of improving real access to the poor. In this context, the Ethiopian government will need to reconsider the manner in which higher education is currently funded. Since private providers serve a useful social purpose, government may need to consider new criteria for allocating funds among higher education institutions and across programmes. A new funding mechanism should be used to introduce differentiation in the higher education sector, enabling institutions to exploit their comparative advantage. Some of the institutions should be encouraged, through the funding system, to expand access while others can concentrate on research and competing with the best in the world.

One panellist appreciated the sector for achieving academic excellence and hence recommended the need for consolidation.

34. Prof. Eshetu Wencheko from the private Alpha University identified a number of factors that inhibit the growth of private higher education in Ethiopia. The major ones are:

- Newness of the sector to the country,
- Absence of a sense of partnership between government and private stakeholders,
- Lack of capacity in human resource and finance,
- Difficulty to come up with a common nationwide strategic planning in higher education population growth, infrastructure development, trained manpower requirements, etc.

The key incentives to stimulate growth are:

- Capacity building in the areas of deficiencies,
- Financial support and loans,
- Sharing of resources,
- Tax exemption for certain imports of educational support materials and equipment,
- Efficient response from service provider offices,
- Establish a standard quality assurance and accreditation centre.

As the private higher education institutions in Ethiopia are self-financing, the government needs to reconsider the current funding conditions in higher education.

It was observed that the prospects of the private higher education sector in Ethiopia are bright. If the economy maintains the average annual growth rate of 5%, it will be safe to assert that the demand for private higher education is likely to expand. The country's demographic profile, dominated by young people, is going to be a very important factor too especially as it is unlikely that government expenditure will continue to grow at the current rate. This potential can easily be exploited if a conducive hand-in-hand working environment among industry, enterprises, NGOs and government could be created. In order to get a good result from such activities, discussion forums must be organized so that interested parties could come together and work on specifics where they can carry out some collaborative work. He also argued for the government/private partnership to work together to design a credible accreditation mechanism that will assure quality.

The Third Education Sector Development Programme (ESDP III) underscores that private delivery of higher education will be encouraged through facilitation of quick access to incentives like provision of land, tax exemption, etc. Annual intake capacity of private institutions is anticipated to reach between 45 and 50 thousand by the end of the five-year planning period: 2005/6 to 2010/11. In the accomplishment of all the plans and programmes laid in ESDP III, it is essential that all the available resources within reach are genuinely mobilized.

35. Dr. Helen Lawton Smith made a presentation to the conference on 'the New Economy-Innovation and Regional Development'. Her presentation focused on the experience of the Oxfordshire Economic Observatory Project. The project has the mission to undertake world class research, providing data and analysis to major stakeholders in Oxfordshire region and to broaden communities - on regional, national and international scales.

The Oxfordshire Economic Observatory Project was established in January 2001 following the political agenda of the Labour Government that prioritized universities' role in economic development post 1997, which is based on the White Paper, "Our Competitive Future, Building the Knowledge Driven Economy" in 1998, and clusters (White Paper on Business Cluster published in 2001) among others. The Oxfordshire Economic Observatory Project has produced a number of outputs that have direct relation to university-industry link.

36. The strong Latin American participation in the conference provided opportunities for sharing experiences with Brazil (Marli Elizabeth Ritter dos Santos and José Luis Solleiro Rebolledo on "Management of Technology Transfer Offices: Lessons for Brazilian Universities", and José Manoel Carvalho de Mello on "Integrating entrepreneurial initiatives in Brazilian universities experiences". Their shared experiences on how the emergence of the entrepreneurial university

has been assisted by university technology-transfer offices, entrepreneurship centres, technology parks and incubator facilities.

Prof. José Manoel Carvalho de Mello, Visiting Professor, Universidade Federal Fluminense Rio de Janeiro, Brazil, presented a paper on "Integrating Entrepreneurial Initiatives in Brazilian Universities". Universities' contributions to development are being thought to go further than generate knowledge and training highly qualified professionals, performing a third stream of activities in a proactive fashion, for economic and societal development.

He analyzes the Brazilian universities' third mission evolution as the result of a socio-historical process, showing the knowledge transfer mechanisms created integrating the diffusion, production and relationships aspects of it. He also said universities' strategies concerning their third role are taking into account a proper balance between national government interests, on one side, and state and regional governments on the other.

37. Mrs. Marli Elizabeth Ritter dos Santos presented a paper on "Management of Technology Transfer Offices: Lessons for Brazilian Universities". She said the development of an innovative system based on the interaction of academy with industry has promoted different ways to optimize the link between science, technology and economic development. In this context, the association between universities, industries and government constitutes one of the best ways to establish links between technology and economic development.

From the theoretical point of view, the linkage of these three agents - university, industry and government - has been the object of different analyses, ranging from the macro perspective to the establishment of conceptual models of technology transfer from the university to industry. As a starting point for enhancing their participation in these institutional arrangements, specific mechanisms have been devised by universities, such as Technology Transfer Offices (TTOs), created with the objective to stimulate and to facilitate their interrelation with the other two agents of the innovation systems: industries and government.

In Brazil, although the creation of this mechanism represents the institutional recognition of the importance of incorporating technology transfer as a formal function, the introduction of new routines that are "imported" from private sector practices in the academic environment has not been fully accepted due to different perceptions from the university community about the university's mission as well as to a lack of capabilities to deal with business activities that are new for universities' managers. Those institutions where such offices have been adopted assign them the duty of administrating all the services related to the interaction activities, including management of intellectual property and licensing.

Within this context, her paper analyzed the importance of the role performed by Brazilian university TTOs, from the point of view of their organization, policy and performance. The diagnosis carried out has the purpose of determining: a) the main functions of the offices, (b) the position they must have within the university structure and (c) the pattern of internal relations and with the market.

38. Prof. Mariza Almeida addressed the conference on the "Incubator as Organizational Training Method". The cooperative incubator of Brazil was initiated by the Brazilian Universities to create job for marginalized social sectors, increasing their income, improve their living condition and provide educational opportunities. The consolidation of this process through collaboration of the Triple Helix actors has lead to the transformation of the experiment into public policy.

The first Technological incubator of popular cooperatives was established at the university in 1995. This was a time when a number of civil entities organized to combat poverty. This movement called itself "Citizens in Action Against Hunger and Misery and in Favor of Life". It was only towards the end of 1999, with the internet phenomenon already at its peak that private internet incubators started to appear in Brazil. These incubators are concentrated in the area of information technology, particularly in business involving the internet.

39. Papers from Latin America provided the venue for the analyses of significant innovations in organizational mechanisms that may be applicable to Ethiopia. Of particular interest is the paper by Mariza Almeida on "The Incubator as Organizational Training Method". Prof. Almeida presented a model of the cooperative incubator created in Brazil in 1995, the aim of which was the creation of cooperatives, not firms, in the classical sense. The Brazilian universities have always been concerned about the country's social inequality. The consolidation of this process through collaboration amongst industry, government, universities and civil society - the Triple Helix, has transformed this experiment into public policy.

40. Participants discussed the Brazilian experience and drew parallels between the Brazilian and recent experiences in Ethiopia. Mr. Abdurahman Ame, Managing Director of the Ethiopian Triple Helix Association, noted that the industrial development strategy of the country paid significant attention to this sub-sector particularly with respect to its role in absorbing unemployed urbanites and in serving as a springboard for the development of medium and large-scale enterprises.

New entrepreneurial firms and micro- and small enterprises (MSEs) are gradually recognized as generators of innovation and economic wealth. In order to address internal lack of sufficient skills and competencies among Ethiopian start-ups[5], different institutions are involved in skills development in new training programmes targeting young professional entrepreneurs. Today, the study of - and policy focus on - entrepreneurship is rapidly gaining importance and initiatives supporting the development of entrepreneurial activity have become a priority issue. Entrepreneurial courses were given at the universities and technical and vocational education and training at higher institutions level.

In order to overcome the difficulties SMEs face in securing funding to support their initiatives, the government of Ethiopia provided some money for start-up firms. One of these strategies, which have become increasingly popular in Ethiopia since the early 1990s, involves micro-finance schemes, which provide financial service to the working poor. In line with this, the Ethiopian government has issued a proclamation to establish and run Micro-Finance Institutions (MFIs) in Ethiopia and currently a number of MFIs are operating legally. These micro-finance schemes mainly focused on the rural poor; however, since the last election, urban unemployed youth is getting credit from MFIs.

In the era that has arrived, universities and research institutions (including Technical and Vocational Education and Training Institutes - TVETs) are deeply integrated into the productive sector as well as in society at large. Universities are starting to be viewed as a valuable resource for business and industry. Universities can undertake entrepreneurial activities with the objective of improving regional or national economic and social performance to their own advantage. For instance, many analysts claim the current competitive environment places demands on firms to

[5] Start-up firms are firms whose products or services develop out of technology-based ideas or scientific/technical know-how generated in a university/TVET setting by a member of faculty, staff or student who founded (or co-founded with others) the firm. The individual or individuals may either leave the university to start a company or start the company while still inside the university.

draw on knowledge sources outside of the firm (e.g., Gibbons et al., 1994). Needless to say, the enhancement of the competitiveness of domestic firms, and thereby also the acceleration of industrial development in the country, could only be guaranteed via the reinforcement of the university-industry link. Ethiopian universities mainly due to rigidity are not ready to deal with micro- and small enterprises. The government has taken the initiative in triggering a process of strong interaction between universities/TVETs and the MSEs by establishing at the federal and regional levels a small and medium enterprise development agency. Their roles range from providing affordable space to providing the necessary technical and managerial skills, financing, marketing, and legal services to cooperative firms established by unemployed youth.

In recent years, there has been growth in the number of firms that have been spun off from universities/TVETs sometimes facilitated by action at the federal and regional governments and NGOs, which proves an interesting focus for analysis as the opening of the political space, the freedom of individual and groups to freely organize and take initiatives increases. Unemployed youths are organized as cooperatives/firms and engaged in traditional industries: construction, clothing, furniture and metal works. The point is whether the traditional industries within construction, clothing and furniture manufacturing and metalworking find new ways to overcome the pressure of foreign competition.

It was reflected that these enterprises need to be promoted to grow and become competitive in the formal market in order to contribute to industrial development in the country. Yet investment alone is likely to be insufficient to improve the technological capability and competitiveness of firms. They need to have the necessary skills and technical know-how to optimally choose the relevant technology, put it into effective use, adapt it to local conditions when necessary and eventually improve the technology itself.

41. H. E. Dr. Sintayehu Woldemichael, Minister of Education, noted that efforts are being exerted by regional governments to link the TVETs with the micro- and small businesses in the urban centres. In Addis Ababa, for instance, business clusters have been established to cater for graduates of TVETs. Similar exercises are being widely undertaken in the major urban centres all over the country. The cluster approach provides a linchpin to join policies that were in the past separated, especially industrial technology, foreign trade and investment initiatives. Delivering assistance to SMEs through clusters also economizes government resources. A considerable part of the technological problems faced by SMEs may be solved by the use of well-known technologies and organizational procedures (Etzkowitz et al., 2004). A cluster provides three favourable conditions for the diffusion of technologies: similarity of technical problems, geographical proximity and cultural homogeneity. Such conditions enhance the cost-effectiveness of policy in terms of design, implementation, monitoring and assessment (Etzkowitz et al., 2004).

Experience in Brazil, however, reminded us of the urgency to sustain productivity gains, job creation and accelerate growth. Hence, there is an urgent need to search for the organizational innovation that is transferable to Ethiopian situation and a detailed study on the nature of firm linkages with universities/ TVETs.

In his keynote speech to the conference the Minister for Education underlined the need to undertake future research in the following areas:

- How to scale up to the wider community?
- How to generate ecologically specific technology?
- How to promote university-industry linkages?

- Sustainability of innovation. Are these innovations/interaction driven by the underlying economic forces or subjected to government interventions?
- What constitutes appropriate levels of government intervention?

42. Mrs. Devrim Göktepe presented a paper on assessment of "the University Industry Relations in Israel: The Experience of the Magnet Program and Implications for Ethiopia". She said social and economic networks determine the economic success of nations and thus play a prominent role in explaining the wide-range of economic growth and performance in especially knowledge-based economy. Reasonably networking between the users and producers of knowledge thus the achievement of the synergy among the networking participants has been argued as an efficient way for the better utilization of the benefits of the knowledge-based economy. Correspondingly, innovation networks and national innovation systems have been acclaimed as accurate models for science, technology and innovation systems of the twenty-first century.

She said the Israeli Magnet Program for pre-competitive generic technology production within the consortia of university, industry and government (UIG). The analysis of the Magnet Program reveals the importance of the interaction of domestic and international factors and typical organizational setting of Magnet for the formation of innovation networks successful in Israel.

Consequently, a network-based innovation system, which provides the communication linkages and basis among the actors of innovation, leads to the achievement of the synergy among these actors of innovation. Such a production system is believed to bring about much more economic and industrial development to the Israeli nation than the sum of these participants individually.

43. Prof. Chunyan Zhou, of the National Research Center for Science and Technology for Development, Beijing, China, The entrepreneurial university and the Future of higher education in China. She focused on the issues about the entrepreneurial university, such as the possible differences between developed countries like the US and developing countries such as China. What is the definition of an entrepreneurial university? What characteristics does it have? Why has it emerged and developed in the US since the early and mid-twentieth century? Can the entrepreneurial model in US be adapted to developing countries?

In order to answer these questions she discussed the recent situation and future of the Chinese university system. She also discussed university-run enterprises, and why Chinese university-run enterprises are hierarchical or the "baby" of the university mother rather than its "spin-offs". Moreover, there was an analysis of the relations among the technological academy, teaching university, research university and entrepreneurial university.

Drawing upon the physical concept of "field" she proposed a "field theory" of Triple Helix, i.e. the model of Triple Helix and field interaction in innovation systems. She found out each helix can be seen as having its own internal core and external field space. In this field theory of Triple Helix, field intensity is a key concept which explains the degree of interaction of each helix with the others. She suggested that field theory of Triple Helix can be used to analyze the development of an entrepreneurial university during the early stages of transition from a statist regime.

The interacting force mainly depends on three factors: guidelines arising from government policy, possible spillover of university knowledge innovation and absorptive capacity of industry.

Conclusions

Recognizing that higher education as a critical aspect of the development process especially with the growing policy awareness the role of science and technology can play in economic renewal, the government of Ethiopia is investing in higher education as a strategic input into the development process. Higher education in Ethiopia has been under transformation both in size and composition from public and private domains. Until a few years back, Ethiopia had only two public universities. There are now nine such universities. A major campaign is currently underway to establish another 16 universities at a cost of about 2 billion US dollars.

The capacity building strategy of the Federal Democratic Republic of Ethiopia (FDRE) underscores the developmental role of universities. The national strategy recognizes the important role universities can have in fostering science and technology, in adapting advanced technologies to solve local problems, and in supporting economic development more broadly. The Industrial Development Strategy of the FDRE also recognizes the integration of economic and social development with teaching and research.

Bringing together University, Industry and Government to discuss the traditional approaches to university industry and government, aiming at re-dynamising the role of university service in order to better equip the universities to face the changing socio-economic and political conditions in Ethiopia is important for two reasons. First, knowledge is a crucial tool for overcoming underdevelopment. Relying on rich endowments of natural resources and cheap labour, without any contribution of local “intellectual added value”, has been - and continues to be - a dead end for development.

In a traditional view (Neoclassical economy theory), the role of knowledge and of institutions involved in the creation of knowledge was seen as exogenous although not unimportant to the production system. The development and diffusion of knowledge was viewed in linear terms – the science push model – in the sense that knowledge was created outside the productive system, either in universities or the laboratory of large firms and then “pushed” out to industry for applied development and adoption.

The emergence of the concept of “triple helix” of university-industry-government relations approach changes this conceptualization of the generation, diffusion and use of technology. The creation, diffusion and adoption of knowledge were envisioned as dynamic complexes of interaction among industry, government and university. The locus of action in knowledge creation, diffusion and adoption are re-focused from an exogenous position (to the firm) toward a clear endogenous location within firms, networks of firms and networks of firms, universities and government.

The triple helix model of university, industry, government relations is a new approach conceptualizing the role of university in socio-economic development. Universities and technical colleges are not only training students and conducting research, but are also making efforts to put knowledge to use. Nowadays it is increasingly recognized that important roles as enablers, even leaders, of regional and social development, which has been incorporated under the notion of a third role for the universities, besides the teaching and research ones.

Triple Helix acknowledges the enhanced role of university in the innovation system of knowledge-based society. The Entrepreneurial University plays a key role in the transition to a Triple Helix model of regional innovation and economic development. In the movement from knowledge and consensus to innovation spaces, the university provides the knowledge space by generating knowledge with economic and social relevance and providing the leadership in initiation of collaboration with government and private sector to generate ideas/strategies and also the innovation space where the new organizational mechanisms or socioeconomic policies are initiated to transform ideas/projects conceived in the consensus space.

Triple Helix acknowledges in addition to fulfilling their traditional functions, each institutional sphere also takes the role of others, like universities establishing firms. The new university elides the traditional boundaries between academia and industry. Strategic R&D alliances among companies and governments taking the role of venture capitalists are parallel developments. Interaction among the three institutional spheres is the source of sustainable generation of innovation/institutional arrangements, especially in developing countries where a university has traditionally had limited R&D capacity and industries are not innovating.

The Triple Helix thesis underscores the possibility of developing capacity to generate science-based innovation locally rather than relying on turnkey technology-transfer/ traditional technology-transfer mechanisms. University-Industry-Government interactions are increasingly the basis of economic and social development strategy in both developed and developing societies.

The conference explored the relevance of the triple helix model in Africa. A special feature of the conference was the presentation of African countries' experiences from Cameroon, Tanzania, South Africa and Zambia with sharing of experience in triple helix transition. These presentations gave rise to a debate on whether the triple helix model is relevant for developing countries, where universities are not producing enough research; industries don't exist or are not innovating. These included the need to expand to include a fourth helix. The proposed candidates are the informal economy, donors and NGOs. A heated debate was made on whether the expanded model may affect creative dynamics of the university-industry-government interaction.

Participants appreciated the attempt to modify the analytical model to meet the realities of developing countries. As the Triple Helix illustrates dynamic interaction among different spheres that can enhance their contributions to the economy by interacting in a complementary, mutually-reinforcing manner, some participants felt that adding additional spheres may cause the model to lose its creative dynamics.

It was reflected that no ready-made model exists to guide these changes; they will require both creativity and the willingness to engage in thoughtful dialogue, both within and outside universities. It was stressed that the sources of innovation in a triple helix configuration are no longer synchronized a priori. They do not fit together in a pre-given order, but they generate puzzles for participants, analysts, and policy-makers to solve. Creative reinterpretation of the concept of Triple Helix is needed to make it more relevant to local realities.

One important issue brought out by the conference concerned a better understanding of the relationship of the institutional spheres of UIG in the development. It was reflected in the conference for a need to hold a similar forum but specifically designed to for each regional university.

Participants found the concept of the triple helix of university-industry-government relations has proved useful in conceptualizing the role of universities in economy. Participants felt that in analyzing the Ethiopian universities third mission role, the importance of the triple helix concept as a framework for realizing the potential and resolving the problems inherent in the national innovation system. It is expected that it will help to designed strategies that facilitate collaboration and modalities for an effective networking amongst university, industry and government in the interest of furthering the Ethiopian economy.

Building Ethiopia – a presentation of the GTZ (German Technical Cooperation) – Engineering Capacity Building Program

ecbp engineering capacity building program

Building Ethiopia

Bridging Universities and Industry in Ethiopia

Presentation to the Conference on launching a Program to Transforming University-Industry-Government Relations in Ethiopia

United Nations Conference Centre – Addis Ababa, May 29 – 31, 2006

Nele Wasmuth and Michael Nebelung, GTZ - ECBP

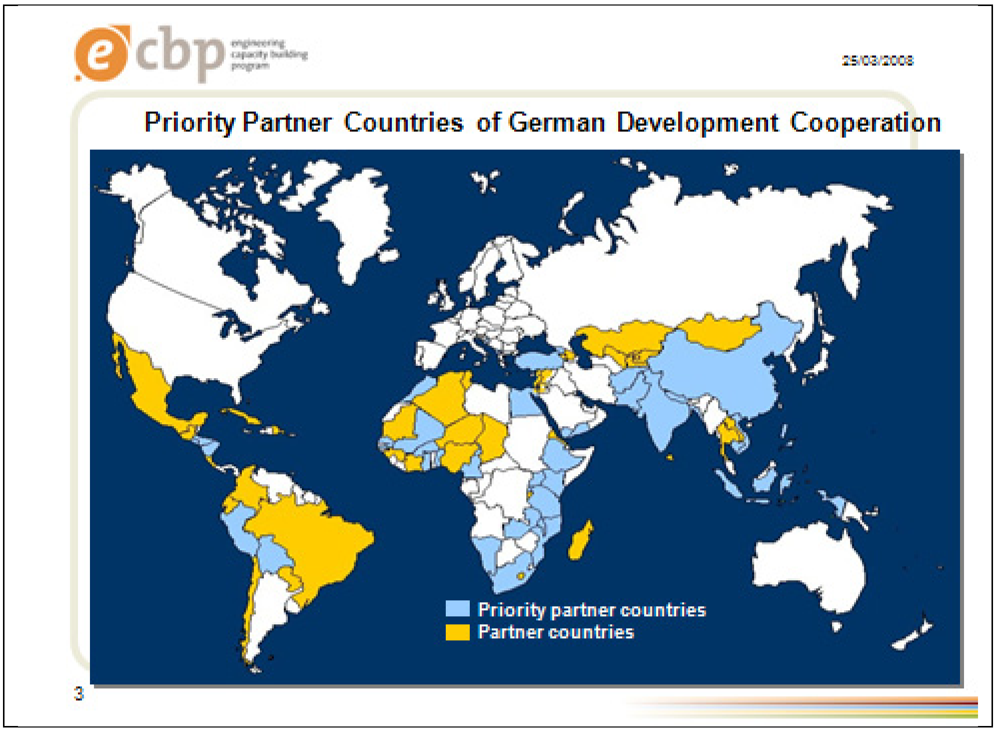
ecbp engineering capacity building program

25/03/2008

The mission of GTZ (German Technical Cooperation)

- GTZ is a government-owned corporation with international operations
- GTZ implements commissions for the German federal government and other national and international public and private-sector clients
- GTZ furthers political, economic, ecologic and social development worldwide, and thus improves people's living conditions.
- GTZ provides services that support complex development and reform processes, like ECBP in Ethiopia.

2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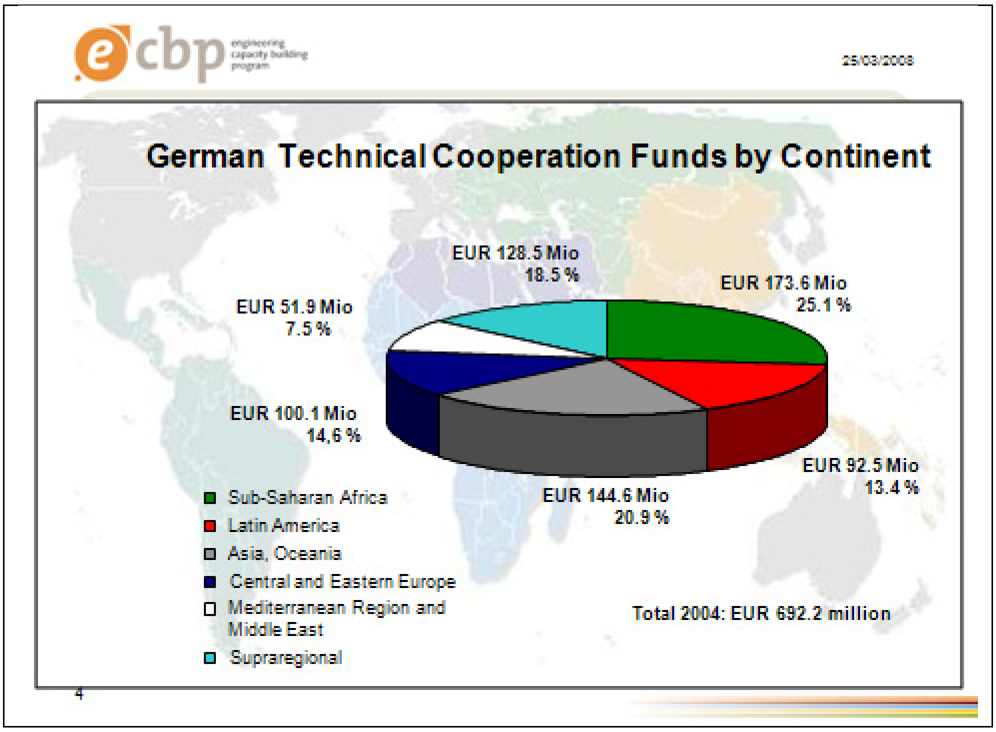
Priority Partner Countries of German Development Cooperation
Priority partner countries
Partner countries
3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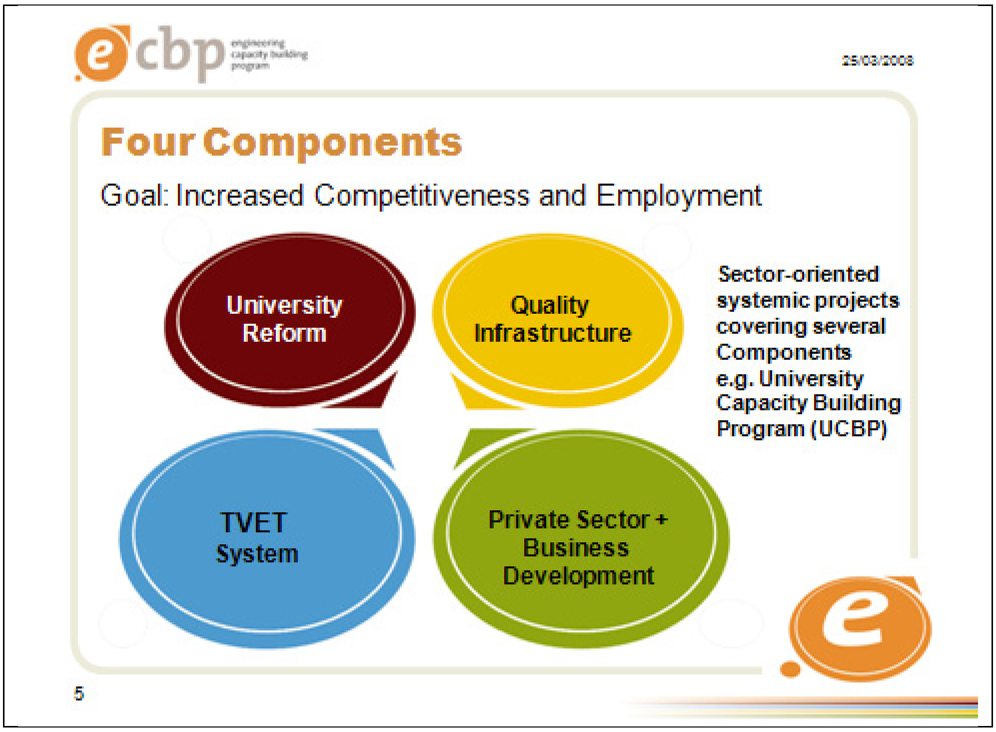
25/03/2008
German Technical Cooperation Funds by Continent
EUR 128.5 Mio
18.5 %
EUR 173.6 Mio
25.1 %
EUR 51.9 Mio
7.5 %
EUR 100.1 Mio
14,6 %
EUR 92.5 Mio
13.4 %
EUR 144.6 Mio
20.9 %
Sub-Saharan Africa
Latin America
Asia, Oceania
Central and Eastern Europe
Mediterranean Region and Middle East
Supraregional
Total 2004: EUR 692.2 million
4



ecbp engineering capacity building program

25/03/2008

What is ECBP?

- ECBP is an Ethiopian Program to improve competitiveness and promote employment
- ECBP accelerates the Ethiopian industrialization process
- ECBP orientates on international benchmarks and standards
- ECBP creates perspectives for the younger generation: 1,5 mio young people are searching every year for skills training or higher education, only 5% succeding further formal education
- „This program is a matter of national survival“ → crash-program

6

ecbp engineering capacity building program

25/03/2008

Cooperating

- ECBP is implemented and guided through the Ministry of Capacity Building with the Ministries of Education, Trade and Industry and the private sector
- ECBP is financially supported by the German Federal Ministry for Economic Cooperation and Development (BMZ), bringing together German Development Cooperation partners (e.g. KfW, DED, CIM, SES, InWent, DAAD, SEQUA, PTB, IIZ/DVV, DGQ, TÜV and others)
- The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH is taking the overall lead for their contributions to the ECBP
- Integral to ECBP is the University Capacity Building Program (UCBP): building and renovationg 15 universities nationwide, providing capacity building for the contractors and labor forces

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ecbp engineering capacity building program

25/03/2008

Principles of Our Cooperation

- ECBP is an Ethiopian Program
- Sustainability through Ownership
- Impact-orientation
- Demand-orientation
- Participation on all levels
- Private and public sectors go hand-in-hand
- Capacity building on three levels:
    1. Systems
    2. Institutions
    3. Individuals
- **Therefore:** Capacity Building is much more than providing training
- Regional orientation: Impact has to show in the regions
- ECBP stands on regional feet

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ecbp engineering capacity building program

25/03/2008

Long-Term Development Goal

- Accelerate industrial development-Improvement of Competitiveness
- **Framework:** Ethiopean Industrial Development Strategy (agriculture-led growth; export-led industrialization; strengthening labour-intensive industries)
- **NEW:** A Plan for Accelerated and Sustained Development to end Poverty (PASDEP)

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Examples for Horizontal Linkages

University – Industry linkage

- Application oriented research activities solving problems of local industries
- Project oriented studies-link with company re-engineering and business development services

TVET - Industry linkage

- Demand-oriented TVET and private sector associations
- Companies for internship

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Examples for Horizontal Linkages

TVET + Private Sector - Quality linkage

- Integration with TVET with Total Quality Management Systems Implementation
- Stimulate market for business quality and standards consultants

Private Sector – University + TVET linkage

- Involvement of universities/research institutes in value chain development
- Participation of private sector institutions, universities, TVET and others in learning platforms/working groups/forums

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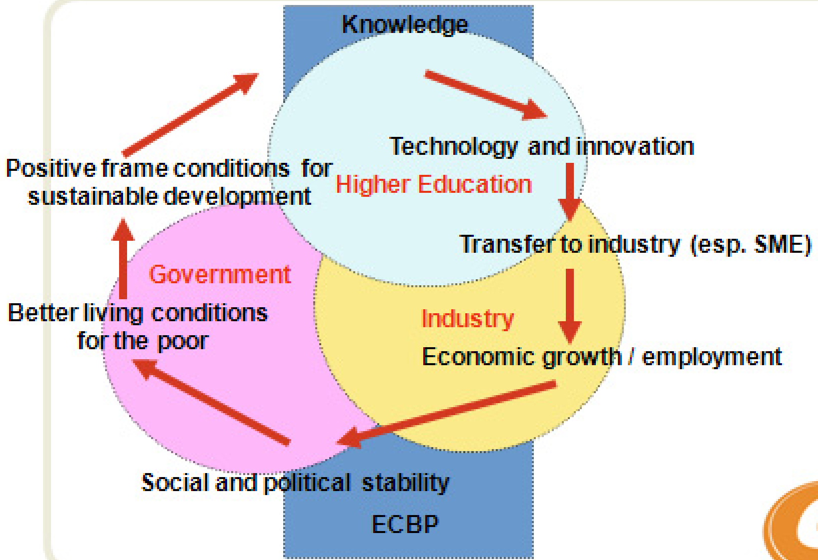
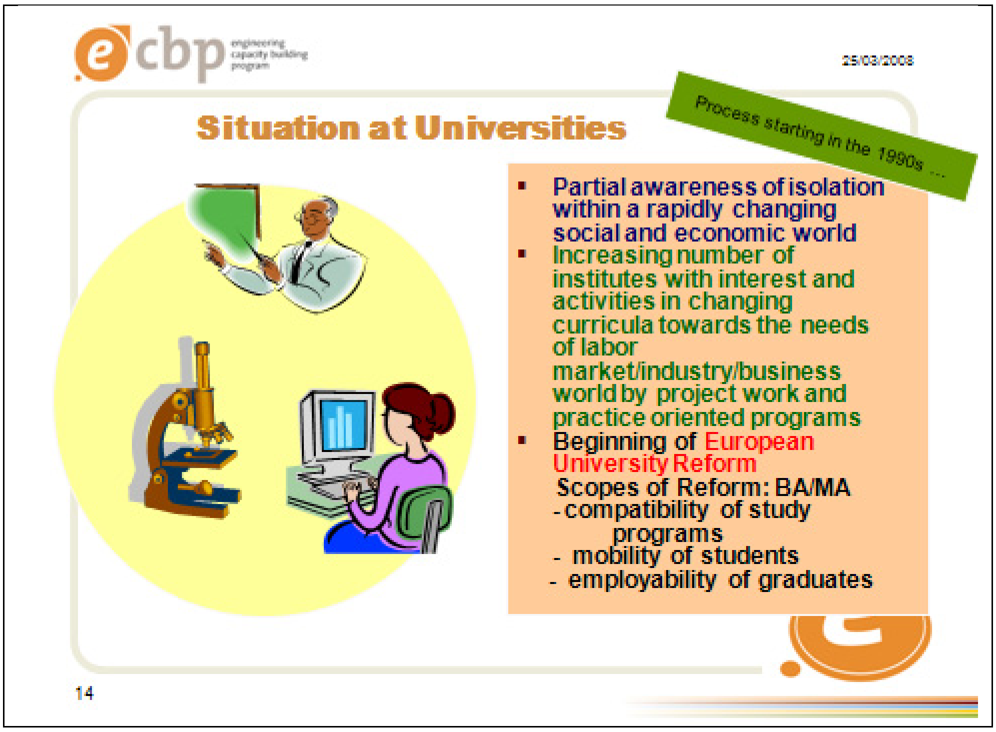


12


Career Development -
Activities at German
Universities


ecbp engineering capacity building program
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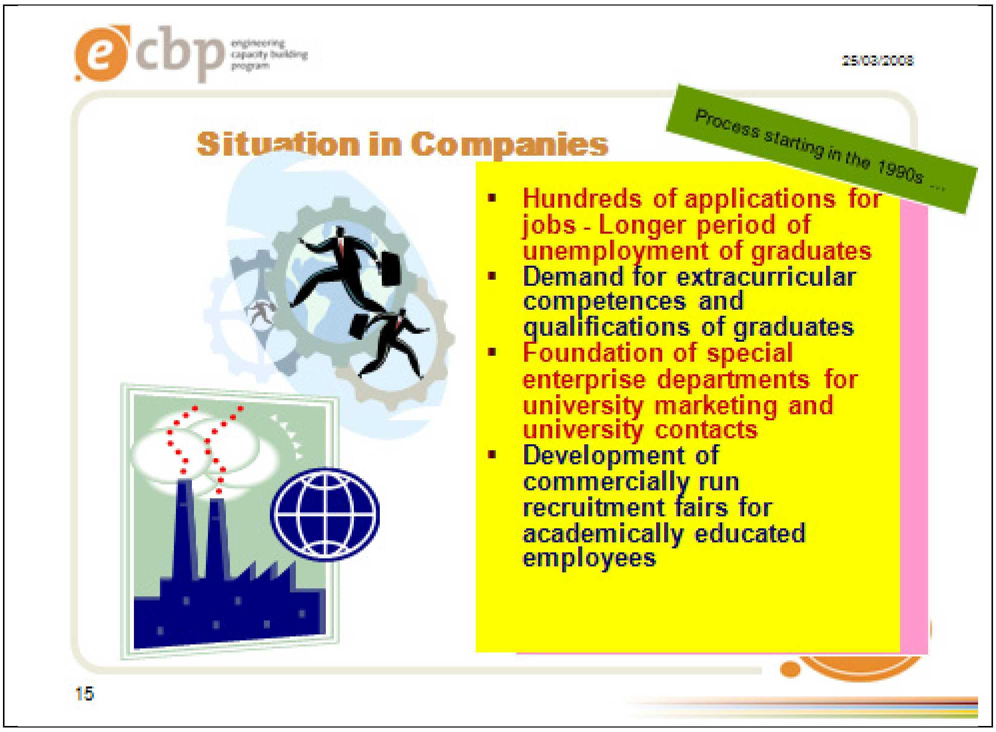
Situation at Universities
Process starting in the 1990s ...
Partial awareness of isolation within a rapidly changing social and economic world
Increasing number of institutes with interest and activities in changing curricula towards the needs of labor market/industry/business world by project work and practice oriented programs
Beginning of European University Reform
Scopes of Reform: BA/MA
- compatibility of study programs
- mobility of students
- employability of graduates
14


ecbp engineering capacity building program
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Situation in Companies
Process starting in the 1990s ...
▪ Hundreds of applications for jobs - Longer period of unemployment of graduates
▪ Demand for extracurricular competences and qualifications of graduates
▪ Foundation of special enterprise departments for university marketing and university contacts
▪ Development of commercially run recruitment fairs for academically educated employees
15


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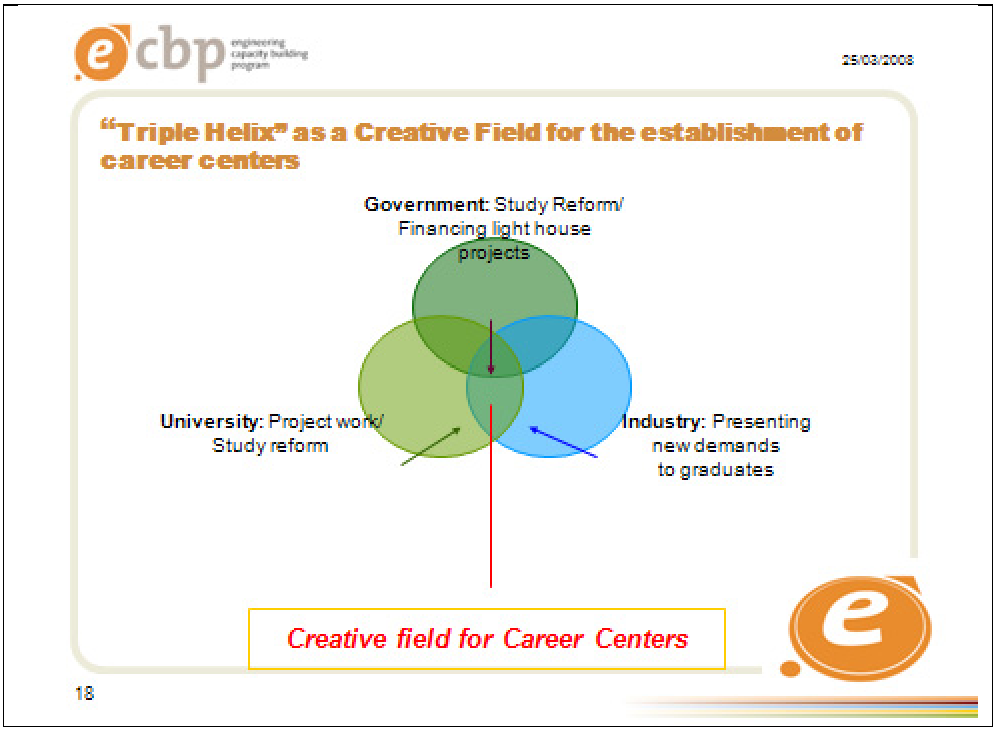
Situation of Federal Government in Germany
▪ Becoming a change agency by sponsoring hundreds of university reform projects
▪ Installing light house projects of study reform at universities
▪ Taking over the responsibility for the study reform all over the Federal State, setting dates and frames
Process starting in the 1990s ...
16


University – Economy - Government
Simultaneous and interdependent process of change
New Core Competence of Higher Education
Responsibility for the Employability of Graduates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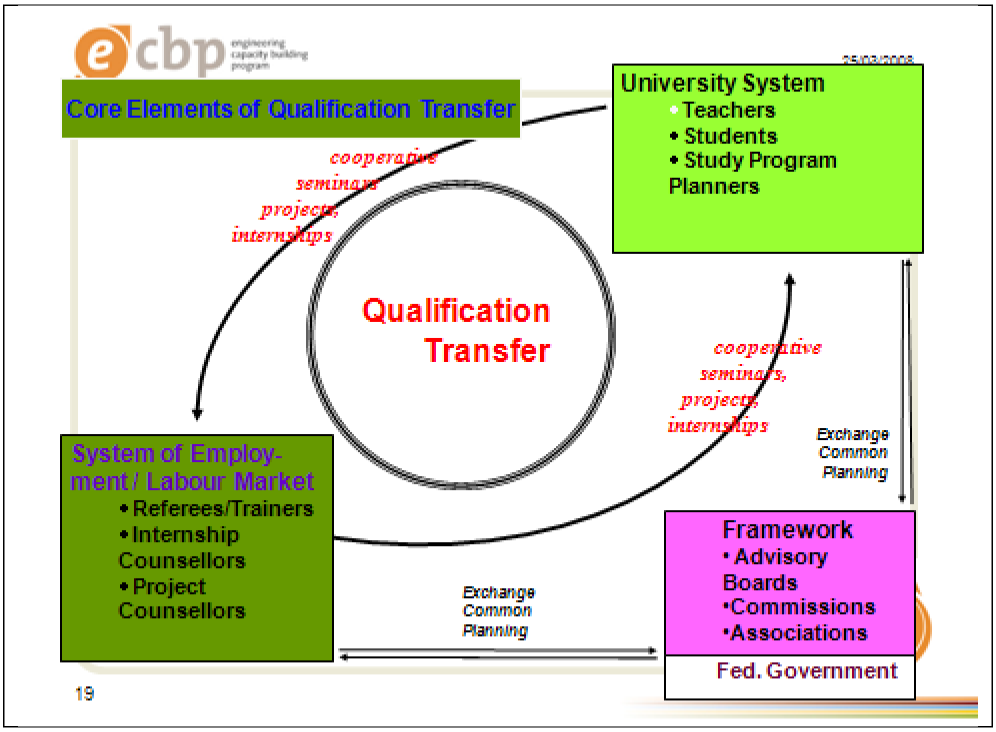
"Triple Helix" as a Creative Field for the establishment of career centers
Government: Study Reform/ Financing light house projects
University: Project work/ Study reform
Industry: Presenting new demands to graduates
Creative field for Career Centers
18



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Work of Career Development Centers for Students

- University wide courses to train interdisciplinary key competences (time management, project management, conflict solving skills, self-presentation, entrepeneurial skills, ethic attitudes in professional life)
- Organisation of internship programs during and after study programs
- Counselling for practice orientated subjects of thesis
- Lectures about classical and innovative work fields Counselling for application
- Organisation of - or participation in recruitment fairs

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Work of Career Development Centers for Enterprises

- Organisation of cooperative seminars according to needs of enterprises
- Organisation of enterprises' presentation on campus
- Counselling for projects of applied research and of internship programs
- Invitation of managers from Industry to give lectures about work fields
- Contact management between enterprises and university departments
- Invitation to round tables, commissions, advisory boards

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Support of Enterprises for career development

- Financing trainers and lecturers
- Financing recruitment fairs
- Financing own presentations on campus
- Offering interesting fields for internships, projects, thesis
- Participation in boards and round tables
- Participation in Study Reform Process by own research about the demands of industry concerning knowledge, skills and competences of graduates

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Framework for a growing network between economy and university

- Establishment of regular career networking round tables on federal level
- Establishment of nationwide career services network Germany www.csnd.de (in 2003):
- CSND as publisher of Career Service Papers – a magazine supporting the development of career services at universities (from 2003 on)
- International cooperation of career services with Fulbright Foundation, European Research program about needs of enterprises and recruitment processes
- Cooperation with dapm (german working group for human resource marketing) www.dapm.org

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csnd Career Service Netzwerk Deutschland e. V.

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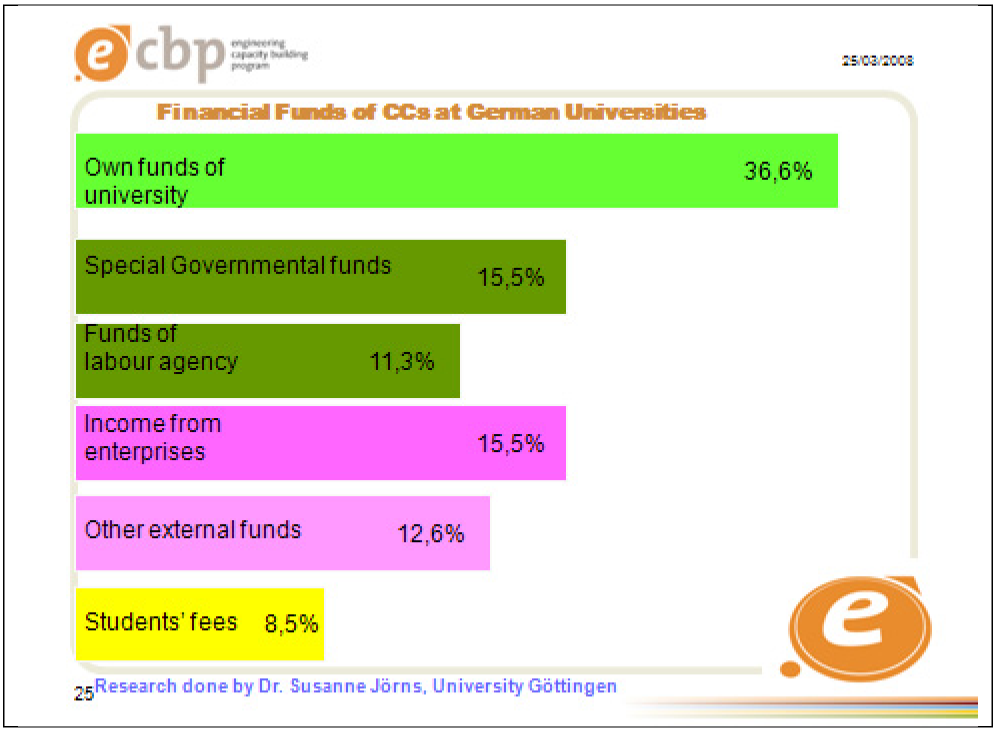
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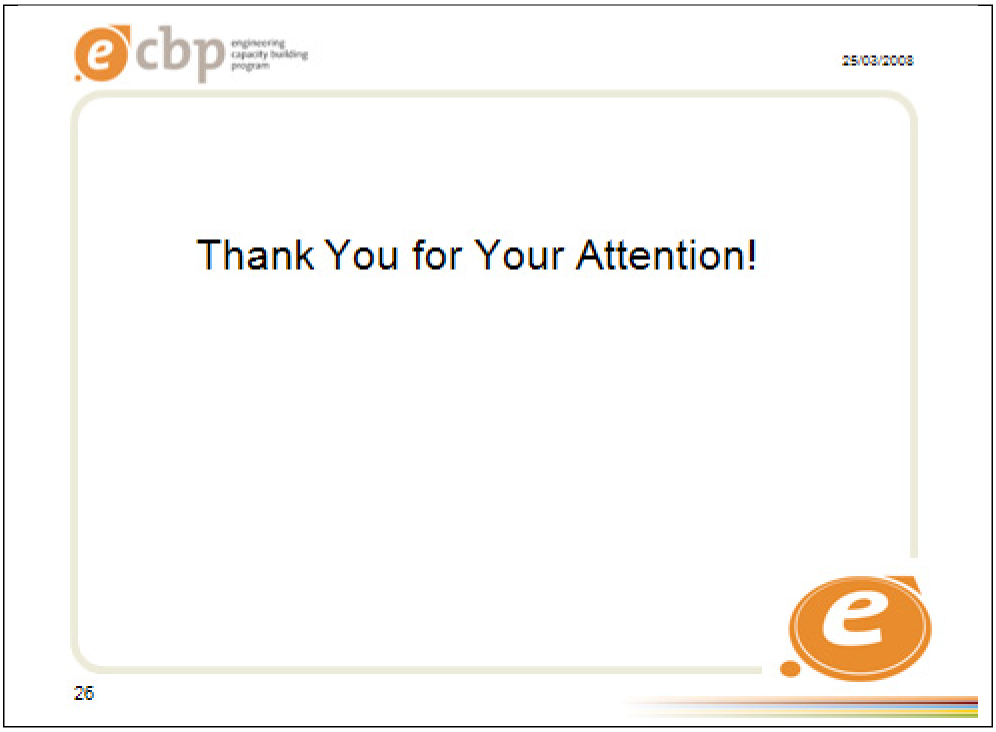
Financial Funds of CCs at German Universities
Own funds of university 36,6%
Special Governmental funds 15,5%
Funds of labour agency 11,3%
Income from enterprises 15,5%
Other external funds 12,6%
Students' fees 8,5%
25
Research done by Dr. Susanne Jörns, University Göttingen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Thank You for Your Attention!
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SECTION 3

VIEWS FROM WITHIN ETHIOPIA

A Preliminary Review of the S&T Policy of Ethiopia in the Framework of the National System of Innovation

Mulugeta Amha
Director General of the Ethiopian Science and Technology Agency (ESTA)

Abebe Mekuriaw
Head, Department of Mines, Water and Energy, ESTA

Abstract

The Ethiopian Government issued the National Science and Technology Policy in 1993 in response to the realization of the country's weak science and technology capacity, on the one hand, and recognition of the role of science and technology for development, on the other. The major objectives of the policy include building capability to generate, select, import, develop, disseminate and apply appropriate technologies; and improving the knowledge, culture and the scientific and technological awareness of the peoples of Ethiopia.

The purpose of the paper is to examine this policy using the national system of innovation as a policy analysis framework. It is widely accepted that such analysis makes explicit the many different kinds of necessary inputs and interactions to produce an innovative and competitive economy.

Ethiopia needs to pay attention to supporting and promoting innovative activities in conjunction with building its scientific and technological capacity. Appropriate attention needs to be paid to encouraging and supporting SMEs in the national system of innovation and to demand- side interventions, including the use of the government purchasing power. It is therefore high time to review the national S&T policy, taking into consideration the functions and interactions of the stakeholders of the national system of innovation. Measures should be taken to put in place the necessary legal, organizational, operational and financial instruments to make the national system of innovation more relevant, effective, efficient and sustainable. In this paper, a preliminary attempt is made to do this, in the hope that it can provide a useful contribution for further in-depth study of the subject.

1. Introduction

The level of technological knowledge that is actually in use throughout the entire economy of a country determines the manner in which resources can be combined to yield outputs of goods and services. Development of new technology and its application in the overall production system has therefore been identified as a powerful factor in raising the standard of living. Technological progress has contributed to the improvement of the health of people, increased the amount of their leisure, improved the working and living conditions, and increased their income many folds in different parts of the globe.

Developed countries are able to generate and extensively apply science and technology so as to ensure their development and global competitiveness. They have already created the necessary preconditions for the generation, promotion, diffusion and application of scientific and technological knowledge whereas, in the case of many third world countries, the application of this knowledge in the realization of their development objectives is at a very low level. The daunting challenge centres on how S&T can be developed so as to contribute to a country's socio-economic development objectives.

It is believed that the first half of the 20th century is considered as the beginning of application of modern science and technology in Ethiopia, along with the establishment of higher learning institutions. However, most socio-economic problems of the country are deeply rooted largely in the absence of well-established scientific and technological base to generate and/or select, adapt and innovatively apply scientific and technological knowledge to solve development and environmental problems.

The Ethiopian Government launched the National Science and Technology Policy in 1993 as part of the national endeavour in the fight against underdevelopment. The Policy was issued with due consideration to the existing realities and knowledge spectrum of policy during that time. The major purpose of this paper is therefore to examine the national science and technology policy framework of Ethiopia from the wider perspective of the national system of innovation. In doing so, an attempt has been made to briefly introduce the policy, to identify the major policy directions set to promote innovative activities, and to point out the main strengths and weaknesses of the policy. The gap observed between the intentions expressed in the policy document and their implementation over the last twelve years has also been identified. The paper concludes by suggesting some recommendations regarding the need to use the national system of innovation to revise the policy highlighting some possible policy directions and implementation actions.

2. National System of Innovation

According to the OECD, national system of innovation is defined as "a system of interacting private and public firms (either large or small), universities and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social and financial, inasmuch as the goal of the interaction is the development, protection, financing or regulation of new science and technology". Such a system can be seen as comprised of a set of functioning institutions, organizations and policies which interact constructively in the pursuit of a common set of social and economic goals and objectives, and which use the introduction of innovations as the key promoter of change.

All countries have, at least in embryo, a national system of innovation. What varies immensely among countries is the extent, efficiency, and effectiveness of their different systems (UNESCO, 1997). Thus, the concept of a "national system of innovation" provides a useful framework for technology policy analysis and formulation since it makes explicit the many different kinds of inputs which are necessary to produce an economy which is innovative and hence competitive in today's increasingly globalized markets.

The three principal reasons underlie the utility of the concept of a "national system of innovation" as a basic framework for policy analysis are the following:

1. It affords an opportunity to think of means for the promotion of coherence and integration among national activities,
2. It offers a means of identifying what needs to be done without automatically tying the necessary functions to any particular institution or organization which is currently in place; and
3. It focuses attention on "innovation" – on doing new things in new ways – rather than simply on the production of knowledge.

2.1. The Functions of a National System of Innovation

There are six sets of functions of the national system of innovation, the first two sets of which are the exclusive domain of government, while all of the others are the domains of activities of many stakeholders.

Government functions

- Policy formulation and resource allocation at the national level,
- Regulatory policy-making.

Shared functions

- Performance-level financing of innovation-related activities,
- Performance of innovation-related activities,
- Human resource development and capacity building; and,
- The provision of infrastructure.

2.2. Stakeholders in a National System of Innovation

Stakeholders are the set of individuals and institutions that influence and are influenced by the activities of an NSI. They may have different relationships with the system. In any country, the principal groups of stakeholders in an NSI are to be found in government, the business sector, the education and training sector, within organized civil society, and among interested outsiders. The typical stakeholder groups that exist in the setting of a national system of innovation, according to the experience from South Africa, are shown below (UNESCO, 1997).

A. Government

- Central policy and budgetary agencies,
- Relevant Parliamentary or Congressional Committees,
- Science councils (or other specialized S&T financing bodies),
- Departments of government with S&T functions (e.g. in health, agriculture),
- State corporations,
- Defence forces,
- Other government S&T bodies, including regulatory agencies,
- Government advisory mechanisms,
- Other levels of government (including municipal authorities, especially in the larger cities).

B. Business

- Large local corporations,
- Transnational corporations (TNCs) and their subsidiaries,
- Small, medium and micro-Enterprises in the formal sector,
- Micro-enterprises in the informal or subsistence sectors,
- Business associations, producer groups, chambers of commerce,
- C. Education and Training Institutions,
- Universities,
- Technical colleges,

- Teacher training institutions,
- NGOs or private bodies involved in S&T education and training,
- Primary and secondary schools,
- Other education or training institutions.

D. Organized Civil Society

- Professional and Academic Societies,
- Labour unions, especially those dealing with technical change,
- NGOs interested in technical change.

E. Interested Outsiders

- Other countries, especially the participants in their national systems of innovation,
- Other countries, including primarily both the participants in their national systems of innovation and their Official Development Assistance Agencies,
- Multilateral Agencies (including UNESCO, UNCTAD, UNEP and other S&T-related UN Organizations, the African Development Bank, the World Bank, WHO, etc.).

3. The Need for Science and Technology Policy

S&T policy is an integrated sum of principles, strategies, and objectives and actions adopted by a government in response to the realization of the country's weak science and technology capacity, on the one hand, and the critical role of science and technology for development, on the other hand. National S&T policy is therefore required in order to develop long-term national scientific and technological potential and capability to generate and apply S&T for socio-economic development. As a government response to the critical and defining role of science and technology for socio-economic development, S&T policy is, among other things, a call for:

(i) **Coordination:** to bring about synergy and cost-effectiveness in science and technology activities through conscious and systematized provision of strategic directions and creation of enabling environment.

(ii) **Priority setting:** to focus on a few, but strategic areas of activities.

(iii) **Core budget allocation:** government commitment to allocate an annual core-budget specifically devoted to S&T and create various funding mechanisms, including fiscal incentives, to those engaged in science and technology development activities, in addition to the national core-budget.

3.1. Arguments against a National S&T Policy

1. National S&T policies are designed to benefit a national economy by creating and facilitating a competitive edge for the goods and services it produces. A globalized trading arrangement means that not only goods, business, and finance but also S&T move unrestrictedly across national borders. Thus, any possible benefit from national S&T policies will quickly move ("leak") outside a country, and in a globalized world, such policies are therefore doomed to failure.

2. It is generally accepted that national policies are desirable for macroeconomic stability (for example, exchange-rate policies, fiscal balance). Beyond such fundamentals, however, rather than facilitating a national competitive edge, national S&T policy actually prevents development. Effective S&T decisions, it is argued, can only be made at the level of the individual company or firm; approaches to S&T must be entirely flexible to take advantage of rapid technological change; but national (that is, government) policies are necessarily rigid and run counter to the interests of development.

3.2. Arguments for a National S&T Policy

1. The role of national policy is critical to establishing conditions for developments that go beyond those the market is likely to create (World Bank 1997). In arriving at this conclusion, the World Bank made it explicitly imperative that poorer countries build up the appropriate human capital and fine-tune the complex relationship between the market and society. In this regard, the World Bank observed that the experiences of the East Asian Tigers, as well as the failures of national efforts elsewhere, strongly support the need for appropriate instruments of modernization, including instruments of national S&T strategy.
2. Firms and companies target the investments that come with globalization, and on which it depends, to locations with a comparative advantage not only in low-cost labour but more often in S&T. Long-term national policies and actions, particularly in Asia, have been critical in attracting and retaining such investments.
3. If the strength of globalization is in its wealth-creating capacity, its weakness, if undirected and uncontrolled, is in its disregard for, and damage to, the environment and in its exacerbation of gross inequalities both within and between nations.

3.3. S&T Policy Instruments

A policy may remain a mere rhetorical statement if not followed by appropriate policy instruments. A policy instrument comprises the means used to put a given policy into practice. It can be considered the vehicle through which those in charge of formulating and implementing policies use their capability to orient further decision-making by others. Thus it may also be said that a policy instrument is supposed to induce individuals and institutions to make decisions following the collective rationality established by those in power. In short, it is the vehicle or connecting link between the purpose expressed in a policy and the effect that is sought in practice.

An instrument is a complex entity comprising one or more of the following components:

- **Legal device (legal instrument):** embodies the policy, or parts of it, in the form of a law, decree, resolution or regulation. Formal agreements and contracts may also be considered here. The legal device goes beyond a policy and stipulates obligations, rights, rewards, and penalties connected with its being obeyed. The intention of the government enshrined in the policy, derives its validity and power from the legal acts put in place by the responsible body in the government structure.
- **Organizational structure:** This refers to the state structure or ministry that is put in place so as to ensure the implementation of the policy after it has been adopted. The introduction of a policy does require an institutional framework with unequivocally spelt out duties, responsibilities and accountabilities. Apart from describing mandates the

framework delineates the duties and accountability lines of the major actors involved in the national S&T system.

It includes in one hand, one or more existing institutions which may be thought as the hardware" of the organizational structure. On the other hand, the procedures, methodologies, decisions, criteria, and programs of one or more institutions that must be carried out in processing the pertinent information for the purpose of applying the policy. This are considered the "software" of the organizational structure.

- **Set of operational mechanisms:** refers to the organizational arrangements (government departments or directorate) created to oversee the day-to-day operation of the policy. These are the levers, or actual means, through which the organizational structure makes decisions on a day-to-day basis, and attempts to obtain the desired effect the policy, was set out to influence.

4. The S&T Policy of Ethiopia

The National Science and Technology Policy of Ethiopia was formulated by the Ethiopian Science and Technology Commission through a series of consultative discussions with the stakeholders during 1987 – 1993. The formulation process involved working visits of task forces to some countries for experience sharing, sectoral S&T situation assessment and a national workshop. The policy was issued in December 1993 by the then Transitional Government. The main reasons stipulated for the enunciation of the Policy include the need for:

(a) Sustained science and technology capacity building,

(b) Committing resources for the long term on sustainable basis,

(c) Avoiding unnecessary duplication of efforts and uneconomical use of resources,

(d) Reduction of the level of technological dependency,

(e) Coordination of S&T activities (effective and efficient use of the resources the county can make available for the activities.

The objectives of the Policy are:

1. To build national capability to generate, select, import, develop, disseminate and apply appropriate technologies for the realization of the country's sustainable socio-economic objectives,
2. To improve and develop the knowledge, culture and the scientific and technological awareness of the peoples of Ethiopia, and promote the development of traditional, new and emerging technologies,
3. To make Science and Technology (S&T) activities more productive, efficient and development oriented.

The national S&T policy comprises of policy directives, strategies; and priority sectors and programmes. It also determines the organizational structure of the national S&T system and sources of financial support and the kind of international collaboration deemed appropriate.

4.1. Major policy directives and provisions of the national S&T policy relevant to the National System of Innovation

The following are the policy directives intended to help realize the set objectives and to build S&T capabilities in the priority accorded areas.

1. Build the capacity to search, select, negotiate, procure, exchange and introduce technologies suitable to Ethiopia's socio-economic conditions,
2. Establish and/or strengthen S&T institutes, Research and Development (R&D) centres and support services as necessary and appropriate in the various administrative regions,
3. Establish responsible bodies/organs in every economic and service sector for the execution of S&T development activities,
4. Facilitate conditions for the wider participation of women in S&T activities,
5. Establish a system to encourage young scientists and technologists,
6. Establish a system for a wider popularization of science and technology amongst different nations and nationalities utilizing their languages in order to improve and enrich the S&T culture of the Ethiopian people,
7. Create a working environment conducive to encouraging scientists and researchers for better productivity,
8. Ensure rapid dissemination and application of Research and Development (R&D) results,
9. Encourage the private sector and its capital to participate in the promotion and development of scientific and technological activities,
10. Build trained manpower in Science and Technology (S&T) both in quality and quantity,
11. Promote the mutual support between S&T education, research and production,
12. Encourage the improvement, wider diffusion and application of traditional technologies.

The national S&T Policy also identifies about twenty strategies to implement the policy directives. Among these, the strategies that refer to the national system of innovation in one way or another include:

1. Develop, strengthen and modernize the country's engineering and technology base to build a strong national economy and to assist the chemical, textile, agro-industry, mineral and other production sectors which are necessary to meet the demand for basic consumer goods,
2. Expand and raise the quality and understanding of science and technology education at all levels of the educational establishments in all regions,
3. Facilitate conditions to create favourable & mutually reinforcing relations between S&T education, R&D, and the production & service sectors,
4. Establish a national S&T information network capable to acquire S&T information relevant to national development needs and suitably process it for dissemination to potential users in government and private sectors,
5. Develop the capacity and the mechanism to search, choose, negotiate, procure, adapt & adopt and exchange technologies that are appropriate and environmentally sound to the Ethiopian socio-economic conditions,

6. Establish a system to encourage and support applied and basic S&T research in areas appropriate to the needs of the country,
7. Encourage and support the publication of books, research results, journals and periodicals of Science and Technology of interest in the different languages of nations and nationalities as appropriate,
8. Build capability and methodology to identify the scientific content of traditional technologies; improve & change those that are useful for wider dissemination and diffusion,
9. Establish efficient mechanisms for a speedy dissemination and application of Research and Development (R&D) results,
10. Develop a conducive working environment and an appropriate career and promotion structure for scientists and researchers and encourage & support the establishment of professional and amateur associations,
11. Prepare awards and prizes for outstanding innovations and productive achievements in the fields of Science and Technology (S&T),
12. Establish an efficient national patent and technology transfer system to promote and support local technological innovations and creative achievements,
13. Promote locally developed material inputs,
14. Encourage the private sector and its capital to participate in S&T development activities through the provision of tax and other incentive mechanisms,
15. Mobilize resources for S&T development and strengthen international cooperation.

The policy also identifies agriculture, natural resources development & environmental Protection, water resources development, energy, industry, construction, transport and communication, mineral resources, health and population planning, education, and new and emerging technologies as the priority sectors. Programmes are also identified for each priority sector.

The National Science & Technology Policy also maps out the governance structure of the National Science and Technology System. Accordingly, the national science and technology system has four management structures: National S&T Council, Technical Advisory Committee of the National S&T Council, Ethiopian Science and Technology Commission, and S&T operational institutes and centres.

The policy indicates that the National S&T Council presided over by the Prime Minister, with a membership of Ministers of selected Ministries is the highest decision making body of the system. The Ethiopian Science and Technology Agency, according to the Policy, is mandated to plan, promote, coordinate, finance and oversee science and technology activities of the country. In addition, the Agency is responsible to advise the government on issues of S&T, implement the government's S&T policy and follow up the appropriate and immediate application of research and development (R&D) results.

Operational institutions are responsible for the actual performance of S&T activities. According to the spirit of the policy, establishment of research institutes, technology centres, design enterprises, and various S&T support services is mandatory particularly in areas requiring special attention. Such operational institutions can be established under the Ethiopian Science and Technology Agency and could either be merged with other relevant organizations or operate as autonomous bodies at the stage of maturity.

Pursuant to the National Science and Technology Policy, sectoral S&T policies on agriculture; health; industry; mines, water, energy and geo-information were also formulated and approved by the Council of Ministers in 1994. For the implementation of the Sectoral Policies, sectoral Councils composed of professionals and/or institutional representatives drawn from the respective sectors were established to advise the Ethiopian Science and Technology Agency and follow the execution of Sectoral S&T policies and strategies. Although, the Sectoral Council on Agriculture was dissolved following to the establishment of EARO, the other three councils are still functional.

4.2. Strengths and Weaknesses of the National S&T Policy

Strengths

- It provides a comprehensive and broad base that serves as a springboard to initiate formulation of detailed policies and prioritized action programs in the various socio-economic sectors.
- The National S&T Council is organized under the chairmanship of the Prime Minister of the country and membership of Ministers of relevant ministries. This provides the required commitment and leadership for productive and effective business in S&T capacity building.
- The Government is committed to allocate up to 1.5% of annual GDP in order to support and sustain the different S&T activities, build up S&T capability in all sectors and apply generated research results.
- Equipment and materials imported for R&D activities are exempted from all kinds of taxes.
- The policy consists of a number of directives that can be used to encourage, support and coordinate scientific and technological activities of the various stakeholders.

Weaknesses

- The policy does not treat social science as one branch of science and technology.
- There are no clear distinctions between the policy directives and strategies.
- The priority sectors and programs in the policy document do not clearly show priorities.
- The Policy is too much focused on the public sector.
- Demand side government interventions are not well stipulated.
- The organizational structure of the national S&T system is centralized type; it does not take into consideration the existing Federal Government Structure.

4.3. Gaps between the Policy and its Implementation

A number of encouraging developments have been observed in Ethiopia since the issuance of the national science and technology policy. The following are the major steps that are recognized by the national S&T system for their potential contribution to building innovative economy in the country:

1. Rapid expansion of elementary, secondary, technical and vocational; and university education (both at undergraduate and graduate levels) through the Government capacity building national program. Growth of the number of universities and colleges and their

intake capacities is particularly impressive. The number of universities has increased from two to nine. Participation of the private sector in education is also encouraging.

2. Strengthening of the national agricultural research system through human resource development and infrastructural capacity building of the Ethiopian Agricultural Research Institute and establishment of Regional Agricultural Research Institutes.
3. Technical, financial and administrative support to young graduates of Technical and Vocational Education and Training Colleges to develop and run their own small businesses.
4. Provision of continued government research and development grant to encourage young researchers and promote problem solving applied research.
5. Establishment of a national intellectual property system with the necessary legal, organizational, and operational framework.
6. Creation of conducive business environment that attracted a good number of foreign and local investors to establish business enterprises in agro-industry, manufacturing, construction and services.
7. The aggressive and commendable efforts of expanding ICT use across the country (including the Woreda Net and School Net programs).

Although all the above-mentioned undertakings are basic steps for building and utilizing national S&T potential for socio-economic development, we believe that a lot has to be done yet in a coordinated manner to implement the directives of the national S&T policy and to achieve its objectives. The major problem with respect to the national S&T policy of Ethiopia is therefore mainly the wide gap observed between the statements of the policy and their implementation. The major gaps can be summarized as follows:

- The general directives and strategies of the policy have not been followed by the appropriate policy instruments and action plans as well as prioritized concrete programs and projects that could contribute to the development of national science and technology capability.
- The organizational structure of the national S&T system envisaged in the policy document has not been realized in full. The prevailing situation is that the council is chaired by the Director General of ESTA with membership of State Ministers and vice Ministers. Coordination and prioritization of S&T activities which are multi-sectoral, multidisciplinary and multi-institutional at national level could have been more effectively handled by a national S&T council that is chaired by **the Prime Minister or the Deputy Prime Minister as his representative or a high level minister of with a stature of political seniority.**
- **Absence of legal basis that defines the relationship between the various elements of the national S&T system is also another important gap.** The responsibilities, roles, relationships and accountabilities of the elements of the system have not been legally defined and established. The functional relationships between all the elements are in fact based on their willingness to collaborate and implement the policy.
- Absence of any system to prioritize and allocate resources for the national S&T efforts. **Although the policy stipulates that the Government of Ethiopia is committed to allocate up to 1.5% of the annual GDP for S&T activities in the country, no mechanism has been developed to allocate core S&T resources annually for**

programmes and projects approved by the national S&T council. It has to be emphasized here that the intention is not on controlling the flow of annual budgets to the various S&T institutions; it should rather be on creating a system by which resources meant for national S&T activities are earmarked and used taking into account national inter-sectoral and inter-regional priorities and needs.

- Equipment and materials imported for R&D activities are exempted from all kinds of taxes according to the policy. **The present practice, however, is that all equipment and materials imported even as donations are taxed.** This does not pause much of a problem for public institutions, as the Government has shown demonstrated willingness to absorb such costs in the annual budgets of institutions. **Probably the problem is when it comes to private and civic institutions.**

5. What Needs to be Done to Strengthen the National Innovation System (Policy Directions and Actions)?

Ethiopia needs to pay attention to supporting and promoting innovative activities in conjunction with building its scientific and technological capacity. It can be clearly seen that the most important issue in the Ethiopian S&T development is not lack of a policy guideline; it is instead lack of systematic efforts to implement the Government policy.

Not enough attention has been given to encouraging and supporting SMEs in the national system of innovation (Comment: and removing barriers, their role in innovation, but not R&D, could be elaborated). The major directions of the present national science and technology policy and the attempts to implement it are focused mainly on the supply measures of scientific and technological knowledge generation with inadequate attention to innovative activities at firm level. Revision of the policy should therefore take into consideration all the stakeholders of the national system of innovation and pay adequate attention to the demand side interventions including the use of the government purchasing power.

Given the above it is now imperative to **review the national S&T policy of Ethiopia** using the national system of innovation as a framework of analysis. It is believed that the existing policy could be upgraded taking under review the functions and interactions of the stakeholders of the national system of innovation. Participatory policy formulation, and adoption of policy implementation instruments including legal, operational and financial should therefore be followed to make the national system of innovation more relevant, effective, efficient and sustainable.

The S&T policy review must obviously focus on local conditions because any model that is simply imported is unlikely to yield the desired benefits. Relevant lessons can be learnt about the review procedures and activities from the past experiences of OECD and IDRC (S&T policy review of Chile, China, South Africa, Vietnam, etc. in late 1990s). The essential features for undertaking such a review could be:

- Strong national leadership,
- Participation of S&T-policy professionals from both developed and developing countries,
- Assessment and sharing of previous experiences and the lessons learned from these,
- A substantive national assessment, and

- Combined open examination, and tabulation of national views, observations, and recommendations (obtained from government, scientists, technicians, and the business community) and those of the international team of policy professionals.

6. Conclusions and Recommendations

Although the National S&T policy has some weaknesses, it has provided the basis to consider S&T activities in a national system. In the review, it was observed that the most important issue in the Ethiopian S&T development is lack of systematic efforts to implement the Government policy. It is believed that the existing policy could be upgraded focusing on coordinating, supporting and enhancing interactions of the various stakeholders of the national system of innovation including universities, industry and the government. The following section summarizes the most important points that need to be considered during **policy revision** and subsequent implementation.

- Appropriate policy instruments including legal, organizational, operational and financial should be adopted to make the national system more relevant, effective, efficient and sustainable,
- Adequate attention should be given to supporting and encouraging innovative activities at small and medium firm levels,
- Demand side government interventions including the use of government purchasing power need to be applied to promote and support interactions of the stakeholders,
- The organizational structure of the national system science and technology should be based on the decentralized governance structure of the nation to ensure active participation of the federal and regional stakeholders,
- Science and technology capacity building and applications need to be integrated with the overall development plan of the country,
- The capacity to define and make use of policy instruments needs to be developed. Building the capacity to undertake policy analysis as well as to assess and forecast technical change in the country also needs to be accorded priority,
- Banking and financial institutions need to improve their role of fostering technological innovation by introducing venture and other forms of risk capital to create new innovative businesses and improve their sustainability,
- It is imperative to install mechanisms by which institutional research capacity is strengthened and/or built based on national priorities,
- The linkages between industries and higher level technical and engineering establishments and industries of all types should get policy support to enhance their joint technological development and innovation activities,
- Business and technology incubators should be nurtured to provide affordable space and core business support such as business development, financing, marketing, and legal services,
- Adequate scale of investment should be ensured in R&D for the absorption, adaptation and, wherever possible, improvement on and generation of new technology,
- Policies and capacity building efforts are needed to stimulate technology diffusion and its effective usage to the desired levels. These efforts include: a) infrastructure (b) education and human capital building, (c) public and private research activities,

- Capacity building efforts in the national system of innovation should emphasize understanding, adopting and using new technological knowledge by the private and public business enterprises,
- The role of institutions of higher education in producing new knowledge through research, serving as conduits for the transfer, adaptation, and dissemination of knowledge generated elsewhere in the world, and their support to government and business with advice and consultancy services need to be duly recognized in the national system of innovation,
- R&D is essential to maintaining and improving competitiveness. Therefore companies need to be encouraged and provided incentives to spend on R&D to be competitive in an innovation-driven economy,
- Facilitating the linkage between the universities/ research institutes currently engaged in R&D activities and industry via the provision of subcontracting services for basic and applied research needs to be encouraged.

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Innovation and its Essential Contribution to the Growth of the Private Sector and the Development of a Country

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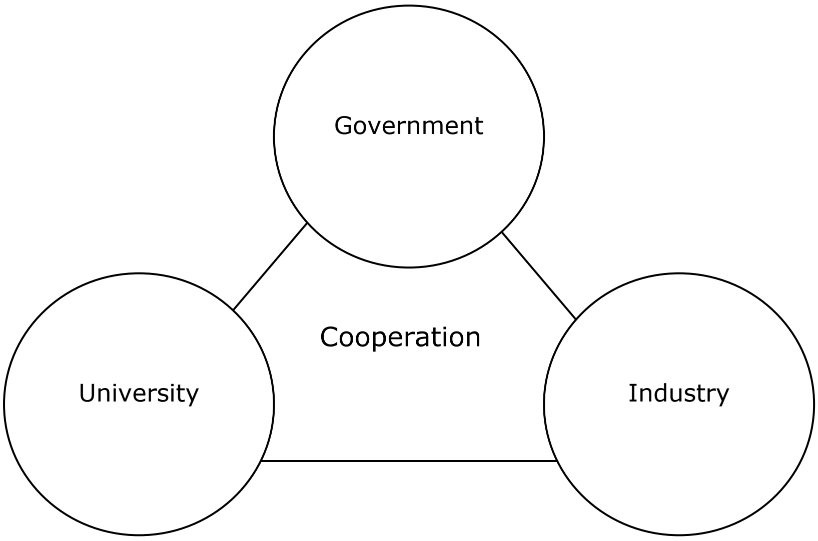
1. Introduction

It is indeed enlightening and profoundly encouraging to observe that notable professionals with ample experience in and exposure to the inner workings of the academic institutions as well as the private and public sectors are engaged to design a system that can create an environment of collaboration and mutual benefit among universities, industries and governments by using what is known to us as "The Triple Helix Model".[6] It is a privilege and indeed an honor to be here today, in this respectful forum, to make few remarks about the role and contribution of the private sector, as one of the three institutions, and the expectations it has from the other two institutions.

At the outset, I would like to underscore the fact that this paper is based merely on the practical realities and experiences acquired in the day-to-day operations of the private sector.

Figure 1: The Triple Helix Model



Innovation in the context of this presentation is taken as any activity that deals with new or improved ideas related to science & technology, management & leadership, manufacturing & production, methods & processes, and the like. It is primarily about the adoption of globally or locally available ideas to enhance productivity.

In this globalized world, the private sector is faced with the challenge of providing quality products and/or services at competitive price to well-informed, savvy and educated customers/consumers. These customers utilize modern information systems to gainfully transact with manufacturers/suppliers and achieve the best possible satisfaction for their money.

- What must the private sector do to use innovation as one of the elements for productivity and growth?
- What must the private sector expect from the academia and policymakers (i.e., universities and governments) to achieve a modern, knowledge-based, technologically acceptable companies with sustainable growth and profitability?

[6] (Etzkowitz et al, 1998).

This paper is prepared to shade light on the above two questions to help provide to the forum the point of views from the private sector.

2. Recognition of Reality

In an effort to set aside generalities and focus on ideas and suggestions that may produce near term results, it is essential, at the outset, to recognize the realities faced by private, public and other institutions in any underdeveloped countries including Ethiopia.

First:

To be part of the global market, such countries are required to conform to the demands of the international or global market and play an active role to survive and grow. This requires the availing of products and services that must meet international quality standards at a competitive price.

Second:

To compete and be successful in the global market, the private sector needs to operate using resources which must, not only be compatible with the international standard, but also compete in a playing field where the other players have huge historic, technological and financial muscles to crush or knockout new entries from marginalized economies. It is obvious that the poorer a nation, the less its innovative resources, the stiffer the challenge for it to be in the global market.

Third:

The private sector must also provide satisfaction to local consumers by providing products that can compete and win the invading imported products from countries privileged with own raw material, modern equipment and better innovative capabilities.

Fourth:

The realities surrounding the infrastructure, financial strength, governance, health and the like are factors that hinder success in the ever-challenging and difficult local and international market that the private sector must participate.

Fifth:

Globalization and its implementation has created a paradox in the activities of the private sector. On one hand, it is a fact of life to be a part of the global market for survival, growth and development. This, without a doubt, must be the goal of any institution that strives to succeed as an institution. On the other hand, the reality of the market requirements and the practical implementation of globalization in the third world create undue pressure on the private sector with technologically inadequate resources such as capital, machinery equipment, as well as skilled manpower.

This phenomenon where industries are required to provide quality products meeting strict international standards, while lacking all the tools needed to do so, is a paradox that is currently being faced by the players. Likewise, it is also clear to the private sector that some strategy needs to be utilized to be part of the global market while making sure that such participation is implemented with full recognition of the stated paradox and the need for accelerated support in upgrading resources through innovation. The "Triple Helix Model", which promotes cooperation among key players, can help alleviate the problem. It is an undeniable fact that any lone player in a private sector will be doomed to failure unless supported by relevant institutions.

3. Role of the Private Sector

In order to successfully meet the challenges stated above, it is imperative that the private sector make the necessary effort to constructively engage with all those institutions that will make it possible for the sector to be productive.

The private sector, by its very nature, needs to be profitable. To achieve this, it is essential that the sector plays its role as a team member. It shall accomplish this by focusing:

- on the growth and expansion of the sector by introducing innovative ideas.
- on the growth of the country by being profitable thereby paying taxes to the country. This, in turn, will enable the government to provide the necessary fund for its regulatory and other services.
- on the growth and development of the community through its corporate citizenship contributions and participations.
- on the growth of the number of skilled and technologically advanced workforce by providing support to relevant academic institutions, and
- on the growth of foreign capital and investment by successfully rewarding investors with the necessary return on their investments.

To achieve the above, leaders in the private sector are required to accept the realities of the local and global economy, the competitive environment and the inadequacies that currently exist in the support and regulatory institutions.

This situation, hence, requires the private sector to re-double its efforts and meet its obligations by recognizing:

- the need to provide quality products and services marketable at a competitive price,
- the need to accept the realities of the market, adjust, adapt, re-engineer, re-align and change activities accordingly,
- the need to constructively engaging with the regulatory bodies/agencies to help promote and improve the working environment for the private sector, and
- the need to establish and work hand-in-hand with institutions that are organized to add values to the private sector through their innovative ideas.

In practical terms, at this stage in time, the private sector in this country, can engage with the universities and the government to help encourage innovative ideas.

With regard to cooperation and collaboration with universities and other similar institutions, the private sector can and must:

1. Participate in the formulation of curricula relevant to the enhancement of the private sector.

2. Participate in the development and implementation of specialized classes that will help add-value to the private sector in its effort to reduce cost, improve productivity, manage and lead companies for profitability, meet global challenges, adopt or create new methods and processes, and secure skilled labour force.
3. Participate in promoting "entrepreneurial university" for the university's own development as well as the private sector and the government.
4. Participate in the training of management, leadership and other relevant technical skills by placing the resource of the private sector at the disposal of the university.
5. Participate in availing industry leaders and qualified experts to participate in the entrepreneurial activities of the university in a form of research or classroom activities.
6. Participate in availing sponsorships to the universities to help accelerate the innovative process that will benefit all players.
7. Participate in studies that must be made by universities to help growth and development by bridging the gap between the private sector and the regulatory agencies with the prime goal of promoting the growth and development of the country by utilizing researched and useable data/information.

With regard to the cooperation and collaboration with the government/policymakers and regulatory agencies, the private sector must constructively work:

1. to ensure a healthy, productive and cooperative spirit between the policymakers and the industry.
2. to promote the country to foreign investors by demonstrating "showcase success" stories in the private sector that can help attract foreign capital and create the possibilities of securing an equitable portion of the pie in the market.
3. to facilitate the introduction of new or the revision of old proclamations, laws and regulations that help promote growth and development in the private sector.
4. to participate in the alleviation of the socio-economic problems and challenges faced by the government through the introduction and implementation of innovative ideas.
5. to assist the policymakers by providing relevant data as well as first-hand-experience that will be used to formulate rules and regulations, relevant to the growth and development of the country.

The private sector, therefore, can be an active partner in the "Triple Helix" cooperative effort by employing the above and other similar ideas and assumptions that can help promote innovative ideas for the benefit of the Nation.

4. The Private Sector's Expectations

Any reasonable and well-informed leader in the private sector recognizes the national and international constraints and challenges faced by underdeveloped countries like ours. Such leaders do also appreciate the positive and constructive efforts that are being put forward by policymakers to help the private sector.

The necessary focus and assistance, although not satisfactory by any measure, provided by the Ethiopian government to the private sector during the last four to five years is a testimony to the dedication and determination of the leaders to help promote growth and prosperity in the private sector.

Likewise, the universities, despite their limitations in resources, have been the major sources of trained manpower for use by the private sector.

One, however, cannot help but wonder how the private sector ought to operate in an environment where the two key allies in the promotion of growth and development are seriously under-funded. The fact that the industry, the universities and the government have serious limitations to meet the demands of the global market, makes it imperative that the three institutions need to join hands and network effectively to exploit each other's innovative ideas for the betterment of their own activities as well as the growth of the nation.

Some of the expectations of the private sector from the two institutions are provided herewith, not arranged in any order of importance, for possible considerations.

5. Expectations from Governments

In the context of innovative ideas and the growth and development of the sector, industries expect the government to:

1. Provide the necessary fund and support to government-run universities so that innovative ideas can be exercised for the benefit of all.
2. Provide necessary assistances to private educational institutions to help encourage their participation in the innovative ideas.
3. Provide and implement laws and regulations that are conducive to implement innovative ideas.
4. Provide supportive and enabling environment for the universities and the private sector to effectively network to advance the implementation of innovative ideas.
5. Provide incentives to help instil innovative culture and practice among the parties involved.
6. Provide the framework and policies that can help generate constructive and fruitful interactions between the private and the public sector.

6. Expectations from Universities

Despite the fact that most universities are mainly part of the government thereby, subjected to several operational and financial limitations, it is, nonetheless, important for them to do what is possible to participate in the efforts to help cement the growth, expansion and profitable operation of the private sector. To achieve this, the sector expects universities:

1. to recognize the critical aspect of higher education in the development process and play the necessary role in meeting the demands of the private sector by availing them with graduates with marketable skills.
2. to enhance the traditional research and teaching functions by engaging with entrepreneurial activities that help promote economic development.
3. to promote and become the prime mover in the adoption of innovative ideas that can easily be implemented to assist the efforts of the private sector as well as the government.

4. to re-engineer the courses and re-direct the priorities to help focus on the activities that are currently needed to support the private sector to compete effectively. This requires products and services that are made available by knowledge-based companies supported by innovative ideas.
5. to foster innovative culture and practice in all social fabrics of the country thereby helping the private sector operate in a conducive environment.
6. to take advantage of the system of the market economy and help provide relevant and researched material that can be used not only by the private sector, but also by the government.
7. to focus on creating innovative solutions to improve or replace century old tools or other productivity related methods and practices.
8. to engage in the production of simple but useful "how-to-do" publications to help small or medium entrepreneurs so that success to failure ratio of entrepreneurship can be improved.
9. to ensure their existence as viable and relevant institutions with practical and result-oriented contributions to society through the implementation of technology and non-technology related specializations such as leadership, managerial and marketing skills as well as the use of electronic based communication systems.

7. Conclusion

In conclusion, if our goal is growth and development, then it is essential that the three institutions mentioned above recognize that they have no better alternative other than working together to meet the developmental needs of the country.

If we believe that any dynamic innovative system provides the means to utilize new ways of doing things through invention, technology transfer and the like, then it is imperative that the three institutions lead the way to exploit its usefulness.

Each one of the institutions can play their own roll by improving their activities within the limits of the realities they are confined with. This may not be of great challenge. The major challenge, however, is the development and implementation of a network system that can serve as a catalyst to create result-oriented relationship among the three players. This task may require the creation of a body that can take the challenge and help achieve the benefit that can be obtained from the use of the "Triple Helix" concept of collaboration.

No one will deny the challenges faced by underdeveloped countries like ours with regard to lack of infrastructure, skilled manpower, inadequate exposure to science and technology, red tapes, bureaucracy, limited access to finance and the like.

All developed nations, however, in one form or the other, have gone through such challenges prior to becoming industrialized and wealthy. Having said that, we have no choice other than working together in an environment where all institutions are employing better and innovative ideas to accelerate the implementation of changes that are required for the growth and development of the country. The private sector will constructively engage with the academia and the policymakers to help the "Triple Helix" concept become a reality in Ethiopia. This concept, perhaps, will test our resolve and determination to accept new techniques and methods for better and profitable use of our resources. The private sector welcomes the initiative and looks forward to positively participate in its implementation.

Higher Education - Industry Resource Integration Center - Towards Solving Existing Industrial Problems

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Abstract

This paper depicts a short history of the Ethiopian industries and deals with the problems and constraints that these industries are facing in this unprecedented competitive world. Furthermore the missing link between higher institutions and industries is discussed under the light of international experience, Addis Ababa University-Ministry of Industry Cooperation program and Technology Faculty Industry Linkage Unite.

The paper uses the concept of triple helix and proposes the establishment of **Higher Education Institutions-Industry Resource Integration Center** as a way foreword to solving the problems that the Ethiopian industries are facing.

1. Introduction

The central economic difference that distinguishes the 21st century man from that of the preceding ages lies in the capacity to produce goods and services. If the technological capacity of a country is to be assessed, a much greater role has to be assigned to the means of the practice needed for translating the general concept of technology as “capability” into actual “capacity” to produce goods.

There are basically two schools of taught with regard to the technological gap between developing and developed countries. One school of thought believes that, the gap is very large and is growing every year. At the other extreme is the views of the second school of thought that however large the gap may be, with recent technological advancements, the bases are being built up for narrowing it rapidly.

Those who have the second view, generally maintain that the task is to pursue the building up of national capacity, so that maximum advantage may be taken of all available technologies, wherever they have been developed, and to embody them in the instruments of production and in the labour force in order to achieve an accelerated rise in productivity. They urge a rapid expansion of output of producer goods, training of technological personnel and promotion of design and engineering capabilities, so as to achieve as quickly as possible the objective of much greater technological and economic development. To this effect, this paper proposes the establishment of Higher Education-Industry Resource Integration Center to enhance the acceleration of industrial development.

If rapid economic development is to be achieved, it is essential to transfer and make use of emerging technologies. The concept of technology transfer is the purposive movement of established technology in one context when implemented in a different cultural, economical, and technological context. A technology is said to be transferred when the recipient understands and knows the technology deep enough to use it, adapt it, modify it or adjust it until it begins to spread within the recipient’s economy.[7]

However, the transferred technology may entail non optimal use of natural resources, which may have its root in the wrong definition of raw materials for the technologies conveyed. It is not always possible to get the appropriate technology with all the necessary criteria fulfilled.

Technological information about the source, terms, and conditions associated with acquisition; the cost of machines and life time; the skill, raw materials and maintenance requirements, and so

[7] Charles H. Smith, III “*Japanese Technology Transfer to Brazil*” UMI Research press, Michigan, 1981

forth are important in order to select the right one among alternative technologies. Unfortunately, people who make decisions on technology selection are usually misinformed. As a result people tend to rely on technologies with which they are familiar or which are easily accessible, even if more efficient or cheaper alternatives are available.

An important remedy with this respect would be the introduction of triple helix: the linkage between government, university and industry. In the triple helix "technological facilitators" would be identified. These are people in the higher education and research institutions, who because of their intellectual capabilities, investigative zeal and contacts with the centers of relevant technological developments and industries, become vital sources of technical information. The "facilitators" combat the calm acceptance of advertiser's claims and promote a healthy scepticism of current claimed advances and alert to the changes of being overwhelmed by a rapidly changing technology. The "facilitators" will also have the responsibility of ensuring that the transferred technology entails optional use of natural resources in the country, and adapting the imported technology so that is becomes compatible to the domestic market and should have a comparative advantage.

Ethiopia's comparative advantage today lies in its natural endowment, mainly agriculture and cheep trainable unskilled labor force. However, given the *low level of labor productivity* and the traditionally nature of agriculture even exploiting its static comparative advantage *cannot be relied on for long. Developing dynamic comparative advantage primly requires developing technologically leading industries, which could create positive externalities and spill over effect for other industries.*

2. Ethiopian Industries

The history of industrial enterprises in Ethiopia is a very short one compared to its early civilization and independence which dates back over three thousand years. It was during Emperor Menelik's reign that modernization of the country started. The establishment of the Bank of Abyssinia, modern education, hospitals and the appearances of the first bicycles, sewing machines and shoes were during his reign. The only railway transport, the Djibouti-Addis railway, the first notable infrastructure, which linked interior Ethiopia to the outside world, was constructed by 1917.

Until the 1939-45 war, Ethiopia remained largely insulated from the influences of the world market. Italy had colonized Eritrea in 1896 and during the next forty-five years built up a network of trade and some small-scale production in the area. Yet Eritrea was only a small part of Ethiopia and remained isolated physically, politically and economically from the rest of the Ethiopian Empire. Such relations as existed with the world markets took the form of a division of labour according to which Ethiopia exported a few primary products (almost entirely coffee and animal skins) and imported some manufactured goods. Nevertheless, capital accumulation and participation in the international division of labour remained insignificant.

While Ethiopia's topographical features played an important part in the economy's historical isolation from the world market, the country's inaccessibility by land, the immobility of labour for both geographical and social reasons were also factors explaining why colonial powers did not expand their interests in Ethiopia. Although there were some military expenditure and infrastructure investments during the Italian occupation of Ethiopia (1936-41), the insulation of Ethiopia did not change significantly until the 1940s. The principal reason for this change was that, owing to various mainly non-economic considerations, the United States began to take an increasing interest in Ethiopia's strategic importance.

During the reign of Emperor Haile Selassie modern schools and universities were opened; roads were built and a few small enterprises mainly foreign-owned and owner managed appeared. They were traditional industries of food processing, beverage, tobacco, and sugar; leather shoes and woodwork; cement and foundry; textile, soap, chemicals, paper and printing presses. The account of the evolution of government policy towards foreign investment in particular and the transfer of technology in general over the year 1950-74 could best be divided into two periods: 1950-59 and 1960-74. The former period was characterized largely by piecemeal changes in Ethiopian policy in response to specific circumstances whereas in the latter period there was a gradual attempt to integrate policy with development planning.

After the fall of Emperor Haile Selassie much has been tried to develop the industrial sector. The ten-year Perspective Plan, 1984/85 - 1993/94, was the first long-term plan to be introduced since the early 1970's, when scientific socialism was adopted as a guiding ideology of the revolution. The Plan had been launched with a view to bring about rapid economic and social change and to lay the ground for socialist economic reconstruction. In the centrally planned economy all private industries were nationalized and were put under ten corporations of the Ministry of Industry.

With the end of the civil war in 1991 and the take-over of power by the Ethiopian People's Revolutionary Democratic Front (EPRDF), the main preoccupations of the Transitional Government were security concerns and the quest for relative political stability. A process of rehabilitating the economy was soon initiated. Essentially, the objective of the program was to utilize emergency assistance to overcome the devastating effects of decades of war and to recommence economic activity. Crucially, however, the government recognized the need for a more coherent economic strategy to correct entrenched macroeconomic imbalances.[8] This culminated in the New Economic Policy (NEP), which was unveiled in late-1991. The emphasis was to dismantle the enormous state intervention and to limit the role of the state in economic activity. The systematic reduction in the role of the public sector in productive activities was to be undertaken in favour of the expansion and deepening of the private industrial sector.

Because of lack of technological capability, *most firms are inefficient*. Furthermore their *productivity and profitability has been declining for long*. Thus the firms must update their technology improve their managerial and labour skills significantly improve their technical know how and enhance marketing capabilities so as to move to a high productivity and efficiency frontier.

These industries that have come to existence through the century, however small and technically backward, they have trained industrial personnel, disseminated the industrial culture and are stimulus to the development of heavy industries. These are then the heritage of the past and the springboard for the future.

2.1. Problems and Constraints in Industries

The problem analysis in figure 1 summarizes the problems and constraints of Ethiopian industries.[9] The decisions with respect to the types and capacities of industries have, to a large extent, disregarded the market potentials of the products to be manufactured.[10] As most industries were aimed at producing consumer goods that were imported, they were consequently directed to urban centres, while the majority of the population lives in the rural areas. Such policy

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[8] *"Basic Principle and Practices in Industrial Policy Formulation and Plan Preparation in the Eastern and Southern Africa Subregion"* ECA Subregional Workshop, Djibouti, 1991.

[9] Daniel Kitaw "Objective Oriented Problem Solving - A case study: Mugher Cement Factory" Journal of EAEA.Vol 12,1995.

[10] Contractor Faroke J. e Lorange Peter "La cooperazione tra imprese: joint ventures, alleanze technologiche ed alter forme di collaborazione per I mercati internazionali" Etas libri, Milano, 1990.

contributed to forcing most of the industries to operate at a very low level of their capacity since, after the rapid growth of the early stages, they were not able to extend their market to the rural areas. The other causes of capacity under-utilization include poor design of industrial plants, inadequacy of skilled manpower and qualified managers, shortage of inputs, poor physical and institutional infrastructures, etc.

Poor maintenance is the result of insufficient planning in the procurement of spare parts and replacement components. Generally, when foreign companies provide some maintenance services, its cost is such that it undermines the competitiveness of the industries concerned.

The management of the industrial enterprises has been characterized, in most cases, by insufficient planning with respect to raw materials supply, marketing, optimum production and manpower utilization. Such a situation generally resulted in financially inefficient enterprises which, rather than generating surpluses, constituted a financial burden for the economy as a whole.

High cost of production is another major characteristic of the existing industries. High costs of investments, due mostly to lack of proper feasibility studies, excessive use of expensive expatriate skills, over-supply of equipment (in some factories) and wrong technological choice have resulted in a very low productivity of the capital in the manufacturing sector.

The importance of programming or planning manpower requirements for industrial development in the country is twofold. On the one hand, success in industrial development depends in part on the availability of skills, and it is the task of the planners to ensure that skills are available at the appropriate moment. The productivity of plants and equipment is low when the managers and workers handling them are of low capability. Domestic investment may become a burden on communities already poor, and foreign investors may be deterred when no skilled manpower can be recruited or trained.

Three major constraints seem to emerge with regards to higher education and industry linkage, needs and capability assessment and co-ordination of manufacturing industries.

Constraint C.1 Many higher education institutions, research institutions and industries are working in isolation and their efforts fail to result in improved tools, equipment and services reaching the community in volumes, which would make a real impact on productivity.

Constraint C.2 A critical misalignment exists between the research output from research institute, the type of curricula and skill endowments of graduates from universities against the immediate skill needs of industry. This may be due to the information gap between the needs of the industrial sector and the resources available at the higher education and research institutions and the inadequate linkage between the economic development objectives of the country and the education policy that helps to match the needs of industry.

Constraint C.3 Most enterprises in Ethiopia like Kotebe Metal Tool Factory and the Akaki Spare Parts factory are operating at less than 25% of capacity while complaining that competition from imported tools is robbing them of their market. The causes of capacity under-utilization may include poor design of industrial plants, inadequacy of skilled manpower and qualified managers, shortage of inputs, poor physical and institutional infrastructures, etc.

3. Higher Education Institutions

The main aim of higher education institutions is to train mature citizens and carryout research and consultancy activities to make significant impacts in the country's development in various sectors of the economy. To this effect the higher education institutions have been imparting fundamental education to students and carrying out research activities in their faculties and institutions.

If the available technology and the available skills are incompatible, either the technology needs to be adapted or the skills improved. Training does the latter; for instance, it makes it possible for people to use, repair and maintain machinery so far unknown or unfamiliar to them. Training can be imparted in formal institutions or on the job; its content and duration vary depending on the nature of the job and the complexity of the technology involved. Experience suggests that there is a trend towards on-the-job and tailor-made training and away from formal and general training. Moreover, it has been found that training is more effective if it is planned and organized with the active involvement of those to be trained. A good example is the National Cleaner Industrial Production Project of Ethiopia (NACIPPE) in which the Chemical Society of Ethiopia was involved in the training of industry employees in cleaner production. At the end of their training, the employees came up with a number of projects, some of which were implemented by the industries concerned with substantial financial gains in some instances in addition to having trained employees.

Training can help managers to appraise alternatives and choose more appropriate technologies to use installed capacity more efficiently, to be better supervisors, etc. At different levels, training may enable workers to contribute to improving product quality, to adaptation of technologies, and to innovation.

Technology adaptation and the generation of new technologies require research and development, and more broadly, an environment in which R and D have a chance of being effective. Where urgent national problems have to be solved, the direction of R and D efforts should be determined by national science and technology policies whose priorities are compatible with available skills and financial resources and have been shown to be valid in the light of what is being done elsewhere.

Many of the Universities with their teaching and research resources available in the Faculties, Schools and Institutes carry out teaching and research activities. Nearly all faculties in the Addis Ababa University have started post-graduate studies to satisfy the manpower requirement of the country, especially for the newly emerging regional universities.

However, in most of the faculties and research institutes, problems of research staff development, financial constraints, adequate selection of relevant research areas and proper research facilities including infrastructure, equipment and supplies are evident. As a result, the research activities carried out are not to the university's satisfaction both in quantity as well as quality. The over crowdedness, impoverishment, dilapidated infrastructure, and poor status of the rewards and morale of the academic staff seem to lead to a crisis in university education and research.

The time which qualified and experienced R and D workers can devote to actual R and D work is minimized by a shortage of efficient, well-qualified researchers and supporting staff. The social status, even of good researchers, tends to be as low as their income. There is a preference of R and D workers for theoretical research (Ph.D. thesis syndrome) and a relative distaste for practical application. Monitoring of research in progress and evaluation of R and D effectiveness are quite unheard of.

It is evident that, while it is essential for R and D institutions to establish a close relationship with the productive sector, effective linkages are often lacking. Research results, for example in the form of designs for more appropriate technologies, often stay on shelves instead of being tested and disseminated. One proven and significant reason for establishing linkages is the need for indigenous consultancy, which has the ability, knowledge and experience to tailor results to the practices and needs of the market.

An attempt was made to form Addis Ababa University-Ministry of Industry co-operation program in mid 1980's. The program had done quite a lot in solving industrial problems. However after the change in policy by the present government, from centrally planned economy to market economy, the university-industry linkage deteriorated and the program was suspended (*vide infra).*

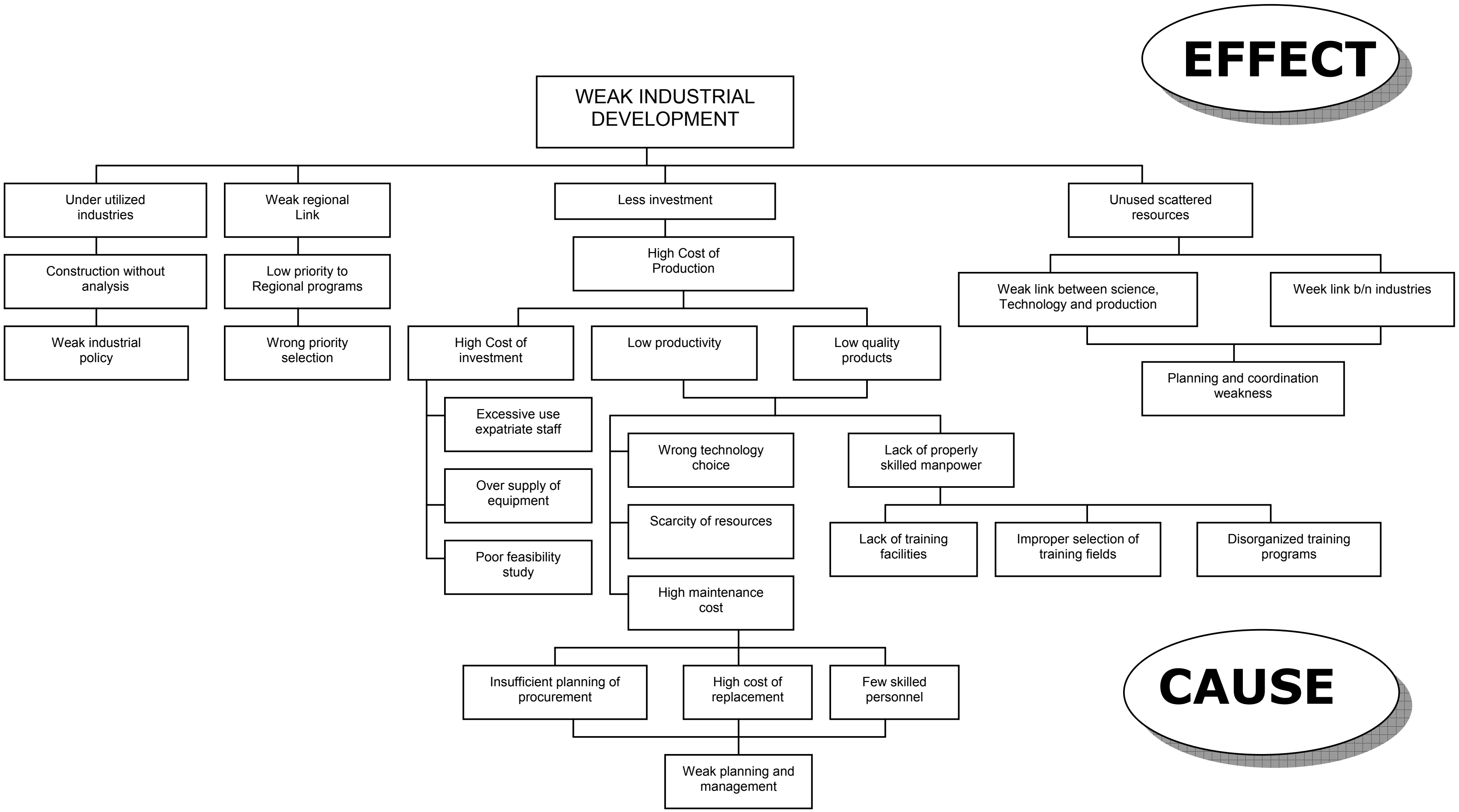
Another attempt was recently made by the Technology Faculty so as to revive the linkage between the University and the industries.

4. University-Industry Linkage Programs

4.1. Foreign Experience

There is hardly any university in the developed countries that does not have some form of interaction with industry. These interactions are very greatly supported by the governments.

Figure 1: Problem Analysis of Industrial Development



of the different countries for instance in the US, the National Science Foundation (NSF) is one of the many government agencies that play a great role in fostering university-industry interactions. It does this in several ways, some of which are: encouraging and providing partial support for academic and industrial researchers to cooperate in an ***Industry/University Cooperative Research Project***. The projects are in specified areas deemed to be of great importance for the nation to be competitive; this varies according to the era: for instance, condensed matter physics, materials chemistry (polymers), biotechnology have all been or are presently receiving NSF funding under this program; establishing Industry-University Cooperative Research Centers; creating the **Small Business Innovation Research** (SBIR) program. SBIR provides an important opportunity for small science and technology-based firms to participate in NSF research and working with universities, government agencies and large companies.[11]

The nature of university-industry interactions varies widely. In some instances the interaction will be between a single industry and a university in a specific area e.g University of Texas and Raytheon Company in Systems Engineering Master's Program. In other cases it may be a university with a consortium of industries and in still other instances it could be a consortium of universities with a consortium of industries covering wide fields of cooperation. There have been several advantages to these interactions; among the most important advantages are the establishment of Science and Technology Parks near many universities (e.g. the Research Triangle Park near the University of North Carolina) and of spin-out companies (e.g. the many biotechnology companies near Oxford University) near universities. These have benefited universities and industries in varied ways and have facilitated the university-industry interactions even more. It is not only the developed countries that have well established university-industry interactions but also the newly developed countries such as South Korea and Singapore which have used these interactions to be highly competitive in a variety of fields such as electronics. The Science and Technology Park set up near the University of Pune in India "proposes to convert into applied technology some of the discoveries and inventions of the University departments".[12]

Because the distinctive assets of a modern economy are now recognized as knowledge, skills and creativity, the future competitiveness of any country's business in this age of globalization will be dependent upon the country's ability to create innovation networks among universities, industries and government agencies. In the words of the US Council on Competitiveness ***"Interconnectedness is one of the keys to competitiveness in the knowledge-based economy"***. The nation that fosters an infrastructure of linkages among and between firms, universities and government gains competitive advantage through quicker information diffusion and product deployment.[13]

4.2. Addis Ababa University - Ministry of Industry Cooperation Program[14]

The oldest national university, Addis Ababa University, has been the main source of trained manpower to the economy. There has been a continuous contact between individual academic staff members of the University and the industry. Many scientific researches have been carried

[11] E.Bloch and C.E. Kruytbosch, *"The NSF Role in Fostering University-Industry Research Relationships"*, IEEE Transactions on Education, E-29, 1986.

[12] http://intcent.unipune.ernet.in/site/interactions.htm.

[13] *"Global: The New Shape of American Innovation"* US Council on Competitiveness, September 1998.

[14] Tarekegn Gebreyesus, *"Past University-Industry Cooperation"* March 1998 (Paper presented at a workshop on University-Industry Cooperation, March 27, 1998, Addis Ababa).

and remarkable results obtained. However, a coordinated effort has not been made for the research outputs to make a significant impact on the society. This is simply because of the lack of a sustainable institutional linkage between the University and the industries.

Some twenty years back, a number of meetings were held at the highest levels to establish a university-industry cooperation program. It culminated in the formation of the Addis Ababa University-Ministry of Industry Cooperation Program (UICP) in February 1986 through a formal agreement between the Addis Ababa University (AAU) and the Ministry of Industry (MOI).

The overall objective of UICP was to bring together Addis Ababa University and the Ministry of Industry so that they can accomplish their respective goals to achieve different aims. On the part of industry these aims included

- solving technical and managerial problems,
- injecting new processes, technologies, etc.,
- maintaining and improving productivity and efficiency,
- facilitating further training of existing staff, etc.

The aims of the university included

- practical training of students,
- making R&D relevant while maintaining independence of staff,
- augmenting its R&D resources with those from UICP,
- obtaining feedback on the direction of R&D, curricula, teaching approaches and consultancy services, etc.

The UICP was composed of four bodies:

- the Policy Committee,
- the Executive Committee,
- the Secretariat and
- the Liaison Office.

The Policy Committee was in overall charge of the UICP. It was composed of 12 university delegates and 13 from the Ministry of Industry and corporations under its control. Until the change of government in 1991, it was reported that the Minister of Industry, who served as the Chairman, ran the UICP personally through the Secretariat.

Funding was of two types: the regular budget for administration and office expenses was funded equally by MOI and AAU; the operational budget was funded partly by the two institutions and partly by "voluntary" contributions from the corporations of the Ministry of Industry. Each budget was approximately Birr 50,000 (US$25,000) per year.

Operational Activities

Some of the main functions of the UICP as described in the Policies and Procedures Manual included:

- research and development projects,
- seminars, workshops and symposia,
- thesis support,
- sponsorship of students,
- short courses,
- AAU-MOI cooperation program week, etc.

It was reported that a number of projects had some kind of UICP involvement but it was difficult to ascertain whether these projects would not have been carried out even if UICP was not involved.

4.3. Technology Faculty – Industry Linkage Unit (TFILU)[15]

It is believed that some groundwork has to be accomplished in order to establish a sustainable University - Industry Linkage. To this effect the Faculty of Technology, Addis Ababa University, started a Technology Faculty – Industry Linkage Unit (TFILU) on its premises. The main objective of this unit is to pave the way for the establishment of sustainable University - Industry Linkage. It had the responsibility of conducting need and capability assessment of Technology Faculty and the industrial sector at large so as to form a strong foundation for a reliable linkage. The Unit examined the activities carried out by the Addis Ababa University – Ministry of Industry (AAU-MOI) co-operation program to learn from the successes and shortcomings of their experiences.

TFILU run its activities in collaboration with the National Advisory Body (NAB) of the Unit and the Addis Ababa University Research and Publication office. NAB is composed of members from the Ministry of Industry, the Ethiopian Science and Technology Commission (ESTC), the Public Enterprises Supervising Authority, the Chamber of Commerce, private companies and the Faculty of Technology. The activities to be carried out by the Unit towards meeting its objectives include;

1. Study on "Survey on Skill Needs and Capabilities of Technology Faculty and the Industrial Sector",
2. Lay the foundation for (IT) technology information dissemination,
3. Prepare and conduct summer courses for industrial personnel,
4. Organize seminars and workshops on recent industrial issues (at least one workshop and one seminar a year),
5. Organize educational visits and vacation jobs for students,
6. Conduct research activities on already identified problems of industry and promote and co-ordinate research activities in the Faculty.

<u>Organization of the Unit</u>:

The Unit began its operation in July 2000, soon after the grant had been obtained from ESTC. The first few months have been devoted to organizing the office

[15] Daniel Kitaw *"Proposal for Technology Faculty Industry Linkage"* AAU, Faculty of Technology. Jan. 2000

- The **executive committee** of the Unit, which has five members, was formed from various departments of the Faculty.
- **Sub committees** for Training, Research and Consultancy, Industry Job-Core, Workshops and Seminars, and Information Technology were formed maintaining the departments' mix of the Faculty.
- **By-laws** of the Unit were drafted and discussed upon at all levels of the Unit's organization.

Operational Activities:

Some of the main functions of TFILU as described in its document include

1. Training,
2. Researches and Consultancy,
3. Industry Job-core,
4. Workshops and Seminars,
5. Information Technology.

The initial fund to establish TFILU was provided by Addis Ababa University (in kind by providing office facility) and the Ethiopian Science and Technology Commission and was expected to continue. However the freezing of the project fund by ESTC made it very difficult for the Unit to carryout its activities as intended. This has jeopardized its activities and quenched the vigorous interests of the committee members who freely sacrificed their time and energy for the cause.

4.4. Recent Developments

In the first week of February 2006 the Ethiopian Manufacturing Industries Association took the initiative to carryout activities during the Ethiopian industry week. There were work shops, seminars and discussion forums during the week. The main topic that was debated upon was University Industry linkage. At the end of the workshop a steering committee was set up to follow the linkage issue through.

The committee then approached the Ministry of Capacity Building, Engineering Capacity Building Program. An encouraging progress has been achieved in the past three months. An international consultant (from Germany) and a national consultant have now signed contracts to carry out a study on university industry linkage and come up with a concrete proposal on the modalities of the linkage that has to be institutionalized.

In April 2006 a memorandum of understanding was signed between the Faculty of Technology, Addis Ababa University and the Ethiopian Manufacturing Industries Association. The cooperation was an outcome of the preliminary contacts and discussions made between officials of EMIA, and the Faculty of Technology. After the signing of the understanding the planning of joint activities (training, research, consultancy, exchange of staff and the like) is in progress by a joint team.

5. A Way Forward[16]

5.1. Development Rationale

The Ethiopian industries are operating in business environment characterized by unprecedented global competition and technological change. Furthermore, their efforts fail to result in improved tools, equipment and services reaching the community. For the industries to survive and be competitive it is essential that they have to consciously link with higher education and research institutions so as to optimally use the available scarce resources of county.

The existence of scientific and technological institutions in the country doesn't guarantee the provision of appropriately skilled workers and relevant research out put to satisfy the immediate needs of the industry.

The proposed Center, in this study, is not in the slightest to duplicate what the others are doing nor to create a giant institution as to satisfy the national pride. But, it is an attempt to make a conscious and co-ordinated effort in order to integrate the scarce available resources of the country. On one hand, it would provide a linkage to integrate the resources available at higher education institutions and the industries, and set research priority areas and bring an immediate impact on the rural communities. On the other hand, the proposed Center would enhance the underutilized industries to produce better tools and equipment and would thus provide a direct stimulus to the industrial development.

As a cross-sectoral project, the counterpart institutions would be the Ministry of Trade & Industry, the Ministry of Education, the higher education academic and research institutions, Ministry of Capacity Building, Ethiopian Manufacturing Industries Association and Chamber of Commerce.

5.2. Objectives of HEIRIC

This proposal has the main objective of establishing a "Higher Education–Industry Resource Integration Centre" (HEIRIC).The primary thrust of the proposed HEIRIC, is to integrate the Higher Education Institutions staff and students as well as its research infrastructure to resolve problems of industries and boost productivity and to improve their own teaching and research capabilities. To realize this objective, HEIRIC plans the following distinct but interrelated activities.

1. Short term training courses tailored to industries in various fields and at different levels,
2. An internship program (or vacation jobs) for pre-graduating students in industry during their study period,
3. Organizing sponsorship program for students,
4. Carrying out research activities based on the needs of the industry,
5. Involving the University staff as advisors to industries especially as counter parts when the industry is involved with foreign advisors,
6. Inviting experienced industrial workers as part-time lecturers, guest lecturers or through joint appointment both at under-graduate and post-graduate level,

[16] Ideas are taken and adapted from *"Proposal for a Sustainable University Industry Linkage Program"* Tarekegn G.Yesus and Daniel Kitaw AAU Dec 2003.

7. Strengthening and developing research facilities of the Technology and other Faculties through the fund generated,
8. Providing technical support during purchase and running of sophisticated equipment,
9. Promoting and fostering appropriate "Technology Transfer",
10. Prototype development and building incubation units,
11. Promoting and initiating Techno parks.

Such activities and interactions would be of benefit to both industry and university by enabling them to:

- Establish multidisciplinary programs that are responsive to industrial needs,
- Carry out specific company-sponsored projects,
- Strengthen team-based, cross-disciplinary, problem-solving industry-university exchanges by placing faculty and students at industry sites and industry scientists/engineers at the university,
- Provide a real world and a high-calibre educational experience for graduate and undergraduate students.

5.3. Organisation

HEIRIC requires a Board of Directors (composed of government, higher education institutions and the industries), which will be vested with responsibility for establishment of polices, and strategy, and supervision of its activities. The Board should be represented by the following (with additional members to be added as needed)

-	Ministry of Capacity Building	1
-	Ministry of Education	1
-	Ministry of Industry	1
-	Science & Technology Agency	1
-	Public Enterprises Supervising Agency	1
-	Public Higher Education Institutions	5
-	Private Higher Education Institutions	3
-	Ethiopian Chamber of Commerce	1
-	Addis Ababa Chamber of Commerce	1
-	Professional Association Joint Secretariat	1
-	Private Companies	5

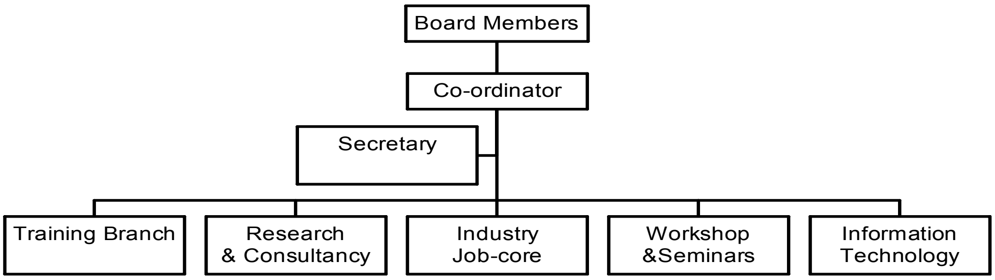
Membership to the board shall be on a three-year rotation basis. Under the guidance of the Board members, the Center director serves as chief executive officer of HEIRIC and will be responsible for the planning, direction, supervision and control of all day-to-day activities of the centre.

Under the Center director there will be committees (Figure 3) responsible for

1. Training,
2. Research and Consultancy,
3. Industry-job core,

4. Workshops and Seminars,
5. Information Technology.

Figure 3: Proposed Organizational Structure of the HEIREC



Training

The objective of this program encompasses both formal and informal education and other forms of learning experiences. It relies on structured approaches to knowledge and skill enhancement that better match labour force needs. It is possible to have three different types of trainings: tailored; off-the-shelf; and combinations of tailored and off-the-shelf training.

Research and consultancy

The main objective of the Research & Consultancy branch is to facilitate a conducive environment for researchers to carry out research that is relevant to the Ethiopian industries.

Industry-Job core

The primary objective of the "Industry-Job Core" program is to introduce students into the workplace early on their academic studies. The program has dual impact. First, it helps to close the gap between the academic studies and the practical application of acquired knowledge and skills in the working environment. Secondly, it provides the industry with an opportunity to access semi-skilled labour as well as to have direct influence over the development of skills of future graduates.

Workshops and Seminars

The objective of this program is to organize relevant workshops and seminars on a regular basis and disseminate the outcomes using newspapers, newsletters, professional journals or any other appropriate means.

Information Technology (IT)

The objective of this program is to electronically network higher education institutions and industries. To this effect the network set up by Addis Ababa University (AAU) promises a revolution in information gathering and dissemination both for institutions of learning and the public at large. For industries affiliated with the HEIRIC, the network promises to greatly increase their information gathering capacity; with the envisaged computerization of the library system at AAU.

5.4. Source of Finance

The initial fund to establish the HEIRIC is expected to come from the Ministry of Capacity Building, Ministry of Trade and Industry, Ethiopian Science and Technology Agency, public and private Higher Education Institutions and Manufacturing Associations. In due course the Centre will search for internal and external collaborators both in the public and private sectors. It will also start generating its own fund through consultancy and training activities.

Basically, profit making is not the Centre's principal objective. However it shall generate reasonable incomes by rendering consultancy and/or training services to the community at large and to the industries in particular. The Centre shall also seek donations, in cash and/or other forms, from national and international institutions wishing to support its objectives.

The Centre shall encourage industrial firms and organizations to be its institutional members and pay nominal standing fees and, as a reward, get a 15% reduction for institutional members and 10% reduction for associate institutional members on the charges for consultancy and/or training services.

6. Concluding Remarks

There have been many attempts, by national and international organizations, to resolve the problem of technological under development. Some of the efforts made are establishments of industrial plants, design centres, scientific and technological institutions and the like, in addition to the seminars, workshops, trainings abroad and advisory services at different levels. The effort made by many governments, donor organizations and international agencies is undoubtedly remarkable and has addressed the problem to a certain extent. However, the attempt lacks a co-ordinated effort and falls short of making the maximum out of the existing under-utilized industries, reforming the weak regional co-operation, making the industrial ambient attractive to investors and strengthening the link between University, Industry and Government.

The past Ethiopian University-Industry linkage experiences were primarily anchored on administrative decision rather than being on needs and demand. The administrative decision was easily executed for it was public-public partnership. The current and future scenario would be complex: public-public, public-private and private-private: where the players would be both public and private higher education institutions and industries owned by the government and private sector. The Centre would be established on true demand and assured sustainability.

Based on the experience of other countries, AAU-MOI cooperation program, TFILU, and the felt need that exists in the industries, the author strongly recommends:

1. Ministry of Capacity Building, Ministry of Education, Ministry of Industry and Trade, the Ethiopian Science and Technology Agency, public and private Higher Education Institutions and the business community should make a coordinated effort to establish and strengthen a nation wide ***Higher Education - Industry Resource Integration Centre.***
2. Secondly, all higher education Institutions should start ***linkage units at an associate vice president and associate dean level*** as early as possible. And those who have already started should properly appreciate the efforts made and strengthen the initiatives.

Practical Attachment Program: Achievements and Constraints

Mulu Bayray
Esubalew Tamrat
Yeshambel Mekuriyaw

Mekelle University

1. Presentation outline

- Mekelle University in Brief,
- Background of Practical Attachment Program (PAP),
- Objectives of the Program,
- Achievements of the Program,
- Constraints of the Program,
- Conclusion and recommendation.

2. Mekelle University in Brief

- Mekelle University was established through a merger of Mekelle Business College (MBC) and Mekelle University College (MUC),
- MBC begun accredited diploma program in 1991 in the fields of business, while MUC started as College of Dry land Agricultural and Natural Resource (CDANR) in 1993,
- MBC enrolled 150 first batch of diploma students while CDANR enrolled 42 degree students in its first batch,
- Mekelle University currently enrolls close to 20, 000 students in its regular, continuing and distance programs,
- The yearly student population for the last fourteen years is shown in Table 1

Table 1: Student Population Mekelle University 1991 - 2005

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999
Male	129	483	788	509	567	1498	2010	2489	2364
Female	21	199	285	140	145	448	472	589	630
Total	150	682	1073	649	712	1956	2482	3078	3094

Year	2000	2001	2002	2003	2004	2005
Male	5214	5648	4764	10231	13377	15619
Female	1381	1548	998	2621	3514	4159
Total	6585	7196	5762	12852	16891	19778

- Currently Mekelle University has six academic Faculties and one College.
- Overall the University runs 40 academic departments offering undergraduate program and 5 departments offering graduate programs.
- Staff profile (see Table 2).

Table 2: Staff Profile Mekelle University

Faculty	No. of staff
FDANR	115
FBE	158
FST	125
FOL	26
FED	198
FVS	11
CHS	44
Total	624

3. Background of Practical Attachment Program (PAP)

- Mekelle University has a motto which says "Higher Education with Practical Emphasis",
- The University began its PAP in line with the motto for the first time under the Faculty of Dry land Agriculture and Natural resources,
- Faculty of Science and Technology, Faculty of Business and Economics and Faculty of Law followed in introducing PAP in their curriculum,
- The PAP at Mekelle University is designed as part of the curriculum that a student should fulfill before graduating,
- The program has two to four credit hours with clear objective, tasks to be carried out by students and method of evaluation,
- The duration of practical attachment program varies with Faculties. In Faculty of Dry land Agriculture and Natural Resources the duration is three months while for the Faculty of Science and Technology, Faculty of Business Education and Faculty of Law the duration is two months,
- Students are evaluated on their performance of the program by their respective departments. The evaluation process generally is based on three stages:

    1. evaluation by host institution,
    2. supervision during the program, and
    3. report and presentation of their work.

- Mekelle University incorporated the Practical Attachment Program as one of its objectives in the 20 years strategic plan. In line with this plan the University established PAP offices at each Faculty and appointed coordinators.

4. Objectives of the Program

- The general objective is to produce graduates with practical orientation, competent, and confident to carry out their jobs. The program enables students to understand the existing situations of the community, organization or industry.
- The course is designed with the following major objectives:

  - To orient students with their field of profession,
  - To enable a good career development for students,
  - To identify potential employers through networking,
  - To enable students understand the livelihood of the rural community, work procedures of organizations and industry.
- In addition to fulfilling their academic requirement students benefit from PAP:
  - Identify practical problems for their senior essay or final year projects,
  - Attain practical skills,
  - Change attitude and behavior,
  - Test their theoretical knowledge and professional competence,
  - Develop and instill confidence.
- Host institutions will benefit because they will:
  - Get areas of interventions identified in their activities,
  - Get feedback on the performance of their developmental activities,
  - Identify research priorities,
  - Fill man power gaps during the program period,
  - Have opportunity to asses potential employees.
- The University will benefit because it can:
  - Produce practically trained, skilled manpower,
  - Gather information for practical and problem solving researches,
  - Get feedback for curriculum review,
  - Establish partnership with institutions,
  - Analyze current situations in communities, organizations and industry.

5. Achievements of the Program

- The University conducted annually the PAP during the summer season in collaboration with host institutions. It has successfully conducted ten rounds with all students hosted in different institutions.
- The feedback from students who participated in the program and host institution was very positive. Students have benefited from the program and many have been employed in institutions where they were initially hosted for the PAP.
- Institutions have also positively responded to the objectives of the PAP (see Table 3).

Table 3: Students from Mekelle University Faculties involved in PAP

PAP cycle	Faculties				Total
	FNDAR	FST	FBE	FOL	
1st - 1996	28				**28**
2nd -1997	38				**38**
3rd –1998	42				**42**
4th -1999	48				**48**
5th - 2000	53				**53**
6th - 2001	101				**101**
7th - 2002	84		191		**275**
8th –2003	118	145	186		**449**
9th - 2004	196	132	198		**526**
10th-2005	606	117	257	34	**1014**
Total	1314	394	832	34	**2574**

6. Constraints of the Program

- Even though the program was successful and benefited all stakeholders there is difficulty to accommodate all students to potential sponsors with the increasing number of students.
- Due to sponsorship problem students were forced to complete the program by their own (self-sponsor) and resulted in not objectively designed practical works.
- Due to the significant increase in number of students since last year, the university was unable to secure placement of all students.
- The main constraint of the program is lack of budget to run the program. The University has made some efforts to close the gap:
  - Through encouragement of students to sponsor themselves,
  - Soliciting sponsorship by projects under Mekelle University,
  - Arrangement of placement of students close to their homes,
  - Through encouragement of students to work in their localities.

7. Conclusion and Recommendations

- Practical attachment program will equip students with appropriate tools to be competent citizens in their field of profession. This program should be strengthened and given attention by all stakeholders.
- Therefore, the government, funding institutions, private institutions and organizations should actively get involved to overcome the budget problem to accommodate the increased number of students.

- This conference which aims at transforming University-Industry-Government relations is an opportunity to create awareness about the problems associated with PAP and pave ways to bring about solutions.

8. Recommendations

- The relationship between higher education, government, non government and private organizations has to be strengthened,
- Higher institutions have to work towards involving more non governmental and private institutions in the program,
- Encourage students to sponsor themselves,
- Funding organizations should support the program until sufficient awareness is created in all stakeholders,
- The government has to allocate budget to partially cover the expenses of the program, which may be included in the cost sharing scheme.

Operational Research Program for Food Security and Sustainable Livelihood: A case study on Participatory Varietal Selection (PVS)

Hawassa University Southern Agricultural Research Institute & Bureau of Agriculture and Rural Development

Funded by: Ireland Aid

1. Presentation outline

- Theoretical foundation of operational research:
  - Why Participatory Action Research,
  - Evolution of research and development thinking,
  - Agricultural Research and Innovation Continuum.
- Components of operational research,
- Participatory Varietal Selection: the process and outcomes,
- Scaling-up.

2. Why Participatory Action Research?

- The conventional research and development model:
  - Has failed to provide appropriate and relevant technologies that support agricultural and economic development
  - Has not taken sufficient time to understand clients needs, priorities and practices
  - Underpinned by instructional and blue-print approach

Table 1: Evolution of Research and Development

Period	Explanation to farmers non-adoption	Prescription	Key extension activity	Socio-economic research frontier	Dominant research methods
1950s & 1960s	Ignorance	Extension	Teaching	Understanding the diffusion & adoption process	Questionnaire surveys
1970s & 1980s	Farm level constraint	Remove constraint	Supplying inputs	Understanding FS	Constraint analysis FSR
1990s	Technologies doesn't fit	Change the process	Facilitating farmers participation	Enhancing F competence, changing professional behaviour	Participatory research by and with Farmers

3. Objectives of Operational Research Programme

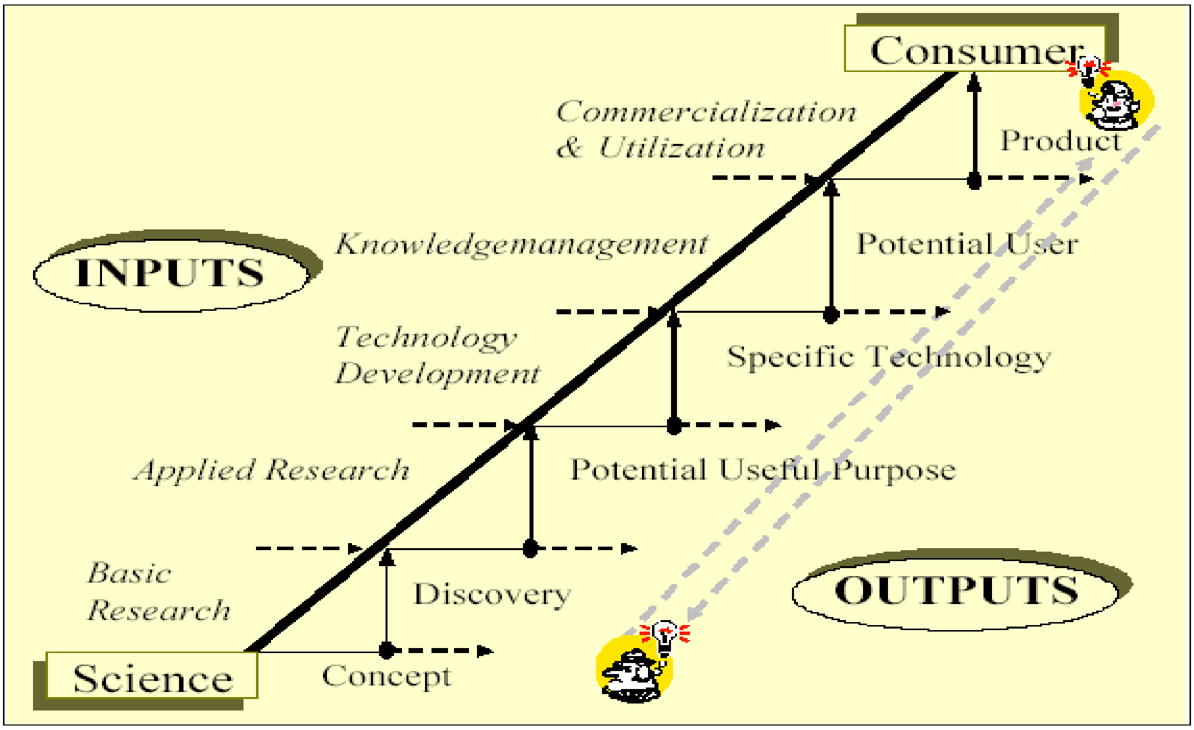
1. Undertake relevant and appropriate research "in-situ" that is farmer-led, disseminated to all relevant stakeholders, and which informs future program orientation;

2. Conduct training needs assessment for farmers, development agents, subject matter specialists, and key policy makers in the region; design/modify training materials as appropriate, and deliver appropriate training and related capacity-building activities.

4. What PAR Change?

- PAR recognize that innovation is a social competence (several actors or stakeholders are involved and contribute successfully and less successfully in the process)
- PAR demand new methodologies, institutional set-up and professional attitude
- PAR links research, development and policy

Figure 1: Agricultural Research and Innovation Continuum



5. Components of Operational Research

- **Diagnostic and site characterization:** a wide range of participatory appraisal on bio-physical and socio-economic aspects was undertaken (PRA, SLS, Transect survey on vegetation and feed resources, HIV/AIDS etc.).
- **Farm recording:** was carried out with farmers selected and trained to keep a daily record of all their farming operations as well as inputs and outputs.
- **Technology testing and dissemination:** different action researches in crop, livestock and forage development, soil and water conservation has been conducted.

6. Participatory Varietal Selection (PVS)

- Participatory Varietal Selection (PVS) is a process of active and functional involvement of farmers in the planning, implementation, monitoring and evaluation of crop varieties and their promotion,
- PVS can be used to identify acceptable new varieties and thereby overcome the constraints that cause farmers to grow landrace and obsolete cultivars,
- PVS exploit local expertise (farmers' wisdom) and local resources (farmers land in place of on-station plots) in achieving outputs that are more appropriate to the environment.

7. PVS Process and Outcomes

- **Selection of varieties:** Five varieties of haricot bean; three varieties of soybean, five varieties of teff, and four varieties of wheat were tested.
- **Selection of farmers:** A well-being ranking, largely based on the levels of food sufficiency and resource endowment, was conducted at the beginning to allow farmers

from different well-being categories to be equally represented in Farmers Research Groups (FRG).

- A total of 25 farmers were selected for FRG in each PA

8. FRG has Played the Following Roles in the Process of PVS

- Actively participate in action research activities,
- Participate in testing and selecting appropriate technologies and practices,
- Share their knowledge and expertise with researchers and development practitioners,
- Mobilize the communities for field days, trainings and seminars,
- Play a model farmers role.

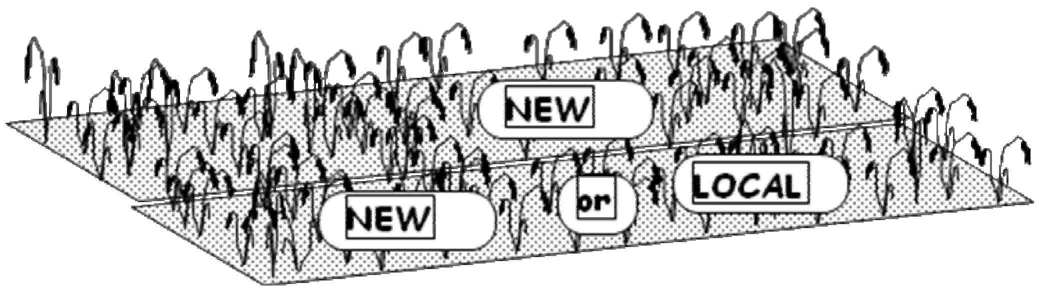
9. PVS Design

- Mother and baby trials was employed due to its simplicity and suitable to the condition of Ethiopia.
- **A baby trial** consists of a single new variety that is given to the farmer to enable him/her to compare it with his/her own variety. Sufficient seed was given to allow the farmer to plant a relatively big plot so that the comparison can easily be made.

The "Baby" Trial (Figure 2)

- one or two new cultivars per farmer;
- compared to local cultivar or second new variety:
- farmer managed, farmer inputs:
- evaluation of farmer's perceptions.

Figure 2: "Baby" Trial



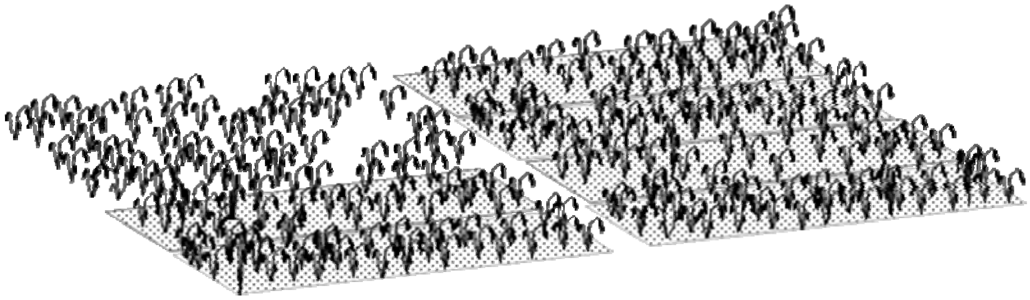
- In the **mother trial** all new varieties tested in baby trial were grown in as a single replicate in centrally located villages often with innovative farmers. The varieties comprising the baby trails came from the mother trial. Each mother trial in our case was composed of 4-5 varieties.

The "Mother" Trial (Figure 3)

- many cultivars, several locations, one replicate per location;
- researcher designed, farmer managed, farmer level of inputs;

- yield and maturity measured by researchers;
- consultative evaluation of other traits.

Figure 3: "Mother" Trial



10. Result and Discussion

- **Haricot bean:** Haricot bean is one of the major grain legumes widely cultivated by smallholder farmers in SNNPR. The farmers are using the crop for home consumption and income generation.
- Only a single variety has shown a yield advantage over the local one (Figure 4). However, farmers employed a number of parameters to select their preferred Variety (Table 2).

Figure 4: Haricot Bean Yield Performance.

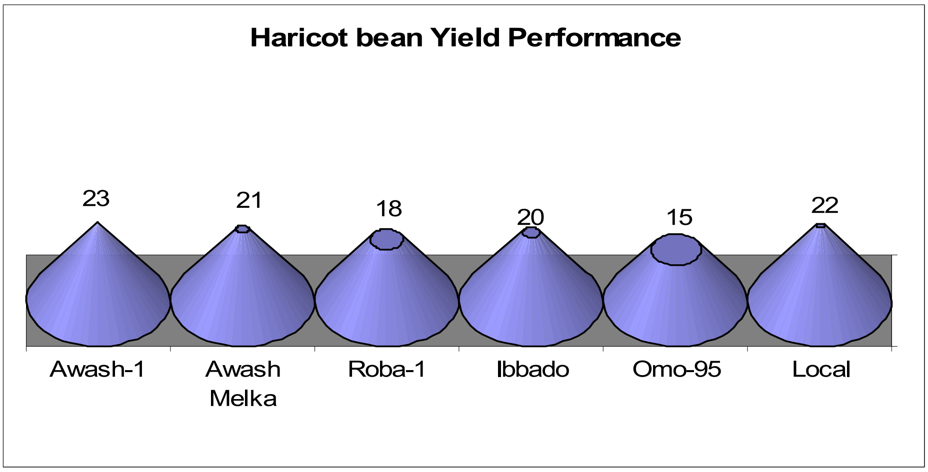


Table 2: Farmers' preference ranking

Parameters	Awash 1	Awash Melka	Roba - 1	Ibbado	Omo-95	Local
	Varieties					
Seed colour	1	3	5	2	6	4
Seed size	2	3	5	1	6	4
Earliness	4	5	2	1	5	3
Market demand	1	2	5	3	4	4
Yield	1	2	5	3	6	3
Overall score	1.8	3	4.4	2	5.4	3.6
Rank	1	3	5	2	6	4

Farmers' preference ranking, *Key for scale (1-6); 1= best, 6= least*

Farmers selected Awash-1 and Ibado because of their market and best food value respectively

11. Soybean

- Soybean is a newly introduced crop in the region and its production is not as such intensive among smallholder farmers. Awassa Agricultural Research Centre has recently released seven varieties for production. In operational research only the three varieties were selected for PVS due to their earliness (Table 3).

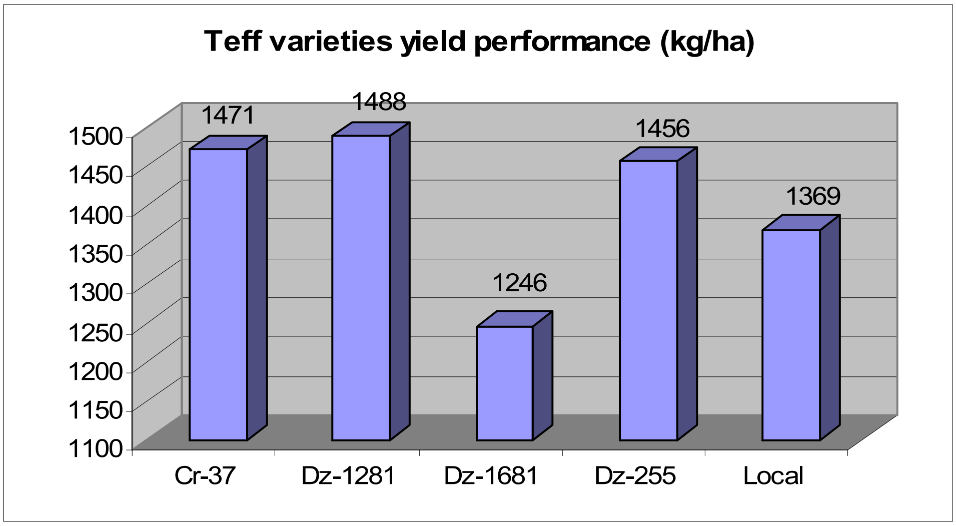
Table 3: Soybean Varieties Yield Performance (kg/ha).

Varieties	Locations			Mean	Rank
	Awassa Zuria Woreda	Boricha Woreda	Meskan Woreda		
Awassa 95	1981.0	1855.5	1050.0	1628.8	2
Crowford	**1881.8**	**1956.5**	**1168.0**	**1668.8**	**1**
William	1950.8	1431.8	1001.8	1461.4	3

12. Teff

- Except one variety (i.e. Dz-1681) all improved varieties showed yield advantage over the local varieties. As a result farmers in both woredas selected Dz-1281 and Cr-37 for seed multiplication (Figure 5)

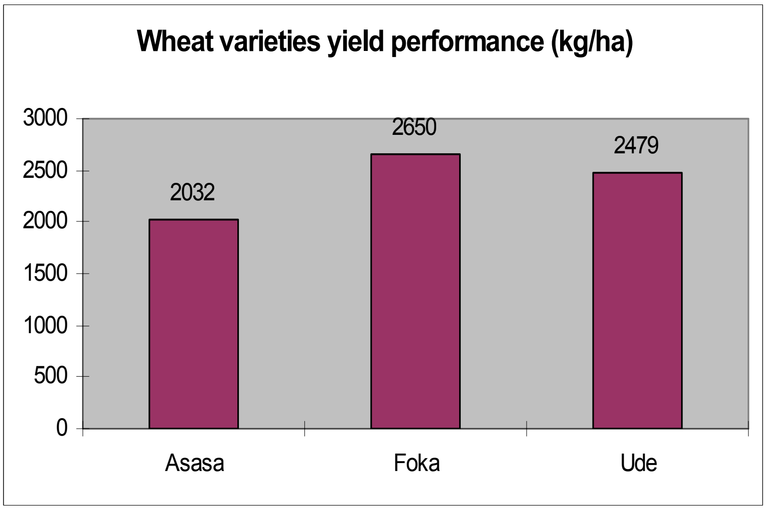
Figure 5: Teff Varieties Yield Performance (kg/ha).



13. Wheat

- The wheat varieties were introduced only in Meskan woreda due to its agro-ecological suitability. All the varieties are durum wheat and they have shown better yield performance (Figure 6).

Figure 6: Wheat Varieties Yield Performance (kg/ha).

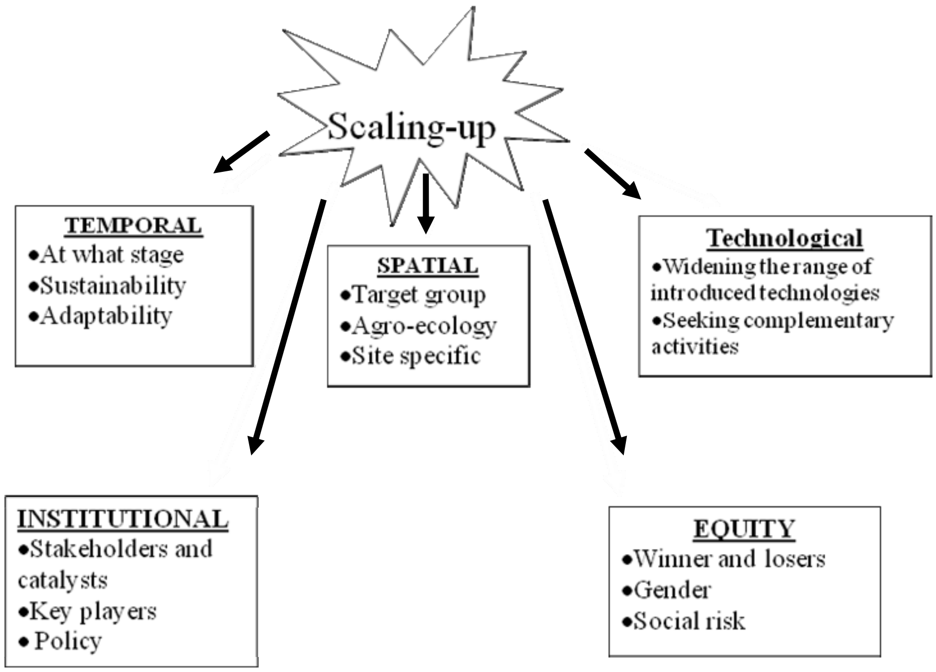


Farmers selected Ude and Foka variety for seed production.

14. Scaling-up

- Scaling-up of process, innovations and products have a significant contribution to institutional development, biodiversity and farmers livelihood (Figure 7).
- Scaling-up is a process of reaching large number of people. Specific innovation and methodologies accepted by conventional research, development and policy framework should be scaled up.

Figure 7: Scaling-up framework



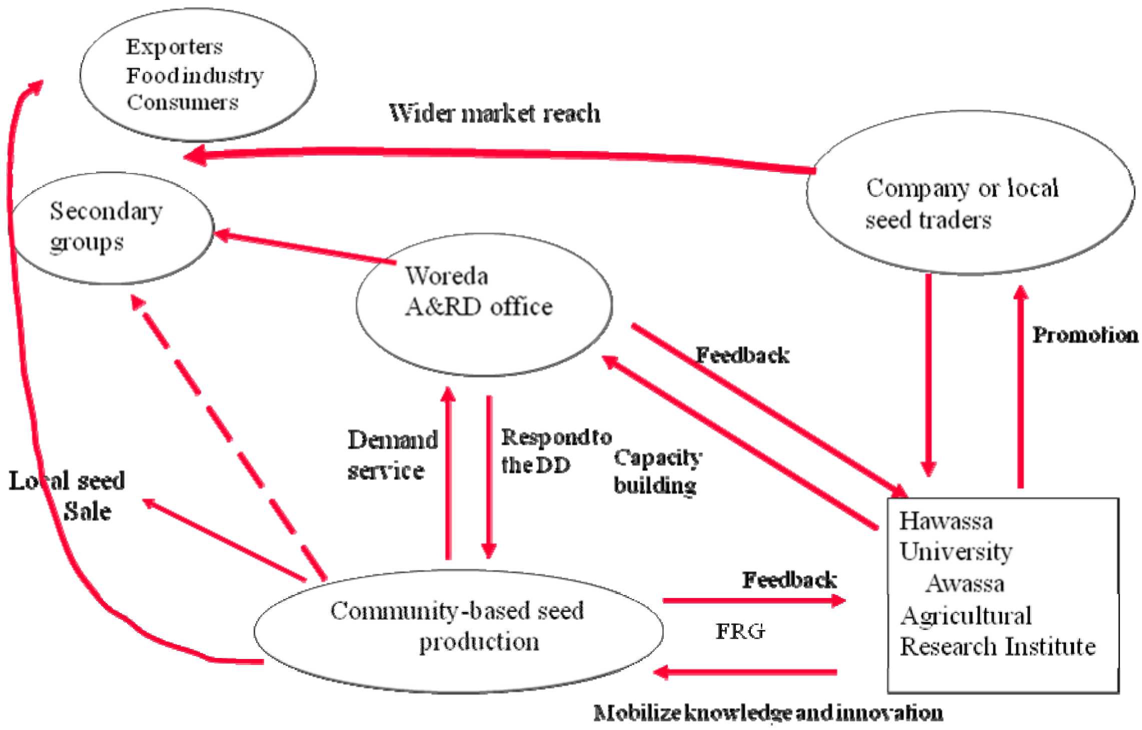
15. Scaling-up in Operational Research

- Community based seed production scheme:
  - Local seed production scheme should be seen in the context of enhances linkage among research-development continuum stakeholders,
  - The FRG organized at PA level has taken the responsibility for starter seed **multiplication**; and at the moment seed increase work has been done on **two varieties of haricot bean, wheat and teff and on three varieties of soybean,**
  - This year the FRG groups are up-graded into community based seed production organization and currently it has 50 members in each woreda.

16. Issues in Community-Based Seed Production

1. Choice of crop(s) and variety,
2. Source of seed,
3. Training of seed producers,
4. Quality control/inspection,
5. Need for credit to produce the seeds,
6. Cleaning, packaging, and marketing of seed,
7. Sustainability issues.

Figure 8: Community-based production scheme framework



SECTION 4

ANALYSES FROM AN INTERNATIONAL VIEWPOINT

Ethiopia: Innovation and Growth in International Comparison

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Introduction and Background[17]

With technical progress and, notably, the advance in information and communications technology (ICT) allowing for access to information at rapidly declining costs, societies around the world encounter new opportunities for development. At the same time, it is becoming more difficult for any society to compete and lay the foundation for an acceptable level of living based simply on standardized production, low wages, and low costs. Increasingly, innovation is recognized as key to economic transformation, growth and poverty reduction. A country's ability to tap the creativity of its population and foster new, commercially relevant, ideas and products is becoming critical. Many countries find it urgent to upgrade the institutions and economic activities that are essential for making use of the new tools. Yet, progress with respect to new technology and knowledge cannot be commanded from the top. A formula for success must critically include the adoption of policies and instruments that allow each society to advance from within.

The innovation systems approach (Freeman, 1987; Lundwall 1992) views innovation as resulting from a constructive interplay between different but complementary spheres of expertise, and between key players. More specifically, innovation and better knowledge use is dependent on capabilities and initiatives undertaken by actors within three spheres: academia, the private sector, and government. Interactions between them are influenced by the role of each entity, and the incentives and means that drive their behaviour, as laid out by the theory of triple helix. Increasingly, the success of innovation systems depends on what integration and collaborative interaction develop between these entities. The triple helix model illustrates how relations between policy makers, scientists and business must be framed in order to account for healthy linking of research and technological and commercial opportunities (Etzkowitz et al., 1998).

With technical breakthroughs and the ongoing globalization process, despite continued market integration and barriers to liberalization in many markets, product and factor markets are nevertheless inevitably becoming more accessible more or less across-the-board. Countries are very differently placed to capture the opportunities, however. Most developing countries have not yet paid sufficient attention to the importance of innovation and entrepreneurship for generating growth. Developed countries, meanwhile, have so far not sufficiently considered the role of international cooperation in fostering technical and non-technical innovation (Juma et al., 2001). Numerous regulations and governance practices tend to standardise universities and hamper their dynamism, confine entrepreneurship, and account for lock-in of knowledge flows and innovative efforts.

The problems of turning knowledge creation and use into a driving force for local, economic development are particularly stark in Africa. Whereas each country needs to learn how to master and upgrade its own specific assets, it is important to study and draw lessons from the experience of others. So far, there have been relatively few in-depth considerations of the African context. Against this background, the present paper provides an overview of the growth and innovation performance of one individual country, namely Ethiopia, while adopting an international perspective and drawing on multiple comparisons with other relevant countries, including in Africa.

[17]. Extensive input was provided by colleagues at IKED. The authors are grateful to Boyan Kostadinov for assistance with graphical material and to Karin Helene for editing and formatting the document.

Ethiopia is a country with a long, proud history, and which has remarkable and impressive institutions in many respects. In recent years, economic growth has increased significantly. However, after decades of both political and economic problems, Ethiopia is one of the poorest countries in the world, and an impetus to sustained and equitable income growth is needed. An analysis of the potential and problems inherent in its national innovation system could help identify outstanding issues and point to opportunities for growth-friendly reforms. An application of the triple helix concept can further contribute to essential understanding how the various key societal actors can be engaged so as to facilitate effective implementation of such reforms.

This benchmarking exercise takes its main thrust and structure from two important points. First, drawing on the entities outlined in the triple-helix model – government, university and industry - it focuses on the importance of allowing all these three spheres to be dynamic and able to develop and excel in their own agendas, while also demonstrating how the interface between them could be either hampering or facilitating progress. On this basis, the paper moves towards pinpointing basic ingredients needed for a successful innovation system. Second, it recognizes that fostering science and technology and innovation more broadly is especially challenging in low income countries.

To this end, the paper is organized as follows: The next section suggests some specific issues related to innovation systems in low income countries. The third section looks at the challenges facing Ethiopia specifically, while the fourth section focuses on its international competitiveness. The fifth section looks at the national innovation system, especially aspects of relevance to the triple helix, and indicators that measure its outputs, inputs and, to some extent, its linkages. The sixth and final section concludes.

1. Innovation in Low Income Countries: Opportunities and Challenges

The World Bank defines low income countries as countries in which (2004) GNI per capita was $845 or less – i.e., an average income of less than two per cent of that of the United States. This groups together many geographically, culturally and structurally very diverse countries. In spite of vast differences, many of these countries are likely to face similar opportunities and challenges with respect to innovation. What hopes does innovation hold for the poorer countries, and what challenges need to be addressed for its promises to be realized?

- <u>The promise of income growth.</u> The literature on endogenous growth has developed a strong case for the role of innovation and ideas more broadly in spurring higher income growth. Innovation is a process that can raise productivity; higher productivity is, over the longer run, essential to higher income per capita. Clearly, poor countries have most to win, if innovation can spur a growth process that can bring the majority of the population above minimum standards of living. High growth dynamics in small firms, which dominate the private sector in low income countries, can result in better spread of wealth.
- <u>The promise of better health and more food.</u> The role of innovation in raising growth can be seen as an "indirect" - albeit extremely important - effect of innovation on wellbeing. There are also many areas where science and technology advancements could directly improve the lives of millions of people, with potentially dramatic effects especially in low income countries. There is a dire need for drugs against pandemic diseases like malaria and HIV/AIDS. New fertilizing techniques to raise crop productivity would help small farmers feed their families and raise incomes. Technology can help provide clean and safe water (see Box 1). Indirectly, improved health and higher farm productivity would

increase both the quality and quantity of labour supply, which in turn could feed back positively into growth.

- The promise of indigenous knowledge. Developing countries and development agencies are increasingly recognizing the knowledge base in developing countries, including traditional medicines, farming methods, etc., and the need to focus not only on appropriate technology transfer, but on integrating and adapting indigenous knowledge in the innovation system (Finger and Schuler, 2002).

Box 1: The Role of Science and Technology in Improving Access to Water and Sanitation in Developing Countries

Sound water management is one of the key pillars to sustainable development. It is essential for agriculture and food, energy, biodiversity, health, and poverty reduction. One of the Millennium Development Goals, agreed on by the international development community in 2000, focuses on halving by 2015 the proportion of people without sustainable access to safe drinking water and sanitation.

Investments in science and technology and their application can directly help improve sustainable water management in developing countries. One the one hand, it is a matter of applying current knowledge to the field. This needs to be coupled with intensified research efforts, however, to meet existing challenges in safe water use and distribution.

Existing knowledge in water science includes the technological hardware for providing drinking water and sanitation in poor countries (boreholes, hand pumps, improved latrines) and improving irrigation service delivery for small-holders (the bamboo tube well, on-demand canal regulation systems). There is also a body of experience on the institutional "software" for implementation and scaling up, such as decentralized community systems for operational management, health and hygiene education, and participatory management systems for small-holder irrigation. With a concerted effort from the international community, the knowledge base can be successfully applied to help promote equitable access and adequate supplies of water. But inefficient water use in agriculture together with climate threats (both variability and long-term changes) means that water availability will remain limited.

Research avenues to pursue include the development of technology and institutional set-up for increasing access to sanitation, especially through eco-sanitation approaches, develop further new institutional approaches to water management (legal reform, partnerships), increase water productivity in agriculture, e.g. through innovations in molecular biology, and increase climate information and improve forecasting. Such advances would help develop consistent water management strategies at all levels, and ultimately, would help the world reach the millennium goal.

Source: Lenton (2002)

But the challenges of adopting and adapting science and technology to local systems are also daunting. The foundations that need to be in place to build a strong national innovation system tend to be much weaker in low income countries (Table 1). Similarly, the linkages between the different entities in the system itself are often more fragile and ineffective than in more developed countries.

- The challenge of low demand. Low income levels mean less demand for new products and services, meaning that entrepreneurs may operate in a low-profit, high-risk environment, which creates a vicious circle.

- The challenge of human capital. Overall levels of education tend to be low and education systems foster few researchers and scientists. Health problems are pervasive, which considerably reduces the productivity of labour and the ability to create or absorb technological change. Brain drain – the flight of educated people to more developed countries where returns on education are higher – can also constitute a risk, although migrants abroad can also increase the international connectivity of local business men and research elite (World Bank, 2005a).

- The challenge of physical infrastructure and communications means. Lower income countries are often geographically challenged – indeed, difficult geographical conditions, lack of access to sea transportation, etc., are in themselves important obstacles to economic growth, and more of the population lives in remote, rural areas. Physical isolation is exacerbated by lack of physical infrastructure, for lack of resources, for lack of technology, or for lack of policy priority. Information and communications technology is much less spread and has fewer potential users.

- The challenge of institutional capacity and set-up. Low income countries tend to be characterized by worse governance systems and more corruption, and often lack institutions and regulatory frameworks to support an effective innovation system.

- The challenge of the economic structure. Triple helix relations have a special character in many low income countries. Perhaps precisely because they tend to have less innovation taking place, these countries are also less diversified in terms of economic sectors and ownership. More often than in the case of richer countries, larger state-owned companies have an important role in production and exports, but the private sector tends to undertake very little research activity. Government bureaucracies are typically heavy and themselves less well adapted to a flexible innovation system, and FDI operations may be confined to isolated islands with little spill-over effects. Universities may be the only natural forum for research in the early stages, but are often bureaucratic and striving to primarily fulfil traditional criteria for academic excellence which may leave little incentive for triple helix interface.

Table 1: Low Income Countries Have Weaker Foundations for Building an Innovation System

Average by country group	Paved roads 1/	Fixed line and mobile phone subscribers 2/	Secondary school enrolment 3/	Government effectiveness 4/
LIC countries	16	40	46	-0.90
OECD high income	88	1240	106	1.59

1. % of total roads, 1999. 2. per 1,000 people, 2002. 3. % gross, 2000. 4. -2.5 =completely ineffective, 2.5 = fully effective (2004)

Source: World Development Indicators and World Bank Governance Data

Again, the above characterization is not well fitted to such a diverse group of countries. While the challenges are real, progress is being made in areas like increasing education enrolment rates and investment climate reforms. And some countries, including among others Vietnam and India, have worked to address some of these challenges head-on and have seen high growth rates. This suggests that there is much to be learned from different countries' experiences, also in a low-income setting.

Finally, a caveat: innovation bridges all new ways of doing things. This includes not only technological change but just as often innovation related to management and organization, or with respect to entrepreneurial efforts to carve out new ways to reach markets with low-cost products. This applies to more or less all sectors, although the specific opportunities and hurdles vary. The non-technical types of innovation tend to be harder to capture than technological advances, but are just as important.

2. Challenges for Ethiopia: Growth and Competitiveness

Ethiopia faces a monumental challenge to raise income levels and pull its population out of extreme poverty. With a GNI per capita of only 110 USD in 2004, Ethiopia is one of the poorest countries in the world (Table 2). Growth levels were moderate in the 1990s, especially in relation to the continued high population pressures. Reflecting the low income levels, about four fifths of the population presently lives on less than two dollars per day.18 Hunger and health risks are pervasive, also in an international perspective: almost half of all children under age five are undernourished and child mortality rates are forbiddingly high. An overwhelming share of the population is located in rural areas, and agriculture – mostly small-scale farming – accounts for some 40 per cent of output and 80 per cent of employment. On the positive side, four out of five two-year-olds are now immunized against diphtheria, whooping cough and tetanus.

As a land-locked country exposed to extreme weather conditions, Ethiopia faces severe environmental challenges as witnessed in serious droughts. There are also important regional differences in economic structure and actual and potential income growth. The geographical, climate and economic conditions vary greatly between highlands and lowlands, east and west.

This said, the last decade saw some important market oriented reforms in Ethiopia. Among other things, trade and foreign exchange controls were overhauled, the agricultural sector was liberalized, and a privatization process was initiated, including the financial sector, and foreign debt was reduced. From 1993 onwards, growth was above Africa average in spite of the armed conflict with Eritrea. The services and industry sector have increased their share of the economy at the expense of agriculture (Figure 1), and the private sector has increased its share of output.

[18] In a regression of $2 poverty rates on average income levels for 74 developing countries, Ethiopia is right on the regression line, neither over nor underperforming relative to its income levels. [Percentage of population living on less than USD 2 per day = 266 – 28 ln (per capita GNI in international USD) + ε].

Table 2: Ethiopia's Challenges in an International Perspective

	GNI per capita	Real GDP growth	Population growth	2$ poverty 1/
	US$, 2004	% p.a., 1995-2004	% p.a., 1995-2004	Latest 1999-2004
Low income countries average	507	4.0	2.0	
Ethiopia	*110*	*5.0*	*2.4*	*78*
Uganda	250	6.2	3.2	
Tanzania	320	5.2	2.2	90
Kenya	480	2.5	2.3	
Vietnam	540	7.1	1.3	
India	620	6.0	1.6	80
Indonesia	1140	2.4	1.4	52
China	1500	9.0	0.8	47

1. Population living on less than two PPP dollars per day, as share of total population.

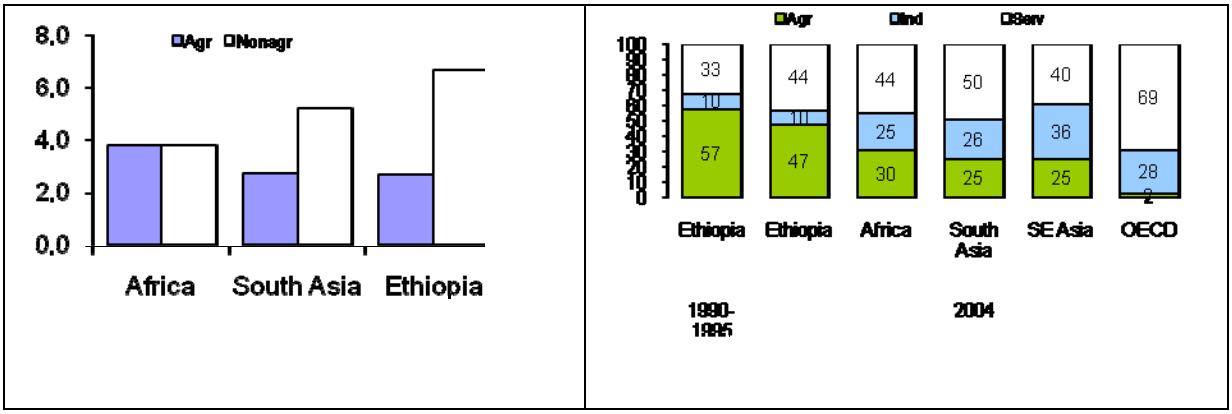
	Child Malnutrition 2/	Under five mortality rate	DPT Immunization 3/	Rural population	Agriculture
	Latest 1999-2004	Per 1,000 2004	2004	% of total 2004	% of GDP 2004
Low income countries average	43	122	67	69	23
Ethiopia	*47*	*166*	*80*	*84*	*47*
Uganda	23	138	87	88	32
Tanzania	29	126	95	64	45
Kenya	20	120	73	60	27
Vietnam	28	23	96	74	22
India	47	85	64	71	21
Indonesia	28	38	70	53	15
China	8	31	91	60	13

2. Percentage of children under 5 who are malnourished (weight for age). 3. Percentage of children under age 2 who had received adequate vaccination for diphtheria, whooping cough and tetanus in their first year of life.

Source: WDI (2005)

Figure 1: Ethiopian Growth vs- African Average and Evolution of the Agriculture-Based Economic Structure

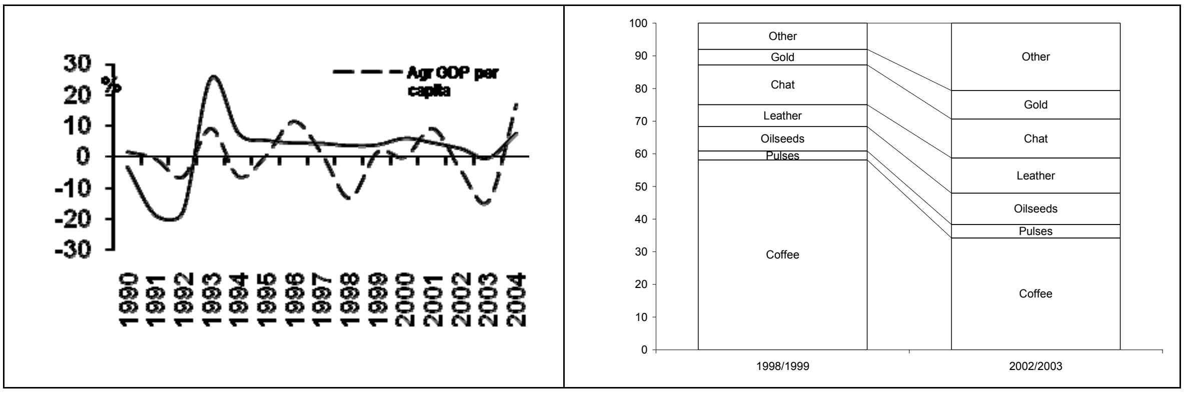
Agricultural and non-agricultural growth 1995-2004 (left), economic structure (right), Ethiopia and comparison countries.



Source: WDI (2005)

Figure 2: Swings in Agricultural Output

Non-agricultural and agricultural GDP per capita growth (left), exports structure, % total (right).



Source: WDI (2005) and IMF (2005)

But in spite of some structural transformation, the economy remains focused on agriculture and traditional exports. Ethiopia is largely an agricultural economy, and exposed to important volatility through agricultural output and international coffee prices. The public sector retains an important role in economic production and the economy is dependent on foreign aid. Coffee continues to dominate exports although its share of total exports has given way to leather, gold, textiles, spices, and oils. (Figure 2).

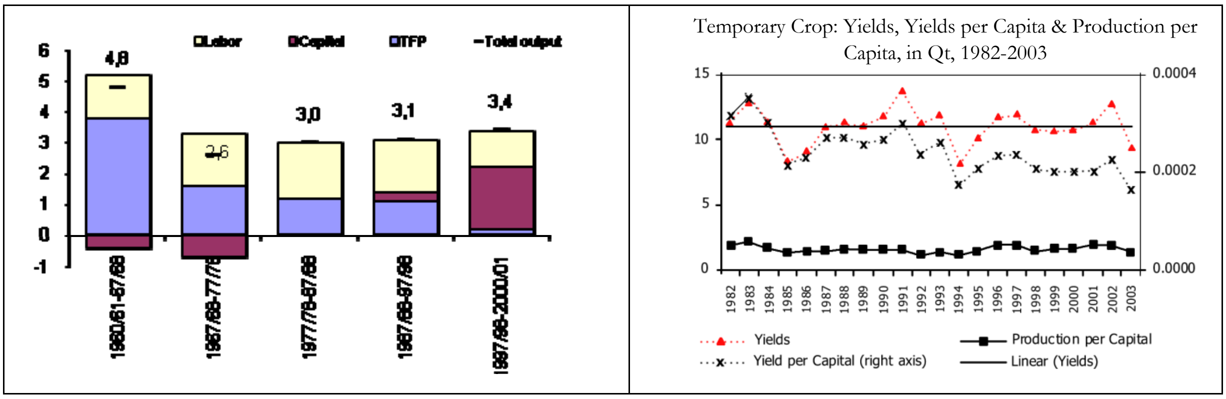
3. How Internationally Competitive is Ethiopia?

How internationally competitive is Ethiopia? The low income levels, high rates of poverty, and traditional economic structure of the Ethiopian economy, are themselves basic indicators of lack of competitiveness, low productivity and little dynamism in the economy from a longer term perspective. Ultimately, low income per capita reflects low labour productivity. But conversely, higher productivity is needed to raise income levels.

Ethiopia has several factors speaking in favour of its growth potential (UNCTAD, 2002): Ethiopia's assets include a large domestic market – with a population of 75 million, Ethiopia is the second largest country in Africa – a location with proximity to both East and North Africa and the Middle East, a well-educated and English-proficient elite, a growing and respectable private sector, and at least until recently, a comparatively safe business and social environment, among other things.

But productivity has fallen over time. There is relatively little information available on productivity developments, especially labour productivity, but what is available does not speak favourably of productivity developments. A growth accounting exercise for 1960-2000 suggests that total factor productivity has been contributing a smaller share to total growth over time. The World Bank's estimates of crop productivity suggest that it has fallen over the past 20 years: a result of soil erosion, increasing incidence of droughts, and continued high population pressures. (World Bank, 2005b).

Figure 3: Total Factor Productivity



Source: World Bank (2005)

Other measures of competitiveness confirm and partly explain Ethiopia's low productivity and income levels. The World Economic Forum's (WEF) competitiveness benchmarking exercises approach the issue of competitiveness from a different perspective using industry surveys and hard data to compare country standings. As expected, Ethiopia performs poorly also in these rankings. According to WEF's 2004 African Competitiveness Report, Ethiopia ranks number 19 out of 25 sub-Saharan economies. In a global ranking of 117 countries, Ethiopia is the twelfth least competitive country in the world, and its rank has fallen over time. (Appendix 1).

Relative to its low income levels, Ethiopia has a fairly stable macroeconomic environment and acceptable public institutions according to WEF's international comparison. The growth competitiveness index is composed of three sub-indices related to the quality of public institutions, the macroeconomic environment, and the capacity to produce and adapt technology. Importantly, it is in the area of technology that Ethiopia performs worst. In particular, in this ranking, the quality of Ethiopia's public institutions appears to be high relative to the country's average income level. Ethiopia's public institutions rank above Mozambique, Mali, Uganda, Zimbabwe, and Chad, countries that are all richer than Ethiopia.[19] The macroeconomic environment is also more favourable than in Mali, Mozambique, Chad, Zambia and Zimbabwe.

[19] Using GNI per capita in international PPP dollars.

But shortcomings in terms of technology production and absorption leave Ethiopia at the bottom in WEF rankings. Only Chad ranks lower with respect to its technological capacity. Given the way the technology ranking is calculated this low standing reflects three problems in Ethiopia: a very weak ICT infrastructure, a low capacity to absorb foreign technology, and an unfavourable perception in the private sector of the national innovation system.[20] This suggests that a specific focus of Ethiopia's national innovation system is warranted.

4. Benchmarking Ethiopia's Innovation System

The WEF rankings suggest that Ethiopia's low competitiveness is due not only to unfavourable broader framework conditions - at least in consideration of its very low income levels, Ethiopia appears to have made important strides in improving its investment climate. Rather, limitations in the broad investment climate appear to be compounded by specific weaknesses related to the innovation and technology system. This section therefore concentrates on some aspects of Ethiopia's innovation system and how they compare to other countries. It starts off by looking at some more standard measures of innovation output. Weaknesses in these may be due to the lack of appropriate innovation inputs, the quantity and quality of the entities that make up the innovation system, and finally and perhaps most importantly, the strength of the linkages within this system. The distinction between these different indicators is blurred – e.g. information and communications technology is a measure of both innovation input and system linkages. The division below is therefore not an absolute classification but a way of organizing the information.

Lack of data for benchmarking the innovation system is a serious problem in the case of Ethiopia. This is reflecting the limited collection of data in poor countries on the one hand and the low level of development of the innovation system in Ethiopia on the other. A great deal of the information below is based on "soft" and not necessarily representative data, i.e. the impression that (parts) of the local business community has of the innovation climate, as revealed in surveys.

To make a useful benchmarking exercise of Ethiopia against what could be considered as its potential, we use as reference point three sub-Saharan African low income countries – Kenya, Tanzania and Uganda, and two Asian low-income countries – India and Indonesia, which have been experiencing relatively high growth in recent years.

Traditional Innovation output indicators – not very relevant

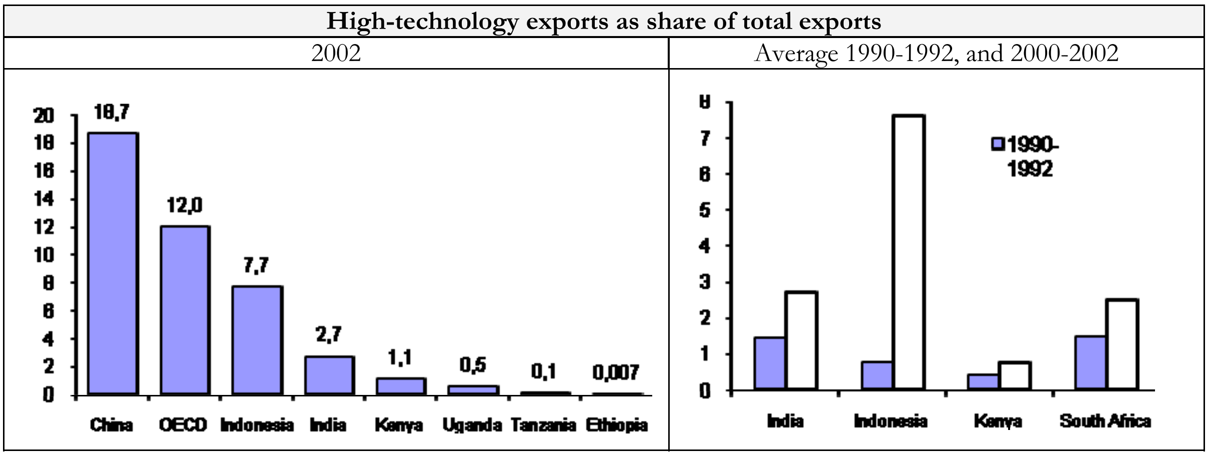
A wide set of indicators can be applied to measure the competitiveness of the national innovation system in terms of what it produces. Some of the more common (see OECD, 2003) include (i) the share of high-technology products in exports, as a measure of the ability to compete internationally in technology; (ii) registered patents, as a measure of the output of possible marketable new innovations; and (iii) scientific publications, as a measure of how competitive the academic community is. A common problem with these indicators is that they are more appropriate for more developed countries with modern economic structures and institutions.

Unsurprisingly, Ethiopia's exports have no high-technology content. In this regard, Ethiopia is not different from other African low-income countries, but behind India and Indonesia. It is perhaps noteworthy that some of these countries have increased their share over time, showing

[20] The technology index is calculated from three sub-indices: an innovation index, a technology transfer index, and an ICT index. Each of these sub-indices is in turn calculated from both quantitative data on e.g. ICT use together with qualitative data from private sector surveys.

some evidence of dynamism (Figure 4). The case of Indonesia is particularly impressive, but also Kenya has doubled its share of high-technology exports, albeit from a very low level.

Figure 4: Competitiveness in High-Technology Products



Source: WDI (2004)

Other more traditional indicators like patents and scientific articles similarly indicate very little effectiveness of Ethiopia's innovation system. Resident and non-resident applications to the national patent office are scarce, and in the past 10 years there have been no applications from Ethiopian nationals to the US patent office, compared to almost 200 from Kenya and nearly 1300 from India (Table 3). While resident applications are scant in other African (and non-African) low-income countries, the lack of non-resident patent applications is noteworthy compared to other countries. This could, of course, reflect several problems, including insufficient property right protection, lack of foreign investors, the use of "strategic" patenting in other countries and so on.

Table 3: Standard Innovation Indicators in International Comparison

	Patent applications, per million people, 1999		Patent applications to the US PTO 1993-2003	Scientific and technical journal articles, per million people, 1999 1/
	Residents	Non-residents		
Ethiopia	0.05	0.10	0	1.5
Kenya	0.07	4895	192	8.4
Tanzania	0.06	4318	2	2.7
Uganda	0.08	6287	5	2.5
Indonesia	0.0	370	57	0.7
India	0.23	76	1271	9.1
OECD	586	47396	--	499

1. Scientific and engineering articles published in the following fields: Physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

Source: WDI (2004) and USPTO (2005)

The above indicators, while conventionally used, are not a complete or perhaps even good illustration of the strength and weaknesses of the innovation system and especially not so for a low-income country. Patents are losing their relevance as a "true" indicator of innovation or economic development, often representing instead strategic protection against unwanted competition and/or lacking "real" economic value (Griliches, 1990; Desrocher, 2001).[21] Conversely, many innovations are not patented because they are of an intangible sort, or because patents are not valuable – in many developing countries, insufficient protection of intellectual property rights makes it less meaningful to seek patents, because they cannot be enforced. Patents are also best suited to protect technology and less so "softer" innovations in management, organizational structures, etc., which may be at least as important as technical innovations in raising productivity. According to Finger and Schuler (2002), patenting may in fact be damaging for the cultivation of traditional values, e.g., in rural areas, and must take second seat to long-term capacity-building in early stages. Publications, further, may have a different significance for the innovation system as a whole depending on whether the researchers live in their home country and the extent to which articles are co-authored with foreign scientists (Andersson et al., 2006). The fact that Indonesia has seen high growth and an increase in high-technology exports while displaying the weakest academic output of all the comparator countries in table 3, also shows that this indicator can be irrelevant (though there seems to be a positive relationship between patents to the USPTO and academic achievements).

A complementary approach in order to gauge the potential of the innovation system is therefore to examine its inputs and linkages.

Inputs – the Entities for an effective Innovation System

What ingredients are important for innovations to happen? A potential indicator can be the amount of financial resources that companies and the government allocate to research and development activities, although again, this is more related to formal and technology-oriented innovation in larger enterprises, rather than smaller incremental innovations which may be just as important. From a more general perspective, a key factor is the human capital available in the country. Another area concerns the physical and financial infrastructures which serve as a basis for entrepreneurial activity. And governance framework conditions – corruption, government effectiveness, rule of law, and others – are another important aspect of the innovation system.

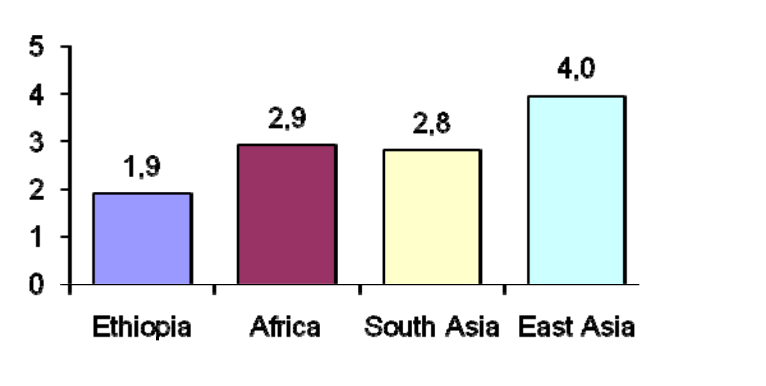
There is no "hard" data available on the level of expenditures on research and development in Ethiopia. Surveys of the private sector indicate that the perception in the Ethiopian business community is that there is very little spending on research and development taking place. This perception is lower than in Africa as a whole and in South Asia, and much lower than in East Asia where, on average, the local private sector considers that there is quite a lot of spending on research and development taking place.

Human capital provides the perhaps most important pillar for a dynamic innovation system. Without people who are able to invent or adapt new ways of doing things, be they technology or non-technology related, innovation cannot happen. And this ability is honed through literacy, education, and exposure to new ideas, but also through good health and overall well-being. In Ethiopia, education outcomes are low, however. Less than half of the adult population is literate, compared to over 90 per cent in East Asian low and middle-income countries, on average. Enrolment rates are far behind competitor countries and regions – in particular, secondary enrolment rates are much lower than the African average.

[21] Corporations are increasingly patenting the results of "thought experiments", before the innovation has been realized.

Figure 5: Private sector spending on R&D

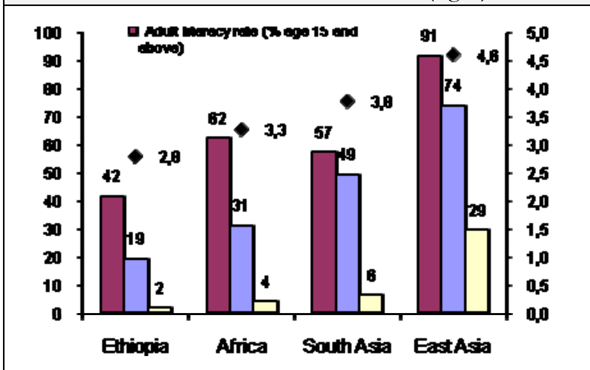
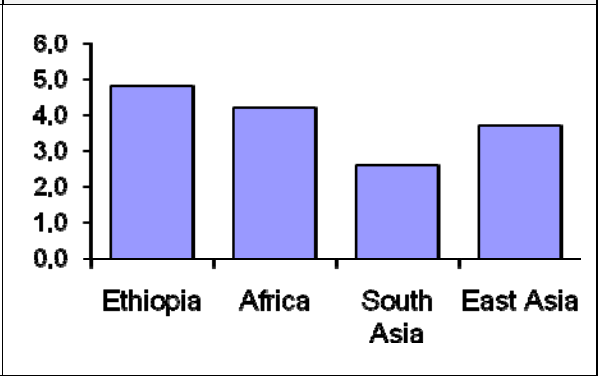
(indicator 1-7, 1=nonexistent, 7=very high)



Source: WBI KAM (2005)

Further, the quality of science and math education, as measured by scores in international tests, is inferior. Relatively speaking, science and engineering enrolment at the university level is not lower than elsewhere (some 26 per cent of total tertiary enrolment, compared to 28 per cent in East Asia). Given the low overall university enrolment rates, at 2 per cent compared to 29 per cent in East Asia, the resulting supply of scientists and engineers inevitably becomes very low, however. Yet, the problem appears not to be spending per se, but the efficiency in its use, as public spending on education is higher in Ethiopia compared to comparator regions (Figure 6).

Figure 6: Spending on and Outcomes inEducation:

Literacy and enrolment (left) and quality of science and math education (right)	Public spending on education as percentage of GDP, 2001/2004
	

Source: WDI (2004) and WBI KAM (2005)

But the availability of human capital is also dictated by health. Ill health, apart from the obvious direct negative effects on well-being, also means a smaller and less productive work force. In Ethiopia as in many other Sub-Saharan countries, life expectancy has fallen over time, from 45 years in 1990 to 42 years in 2002 (WDI 2004), with the onset of HIV/AIDS – which hits young persons at their prime working age – armed conflict, and several famines as important causes. One in twenty adults aged 15-49 has HIV, and almost half a per cent have contracted tuberculosis. From these perspectives, Ethiopia is not far from the – highly alarming – health situation in some other African countries. Instead, Ethiopia stands out for the remarkably low access of its population to clean water and sanitation, which can be part of the explanation for the high child mortality rates shown in Table 1 earlier. With the exception of TBC, the low outcomes in health in Africa stand in stark contrast to those of India and Indonesia, where life expectancies were already higher in 1992 and have increased over time (Table 4).

Table 4: Effects of Ill Health on the Population

	Life expectancy at birth 1992	Life expectancy at birth 2002	Tuberculosis prevalence 1/	HIV prevalence, % 2/	Population with access to -an improved water source		-improved sanitation	
					Urban %	Rural %	Urban %	Rural %
Ethiopia	*45*	*42*	*440*	*5.0*	*81*	*12*	*33*	*7*
India	60	63	431	0.8	95	79	61	15
Indonesia	63	67	742	<0.1	90	69	69	46
Kenya	57	46	462	12.3	88	42	96	82
Uganda	46	43	544	5.8	80	47	93	77
Tanzania	49	43	439	7.1	90	57	99	86

1. Per 100,000. 2. Among 15-49-year-olds.

Source: World Health Report (2004)

Access and reliability of physical infrastructure is another key feature of the innovation system. How can entrepreneurs access new ideas, if they are not exposed to them, and how can they implement and produce them, if there is no electricity to run machines and computers, roads to transport products and perform services, or phone lines to talk to customers and suppliers? Infrastructure access and effectiveness appear to be critical deficiencies in Ethiopia (as evidenced by the low access to water and sanitation services shown above). The country has less developed physical infrastructure, higher costs, and more service delivery efficiency problems than other countries, also compared to low income countries within Africa. The low road density and long delays in service delivery through phone and electricity connections are particularly remarkable. Ethiopia is clearly disadvantaged by its geographical conditions. Yet, in a country with large distances, low urbanization rates and rough terrain, the conditions of physical infrastructure, including telephone connections, become all the more critical for improving the interconnectedness of the population.

Table 5: Physical Infrastructure

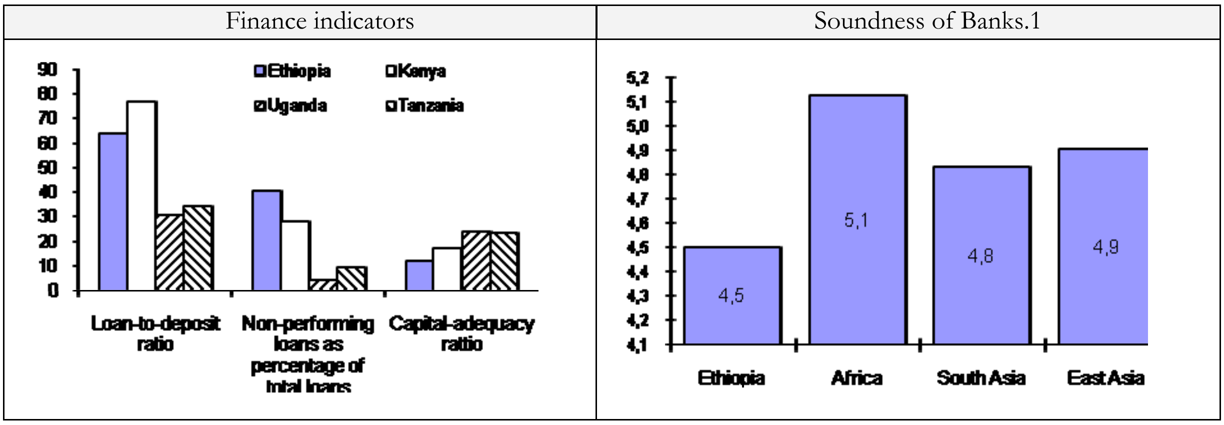
	Ethiopia	Kenya	Tanzania	Uganda	Africa	Indonesia	India	OECD
Electric power transmission and distribution losses (% of output)	10	21	25	n/a	23	13	27	8
Television sets (per 1,000 people)	6	26	45	12	45	153	83	657
Aircraft departures (X 1,000)	28	26	5	0	7	152	242	618
Road density (km/km²)	3	11	10	14	13	19	112	131
Fixed line and mobile phone subscribers (per 1,000 people)	5	30	17	14	22	66	44	1303
Telephone average cost of call to US (US$ per three minutes)	7	6	5	4	4	..	3	1
Telephone average cost of local call (US$ per three minutes)	0.02	0.07	0.12	0.21	0.11	0.03	0.02	0.11
Delay in obtaining an electrical connection (days)	116	39	82	15	57	55	49	n/a
Value lost to electrical outages (% of sales)	5	6	9	4	6	..	9	n/a
Delay in obtaining a telephone connection (days)	155	33	87	27	74	23	99	n/a

Source: WDI (2004) and World Bank Investment Surveys (2005)

The financial system is a key feature of the general investment climate, and is particularly important for the creation of new firms. The availability of microfinance, and for financing of more risky, but potentially innovative enterprises, is key. As an immature financial system, the Ethiopian financial structure is dominated by banking. The banking sector has seen some improvements in recent years, as the government has opened up the sector for private banking. Public banks still account for 75 per cent of the assets and deposits, and they remain closed to foreign investors, however. Ethiopia has a relatively deep financial market compared to other low-income countries in Africa, but financial deepening has largely been driven by an extension of credit to the public sector (IMF, 2005). The loans-to-deposit rate is higher than in Tanzania or Uganda, suggesting some success at financial intermediation. But slower progress on financial reform is reflected in a much higher share of non-performing loans and lower capital adequacy ratio (Figure 7). Moreover, survey based information indicates that firms distrust the national banking system relatively more than do firms in Africa on average or in other regions, although the differences are not remarkable.

A recognized problem is that banks generally lack experience in implementing methods for risk analysis. As a result small firms, in particular in rural areas, are locked out of the formal finance sector. The formal banking system is also focused on short-term credit based on collateral only which needs to reach over 100 per cent of a typical loan's value. The demands on collateral are a problem for small innovative firms who may have the potential to grow but whose main assets may be intangible.

Figure 7: Financial Soundness



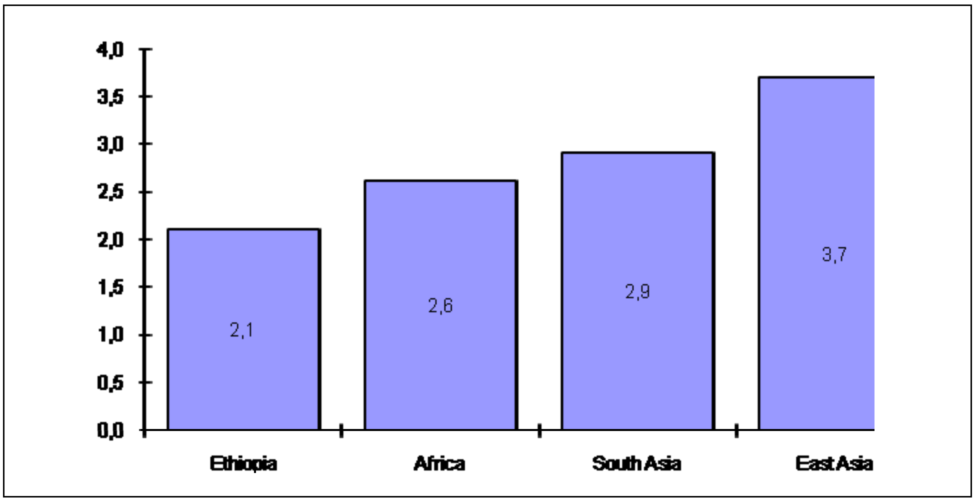
Source: IMF (2005)

Source: World Bank Investment surveys
1. Answers the question: are banks generally sound in your country (1=insolvent, 7=generally healthy)

There are currently some 22 microfinance institutions active in Ethiopia. These institutions are largely rural and a majority (57 per cent) of clients is women. Although the sector has expanded and counts two of the largest MFIs in Africa, estimates suggest that the rural poor's demand remains largely unmet (IMF, 2005).[22] Given the relatively limited outreach of small-scale lending, it is perhaps not surprising that venture capital appears to be virtually unavailable in Ethiopia (Figure 8). Informal sources of capital remain crucially important for supporting new business activities, including remittances from diasporas consisting of Ethiopians living abroad. Some of these funds could become more productive, and informal ventures to a higher extent enter the formal economy, given less red tape in the bureaucracy and regulatory framework.

[22] MFIs and commercial banks cover only some 30 per cent of total demand for credit (IMF, 2005).

Figure 8: Venture Capital Availability



Note Survey-based. Answers the question: Can entrepreneurs with innovative but risky projects generally find venture capital in your country (1= not true, 7=true).

Source: WBI KAM (2005)

The government has an incontestable role in building and supporting the innovation system. At the same time, the government has limited access to experts and skilled officials that can service strategic functions in development projects. Rather than evaluating the specific public innovation policies in place in Ethiopia[23] this paper provides an overview of the more general capacity and quality of Ethiopia's public institutions, as revealed in the governance system. These general conditions are important: for example, where legal frameworks are weak, corruption tends to reduce the incentives to invest in innovation. In WEF rankings discussed earlier, the quality of Ethiopia's public institutions was rated low, but higher than other countries at a similar income level. Other governance indicators give a mixed picture. Figure 9 below presents data for three different aspects of the quality of governance (Kaufmann, 2005):

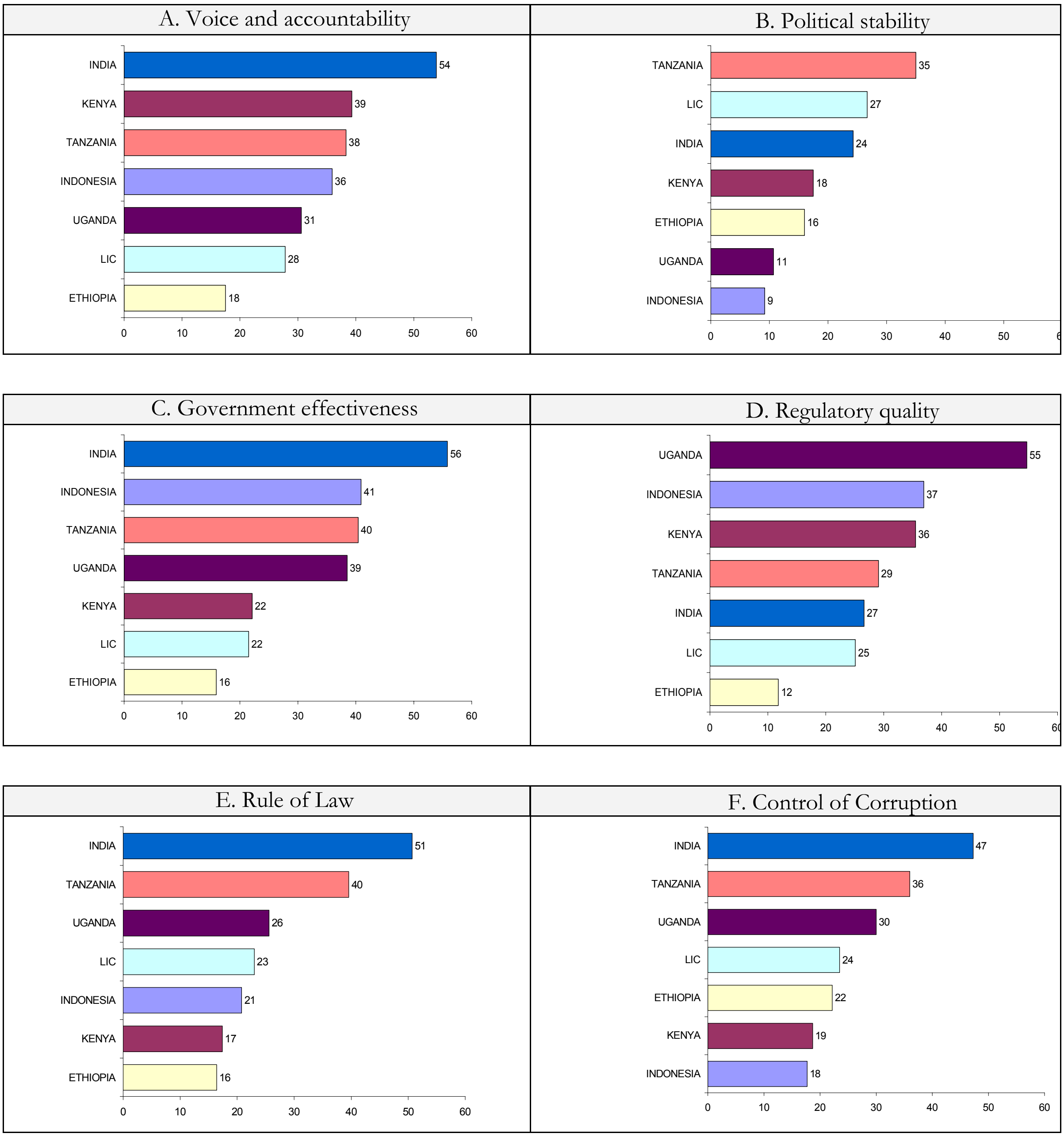
- The process by which those in authority are selected and replaced, as illustrated in voice and accountability, and political stability.
- The capacity of the government to formulate and implement policies, in government effectiveness and regulatory quality.
- The respect of citizens and state for institutions that govern interactions among them, measured by the degree of rule of law and control of corruption.

Ethiopia is among the lowest twenty per cent of all low and middle income countries in terms of governance. At first sight, this could perhaps be attributed to the country's low income levels, but there is, to date, little evidence that low-income levels cause bad governance; instead, bad governance structures are an important cause for low income levels.[24] Ethiopia scores consistently lower than most comparator countries and always lower than average for the whole group of low income countries. The comparative situation for Ethiopia is worst regarding government policy capacity, and low regulatory quality appears to be a particular concern. Ethiopia appears to have made relatively good progress on the control of corruption, however.

[23] An overview of the government of Ethiopia's National Science and Technology Policy (dating from 1993) can be found on: http://www.telecom.net.et/~estc/policy/national1.htm.

[24] See, e.g., Kaufmann and Kraay (2003).

Figure 9: Governance Systems in International Comparison (country percentile rankings).



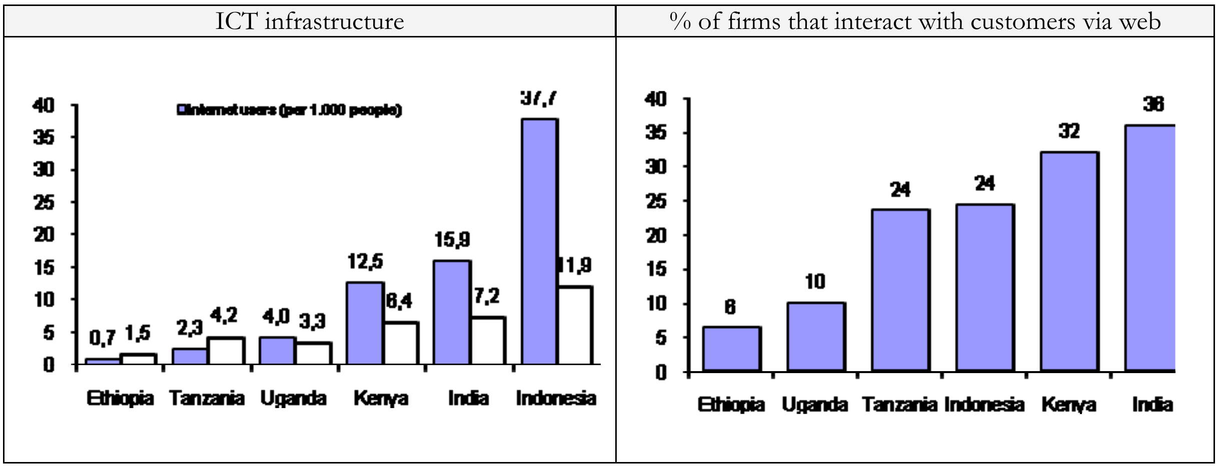
Source: WB governance indicators (2005)

Linkages

An effective government, good climate for private investment, and strong academic performance will not necessarily result in a good innovation climate. The way in which these entities are linked and interact is crucial to building relationships and identifying opportunities for collaboration, so that scientific research can be put to practical use and be commercialized in the private sector, so that ideas flow from the private sector to academia, so that government provides the framework and institutions that can help bridge the gap between the two and so that all can be linked to the global system. Unfortunately, the strength of such innovation system linkages is notoriously difficult to measure, especially informal interactions which may be most important. A few aspects of system linkages are outlined below.

The spread of information and communications technology provides a means of measuring potential interconnectedness between national and international innovation stakeholders. Ethiopia's ICT infrastructure is clearly underdeveloped and its use very limited, also compared to other African low-income countries. There is less than one Internet user in one thousand, the regional distribution is very unequal, and there are very few personal computers. There is little commercial use of ICT (Figure 10).

Figure 10: ICT Infrastructure and Use

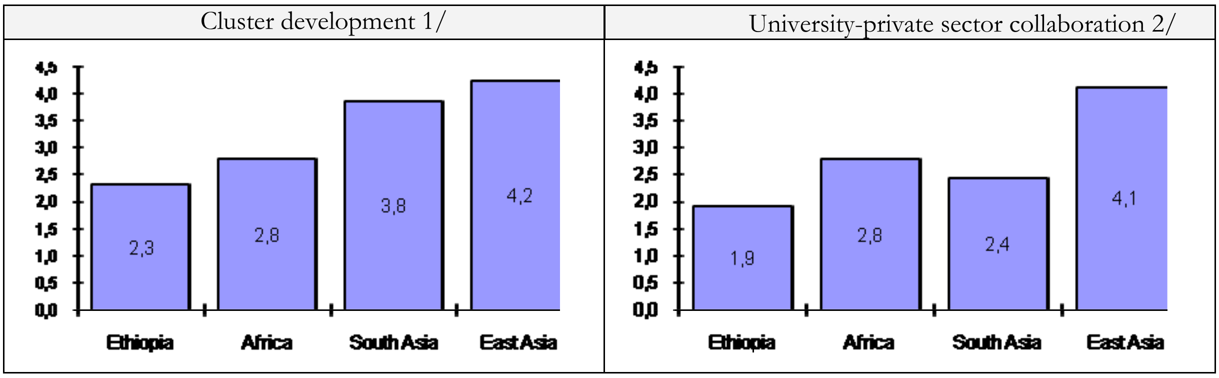


WDI (2004). Latest available 2001-2002.

World Bank Investment Surveys (2005)

Collaboration between firms, and between firms and universities, appears also to be weak. A number of studies have underlined the potential importance for local development of establishing local exchanges of information and joint efforts in knowledge upgrading. The so-called cluster literature points to various ways forward, but also to the presence of pitfalls and what tends to be required for supporting success, including that various local players are able to specialize and combine incentives for co-operation and competition (Andersson et al., 2004). Survey-data indicate that there is very little cluster development in Ethiopia, compared to the average for the African, South Asian, and East Asian regions. And, importantly, local universities and private companies do not collaborate in research and development to any great extent. In this respect, the difference between Ethiopia and the East Asian region is particularly stark.

Figure 11: Linkages in the Innovation System – within Private Sector, and between University and Private Sector



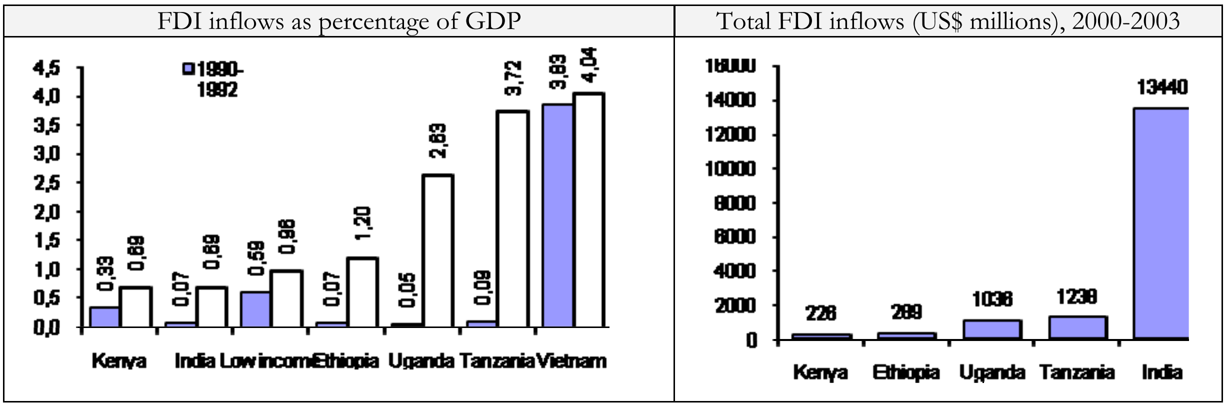
1. Survey based, answers the question: How common are clusters in your country: 1=limited and shallow, 7=common and deep.

2. Survey based, answers the question: Do companies collaborate closely with local universities in R&D activities? 1=non-existent, 7=intensive and on-going

Source: WBI KAM (2005)

Foreign direct investment is one potential source of technical and non-technical know-how, depending on the nature of linkages established between foreign companies and local actors and on the type of foreign investment taking place. FDI has increased from nil in the beginning of the 1990s to one per cent of GDP in 2000-2002 (Figure 12). In absolute numbers (US$), Ethiopia's inflows in 2000-2003 represented less than 25 per cent of the resources going to Uganda or Tanzania, and only two per cent of the resources going to India, however. FDI tends to be concentrated to Addis Ababa; most is directed to the primary sector, although one single project in the hotel sector accounted for about one third of all accumulated FDI in Ethiopia between 1992 and 2000 (UNCTAD, 2002).

Figure 12: Foreign Direct Investment in International Comparison



Source: UNCTAD (2005) and WDI (2004)

Firm Size and Innovation

The strong presence of small firms in Ethiopia can under the right circumstances work to its advantage. Small firms are potentially more flexible and able to introduce innovations, especially those requiring genuine experimentation and that fall outside the domains of established core business in big firms. Innovation in small firms is nevertheless tilted towards gradual, or incremental, changes. Small firms are unlikely to undertake any significant investments in R&D

and, while their innovations may draw on and use technology in new ways, they are often of a non-technological kind. As a result, R&D investments, patent statistics and other more conventional innovation indicators are unlikely to illustrate the extent of innovation taking place in small firms in the services sector. There is indeed some evidence that small firms do innovate in Ethiopia. A special survey of 71 manufacturing enterprises in chemicals, food processing, leather, metal working, and textiles, predominantly (88 per cent) in the private sector, suggested that small and medium sized enterprises were more likely to innovate than larger firms (Table 6).

Table 6: Innovation and Firm Size

	Per cent of firms that introduced minor technological changes	Per cent of firms that introduced new products or production processes
Small	44	18
Medium	51	20
Large	22	0

Source: UNCTAD, 2002. Based on a survey of 71 manufacturing firms.

In most countries, small firms face more problems in undertaking their business than larger firms do. These difficulties appear to be pronounced in Ethiopia, however. According to the World Bank investment climate surveys, SMEs in Ethiopia have less access to infrastructure and land and believe themselves to be worse affected by corruption than larger firms (Table 7). It is also very costly to register a new firm, and there are long delays in other typical start-up activities including electricity and telephone connections, which are likely to hamper the birth, growth and flexibility of innovative firms.

Table 7: SMEs Face Disproportionate Challenges

	Ethiopia	Small (1-49 employees)	Medium (50-249 employees)	Large (250+ employees)
Percentage of surveyed firms citing indicator as a major obstacle to business				
Corruption	39	42	33	22
Access to land	57	62	36	24
Tax administration	60	64	42	51
Percentage firms that				
Share/own a generator	17	10	41	40
Offer formal training	22	10	57	64
New investment from internal funds or retained earnings (%)	70	72	53	73
New investment from banks (%)	21	18	41	23
Delay in days for obtaining an electrical connection	116	118	77	63

Source: World Bank Investment Surveys (2005)

5. Conclusions and Recommendations

This paper has provided an overview of relevant data sets and ongoing trends for the purpose of estimating Ethiopia's competitiveness relative to other comparable countries, and to identify and examine key issues that need to be addressed in order to strengthen Ethiopia's competitiveness and national innovation system. It elaborates only on some of the main issues, however, and does not address in detail some key aspects such as the role of human networks or social capital in innovation. Nonetheless, the available data suggests that, in order to increase economic growth rates and make a lasting dent in poverty, Ethiopia faces important challenges with regard to: literacy, educational enrolment and quality; health, infrastructure, use of technology (including ICT), the investment climate (especially for smaller firms), and addressing critical weaknesses in the governance system.

Some of these issues may take a relatively long time to resolve. Higher enrolment rates may result in a better educated work force, but only in the future, as these children enter the labour market. Better vaccines and less hunger for children have an immediate positive impact on children's well-being; its effects on labour productivity may take longer to realize. Physical infrastructure can take time to develop, even if the resources are forthcoming. The fact that these are long-term adjustments does not imply that they do not need immediate attention, only that they are not a silver bullet for success in the short term.

Action in other areas might bear fruit in the shorter run, however. Some governance issues can be addressed and improved if the political will is there, and if there is domestic and international support for needed measures.

Moreover, apart from the fact that investments in education and health pay mostly in the longer run, they will not necessarily result in more innovation, productivity or growth. A strategic and more immediate challenge for Ethiopia will be to create more autonomy and room for specialisation in universities, to improve conditions for entrepreneurship, and to enhance the network and mobility linking different capabilities and actors in the innovation system through mechanisms and institutions that allow them to interact in a mutually rewarding manner. This implies working towards a system where pluralism of initiatives is cultivated. Conditions must be put in place for the key actors to fulfil their roles, without top-down intervention.

In a sense, academic researchers should not only be in a position to focus on science and education but they, along with government officials, need to have a better understanding of entrepreneurship. Entrepreneurs, on their part, should be more able to work with universities. There need to be fora for academic and industrial researchers to meet, and where government institutions can take on a variety of roles to facilitate and foster a dynamic interface. Agricultural productivity represents one such area where research and business links can make significant advances through joint, interrelated efforts. For these advances to be useful to, and for them to reach, small-scale farmers in remote areas, the public sector can make important contributions through the provision of infrastructure, reforms of conditions for micro credit and the registering of new firms, etc.

What role is there for Ethiopia's universities – one of the Triple Helix pillars – in the institutional build-up? The national strategy recognizes the important role that universities can have in fostering science and technology, in adapting advanced technologies to solve local problems, and in supporting economic development more broadly. But in the right circumstances, the universities could take a stronger lead in encouraging innovation in ways that are conducive to economic development. Their role could potentially extend from providing educated workers and entrepreneurs and undertaking research, to enhancing integration, cross-fertilization and collaborative action between academia, private sector and government. The undergoing expansion of the number of universities could inject such impulses in different regions, industries, and social spheres.

In order to fulfil such roles, universities need to adapt and adjust to specific structures and circumstances. They need to specialize and prioritize their roles, and be able to build local connections as part of a striving to excel in their special areas of expertise. They need to use scarce human and financial resources strategically, and develop specific competences instead of spreading their efforts thin across multiple areas. Regional features do, in fact, already constitute more of a focus in university expansion in Ethiopia. In order to advance further, however, universities need to meet with stronger driving forces that promote appreciation among their constituents for social alliances and impacts, along with the perfection of traditional academic merits. In order to achieve this, there is a need of adjustments to the mechanisms for funding universities, so to become more performance-based and responsive to the whole range of relevant performances.

Whereas universities matter, the triple helix model clarifies the interactive role and the significance of all the relevant parties. Government and public authorities matter crucially through their rule-setting and financial roles. On top of that, government officials act as human beings, to a considerable extent led by their knowledge, perceptions, and values. The business sector, supposedly the research partner and actor in commercialization processes, is likewise bonded by traditions, available skills, and vested interests along with financial constraints. If universities are to become more dynamic, governments and businesses must be induced to play a role in the interface, and assist in the formation of linkages in the triple helix from their end.

In terms of realms for action, a "laundry list" of functions to consider includes:

- Reviewing the direction and selection criteria for research funding, so as to promote pluralism, specialization and the range of relevant performances;
- Participating actively in the build-up of science parks and incubators, and ensure that they are able to accumulate competences, and meet with objectives, that orient their efforts to fulfilling a bridging role;
- Providing a knowledge-base (perhaps through intermediation with other actors abroad) for science and technology challenges specific to Ethiopia – water, disease control, etc.;
- Eliminating excessive bureaucracy, reducing red tape and putting in place tax incentives and better mechanisms for the diffusion of venture and seed capital, so as to remove impediments to the establishment of new firms, and strengthen the incentive for informal business to enter the formal economy;
- Using ICT, notably cellular technology, for demanded and currently under-supplied services to be better articulated and mobilized, to spur and commercialise innovations in for Ethiopia instrumental areas, such as the provision of informal capital and micro-credit, health, sanitation, ecological sustainability, education, and so on;
- Developing and maintaining alumni- and other networks in order to broaden human linkages between the spheres of the triple helix;
- Strengthening links with academic institutions abroad;
- Expanding linkages with migrant networks abroad and put in place mechanisms that ensure safe remittances, so as to provide an interface that can exploit complementary pools of skills and help increase market access and funding.

Expanding synergies between the actors of the triple helix with respect to these tasks, institutional upgrading is also required, including a strengthening of management and governance mechanisms, and a streamlining of priorities for research focus in parallel with decentralization of decision making on how to shape the linkages between the actors.

What role, then, for the international community? Ethiopia receives substantial foreign aid (amounting to some 20 per cent of GNI in 2001 and 2002). These resources, both in the form of technical assistance and financial inflows, could support the strengthening of an innovation system in Ethiopia, by:

- Recognizing the role of science and technology in international cooperation;
- Institutional capacity building and twinning with institutions in developed or other developing countries, facilitating scientific and academic exchange on issues that are socially relevant, improving conditions for interchange through diasporas, etc.;
- Putting in place, or upgrading, regulations and institutions that support technology transfers as well as healthy and competent approaches to intellectual property rights protection;
- Where applicable, help identify best practice experiences abroad in those areas where Ethiopia is in the greatest need of improvement, and facilitate communicating and adjusting them to the local conditions.

One area for action, in relation to this particular study, is for Ethiopia as well as other low-income countries to strive to develop indicators of relevant tangible and intangible assets, of interaction and of linkages between the different entities, in order to heighten awareness of key issues in an international and/or regional perspective, and provide benchmarks for improvement. Where appropriate, the methods and types of indicators used by the OECD and the European Community can be emulated, but there is also clearly a need for introducing other indicators better suited to capture the specifics of the low-income economic structure and its medium-term potentials. The information should be designed to reflect opportunities inherent in the tangible and intangible assets of local culture and traditions, given the predominance of agriculture and the rural setting. It should also take into account the kinds of health and education issues prevalent in the country, and the way that ICT can fill gaps and articulate basic needs.

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World Bank on-line investment climate surveys:
http://rru.worldbank.org/InvestmentClimate/

Appendix 1. Ethiopia's Ranking in WEF GCR and ACR

		African Competitiveness Report 2003 25 countries				Global Competitiveness Report 2005-2006
	GNI per capita 1/	Growth Competitiveness	Public Institutions	Macro Economy	**Technology**	117 Countries
South Africa	9810	Botswana (1)	Botswana (1)	Botswana (1)	South Africa (1)	Tunisia (40)
Botswana	7740	Tunisia (2)	Tunisia (2)	Tunisia (2)	Tunisia (3)	South Africa (42)
Tunisia	6440	South Africa (3)	Malawi (3)	South Africa (3)	Botswana (4)	Botswana (48)
China	4520	Gambia (6)	Gambia (4)	Gambia (5)	Zimbabwe (9)	*China (49)*
Indonesia	3070	Tanzania (9)	South Africa (5)	Ghana (11)	Uganda (10)	*India (50)*
India	2650	Ghana (10)	Tanzania (9)	Uganda (12)	Gambia (11)	Ghana (59)
Zimbabwe	2180	Malawi (12)	Ghana (10)	Tanzania (14)	Tanzania (12)	Tanzania (71)
Ghana	2080	Uganda (14)	Zambia (13)	**Ethiopia (18)**	Ghana (14)	*Indonesia (74)=*
Gambia	1660	Zambia (17)	**Ethiopia (14)**	Mali (19)	Zambia (16)	Uganda (87)
Uganda	1360	**Ethiopia (19)**	Mozambique (16)	Mozambique (20)	Mozambique (17)	Mali (90)
Chad	1010	Mozambique (20)	Mali (17)	Chad (21)	Malawi (19)	Mozambique (91)
Mozambique	990	Zimbabwe (22)	Uganda (18)	Malawi (22)	Mali (23)	Gambia (94)
Mali	860	Mali (23)	Zimbabwe (19)	Zambia 23)	**Ethiopia (24)**	Malawi (105)
Zambia	800	Chad (25)	Chad (25)	Zimbabwe (25)	Chad (25)	**Ethiopia (106)**
Ethiopia	780					Zimbabwe (109)
Tanzania	580					Chad (117)
Malawi	570					

1. PPP (current international $)

Linking University Research to Production Systems within the Context of a Poverty-Reduction Strategy: Case Study of Cameroon

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Abstract

The university and the entire Cameroonian system of knowledge production are under transformation in order to better support economic development and to contribute to the National strategy of poverty reduction. More specifically, university research is becoming more targeted to societal needs, particularly those of the informal production system where 80 % of the poorest people of the country are to be found. In this study we analyse published research articles on the domestication and the development of the products of two multipurpose traditional plants *Ricinodendron heudelotii* and *Canarium schweinfurthii*.

The study identifies the different perspectives demonstrated in the selected research articles in order to examine the arguments used by the researchers to: 1) justify the societal relevance of their work when they constructed their research object; and 2) determine the consequence of the researchers' choice on the interactions between their potential partners. The study incorporates two different theoretical approaches. The fist is historical and cultural activity theory in which the unit of analysis is an activity system. The second approach is triple helix theory in which the unit of analysis is the set of interactions between the university, industry and government.

The arguments used by the authors to justify the social context of their research or the importance of their study were classified and analysed from both theoretical perspectives: as a research object construction and as an interaction between actors. The dual definition of the research object which distinguishes between a research and an application object (Miettinen 1998) was adopted and adapted to demonstration how researchers developed simplified technology and procedures different from those used by industry. Two types of application objects can therefore be distinguished: one destined for industry and one destined for the rural population (and eventually the informal sector). The second type of application object is reputedly possible to accomplish at minimum cost using locally available materials. Researchers have produced artefacts and product processing techniques but only under laboratory conditions. The transfer of application objects from the university laboratory to rural communities has not yet taken place, nor has there been an appropriation of technologies, even simplified ones.

Researchers from another type of institution identify the participation of rural farmers in the research process as a critical element for their strategy. One of the institutional objectives is to integrate scientific data with traditional know how for the development process. This institution is a branch of an international organization that is funded by a multilateral fund to promote the commercialization of research in the rural sector. According to our findings, university research does not seem to be integrated in this process.

This study shows that research initiatives demonstrate a change in attitude concerning informal economic actors in general and farmers in particular. An organizational mechanism is required in order to be able to transfer knowledge and technologies produced by the research to the targeted users. The incubator appears to be an ideal organizational structure for professional training outside the context of formal courses and may be a good candidate for the needed organizational mechanism for knowledge transfer. A well thought out adaptation of the participatory process for the development of research goals and for the dissemination of research results is also a good candidate to form the basis of good research management practices.

Introduction

The university, like other Cameroon State institutions, is called upon to contribute to the National poverty reduction strategy, in addition to fulfilling its traditional roles of education, research, socioeconomic development support, and professional training. These roles are defined and refined by the Council of Graduate Education, Scientific and Technical Research ("Conseil de l'enseignement supérieur et la recherche scientifique et technique") (Ministère de l'éducation nationale, 1974; 1982). It has already been shown that the Cameroon University is not sufficiently transformed in order to be able to assume some of these roles (Affa'a and Des Lierres, 2002) as reinforced by publications stemming from the 1993 reform (Ministère de l'enseignement supérieur, Cameroun, 1993). This reform divided the public university system into six institutions, of which two are situated in the political capital Yaoundé and four were in the provinces. Finally it can be noticed that university research is becoming more targeted to societal needs and that the institutions are taking on these new roles. This brings us to presume that the following formula proposed by Etzkowitz (2002: 7) can be roughly applied to the Cameroon University system:

> *The university is undergoing a dual transformation: an expansion of missions to include economic and social development as well as training, cultural reproduction and research and a shift from an individual to an organisational focus in each mission.*

The knowledge production conditions are, in effect, changing everywhere. Some don't hesitate to treat this as a generalized revolution which will change and subsequently transform the university (Arocena and Sutz, 2001; Etzkowitz, 22-03-2005; Etzkowitz and Carvalho de Mello, 2004). It is therefore not surprising that these transformations are the subject of an international debate on the role the university should play in the production and transfer of knowledge and technologies. The analytical methods used to study this phenomenon and the models developed to understand them are also changing at the same pace making it a significant challenge to study these developments.

Given that the university and the entire Cameroon system of knowledge production is changing in order to support economic development and reduce poverty, this study is limited to some research case studies that address a combination of knowledge production and the development of technologies, products or services. The study examines research articles published on the processing of two types of African plants that have multiple traditional uses: *Ricindendron heudelotii* and *Canarium schweinfurthii*. The research involved with these plants addresses their domestication and the development of their products.

Two types of research institutions served as the sources of articles selected for analysis: Public Cameroon Universities and the ICRAF (International Centre for Research in Agro-Forestry) in Yaoundé. ICRAF is a satellite of the World Agro-Forestry Centre, an international organization that makes use of applied research in agro-forestry to contribute to poverty reduction, improvement in nutritional security and the growth and rebuilding of tropical ecosystems. The organization works in partnership with national research units in agriculture such as universities, NGOs and private organizations in both the South and the North (ICRAF, 2001), which makes ICRAF a good source of research articles for this study.

Although a variety of products of these two plants have been used in the regions extensively in the past, it is still necessary to persuade potential users to integrate the oils extracted from the fruits and seeds of these plants into their dietary habits. They will also have to learn the domestication procedures, how to transform products and commercialize them as well as how to establish production standards in order to ensure quality end products. Researchers will also have to convince the industry to invest in the transformation of these seeds and the fruits as they have not been involved in the development of these new products up until now (Silou and Massamba, Internet document 28 September 2004). What sorts of arguments are used by researchers in the formulation of the object of their articles? What are the consequences of their choices with respect to the development of a research object and the interactions between potential partners?

This study is based on two theoretical approaches that serve to identify the different perspectives demonstrated in the selected research articles. The historical and cultural dimensions of activity theory are used to study the construction of a research object (Engeström, 1987; 1999; Miettinen, 1998; Miettinen, 1999; Hasu and Engeström, 2000; Miettinen and Hasu, 2002). Activity analysis of scientific research and technological development activities allows the differentiation of a research object from an application object (Miettinen, 1998). It is hypothesized that an application object can be characterized in terms of its complexity and inherent difficulties in its appropriation by potential users.

The study also examines the interactions between actors using the triple helix theory (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2003; Etzkowitz, 22-03-2005; Etzkowitz and Carvalho de Mello, 2004). It is proposed that the specific characteristics of the target population, such as the literacy level together with inherent challenges in appropriating new technologies justifies the division of the of the application object into two categories: one for the industry and a more simplified version for the informal population sector. This requires the addition of a fourth component, the informal system, to the triple helix model.

It should be noted that in activity theory, the unit of analysis is an activity system whereas in triple helix theory, the unit of analysis is the set of interactions between the university, industry and government. The two hypotheses in this study stem from these two different perspectives.

1. Data Collection Methodology

Publication abstracts on *Ricinodendron heudolotii* and *Canarium schweinfurthii* that originated from Cameroon were extracted from the Cab database Pour in order to examine the arguments used by the researchers to justify the relevance of their subject matter and their articles. Each selected article had at least one author who was affiliated with a research institution in Cameroon. Two research institutions were predominantly due to the subject matter addressed: "École nationale des sciences agro-industrielles of Ngaoundéré University, a public institution, and ICRAF in Yaoundé, which is part of an international organization. ICRAF intervenes within the program *Diversification of Smallholder Farming Systems in West and Central Africa through Cultivation of Indigenous Trees* funded by International Fund for Agricultural Development (IFAD) (FIDA, 1999).

The titles of the selected abstracts were compared to those extracted from other databases such as Science Citation Index-Expanded, Kluwer Academic, Biological Abstracts, as well as documents published on the Internet. The full text articles were then retrieved from ScienceDirect, Kluwer Academic, Wiley InterScience, Bioline International, etc. A few texts found from Asian and African sources have not yet been obtained. To date, 15 articles on *Ricinodendron heudolotii* and 13 on *Canarium schweinfurthii* have been retrieved as full text articles.

Those articles which address the different processes of transformation, conservation and commercialization of the products of these two plants were analysed. Articles which addressed participatory inventories and the domestication of plants with multiple traditional uses for natural forest populations were also included in this study.

Each article was analyzed to identify the arguments underlying what Locke and Golden-Biddle (1997) refer to as the "intertext." These are arguments that are used by the authors to justify the social context of their research or the importance of their study. This is a mosaic of citations that represent the eclectic choice of the authors. In the introductory section of the article, this mosaic of citations is reorganized in such a way as to emphasize the relevance of the published work. As stated by Locke and Golden-Biddle (1997: 1030): *we can say that each research study places itself in an intertextual field of its own making.*

The arguments used by the authors themselves in their discussion or conclusions were also analyzed. These arguments described the interactions between the researchers and the informal sector, primarily research that was produced by ICRAF. Table 1 shows examples of arguments extracted from articles of both case studies. The arguments have been placed in three categories that enable their analysis from the two different theoretical perspectives: as a research object construction or as an interaction between actors.

Table 1: Examples of Arguments used by Researchers to Demonstrate the Social Relevance of their Work on Ricinodendron Heudolotii and Canarium Schweinfurthii

Reference in text	**Arguments related to a government program /Arguments describing interactions between actors**	**Arguments that address the need for industrial commercialization**	**Arguments related to traditional uses or addressing the informal sector**
Kapseu and Tchiégang, 1995. *Journal of Food Lipid* 2: 87-98.		(p. 94) Djansang seed oil may serve as a valuable component to coating industries similar to tungseed oil, which contains similar trienic conjugated bonds. (p. 94) This seed oil represents a versatile edible oil source from which it is possible to make a tremendous number of products.	(p. 88) These seeds are important ingredients in culinary usage. (88) They are known as Djansang, Nzonel, Ezezang. (p. 94) Djansang seed oil may serve as a valuable component for inclusion in infant formula due to its high polyunsaturated fatty acid content especially in developing countries.
Tchiégang et al., 1997. *Journal of Food Engineering* 32: 1-10.		(in the title) Potential primary material for tropical agro-food industries…. (p. 1) The identification of the nutritional value of the proteins show a chemical index that is inferior to that of soya or cotton but it presents a good chemical equilibrium with respect to amino acids that can serve nutritional needs. (p. 2) The lack of detailed information on the chemical characteristics of almonds is a serious handicap for the development of a technology to extract the oleaginous oil to serve human nutritional needs. (p. 8) *R. heudelotii* contains more oil, salts, minerals and azotic materials than cotton or soya. Its oil can be used in paint and stain manufacturing,	(p. 9) The high level of azotic materials in *R. heudelotii,* as well as a good balance of amino acids makes it possible to use them in certain infant formulas.

Reference in text	**Arguments related to a government program /Arguments describing interactions between actors**	**Arguments that address the need for industrial commercialization**	**Arguments related to traditional uses or addressing the informal sector**
		and as a table oil It can also be used in soap-making.	
Tchiégang et al., 2003. *Journal of Food Engineering* 58: 363-371.		(p. 364) In addition to its rich oil, Moundipa et al. (1998) showed that the consumption of the raw oil increased the level of HDL cholesterol while decreasing the amount of LDL cholesterol, which is in contrast to palm oil. This important property makes the oil of Njansang a good dietary supplement to combat cardiovascular illness and arthrosclerosis, due to it hypo cholesterol and hypo triglyceride activities. (p. 364) Polyunsaturated fatty acids are popular with pharmaceutical nutraceutical and food industries as natural sources that can be produced in good quantity and quality (Ackman & Dha, 1996; Ackman, 1999).	(p. 364) … with respect to its triple interest in the food, technology and nutritional sectors, the extraction of its oil can constitute a good source of revenue for the population and can contribute to the fight against poverty. (p. 370) The craft-based approach on a small scale can be used to extract the virgin oil of *R. heudelotii* …at a minimal cost with the use of local materials available to all.
Aboubakar Dandjouma et al., 2004. *La Rivista Italiana Delle Sostanze Grasse* 81: 299-303		(299) Due to the presence of the acid α-elaeostearic, the oil of *Njansan* can be used in the manufacture of stains, paints and impermeable materials. (299) Despite its potential for technological, industrial and nutritional industries, there has been little work on the extraction and commercialization of this oil.	(p. 299) Given the widespread poverty in Africa since the devaluation of the franc, the populations don't always meet their nutritional needs. In Cameroon, the rate of coverage of lipid needs is around 49%. These populations have available to them a number of oleaginous plants that have been under-utilized.
Kapseu and Parmentier, 1997. *Sciences des aliments* 17: 325-331	(p. 326) in the case of diversification of lipid resources and the marking of oleaginous agro-resources in Cameroon, we have determined the composition of fatty acids and the commercialization of oleaginous agro-resources ....of the seeds and fruits consumed by the population….	(p. 330) The fruits appear more promising than the seeds – the oleaginous fruits constitute a source of primary materials for the cosmetic and pharmaceutical industries.	
Tchiégang et al., 2001. Journal of *Food Engineering* 47: 63-68.		(p. 64) In Nigeria, in the context of commercialization of non-conventional oleaginous materials, Ajiwe, Okeke, Ogbuagu, Ojukwu and	(p. 64) A fruit is said to be ripe if by a simple pressure between the thumb and index finger, the pulp detaches

Reference in text	**Arguments related to a government program /Arguments describing interactions between actors**	**Arguments that address the need for industrial commercialization**	**Arguments related to traditional uses or addressing the informal sector**
		Onwukeme (1998) investigated the possibilities of manufacturing paint, wax, beauty milk treatments, and shampoos from the oil of Canarium.	completely and easily from the pod. This method of determining ripeness is used traditionally and does not require any training. In this way, the number of ripe fruit can be easily determined and we can then calculate the percentage of ripe fruit for each sample lot.
Ngo Mpeck et al., 2003. Food, *Agriculture and Environment* 1(3-4) : 257-262.	(p. 257) The domestication programme at World Agroforestry Centre is based on vegetative propagation of trees identified as "superiors" by farmers collaborating with scientists. (p. 258) With the assistance of farmers in all villages, *Ricinodendron heudelotii* trees were identified, mapped and located (p. 261) The Domestication Program of high-value multipurpose indigenous trees from West and Central Africa at ICRAF is based on cultivar development using vegetative propagation as the means to capture the characteristics of trees identified as "superiors" by farmers collaborating with scientists. (p. 262) ICRAF-West Africa is developing nurseries at village-level, based on vegetative propagation of "plus trees" identified by farmers collaborating with scientists.	(p. 257 abstract) Kernels from the fruit of the species, commonly known as "ndjanssang", constitute one of the most traded non-timber forest products in Cameroon (p. 257) *Ricinodendron heudelotii* is among the economically most important indigenous fruit species, accounting for a significant proportion of local and Cameroon border trade in NTFPs. In Europe, its kernels are frequently found in the stalls of shops specializing in tropical products. (p. 257) The kernels, used as a flavouring agent in local food dishes, are also a good source of oil (49.25 to 63.18% oil content) 8 that can be used to make soap and varnish.	(p. 257 abstract) *Ricinodendron heudelotii*, an indigenous fruit tree species to humid lowlands of West and Central Africa, has been identified through user surveys to have high potential for improving the nutrition and income of rural poor. (p. 257) Genetic variability in this species needs to be determined for traits of nutritional, medicinal and economical importance to end-users (farmers and market). Because of the domestic and market importance of the kernels, farmers in the humid lowlands of Cameroon have identified the following characters for selection: fruit size, reduction of time to bearing, reduction of tree height; so justifying the need for domestication.
Ngo Mpeck et al., 2004. Reviewed papers presented at ANAFE Symposium on Tertiary Agricultural Education, April 2003. ICRAF, Nairobi, Kenya. pp 196-206.	(p. 197) World Agroforestry Centre (ICRAF) in collaboration with the Institut de Recherche Agricole pour le Développement has initiated a participatory tree domestication programme based on the vegetative propagation of tree identified as "superior" by farmers collaborating with scientist (Tchoundjeu et al., 1998). This programme aimed at investigating the potential of these species for agroforestry. (196) In collaboration with farmers and national research	(p. 197) The increasing nutritional and commercial importance of the kernels and other products of this valued fruit tree has led to several domestication initiatives in Cameroon (Nguele, 2000; Shiembo et al., 1997; Mapongmetsem, 1994) (p. 197). To be successful, the domestication of indigenous fruit species should be linked to commercialisation and market expansion (Leakey et al., 2000).	(196 Abstract) The results obtained here highlight the possibility for researchers and farmers to produce planting material that fulfils the dual aims of high genetic variation and reasonable performance to farmers. (p. 197) Studies conducted in the humid forest zone of Cameroon in recent years on the uses and commercialisation of Non-Timber Forest

Reference in text	Arguments related to a government program /Arguments describing interactions between actors	Arguments that address the need for industrial commercialization	Arguments related to traditional uses or addressing the informal sector
	partners in Humid Lowlands of West and Central Africa (Cameroon, Gabon, Ghana and Nigeria), ICRAF conducted a priority-setting exercise identifying the following indigenous species for domestication through participatory household surveys: *Irvingia gabonensis; Dacryodes edulis; Ricinodendron heudelotii; Chrysophyllum albidum* and *Garcinia kola* (Fanzel et al., 1996). (p. 197) The use of this diversity for the selection of 'elite trees' by farmers and researchers (Tchoundjeu et al., 1998), is seen as the starting point for the wider domestication of this species, because the quantification of the species variability available at farmer level can be used for the identification of "ideotypes" to guide cultivar's development.		Products (NTFP's) have shown the potential of *R. heudelotii* to improve the livelihoods of rural populations and urban poor (Ndoye and Ruiz-Perez, 1999; Ayukand*al*., 1999). (p. 197) … new initiative in agroforestry are seeking to promote poverty alleviation and environmental rehabilitation in developing countries, through the integration of indigenous trees into farming systems … in order to provide marketable products that will generate cash for resource-poor rural and peri-urban farmer (ICRAF, 1997).

There is an unequal distribution between the three categories – there is little that addresses the interaction with the State. A survey of the different expressions used shows a pronounced emphasis on arguments that address the informal sector in general and the rural milieu in particular. One has however to notice that arguments addressing the interactions between the administration of ICRAF, its researchers, organized in multidisciplinary team, and traditional agriculture introduce a model of good practices that have been tested and successfully used in other countries.

2. A Re-reading of Miettinen's Dual Definition of a Research Object

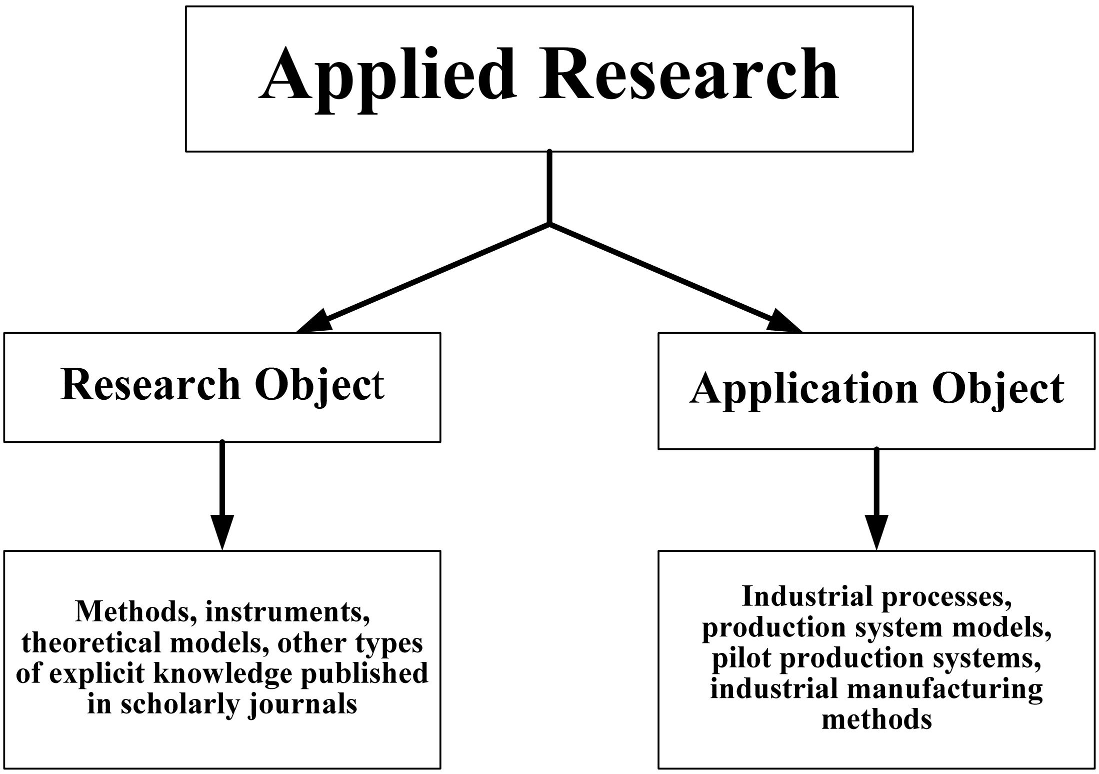
Research that has as its stated objective the solution to practical problems faced by society often consists of highly complex objects. The construction of such objects requires the intervention of researchers from different disciplines who work together in a network and collaborate with other actors who share the same research object (Miettinen, 1998). In this perspective, the object is a research object and an application object. The research object aims to develop methods, instruments, and looks at facts and theoretical models that are transferred as explicit knowledge – often published in scientific journals.

The application object, aims to develop industrial processes, production system models, pilot production systems, and industrial manufacturing methods. The application object is ideally simultaneously developed by a network of innovations that is composed of researchers, manufacturers and users of the end product, service, procedure or technology. These two objects, the research and application object, don't, however, always go hand-in-hand. They are produced by different activity system networks that have different goals, motivations and time perspectives. The duality of the definition of a research object by Miettinen (1998) is revisited by Gopalakrishnan and Santoro (2004) who distinguish between the two at the level of processes of knowledge and technology transfer.

In order to situate the object in the cited article Miettinen (1998) draws upon a number of studies that have already analyzed the different complex processes involved in developing a research object. The construction of intertextual coherence (Locke and Golden-Biddle, 1997) shows that different cited studies share a common orientation: they analyze the emergence of facts or artefacts as a social construction instead of as a mirror image of reality. This type of research is usually completed when a fact or an artefact is accepted by the research community concerned. The publication of the results of the research is the end result of the research activity. The knowledge produced is, at best, accessible to members of the scientific community. In other words, the result research does not reach the actual potential user in a product or service development systems.

Figure 1: Dichotomous Representation of Research and Application Objects

Based on the dual definition of Miettinen (1998: 452)



Miettinen adds to the publication of new scientific facts a second phase that addresses the relationship between the creation of an object with society's use of the research results, outside of the scientific community. This results in a dual definition of the research object that is depicted in Figure 1, which allows us to distinguish between a research and an application object.

3. Adapting the creation of a research object to the case studies

How does this dual definition of a research object apply to the research activities on *Ricinodendron heudelotii* and *Canarium schweinfurthii*? The comparative analysis of the arguments extracted from articles on *Ricinodendron heudelotii* (Table 1) show that the attitudes of researchers have changed during the research activities. In 1997, Tchiégang et al., state that the seeds of *Ricinodendron heudelotii* represent a potential primary material for tropical agro-food industries. The authors state in the French version of their abstract which lightly different from the English one:

> *This study shows the nutritional potential of* R. *heudelotti (Bail.) which is attracting the attention of tropical agro-food industries who recognize the importance of integrating it in tropical food industries* (Tchiégang et al., 1997: 1).

This confirms that industry cannot help but be interested in the transformation of this primary material. There are many arguments used that validate this. Most of the scientific data establishes that the research results of the article address industrial commercialization concerns. The authors don't lack for opportunities to emphasize the potential importance of the seeds studied for diverse industrial sectors.

> *Due to its richness in polyunsaturated fatty acids (79.4% of the total fatty content), and the fact that it can be used in a variety of different meals, the oil of* R. *heudelotii can be an important table oil used to season raw food as well as in the cooking of diverse meals. As with other similar oils, it can also be used in the manufacture of paints and stains.* (Tchiégang et al., 1997: 6).

Tchiégang et al. (2003), also refers to industries, but with less emphasis than the preceding articles. The authors cite references that show the seeds of this plant contain materials sought by industrial companies in developed countries. Here is an illustrative excerpt:

> *The polyunsaturated fatty acids are currently popular due to their nutritional value and their potential use by pharmaceutical, nutraceutical and food industries that are particularly interested in natural sources that can be produced in both quantity and at a high level of quality. (Ackman & Dha, 1996; Ackman, 1999).* (Tchiégang et al., 2003 : 364).

The industrial reaction appears to have been fairly muted. In fact, there does not appear to have been any reaction by industry. In the subsequent articles *Canarium schweinfurthii* the term "industry" makes only very few appearances:

1) These oleaginous fruits constitute primary materials for the cosmetics industry. (Kapseu and Parmentier, 1997: 330).
2) The major research on the oil of the fruit pulp were carried out to improve the extraction by enzymatic addition, and the use of this oil in the manufacturing of shampoos, wax or as a biocarburant. (Kapchié et al., 2003: 1 citing previous studies).
3) … knowledge of the behaviour during the drying of solid products is an essential element for the calculation of the size of industrial dryer and/or to define conditions of use (Noumi et al, 2004: 71).

The enthusiasm of the researchers appears to diminish. They become less optimistic on the eventual commitment of industry in the transformation of the products studied. Very few articles propose in their results prototypes for industrial transformation of those products. Only a few make such statement (e.g. Noumi et al., 2003; 2004). The presentation of knowledge is often associated with its potential industrial exploitation. The researchers show that they consider industry to be an intermediate user of their results – which they need to transform the knowledge produced by the research into a technology, product or procedure.

The researchers worked however towards an application object. They developed extraction procedures for the oil of *Ricinodendron* which is destined for rural user and not for industry. It is stated that:

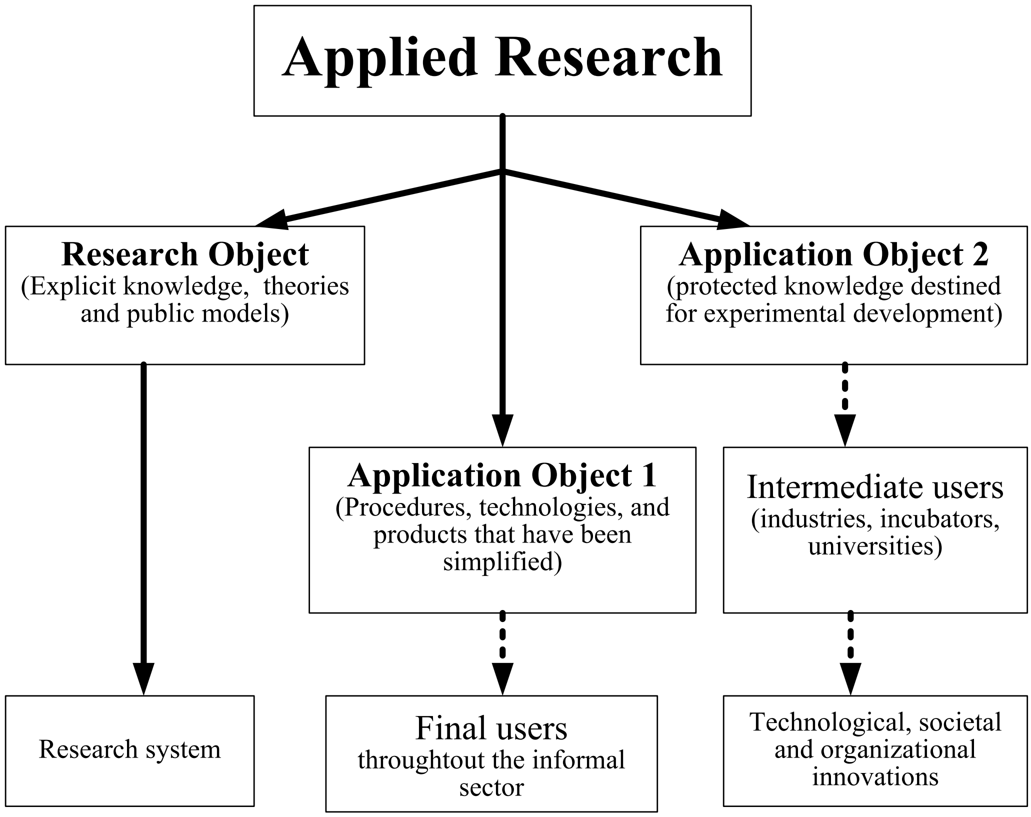
> *With respect to its application in a rural context – it has a number of advantages due to the quality of the oil and the extraction and pressing technique that can be used. The extraction of the oil from the seed of* R. *heudelotii needs to be further studied in order to identify conditions where a high quantity and quality of yield can be obtained….* (Tchiégang et al., 2003: 364).

The idea is to develop a simplified technology that is different from that which can be used by industry. There are thus two types of application objects: one destined for industrial commercialization (not within the scope of this study) and one destined for the rural population. The authors of one article speak of a craft-like approach on a small scale (Tchiégang et al., 2003: 370). These researchers seem to assume that the rural population will find it difficult to appropriate more complex technologies. Platt and Wilson (1999) describe technology appropriation by rural populations. The appropriation process is leaning by doing as we are working with tacit knowledge. We therefore need to distinguish 2 levels of an application object, as shown in Figure 2: one for principal actors in an informal rural system and a second level for industrial actors. Only the first level is addressed in the articles analysed.

It is suggested that Figure 2 be read from left to right. The full line represents researchers who have met their objectives whereas broken lines represent research that has remained at the abstract or idea stage. The researchers have produced explicit knowledge that has been published in scholarly review (*mainstream journals*). The users of this knowledge are limited to members of the scientific community. Potential production system users have difficulty in accessing such vehicles of knowledge transfer.

Figure 2: The Applied Research Object and the Assumed Use of Knowledge and Technologies in the Informal Sector

The broken lines represent objectives that have not yet been attained.



For application object 1, the researchers have produced an artefact, a manual press for the extraction of the oil from seeds of *Ricinodendron*. They have also tested a number of procedures for the optimization of oil extraction in order to ensure storage at room temperature but only under laboratory conditions.

For the fruit of Canarium, researchers developed oil extraction and conservation procedures. Simple fruit storage procedures were also tested. They carried out oil extraction from fruit in a number of different states in order to minimize loss after harvesting. In all cases, the technology and the proposed procedures were simplified in order to be cost-effective in the rural context. The formula used by the authors can be applied to all application objects to make use of the craft-like approach on a small-scale: *that can be carried out at a minimum cost using locally available materials* (Tchiégang et al., 2003: 370).

The modalities and the organizational structures also play a role in the transfer of application objects to potential users. The broken line represents these gaps – cases where the transfer of application objects from the university lab to rural communities have not yet taken place, nor the appropriation of technologies, even simplified ones, have not occurred. It is likely that a mediation process and structure are required here. This process can be broken down into two phases: promotion and dissemination. Promotion refers to making the information or the technology known by those that can then disseminate it. Dissemination consists of increasing the level and accelerating the pace of the uptake of research results in order to develop them into applications for targeted end (Garforth, 1998). We are still labouring under the assumption that rural users are handicapped in the appropriation of any technologies due to illiteracy (Kapseu et al., 2002).

Consider the application object 2. The researchers have remained at a speculative level with few concrete products based on what they proposed. They have multiple citations concerning potential industrial commercialization of primary materials studied but without any prototyping, for example. Our understanding is that they consider development at this level as not being part of their objectives nor of their contribution to the economic development goal or mission. This is shared by other authors and societal actors such as industry and researchers in other disciplines. They are late in joining the activities initiated by the research and have not contributed to their commercialization. Does the government have a role to play here?

4. University Researcher Initiatives that Seek to link Research to the Informal Sector

The arguments shown in Table 1 were distributed in order to highlight the researchers' initiatives directed to the informal sector, the industry and the government. In many of the analyzed articles, the authors have used a variety of different means of linking their research to the informal sector.

The simplest form of link between research and the traditional production sector is in the names of the plants using one of the official languages of Cameroon: *They* (the seeds) *are known as Djansang, Nzonel, Ezezang* (Kapseu et al., 1995: 88). The terms are used to introduce the research: *In this paper, the fatty acid composition of pulp, shell, membrane and kernel of "mbeu"…* (Kapseu et al., 1996: 78). Other examples are shown in Table 1. It is assumed that the researchers use these terms in order to demonstrate their willingness to link their knowledge production to the activities involved in traditional production systems.

In another text, the research objective is linked to the *fight against poverty* (Noumi et al., 2003: 317). Many articles point out that the population of Cameroon can meet only 49% of their lipid requirements and the proposed research purports to correct this deficit. This argument emphasizes a goal of reducing malnutrition, perhaps by improving the distribution channels. This would permit the *distributors and retailers to generate more profit* (Jiokap Nono and Kapseu, 1999: 21 and 22), which in turn will improve the general quality of life.

More explicit goals are stated by researchers who describe initiatives to profit the poor and the informal sector such as ….*these transactions will feed the informal economy*… (Jiokap Nono and Kapseu, 1999: 21). The same authors identify women as the principal beneficiaries of the improved informal economy. Here are two excerpts: 1) *Fresh or heat-processed fruit can be sold in baskets by women...* (Jiokap Nono and Kapseu, 1999: 21). 2) *These products bring a greater value and allow women to not just conduct small businesses but to increase their family revenue* (Jiokap Nono and Kapseu, 1999: 26).

The proactive approach makes research results available to the traditional production sector: In other respects the black olive producers live in rural areas mainly. Small-scale techniques are available to enable people of rural areas to process their own oilseed locally (Tchiégang et al., 1998: 566). There are also less direct means such as: the technique of conservation using humidity was studied in the context of simplifying this so that it lends itself to a craft-like approach ….this technique requires only know-how, organic acids and locally available sites (Tchiégang et al., 2002: 303).

On the other hand, certain research appears to have been inspired by traditional practices which they have attempted to systematize and enrich. Examples are methods of determining fruit ripeness for *Canarium* (Tchiégang et al., 2001).

5. Government Initiatives to promote a Participatory Process

A participatory process is a key requirement of the International Monetary Fund and the World Bank, as introduced in the document, *The Poverty Reduction and Growth Facility (PRGF).* An extract from this demonstrates this requirement clearly:

> *Crucially, the new framework rests on a departure in the way objectives and policies are chosen. The country and its people will need to take the lead. PRSPs [poverty reduction strategy papers] will be prepared by the government, and based on a process involving the active participation of civil society, NGOs, donors, and international institutions.* (IMF and WB, 1999 Internet document).

This requirement was introduced during the reform of programmes which at the time could be considered a *management fad* (Gibson and Tesone, 2001: 22). Management fads are innovative organizational practices designed to improve certain aspects of their performance. Management fads may evolve to become new management practices or be abandoned altogether if they fail. The appropriation of these fads and their conversion into stable management practices requires time, effort, organizational learning, political willingness and a follow up on the part of the directors at all levels of the State and the organization.

The participatory process has been used by the government to prepare a national strategy for poverty reduction. This strategy should then serve to orient university research as discussed in the preceding paragraph. On the other hand, many government programmes were created and implemented in order to promote and sustain user need driven research themes. Among these programmes is the *Programme stratégique du gouvernement en matière de Science et de Technologie pour le Développement* implemented in 1997. The aim of this programme is to

> *… promouvoir au Cameroun la maîtrise de la science et de la technologie au plus haut niveau de l'excellence, de favoriser la mobilisation par les Camerounais des connaissances scientifiques et technologiques mondiales nécessaires pour la lutte contre la pauvreté, l'amélioration rapide et durable des conditions de vie des populations et le développement économique, social et culturel de la nation* (MINREST, Internet document)[25]

Another programme of interest is the *Programme national de vulgarisation et de recherche agricole* which is made of six components: agricultural commercialization, research, training and the development of human resources, support to organizations and rural associations, participatory development of village communities and a follow-up of commercialization activities. These two programmes both advocate objectives of support, promotion and brokering between university research and potential users to which the research is targeted.

While the analyzed articles do not explicitly state a recognition of support or interactions between university research and one or both of these programmes, there are quite a few analyzed articles where the co-authors were researchers of the Agricultural Research Institute for Development

[25]…promote in Cameroon the mastery of science and technology of the highest level of excellence, to promote the leveraging of world scientific and technological knowledge by the people of Cameroon to fight against poverty, to rapidly improve the quality of life in a sustainable way and to develop the social and cultural economy of the nation.

(IRAD), which heads the national agricultural commercialization programme. Perhaps the IRAD researchers collaborate with university researchers as they were former students.

These interactions are highly desirable in promoting the participatory process in the definition of research problems as well as to promote and diffuse the results of internal university research. Could this be a case of an omission based on the assumption that it is taken for granted? An omission of this sort will not help integrate university research in development processes and public university researchers will be obliged to act as sub-contractors or consultants for other researchers who are directly supported by these government programmes and by international fund loan officers. This is the case with the International Centre for Agroforestry Research which benefits from financing from the International Agricultural Development Fund (FIDA) which is a specialized agency of the United Nations.

6. Researchers that have Participation from Actors from the Informal Sector

Many articles by researchers from ICRAF (Tchoundjeu et al., 1999; Ngo Mpeck et al., 2003 and 2004; Leakey et al., 2003) discuss collaboration between scientists and traditional farmers. The participation of rural farmers in the research process is presented as a critical element for the institution. They make use of expressions such as: *With the participation of subsistence farmers; the first step in the domestication process involves household interviews to determine farmer preferences* (Leakey and Tchoundjeu, 2001: 279 and 281).

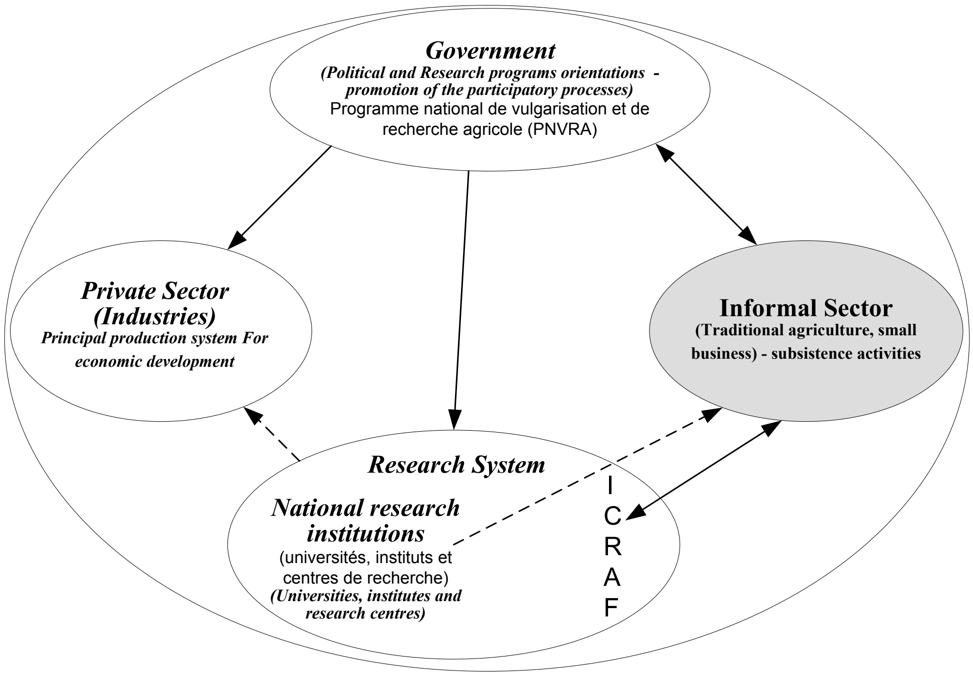
In the domestication of indigenous trees program, ICRAF's strategy is to ensure that the farmers themselves indicate which trees are the most important for them and the best way in which to improve them (Tchoundjeu et al., 1999). One ICRAF objective is to develop domestication techniques that integrate both scientific data in agro-forestry and traditional know how for the plants judged to be the most important by the rural sector.

The initial research problem is then defined in collaboration with a multidisciplinary team composed of economists, forestry experts, agronomists, sociologists, and traditional farmers from the informal sector. Illiteracy, which is often presented as a limiting factor in such contexts, does not seem to impede the collaboration between rural workers in a participatory inventory of plants with multiple traditional uses. This step of the process which ends with a list of priority species in terms of their domestication becomes a stage of research problem formulation that is situated in *highly specific and local contexts of application* (Gibbons et al., 1994: 30). This is also applied research where the application object is the development of plant cultivars to be domesticated.

With the preceding example, we find different dimensions of the triple helix model become fused (Etzkowitz and Leydesdorff, 2000): namely, government, university, and industry. We propose the addition of a fourth component, the informal systems, which are distinct from industry (see Figure 2). Figure 3 summarizes the assumed relationships in the adapted triple helix model.

Figure 3: Relationships between Government, Research System, Industry (designated Private Sector in the document on the Strategy to Reduce Poverty), and the Informal Sector.

This model is a modification of the triple helix model of Etzkowitz and Leydesdorff (2000: 111). ICRAF: International Center for Research in Agroforestry.



The government initiatives are represented as addressing a national strategy for poverty reduction. Political orientations and programs within this context are presented in the document Strategy for Poverty Reduction. This document is endorsed by the members of the UN in Cameroon during the signature of the Executive Plan of the UN for Development Aid in Cameroon for the period 2002/03 – 2006/07 (UNCT, 2002). Promotion of participatory processes was, in principle, carried out as required by the Sazdadoh papka international fund sponsors. But what about the rest of the participatory process which addresses the interactions between the public and para-public administration personnel and the NGOs, the private sector, civilian society members and the universities?

If we look at university research results that have not been conveyed to targeted users in the rural milieu, we would have to say that these modalities have not been transformed into stable management practices. The same can be said for collaboration between universities and industries. We have shown these unrealized interactions as broken lines. University research initiatives intended for the informal sector do, however, represent a significant step forward in the right direction. They signify a certain alignment between the national poverty reduction strategy with societal actors from the informal sector. But these initiatives can also help better recognize the importance of the informal sector in the economic system of a country.

The relationships developed by ICRAF with the informal sector are far more relevant for the acceleration of the integration of research to economic and social development processes than those developed by the university research. The strategy communicated by this institution which aims to promote collaboration between multidisciplinary research team and traditional farmer associations to define research problems and the transfer of research results to targeted end users is an excellent example of interactions between actors engaged in a research process within the context of an application. Our recommendation is to adopt and adapt this good practice for all the relationships between all the actors involved in the process.

Conclusions and Further Work

To conclude this exploratory study, we propose that given the number of initiatives, university researchers need to start assuming the role of contributing to the economic development of Cameroon – more specifically, to contribute to the strategy of poverty reduction. Research initiatives show a change in attitude concerning informal economic actors in general and farmers in particular. In addition to producing knowledge, researchers develop technologies and simple processes that take into account assumed limitations of actors the research results are destined for. Knowledge produced is published but the technologies and procedures developed are not transferred to potential end users. It is not due to a lack of a model of good practices because the ICRAF represents such a model at the national level.

What appears to be the problem is the organizational mechanisms required to transfer knowledge and to transfer developed technologies to the targeted user population (Figure 2). It is therefore necessary to begin a change process that will be accompanied by an organizational change of equally large magnitude. The association of students to the process of knowledge and technology transfer and the development of structures such as incubation offices can help establish links between researchers and end users of university research results. Etzkowitz (2002: 14) proposes that *this organisational training occurs outside the classroom setting and for purposes other than education.* The incubators, such as those used in Brazil, are very versatile. They have been adapted it to a multitude of uses that are quite different from the original intent. The incubator appears to be an ideal organizational structure for professional training outside the context of formal courses. A well thought out adaptation of the participatory process for the development of research goals and for the dissemination of research results should form the basis of good management practices.

The data from this exploratory study form part of a larger project that targets the strategic analysis of research conducted in Cameroon following the university reform in 1993. The research described here addressed the work done by researchers that was destined for rural workers, their systems and their production practices, in order to conserve and manage agro-ecological ecosystems. Two subsequent studies are currently in preparation and will serve to complement the present study. These two studies comprise 1) the dynamic analysis of research conducted over two periods spread out over a span of six years and 2) the factors that affect – either positively or negatively – the formation of a critical mass of national researchers, as well as the process of innovation in this sector. We intend to continue testing our research hypotheses by postulating the rural sector and the informal system as elements of the triple helix in these future research studies.

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The Incubator as Organizational Training Method

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Abstract

This paper presents a model of the cooperative incubator created in Brazil in 1995, whose aim was the creation of cooperatives, and not firms, in the classical sense. It was an initiative of the universities, directed at creating jobs for the marginalized social sectors, increasing their income, bettering their living conditions and providing educational opportunities. The Brazilian universities have always been concerned about the country's social inequality. The consolidation of this process through collaboration amongst industry, government, universities and civil society – the triple helix, has transformed this experiment into public policy.

Keywords: incubator, cooperative incubator, triple helix

Introduction

The first Technological Incubator of Popular Cooperatives was established at Coppe/UFRJ (Graduate Program and Research Coordination in Engineering/ Federal University of Rio de Janeiro)[26,] in 1995. This was a time when a number of civil entities had come together in order to organize a series of activities to combat poverty. This movement called itself "Citizens in Action against Hunger and Misery and in favour of Life" (Ação da Cidadania contra a Fome, a Miséria e pela Vida). This movement started by a non -governmental organization – Ibase – encouraged solidarity and was organized in a decentralized and autonomous manner, with approximately 3,000 groups set up through local initiatives.

The precarious unofficial markets created in Rio de Janeiro - a mega-city within a developing country – have been losing their capacity to absorb all the workers seeking employment, from various different sectors, such as personal and domestic services and various types of odd jobs. A pyramidal occupational structure can be observed, with the service sector gaining predominance over the industrial sector – a phenomenon already witnessed in the developed countries – but with one major difference: the lower tertiary sector is swollen by the loss of mobility in the unofficial economy, leading to a fortifying of criminal tendencies and a fragmentation of the metropolitan social fabric.

It is within this context that the cooperative incubators attempting to fashion a new kind of worker who will take on the guise of a collective entrepreneur, linked with other workers in cooperative networks, associations and/or cooperative micro-enterprises, requiring the mastery of new information tools in productive environments. This methodology is attempting a new qualitative leap in the direction of fulfilling the processes of social and economic insertion (Bocayuva, 2000).

1. Method

The approach adopted in the data collection for this study has been qualitative. This article is based on a review of the literature, analysis of the ITCP network's documents and interviews[27] conducted with incubator coordinators, federal government science and technology policy officials, and customers and members of the cooperatives, as well as participation in events organized by the incubators and their networks.

[26] COPPE/UFRJ is a major graduate engineering school and research center. Besides ITCP, it shelters also a Technological Incubator and a Science Park.

[27] Furthermore, the author analyzes the evolution of the Brazilian Incubator Movement in her PhD thesis, including the Cooperative Incubators, and worked for one year at the Technological Incubator for Popular Cooperatives at Coppe/UFRJ.

2. Invention of the model

One of these groups, called "Committee of Public Bodies against Hunger and in favour of Life" (COEP - Comitê de Entidades Públicas no Combate à Fome e pela Vida), aimed to reflect on the social responsibility of public bodies and to mobilize these institutions to participate in this campaign. At this time, the idea of incubating cooperatives still hadn't been clearly formulated. The view was that the Federal University of Rio de Janeiro - UFRJ would carry out work similar to that being done by the Oswaldo Cruz Foundation (Fiocruz). This public health institute, supported by the federal government, ran a project called "Open University", by means of which, through a local cooperative, it hired cleaners from amongst people living in the Manguinhos slum, that is located not far from the Foundation.[28]

From this initial discussion, the group decided on a different proposal: to utilize the university's potential as a fomenter of jobs rather than merely acting as an employer. The proposal was, in the manner that Coppe/UFRJ was already doing with technology based companies – to incubate projects based on the knowledge resources available at UFRJ, that would become tools for transforming the university's outreach efforts, directed at popular sectors that find themselves socially, economically, culturally and spatially marginalized.[29] The university received financial resources from COEP, an NGO, from Banco do Brasil Foundation and from National Innovation Agency (FINEP) (Guimarães, 1998).

3. The development of Brazilian incubators

Incubators started to be organized in Brazil in the mid-1980s. Significant political and cultural changes were taking place in the country during that period: direct election of the state governors and the mayors of the state capitals, the campaign for direct election of the country's president, the end of the military regime, the appearance of new social agents, such as the MST – Brazil's Landless Rural Workers Movement, the first resistance1 against the devastation of the Amazon forest, the organization of Afro-descendents communities to claim the lands where former slave havens were located. Taken as a whole, these manifestations signaled the advent of civil representation[30] in Brazil.

The military government that took power in 1964 continued to apply, in the Science and Technology (S&T) field, the same policies that had been adopted after the Second World War, directed towards national security, technological autonomy and the development of institutional infrastructure and human resources for the universities and state-owned companies.

In spite some good results were obtained in developing endogenous technology in fields like oil energy (off-shore technologies), telecommunications, informatics and aviation, the project of technological autonomy was circumscribed mainly to state industry in strategic sectors. The private sector, as a whole, was outside that project and wasn't benefited by transfer of technology from universities and public laboratories, without any R&D policy of their own and generally acquiring mature technologies from sources outside the country (Coutinho and Ferraz, 1995).

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[28] This first contract involved providing cleaning services on the premises of Fiocruz, which was able to cut its cleaning bill, while at the same time increasing each worker's wages by 250%. Statement from Paulo Buss, Director of the National College of Public Health, in the book "Ossos do Ofício".

[29] Statement from Prof. Luiz Pinguelli Rosa, Vice-Director at Coppe/UFRJ, in the book "Ossos do Ofício: cooperativas populares em cena aberta", Rio de Janeiro, May 1998.

[30] Interview with the anthropologist Alfredo Wagner for the 'O Globo' newspaper, 'Prosa e Verso (Prose and Verse)' supplement, on February 15, 2003.

The military government came to an end in 1986 and the country returned to democratic rule. The reorganization of civil society allowed a whole new set of policies to be developed. In a climate of increased political freedom, following debate over the transfer of technology from universities to industry, it was proposed that incubators be established. As civil society learned to express itself and the bottom-up policy for creating incubators was consolidated, so different kinds of institutions became involved in the organization of incubators.

The emergence of this civil society space, associated with the S&T infrastructure build-up by the military regime propitiated conditions for the appearance of a huge incubator movement in a triple helix model of overlapping spheres.

In the Brazilian case, in a first move, academics, in alliance with officers from state and municipal governments, created technological incubators. Incubators were easier to be establish because fewer resources was required than were necessary to set up technology parks and the administration was less complex.[31] The first two incubators came into operation in 1986. One was collaboration between the university sector and the government of the State of São Paulo and was located in the town of São Carlos, where a technology park was in the process of being set up (Souza and Garcia, 1999). The Technology Business Incubator was an integral part of the Florianópolis Technology Park project, an initiative of the UFSC – Santa Catarina Federal University and the government of the State of Santa Catarina (Cavagnari, 1987).

At the end of the military regime, industrial associations revived, as part of the renewal of civil society. This political change coincided with a crisis in employment, due to the laying off of large numbers of workers in medium and low-tech industries, as the Brazilian economy opened up to international competition. In response Industrial associations have applied the incubator concept to create firms in so-called traditional industrial sectors such as fashion, shoes, furniture and agricultural equipment (Fonseca and Kruglianskas, 2000).

New types of incubator emerged in the Brazilian incubator scenario in the decade of 1990s. The cooperative incubators, whose aim was the creation of cooperatives. It was an initiative of the universities, directed to create jobs. Initiatives like the incubators of cooperatives are the fruits of the reaction of the social movements to the unemployment problems of the early 1980's, which were aggravated by the opening up of the domestic market to imports after 1990 (Singer, 2002).

It was only towards the end of 1999, with the internet phenomenon already at its peak that private enterprise incubators started to appear in Brazil. These incubators are concentrated in the area of information technology, particularly in businesses involving the internet. Since the end of the year 2000, this segment has suffered the effects of the strong contraction of the internet market and in 2003, only five incubators of this kind were still in business (Botelho and Almeida, 2001).

Starting off at the universities, with expansion in the number of incubators determined by the initiatives of local social agents, the movement was organized at a national level by means of associations that, little by little, gained representativeness, as well as the respect and support of government and industrial sectors.

There are currently 318 incubators in Brazil, of which 155 are incubators of technology based companies; 55 for companies from traditional economic sectors; 51 mixed, for both technology

[31] Almeida, M. Interview with Maurício Guedes, director UFRJ Science Park on April 16, 2001.

based and traditional businesses; 41 for cooperatives, five cultural, three agribusiness, three social and five private.[32]

4. How the Model Works: Role of the University in Organizational Training

As examples of the experience in this area, we present below two case studies: the first involving the first cooperative incubator created, the ITCP/COPPE/UFRJ, based at the engineering research center in Rio de Janeiro, Brazil's second largest city; and the second focusing on one of the incubators set up through the transfer of methodology, INTECOOP, at the Federal University of Juiz de Fora, located in a large town in the south of Minas Gerais state.

4.1. ITCP/COPPE/UFRJ

The ITCP/COPPE is the pioneer in developing this kind of incubator and in the ten years that it has been functioning it has created 48 cooperatives, plus a further 13 that are in the process of incubation[33], in response to the growing unemployment in Brazil. Its aim is to make a contribution towards the social integration of economically marginalized sectors.

The ITCP arose from an innovative concept. Although COPPE/UFRJ already had previous experience in technological incubation, it was necessary to develop new methodology, due to the unusual nature of the work. For this reason, a new methodology was created, modified and evaluated at the same time as the first cooperatives were being set up. As a result, the managers and staff, and also the members of the cooperatives themselves, went through a continuous learning process together.

The structure of this type of Incubator is unusual, while its headquarters are in the University campus; the incubated cooperatives have their own space, located in the very neighborhood where their members live. Incubated cooperatives pay no fee to ITCP. The process of incubating the cooperatives takes place within the community itself, and it is there that the specialists perform their continual monitoring of activities and provide legal, administrative, management and planning advice.

One of the first incubated groups was the Cooperativa Mista dos Trabalhadores do Parque Royal, created in December 1996, during the implementation of projects aimed at generating work and income, carried out by the municipal council (City Hall) of Rio de Janeiro in the Parque Royal slum. A group of local residents applied to the ITCP to set up a cooperative of seamstresses to operate in the clothing industry. This cooperative is in full operation today, participating in a group of 13 cooperatives, with 150 seamstresses, which do regular business with firms in the sector.[34]

Another cooperative, set up in 1997, the Cooperativa dos Trabalhadores do Morro da Mangueira Ltda, is in operation and working mainly in the area of hospital cleaning, through contracts signed with UERJ (State University of Rio de Janeiro). There are other components that work with garbage recycling. Researchers from the National Institute of Technology decided to

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[32] http://www.anprotec.org.br/arquivo-pdf/panorama%20final.pdf accessed on June 20, 2005.
http://www.portaldovoluntario.org.br/site/pagina.php?idclipping=6509&idmenu=45 accessed on March 23, 2005, Almeida, 2004.

[33] Finep. 2005. Folha Inovação, n 21, May, pp. 7

[34] http://www.comerciosolidario.com.br/publique/cgi/cgilua.exe/sys/start.htm?sid=28&UserActiveTemplate=_br, accessed on April 30, 2005.

provide technical support to this cooperative, developing new recycled product from Pet bottles.[35]

The work of the Technological Incubators of Popular Cooperatives has been extended to organizing cooperatives among other marginalized social sectors. In some cases, it was necessary to adapt the original methodology. The first example occurred within the mental health system, with the creation, in 1996, of a cooperative at the Philippe Pinel Hospital in Rio de Janeiro – the Cooperativa Especial da Praia Vermelha. The idea came from discussions that took place at the 1996 State Conference on Mental Health. The concept involves combining the carrying out of manual work with productive insertion of the user, as part of their psychiatric treatment.

Following the privatization of many state-owned sectors, large numbers of workers lost their jobs, due to the restructuring of those sectors, and in 1999 their trade unions looked to incubators to organize cooperatives among these groups, which were then frequently sub-contracted by their former companies. And lastly, there has been the organizing of special cooperatives, such as those involving the operators of the prison and garbage collection systems.

In 2004, ITCP/COPPE/UFRJ was chosen to receive resources from the Infodev program, destined to extend the use of information technology among the cooperatives and to develop cooperatives in this field. The Dinamicoop was organized and directed towards teaching courses and selling services in the field of information and communication technology.[36]

In practice, the creation of a new working relationship – cooperative member instead of employee – has been observed in the cooperative incubators. This involves a process of learning to work in a group, discussion and development that needs to be encouraged by the organizers of the incubator so as to avoid the appearance of conflicts among the members. The tools that are utilized include periodic meetings and the setting up of a council of ethics in each cooperative, thus enabling the democratic discussion of the problems and difficulties that arise in the normal course of their activities.[37]

According to the nature of the activity performed by the cooperative, there may be a need for additional know-how, in order to perform the activity. For example, the cooperative COOPAMA (Cooperative of the Friends of the Environment) operates within an experimental waste treatment plant called Usina Verde located at the Rio de Janeiro Biotechnology Park and training is provided by the owners of the plant as well as by the incubator.[38]

4.2. INTECOOP/UFJF

In the period from 1995 to 1999, the ITCP simultaneously concentrated its efforts in two main activities: (a) the development and experimentation of a suitable methodology to support cooperatives, grounded in basic education, the strengthening of cooperativism and the development of citizenship; and (b) the dissemination of the cooperative incubation concept among municipal authorities and other Brazilian universities. One of the outcomes was the INTECOOP/UFJF.

The Vice-Chancellor for Extension at the Federal University of Juiz de Fora invited the ITCP/COPPE/UFRJ coordinator to visit the university in 1997 and explain the concept of

[35] http://www.canalciencia.ibict.br/pesquisas/pesquisa.php?ref_pesquisa=124 accessed on April 30, 2005.

[36] http://www.cdi.org.br/boletim/boletim016C_site.htm, accessed on March 24, 2005.

[37] Interview with João Guerreiro, member of the Coppe Incubator of Popular Cooperatives team, on October 28, 2001.

[38] Almeida, M. Interview with Luis Carlos Fernandes and Fabio Alves, members of COOPAMA on February 16, 2005.

cooperative incubators. Subsequently, other meetings were organized to explain the methodology and how to organize the incubator. At this time, eight professors from different fields (economics, social services, history and journalism) decided to participate in the cooperative incubator activities.

The group decided to adapt the methodology according to the needs of local social groups. This incubator methodology comprises certain principles that guide the actions: group participation, democracy in decision making, respect for the knowledge of others, the construction of dialogue, the dialectic between 'what I know' and 'what the others know', and respect for popular culture. INTECOOP/UFJF uses an open model of action: while its headquarters are on the university campus, the incubated cooperatives have their own space, located in the very neighborhood where their members live.

At this university, the professors participate greatly in the incubator and the cooperatives. They take care of the specific demands of their technical area and advise the trainees: the production engineering professor handles the office layout; the architecture professors work on the visual identity of the cooperatives; the nursing professors take care of occupational illnesses; and the accounting professor looks after the cooperatives' accounting and taxation.

INTECOOP/UFJF is financed from the resources of FINEP (Funding Agency for Studies and Projects) and the Federal University of Juiz de Fora. The university has a scholarship programme to enable undergraduate students to work with the cooperatives. INTECOOP looks for students who are interested in giving service and applying their talents and knowledge to improving the lives of cooperative members. The students that work in the incubator are looking for answers to social questions, regarding misery and exclusion, and this experience helps them, as professionals, to be more sensitive to social issues.

The graduated cooperatives maintain an ongoing relationship with the Technological Incubator of Popular Cooperatives that allows the incubator access to the technical, administrative and financial information that serves them as a competitive differential. One example is Coopdef (Cooperativa de Portadores de Deficiencias Ltda), one of the first incubated cooperatives, a group for the handicapped, who share special physical needs. It has been operating since 1998 and in 2005 has 330 participants, all of them working as office boys at government institutions. The subsequent monitoring takes place at the work venue or offices of the graduated cooperatives and involves discussing new contracts and planning.[39]

The profile of cooperative participants is generally the following: the associate members have a low educational level, are aged around 40, and are predominantly female (60%), and are unemployed or under-employed. The majority of them don't have professional skills. One such group is the Cooperativa de Matias Barbosa, whose participants know how to cook and decided to produce cookies and cakes.[40]

5. The Diffusion of the Model

Ever since the first popular incubator was created by Coppe/UFRJ, various factors have stimulated other universities to organize this kind of incubator. In 2001, the mayor of Campinas

[39] Almeida, M. Interview with Ana Lívia Coimbra, Coordinator of the Technological Incubator for Popular Cooperatives at UFJF on July 2, 2005.

[40] Almeida, M. Interview with Ana Lívia Coimbra, General Coordinator of the Technological Incubator for Popular Cooperatives at the Federal University of Juiz de Fora on July 2. 2005.

asked Unicamp to create a Popular Cooperative Technological Incubator. The cooperative's field was to be: garbage recycling, school meals and street conservation.[41]

At USP (SP) the Popular Cooperative Technological Incubator is considered to be a model of university action against unemployment and social exclusion, which is seen by those involved as a practical, theoretical and methodological challenge.[42]

The Technological Incubators of Popular Cooperatives began, in 1999, to organize their own national network, called the University Network of Technological Incubators of Popular Cooperatives (Rede Universitária de Incubadoras Tecnológicas de Cooperativas Populares – Rede de ITCPs). Its principal objectives are to stimulate intercollaboration and the spread of knowledge among the incubators and throughout the university environment; to encourage the development of similar incubators in other universities and to work towards the setting up, consolidation and integration of Popular Incubators affiliated to the network.[43]

This network is organized on a national basis, holds an annual general assembly, and produces an on-line newsletter in order to facilitate the exchange of information among the incubators.

There has been no tendency for the incubated cooperatives to organize themselves on an independent basis, but for the national assemblies each incubator generally tends to pay the participation expenses of one representative member of one of the cooperatives, in order to reinforce the level of interaction between them.

This initiative subsequently expanded to embrace 34 other not-for-profit universities[44] and has become an important means of extending the activities of Brazilian universities.

There are 41 cooperative incubators in Brazil sponsored by universities, often with the backing of local government. There are 350 incubated cooperatives, which have generated a total of 8,000 jobs.[45]

A survey of the incubators and their enterprises is still under way, but the partial results, presented in Table 1, show the regional distribution of the cooperative incubators, the total and regional numbers of cooperatives and the total and regional numbers of cooperative members (i.e.: jobs created).

[41] http://www.preac.rei.unicamp.br/itcp/programa-itcp.htm.
[42] http://www.cecae.usp.br/itcp accessed on March 18, 2002.
[43] Interview with Gonçalo Guimarães, General Coordinator of the Technological Incubator for Popular Cooperatives at Coppe/UFRJ, February 15, 2001.
[44] Almeida, M. Interview with Teodoro Koracakis, Finep, on July 13, 2005.
[45] http://www.portaldovoluntario.org.br/site/pagina.php?idclipping=6509&idmenu=45 accessed on March 23, 2005.

Table 1: Regional Distribution of Cooperative Incubators and Cooperative Economic Activities

Region	Number of Incubators	Number of Cooperatives	Number of Cooperatives Members
North	3	5 (a)	82 (a)
Northeast	9	21(b)	601 (b)
Central-West	2	6 (c)	-
Southeast	17	82 (d)	1.975 (d)
South	10	34 (e)	1.453 (e)
Total	**41**	**148**	**4.111**

(a) The figures relate one incubator.
Source: www.ufpa.br/cursoecomia/extensão/relatorio_parcial_proint.htm accessed on July 15, 2005.
(b) The figures relate three incubators. Source: Finep/Proninc, 2005.
(c) The figures relate one incubator. Source: Finep/Proninc, 2005.
(d) The figures relate nine incubators. Source: Finep/Proninc, 2005.
(6) The figures relate six incubators. Source: Finep/Proninc, 2005; www.ucpel.tche.br/Intecoop/Intecoop.htm, accessed on July 15, 2005.

Table 2: Regional Distribution of the Cooperative Economic Sectors

Region	Agricultural	Food	Clothing industry	Civil construction	Garbage recycling	Handi-crafts	Services	Others
North	-	-	-		-		5	-
Northeast	5	2	6	1	3	4	-	-
Central-West	2	-	-	1	-	1	-	2
Southeast	15	11	10	2	10	13	18	3
South	4	1	3	-	16	4	1	5
Total	**26**	**14**	**19**	**4**	**29**	**22**	**24**	**10**

Sources: Finep/Proninc, 2005; www.ucpel.tche.br/Intecoop/Intecoop.htm, accessed on July 15th, 2005 and www.ufpa.br/cursoecomia/extensão/relatorio_parcial_proint.htm accessed on July 15th, 2005.

The link between social incubators and universities makes it easier to bring together different social segments in support of the incubators. The universities help the incubators to maintain their independence from the government and also contribute to the participants' education by awakening their political awareness, in the broadest sense. The universities also help to disseminate this experience to other interested institutions (Pereira, 1998).

The university is the main cooperative's knowledge source. With the aim of providing access to knowledge for these groups, the universities have given courses on cooperativism and how to organize and register a cooperative. Another activity of the universities is to carry out feasibility studies for each cooperative, making use of the workers' knowledge acquired from their previous work experience.

This learning process involves the assimilation of new process and product technologies, as well as new institutional and cultural structures that facilitate cooperation among these new worker entrepreneurs. In order to make use of and develop the knowledge, skills and vocational leanings already acquired and utilize them in a variety of ways, a method of instruction is employed that integrates a critical awareness of the globalization process and its impact on the labour force with a transformation of the previous work experience (Bocayuva, 2000).

6. Organization Cooperatives' Challenges

Although there are methodological differences between the two incubators cited in this paper, the analysis of the difficulties encountered by both in each phase of the incubation process will be presented together, with any specific differences pointed out where appropriate.

6.1. Selection of the cooperatives for incubation

At the ITCP/COPPE/UFRJ, the selection of cooperatives for incubation is carried out by an *ad-hoc* committee of outside experts in a public process that confers transparency to the procedure. The notification is broadly disseminated, through correspondence with a variety of social organizations (trade unions, resident's associations, NGOs, etc), inviting them to recommend groups that may be interested in setting up a cooperative. When they register, among other information, each group will state the number of participants, the address and the intended economic activity. Interviews are carried out with each of the interested groups, in order to assess the level of maturity of the proposed activity and the organizational preparedness of the group for collective labor.[46]

The INTECOOP/UFJF intends to adopt the same procedure for its next selection process. Up till now, groups have been chosen through weekly meetings held to publicize cooperativism or through the recommendation of other civil society organizations. The assessment of the groups is similar to that outlined above.

Pre-incubation

This phase begins with an evaluation of the participants' skills, previous professional experience and educational levels, together with an assessment of the venture's economic and financial feasibility. They are encouraged to organize their basic civil documentation (ID Card, Taxpayer's Registration [CPF] and Voter Registration). The awareness, motivation and preparation of these groups, in terms of organizing themselves into cooperatives, are assessed and discussed with the participants, as difficulties sometimes arise over getting together to define the type of undertaking to pursue, thus affecting whether or not they remain with the incubator.

Incubation

During this phase at the ITCP/COPPE/UFRJ, two courses are held for all the group members.[47] The first is "An Introduction to Cooperativism", addressing issues such as what a cooperative is; the principles of cooperativism; self-sustained management and business ethics. The second is "The Cooperative as a Business", which aims to broaden the knowledge about how a cooperative works and especially about the products/services to be offered, the preparation of cost table and a list of the equipment needed. These courses lead to a refining of the initial project for the enterprise.

A procedure known as "Support for the legalization of the cooperatives" is conducted right from the start of the incubation process, involving the discussion and preparation of the legalization documents: by-laws; charter; records of the meeting that approved the founding of the

[46] Almeida, M. Interview with Paulo Leboutte, member of the Coppe Incubator of Popular Cooperatives team, on February 16, 2005.

[47] Computer courses are available to the participants at the ITCP/COPPE/UFRJ, covering text editing, the preparation of spreadsheets and access and utilization of the Internet (30 hours), so as to encourage them to use computers in their work. Almeida, M. Interview with Paulo Leboutte, member of the Coppe Incubator of Popular Cooperatives team, on February 16, 2005.

cooperative; formal approval of the charter; formal approval of the organization of the social funds[48]; and election of the board and statutory audit committee. In this way, the enterprise will be formally registered with the responsible federal, state and municipal authorities and will be able to operate as an official business.

This incubator also helps to insert the cooperatives within the market: in making contact with new customers; preparing work proposals/estimates/equipment certification/quality management/work safety norms; organizing the work and controlling the quality of the services/products provided, in order to improve the cooperative's methods/processes.

Following the first step, of defining and formally legalizing the venture's economic activity, there is day to day monitoring of operations. Another important feature is the professional training of the workers, which aims to stimulate discussion of issues such as work and a caring economy; democracy, participation and citizenship; cooperatives, associations and supportive networks; planning and management. The INTECOOP/UFJF is equipped with pedagogical support materials (educational booklets and videos). The process of incubating the groups includes addressing the economic aspects of the enterprise in a way that is linked to its social character.

The work with each enterprise goes through the following stages: evaluation of the venture's stage of productive and administrative development; training of the members in cooperative entrepreneurism, planning and management; development, as a team, of the group's strategic planning and business plan, with the aim of obtaining third party resources for the expansion and consolidation of the undertaking.

At both incubators, these activities are carried out by students under the guidance of a social worker and, when necessary, of a lawyer and an accountant. The greatest problems encountered during this phase are: a) the number of cooperative participants, since Brazilian legislation requires that a cooperative has a minimum of 20 participants; b) lack of personal documents; c) doubts regarding the Credit Protection Service; and d) the financial expense involved in the legalization process. The duration of this phase depends on the group's capacity to gear up to the challenge and some are able to get through it quickly, while others get bogged down and end up quitting the incubation process.

Inserting the cooperatives into the market is another challenge for the incubators, which encourage the participants to seek out potential clients and help them to prepare work proposals and define their prices. When the cooperative quickly manages to attract its first client this facilitates the learning of administration, accounting and management[49], since these functions take on a tangible form. Some cooperative members, who were previously self-employed, are unable to adapt to working in a team, with defined functions, hours, etc. If they leave the cooperative for this reason then they are replaced.

Other problems that arise during this phase are generally related to the democratic management of the enterprise, with authoritarian attitudes on the part of the management not being tolerated by the members, who seek the help of the incubator in order to reorganize and replace the managers concerned.

[48] Interview with João Guerreiro, member of the Coppe Incubator of Popular Cooperatives team, on October 28, 2001.

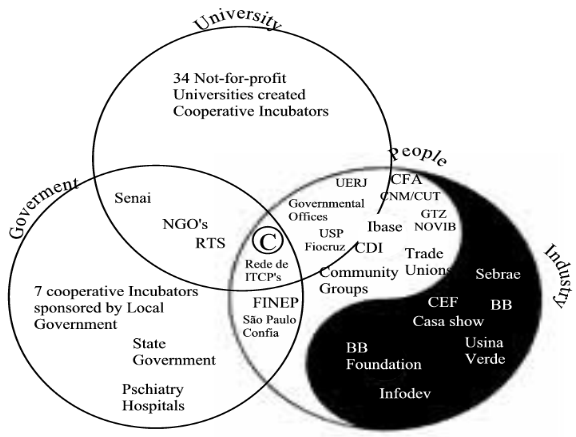
[49] Courses on accounting, the drawing up of minutes and the functions of the audit committee are provided for those cooperative members who are responsible for these activities.

7. Cooperative Incubator and the Triple Helix Model

The incubators of cooperatives adopted a strategy for developing a network of support. This enhanced their feasibility and financial support, as well as facilitating the incorporation of the incubators and their cooperatives within the activities of the universities.

In the analysis of the cooperative incubators, based on the Triple Helix Twins Model (Etzkowitz and Zhou, 2006) is presented at the Figure 1.

Figure 1: Cooperative Incubator and Triple Helix Twins Model



CNM: Metallurgist National Confederation; **CUT**: Workers Union;
COEP: Committee of Public Entities in Action against Hunger and in Favour of Life
Senaes: National Secretary of Solidarity Economics; **BB**: Banco do Brazil
Senac: National Commercial Training Service; **CEF**: Federal Savings Bank
Sebrae: Brazilian Micro and Small Business Support Service
Senai: National Industrial Apprenticeship Service; **FIOCRUZ**: Oswaldo Cruz Foundation
Finep: Projects and Studies Financing Agency; **RTS**: Social Technology Network
Infodev: The Information for Development Program; **USP**: São Paulo University
CDI: Committee for Democratization of the Information Technology
GTZ: Deutsche Gesellschaft für Technische Zusammenarbeit
NOVIB: Oxfam Novib; **UFRJ**: Federal University of Rio de Janeiro

The university becomes the source of knowledge for groups that do not possess formal access to this institution, which assumes a similar role to that adopted regarding technological incubator firms, with a differentiation in the content of the knowledge transmitted to the incubated cooperatives. Moreover, the university's social responsibility is channeled in the direction of reducing inequality and increasing social inclusion.

Other actions are included, as a result of triple helix recursive effect in function of the relation established with the other spheres, as well as of the recursive effect of the own performance of the university: professors and researchers supply specialized advising to the cooperatives; incubators financial management; search of mechanisms of credit for the incubated cooperatives.

In the industrial sphere, action relating to its own area of activity may be noted: financial support for the incubators[50]; the passing on of specialized knowledge to the cooperatives[51]; the use of new support mechanisms, such as the principle of social responsibility, to help in setting up new

[50] Sebrae.

[51] Sebrae, Senai, Sesi, Senac (ITCP network, 2001).

cooperatives[52]; participation in specific partnerships for the organization of new cooperatives (Etzkowitz, Mello and Almeida, 2005).

Municipal and state governments have established partnerships with the ITCPs, in order to organize cooperatives, so as to provide an alternative to unemployment or the informal job market for excluded sectors or socially disadvantaged groups.

In addition to incubating popular cooperatives, ITCPs also perform two other main activities: they participate in the development of public policies regarding cooperativism, and they dedicate themselves to cooperative education. With respect to the former, ITCPs fulfil the role of consultant or advisor to state governments in the conception and implementation of public policies directed to fostering economic development involving the social and economic insertion of the poor.

In 2003, the National Cooperative Incubator Program (PRONINC), organized by FINEP in 1995, was expanded, with the aim of providing support to this kind of cooperative sponsored by Brazilian universities. New resources were approved for 33 incubators in 2004/2005, supported by the following partners: Banco do Brazil, Banco do Brasil Foundation and the National Secretariat for Economic Solidarity, within the Labor Ministry of the Brazilian federal government (Secretaria Nacional de Economia Solidária - SENAES).[53]

These incubators in general keep a relation with institutions to the civil society and establish partnership with trade unions partnership for cooperative creation among the dismissed metallurgist in ABC region (REDE DE ITCPs e UNITRABALHO, 1999), or with NGOs.

Conclusion: Implications for other Developing Countries

Analysis of the incubator experience in Brazil points to the following conclusions:

The Brazilian incubator is a creative reinterpretation of a model imported from an advanced industrial society and the process of implementation reflects the local problems and opportunities.

Incubation evolved from the original model, with the objective of assisting the creation of high-tech firms by universities, in order to raise the technological level of low-tech industries in traditional sectors, create employment opportunities for marginal populations and, very recently, as a mechanism to create non-governmental organizations (NGOs) – local organizations dedicated to the protection of natural resources or to cultural and artistic ventures.

A considerable benefit from the taking off of the Brazilian incubator movement has been the mobilization of civil society and institutions from the triple helix in support of the project. The National Incubator Association (Anprotec) was set up to share experience, help to raise the quality level, gain respect from the authorities and spread the movement throughout the country.

The cooperative incubators provide targeted support to a small select group, often having only a marginal effect on the huge problem of unemployment. Nevertheless, if the cooperative incubators form part of a public policy to fight poverty that includes other support programs, addressing credit and education, the combined results will help to expand the local economy.

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[52] Eletrobrás (ITCP/Coppe/UFRJ, 2003).

[53] http://www.acompanhamentoproninc.org.br/historico.htm accessed on June 20, 2005.

The cooperative incubators are a mechanism that enhances social capital, democracy and self-government among their members and this leads to the development of citizenship and of society itself.

The establishment of cooperatives was intended to strengthen the existing social capital, in order to encounter solutions for the marginalized social sectors. Consequently, the incubator has collaborated in breaking the cycle of social fragmentation and labour market precariousness, with its cultural components of marginalization and criminalization of this element of the population.

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The Renewal of the African University: Towards a "Triple Helix" Development Model

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Abstract

Traditional development models envision a staged series of steps, typically to be followed in sequence, that replicate the development experience of the industrialized countries in the West. Invented in an increasingly superseded industrial era, stage models may no longer be relevant to an increasingly knowledge-based society. Evolutionary models based on Schumpeter's thinking emphasize the recombination of elements in order to create new forms of economic organization. The triple helix model takes this process further by looking at the polyvalent nature of knowledge and to institutional sources outside of the economy, in particular the university, as a source element for recombination and innovation.

Keywords: triple helix, polyvalent knowledge, spiral model of development, the African university

Introduction

Invented in an increasingly superseded industrial era, stage models may no longer be relevant to an increasingly knowledge-based society. Evolutionary models based on Schumpeter's thinking emphasize the recombination of elements in order to create new forms of economic organization. The triple helix model takes this process further by looking at the polyvalent nature of knowledge and to institutional sources outside of the economy, in particularly, the university, as a source element for recombination and innovation.

Though universities are established, nurtured and fueled with public funds to serve as conduits through which scientific research is transformed to enhance the socio-economic interests of their respective countries and regions, this has not typically been the case in Africa. African universities have yet to take up the challenge of encompassing an economic development function in addition to teaching and research as their main mission. The slow nature of the triple helix transformation in Africa is understandable since in African development policies and strategies, universities are not usually considered as critical players and are thus relegated to the background. This stems from the fact that conventional development models envision a staged series of steps, typically to be followed in sequence, which replicates the century old development experience of the industrialized countries.

The process of globalization has resulted in a diminishing gap between scientific research and utilization. This has resulted in the recognition of the dual theoretical and practical uses for scientific research (Etzkowitz, Schuler and Gulbrandsen, 2000). We argue that in the current situation, it may be possible to leap-frog stages of industrialization that are now disappearing in the traditional countries of origin. Perhaps ironically, many advanced industrial countries, such as the UK, have lost much of their traditional industries and are now pursuing a science and culture based strategy of redevelopment based on universities and artistic quarters. By following the strategies of a century ago, the least developed world may be left behind again.[54] The thesis of this paper is that a development strategy for Africa can be fashioned by realizing the potential of universities for economic and social development.

[54] Certainly there can be a balance between the two approaches as, for example, in China and India that have pursued dual strategies of industrial and post-industrial development.

From Stage to Spiral Model in Education

Some observers expect that least developed countries like Ethiopia need the chance to build dams and develop according to the same path as the advanced industrial countries did a century ago. The alternative thesis is that developing countries could pool their technology resources to take the lead in developing alternative energy technologies, such as photovoltaics, without disturbing the natural environment that is the basis for unique tourist industries such as the one that was emerging at Tis Abey adjacent to the Blue Nile Falls. When a new power station reduced the falls to a trickle, destroying their natural beauty and the livelihoods of local tourist operators, this opportunity was lost (Robinson and Island, 2006).

The form and content of education in the least developed world tend to mirror the prevailing concept of development underwritten mostly by Western actors. Most African countries inherited a colonial educational system that was oriented to the developmental needs of the colonial master. The goal of the educational system was to turn out clerks for the purchases of traditional agricultural export commodities, missionary proselytizing activities, and the colonial civil service. Technical education geared towards innovation and creative purposes was not on the colonial agenda. As Julius Nyerere wrote in 1967, colonial education was not designed to prepare young people for the service of the country. It was rather motivated by the desire to inculcate the values of the colonial society, and to train individuals for the service of the colonial state (see Davidson, 1990:187). For instance, until 1987, Ghana the first sub-Saharan country to attain political independence did not alter its educational structure modeled after the British system of education.

In Africa, the largest financier of education is the World Bank. As such, educational policies and strategies often mirror the bank's policy direction. The underlining presumption especially in the educational policy recommendations of the World Bank has been that mass primary and secondary education should precede the extensive development of tertiary educational capabilities. Though the bank is fully aware of the role of universities in economic growth and innovation, its educational policies in Africa have overly focused on basic education. This approach as we will argue ignores the role of universities, as a source element for recombination and innovation. The World Bank is aware that the contribution of universities to economic growth may increase with levels of technology and as countries achieved universal primary and secondary education (World Bank, 1995).

However, beyond calling for privatization and the introduction of fees and user charges, universities do not feature prominently in the priorities and strategies of the World Bank. To the bank, basic education ought to be the priority for public spending on education in those countries that have yet to achieve near-universal enrolment at the primary and lower-secondary levels (World Bank, 1995). This policy regulation underlies the stage model where growth is a discontinuous and dialectical process until a take-off stage of self-sustained advancement is reached (Rostow, 1960).

In fact, in recent times, countries such as Singapore and South Korea that pursued the basic education strategy approach to create a manufacturing work force have realized the limits of this approach and have recently shifted to a knowledge-based strategy, focused on creating research institutes and new universities as the basis for future development. This spiral model of education, which is emerging as an academic reform strategy in a number of developing countries is refocusing on undergraduate and graduate education. Some examples are the University for Development Studies in Northern Ghana, and the State University of Rio de Janeiro (Friburgo Campus). The University for Development Studies, for instance, focuses its efforts on topics that will help address issues of rural poverty and community development, including field work projects as well as classroom training in its curriculum. Thus, rather than developing undergraduate programmes focusing on existing industries, developed a graduate research programme based on information technology (IT) that could be utilized to raise the level of a variety of local industries as well as create a new IT industry, the programmes were projected to follow as a second step in the development of this campus (Juma, 2005).

It is clear that a continuous flow of science to the economy does not need to be achieved slowly through traditional staged development models but can occur more rapidly by expanding and re-orienting universities. The triple helix development model that we propose takes the Schumpeterian endogenous development model further by looking at institutional sources outside of the economy, in particular the university, as a source element for recombination and innovation. In Ethiopia, these efforts typically attempt to upgrade traditional industrial clusters by connecting them to foci of government funded research located at universities and research institutes that are encouraged to become more entrepreneurial (Ethiopian Herald, 2006). Based on these transformations, we argue that the Newtonian linear model whereby, the site of knowledge production is entirely separated from that of application (Gibbons et al., 1994) is outdated and no longer relevant to Africa's search for strategies to unleash the potential of its universities. We call for a triple helix development model that incorporates basic education with university led economic development.

Universities as the Locus of the Third Industrial Revolution

Different types of knowledge were effective in different periods of the three industrial revolutions. Science in the way we came to understand it was by all accounts quite modest in the classical industrial revolution. Similarly, the tight interaction, for instance between scientific knowledge and engineering postdate the middle of the nineteenth century (Mokyr, 2003). Much of the technological progress before 1850 (in the steam engines, textile, and wrought iron) came from practical know-how generated by engineers. There was little inference from empirical mental models in the form of laws of nature. Scientific contribution came mainly from empirical accidental generalizations. There was not much collaboration between scientists and engineers.

In the second industrial revolution, great macro-inventions such as the advances in organic chemistry were based on pivotal breakthroughs in the laws of nature, for example, the discovery of the structure of benzene molecule by the German chemist, August von Kekulè in 1865. Other inventions, like the steam engine or salicylic acid were generated by empirical generalizations and technical pragmatic schemes discovered by trial and error. The steam engine and the salicylic acid were originated mainly by engineers and professional chemists detached from the university. In any case even a macro-invention like the telegraph that was based on the discovery by Hans Oersted of electro-magnetism required many other micro inventions to become a concrete innovation, for example the technology for the transmission of the electric impulses. In the case of telegraphy or organic chemistry the micro inventions stemmed from the close collaboration between science and technology.

The first phase of the third industrial revolution is exemplified by such macro inventions as recombinant DNA and monoclonal antibodies, nuclear power, semiconductors and antibiotics based on important scientific discoveries. The collaboration between science and technology is intense. The centre of gravity of this collaboration is inside the university, with a supporting role of industry. However, government typically plays a role in encouraging, structuring and funding these discoveries. Even the micro-inventions that brought about the development of biotechnologies and information and communication technologies were generated mainly by university-industry relations. The reason why the centre of gravity is inside university is not only caused by the increased scientific density of the inventions, but also stems from change in academic functions from teaching and research to economic development.

This is even more imperative in the least developed world where universities seem to be stronger in terms of human resources than the other two institutional partners-government and industry. The entrepreneurial university makes science, technology and increasing innovation possible and readily accessible. Given that the technology base in Africa is narrow and most industries are basic, the triple helix model is flexible enough to accommodate other knowledge brokers such as those in the informal sector as exemplified by the development of the Internet in Zambia (Konde, 2004).

In the twentieth century there was a change of the process of innovation with the emergence of corporate, university, and government sponsored research and development (R&D), referred to by Mowery and Rosenberg (1998) as the "institutionalization of innovation". Moreover there was the birth of a new type of scientist (the entrepreneurial scientist) who interfaced basic knowledge with the innovation agenda. Like the two faces of Janus, she was able to integrate two different and diverging perspectives the epistemological and the industrial one. It is plausible that in the future, we will see the reinforcement of the integration between different emerging generic technologies (second phase of the third industrial revolution). The acronym NBIC (Nano Bio Info Cognitive) of the new "converging technologies to improve human performances" introduced by National Science Foundation in 2002 in its technological foresight exemplifies the phenomenon. Integration means more than collaboration between researchers in different fields and between university and industry. It also means the reinforcement of the global role of universities (from basic science to innovation and production), the development of less specialized universities with a wider disciplinary scope, and the birth of a new scientist who integrates knowledge and innovation, as in the entrepreneurial model (Viale and Etzkowitz, 2005).

The Emergence of Polyvalent Knowledge

In a science-based global economy, a flow of commercializable knowledge is the ultimate condition for long-term success. The emergence of polyvalent research fields with simultaneous theoretical, technological and commercial potential provides a substrate for the growth of science based clusters.[55] The recognition that knowledge is imbued with multiple attributes encouraged the multiple roles of academics and their involvement in biotechnology firms and of industrial researchers in academic pursuits.

Univalent knowledge follows a sequence from basic to applied research typically carried out in different time periods, at different sites, and by different people. The emergence of polyvalent knowledge called forth the concept of translational research (a less defined notion than applied research) and an activity that is closely associated with fundamental investigation and likely to be conducted in tandem. One hypothesis is that the presence of an entrepreneurial university, which generates new fields of research with theoretical and commercial potential, can make a significant difference to economic organization.

[55] In contrast to the division of knowledge into divergent epistemological spheres e.g. Pasteur, Edison and Bohr's Quadrants (Stokes, 1997); the polyvalency thesis holds for the unity of knowledge, with complementary aspects. Indeed, even the namesakes of these Quadrants spill over into others. For example, the "Edison effect" might well fit into Bohr's space. See also Viale and Etzkowitz, 2005.

Polyvalent science was institutionalized in the U.S. during the post-war, along with funding agencies that offered diverse opportunities. Universities became involved in a closer relationship with government, whether the funds were provided by basic or applied funding agencies, by peer review or program officer initiative. When international competitiveness became an issue in the 1970's, government-funded science was expected to contribute to industrial renewal. Closer ties were forged between university and industry in order to overcome impediments to innovation.

As the triple helix evolves, institutions, organizations and roles are transformed. New tasks are often defined as conflicts of interest and obligation when viewed in relation to old. For example, when research was introduced as an academic task in the late 19th century, some said it diverted teacher's attention from students. A process of normative change takes place as controversies are resolved and new and old tasks are reinterpreted as complementary. Academic patenting is currently undergoing this transformation as professionalization of technology transfer creates an organizational search, marketing and business development capability.

As individual academics become involved, they perceive their findings in a new way, seeking out the practical as well as the theoretical implications of their work. Though the process is uneven, the persistence of pre-modern social structures may explain resistance to change in academia just as feudal relations impeded the transfer of modern technology to Southern Europe in the 19th century (Mazotti, 2004). Indeed, similarities in the social relations of feudal agricultural and academic systems may explain similar resistance to creation of formal mechanisms for inventions that could not be transferred through informal university-industry ties.

The transition from univalent to polyvalent knowledge also brings forth new issues and opportunities to be puzzled out (Beesley, 2003). The entrepreneurial university and the entrepreneurial scientist combine multiple purposes and sources of funding to support their research enterprises, helping to create the conditions for the emergence of polyvalent knowledge. A portfolio of overlapping basic research agency, industry supported, strategic research foundation, applied research agency and start-up firm supported projects is the underpinning of the contemporary academic research group.

At the macro-level, a diversity of potential sources of support is a pre-condition for the combination of resources at the micro-level. The insertion of a series of quasi-public research agencies in between the classic research councils and industry in Sweden, during the 1990's, exemplifies this transition. New organizational arrangements for collaborative research, formerly conducted at a distance, stem from the passage to polyvalent knowledge. The establishment of a research center, focused on an emergent field, integrating several research groups along with industry and government scientists is the next step to encompass the multiple tasks presented by polyvalent knowledge (Viale and Etzkowitz, 2005).

Since polyvalent knowledge is often produced in triple helix contexts such as the "incubator of centers", evolutionary models based on Schumpeter's idea of recombining elements in order to create new forms of economic organization may no longer be sufficient to engineer development and redevelopment in the least developed world. It is on this basis that we argue that there is the need to take the process of development and redevelopment further by looking at the polyvalent nature of knowledge. This demands that we turn particular attention to institutional sources outside of the economy, in particular the university, as a source of elements for recombination and innovation. Therefore, by bringing together academic, industry, and government researchers, we can develop broad-based theoretical knowledge with multiple utilities resulting in a dual transition of knowledge and organization (Etzkowitz, 2002).

Science and Technology Policy in Development and Redevelopment

Although technology has been a permanent feature in human progress since the period of hunting and gathering in bands, in a science-based knowledge economy, modern science and technology transformations have brought universities to the centre of innovation. While technological advancement is spurred by the competition and incentives of the global economy, the new tools of techno-science, based upon advanced knowledge, reinforce the need for development and redevelopment through university led innovation (Dzisah, 2003).

Many African countries face major obstacles expanding their economies beyond agricultural and mineral production, not only because they lack skills and institutions, but also because they have failed to integrate their universities into science and technology development and redevelopment policies. The result is that they are unable to take advantage of their universities as sources of recombination and innovation. As Richard Manning asserts, using the potential of biotechnology as a benchmark, one way to feed the increasing world population is to work with "third world scientists to feed their own people, while ensuring sensitivity to culture and environment that we missed in the first green revolution" (quoted in Machuka, 2001: 16).

For us, a triple helix of university-industry-government interactions is particularly crucial to developing organizational innovations that help reinvigorate a depressed regional economy. Bottom up initiatives led by universities are crucial for a science and culture-based development and redevelopment. This explains why in the United States, knowledge-based development represents a new initiative for state governments, beyond a relative few like Massachussetts that have been active for some decades. Virtually every state now has a S&T agency and at least one, and usually more than one, program that attempts to raise the level of S&T in the state and attract resources from elsewhere. A seemingly self-generating industrial sphere of high-tech business activity has its roots in academic and governmental initiatives (Etzkowitz and Dzisah, 2006).

Again looking at the US, it was not until 1980 that patent law emanating from constitutional authority was elaborated into an "indirect industrial policy", utilizing the universities as an intermediary between government and industry (Etzkowitz, 1994). In subsequent years, a variety of regional strategies have evolved to promote knowledge-based economic growth. The process is multilayered, with significant inputs from states and local governments, academia and industry. This arrangement not withstanding, the federal government for decades has emerged as the foremost sponsor of basic research and of applied research in specific areas such as agriculture, health and the military. The states have especially been active in the transformation of basic research into practical and commercially viable applications (Feller, 1997; Geiger and Sá, 2005; Rees and Bradley, 1988).

In spite of this, a common perception is one of shortfall due to the increased competition for funds. As such, enhancing an academic focus at a local university with possible future relevance to local economic development is now viewed as similar to traditional physical infrastructure development. State governments view these intellectual capacity building efforts as akin to building highways and bridges to improve transportation and encourage business. In the past, state S&T efforts were typically funded through regular legislative appropriations, making them subject to cuts and even closure in an economic downturn. This is especially the case due to requirements that states, in contrast to the federal government, maintain a balanced budget. However, when the problem is framed in terms of science-based regional development, a research university becomes a necessity. This explains why the state of California recently passed through a ballot measure a $3 billion stem cell research initiative called "proposition 71" to strengthen the biomedical research capacities of its universities (Etzkowitz and Dzisah, 2006).

In the African context, despite the diversity of local circumstances, university led development and redevelopment could overcome the problem of weak governments since the global orientation of higher education makes the university system more stable than political regimes. Government initiatives in the short term can be oriented toward providing economic incentives for science-based industrial development and the expansion of the resources of educational institutions to develop programs that will link scientific research to business development. In addition, given the limited human resource base, most of the relatively skilled personnel may be located in universities at the initial stages of the development of technologies rather than in industry (Konde, 2004).

Since African public universities have grown from about eight in 1960 to over one hundred in 2006, the time has come to increase their S&T, transfer and innovation efforts in order to further economic development and redevelopment. The formation of science-based firms from university research should be the centerpiece of this strategy. As the development of the internet in Zambia has shown, even poor universities can adapt, innovate and commercialize advanced technologies to benefit their populations (Konde, 2004).

The Renewal of African Universities

African countries reeling under massive external debt turn to the Bretton Woods institutions for help. The World Bank and the International Monetary Fund (IMF) responded by asking that they undergo economic restructuring and reform under the Structural Adjustment Programme (SAP) policy framework. This reform affected most African universities whose budgets are entirely dependent on national governments. However, this period of retrenchment and decline in funding was followed by an unexpected renewal phase initiated by a half dozen African universities. University reforms included the admission of private fee-paying students, permission for faculty members to retain a share of incomes generated from private consulting income, and the introduction of night classes and private universities (InterAcademy Council, 2004).

But these reforms did not just happen but were part and parcel of larger economic, political and social reforms. For example at Makerere University in Uganda, the Innovation at Makerere program reorganizes its academic programs to contribute directly and immediately to national development within the framework of the government's decentralization process. It aims to train cohorts of public servants in health, agriculture and administration, to staff district offices. It is achieving this through major changes in curriculum and through "sandwich training" programs whereby students undertake fieldwork in the districts throughout their academic training (InterAcademy Council, 2004).

In response to these internal transformations, many donors have rediscovered universities. It must be stated, however, that even with this new vision, which sought to explicate the role of African universities in economic development and redevelopment, the overriding interest of donors such as the World Bank was not totally removed from economic growth and productivity. The emphasis changes though from investment in basic education to universities in order to achieve the goal of human capital development. However, the recognition of the role of universities as a source element for development and redevelopment culminated in a refocusing of higher education policies and strategies based on the concept of the knowledge society (see Constructing Knowledge Societies: New Challenges for Tertiary Education, World Bank, 2002).

In addition, a new USAID global initiative was also introduced to increase the number of scholarships for postgraduate study in the United States and capacity-building grants to retrain university faculties especially those in Agriculture. Four U.S. foundations have played a critical role in supporting the renewal phase of African higher education. In 2000, the Rockefeller, Ford, Carnegie, and MacArthur Foundations launched The Partnership for Higher Education in Africa. With a 10-year time frame, the foundations have committed US$100 million over the first five years to support universities pursuing reforms in Ghana, Mozambique, Nigeria, South Africa, Tanzania and Uganda. During the first two years (2000-2001), the four foundations together contributed US$62 million to higher education in the above six African countries (InterAcademy Council, 2004).

Information and Communication Technologies and African Universities

The World Bank financed establishment of the African Virtual University (AVU) in 1997 to provide quality higher education in science and engineering. The AVU has offered courses but does not yet offer full degree programs. The Institute for Food Laws and Regulations at Michigan State University has created six distance education courses on food laws and regulations (InterAcademy Council, 2004).

Another recent ICT application is the use of teleconference in providing lectures and seminars. Now African students can listen, and indeed interact with, global leaders in their fields while remaining in their home settings. Cornell University professors now provide lectures on cutting-edge topics in breeding and biotechnology to students participating in a regional Ph.D. program offered by the University of Natal, with support from the Rockefeller Foundation. There is scope to enlist more support from private sector ICT companies in these areas of initiatives (InterAcademy Council, 2004). There is in motion a process of the renewal of the African university. African universities have desire as well as the potential to lead Africa's development and redevelopment if the appropriate triple helix relations are created.

Towards a Triple Helix Development Model

Traditional development models are dualistic in nature and are either exogenous or endogenous. Such models envisioned the process of socio-economic growth promotion and regeneration to be wedged in a circular flow. In these accounts, development and redevelopment is seen as consisting of series of historical stages where each particular stage is based on preceding ones. In their original formulations, and as has been replicated in the least developed world, the key actors have been central governments. The current inclination is to promote the private sector as the engine of growth. While this is laudable, it still omits the most critical agent in development and redevelopment--a university that is willing and able to be entrepreneurial by adopting economic development functions in addition to teaching and research (Etzkowitz, 2005).

As such, our thesis is that the traditional stages and evolutionary models of development may no longer be relevant in engineering economic growth and innovation in an increasingly knowledge-based society. For us these models are based on an increasingly superseded industrial era where socio-economic growth was premised on the abundance of arable land and the availability of a large pool of labour. If African countries continue in this vein, they may be left behind again. In a science-based knowledge society, these staged and evolutionary models do not go far enough.

Schumpeter (1934 and 1954) attempts to create new forms of economic organization by employing existing resources in different ways. According to him, the overall development of the economy is derived from emergent processes that arise from the developments of its constituent sectors. Central to this formulation is the fact that these developments are endowed with their own laws and principles. As a result, the development of the economy as a whole is a phenomenon emerging on the basis of the interaction among its constitutive sectors (Becker and Knudsen, 2002). Schumpeter (1934 and 1954) anchors his model of endogenous economic development around a major actor-the entrepreneur. He uses this to explain his idea that changes in the social structure emerges from the actions and social interactions of the individual entrepreneurs living in distinct and yet interacting sectors of social life (Becker and Knudsen, 2002). While the Schumpeterian entrepreneur is the driving force in industrial society, we propose an entrepreneurial university led development model, in cooperation with other institutional spheres, in an increasingly knowledge-based society.

The triple helix development model is derived from Boston regional organizing experience in the 1930's and 1940s and comprises three basic elements: First, a more prominent role for the university in innovation. Second, a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interaction among university-industry-government. Thirdly, in addition to fulfilling their traditional functions, each institutional sphere it also "takes the role of the other" (Etzkowitz, 2005).

In a knowledge-based society, a triple helix development model in the current situation, may lead the way in assisting least developed countries to leap frog stages of industrialization that are now disappearing in their countries of origin. Critics have argued that that the university systems are academically oriented and industries are either non-existent or too weak and governments too bureaucratic to play respective roles envisaged by the triple helix model. However, as Konde (2004) has revealed, the problem does not lie with the model, but the fact that in Africa, these triple helix entities seem to be weak because their elements tend to work in isolation. The development of the internet in Zambia demonstrated that when these entities work together; they represent a significant force for change, similar to those found elsewhere.

Each institutional sphere maintains its core identify as it interacts intensively with the others. While the triple helix institutions at their nodes are active and recursively selective according to their own specific functions and institutional constraints, the network system of university-industry-government relations provides the transaction spaces needed by these development actors to translate policies into goals. As such, a triple helix development model cannot be reified into a neo-corporatist arrangement because of its implied emphasis on the dynamics of change and the appreciation of differences in opinion, position, and interests of their partners (Etzkowitz and Leydesdorff, 2001).

A triple helix development model is based on the following trends:

(1) The transition from an industrial society to a knowledge-based society in which knowledge producing institutions, like universities, potentially play a greater role in innovation and development.

(2) The transition from large scale physical technologies that mandate bureaucratic forms of organization to increasingly flexible smaller scale high technologies that can be utilized by smaller scale organizations.

(3) The emergence of polyvalent knowledge, in such areas as biotechnology, computer science and nanotechnology, that is at one and the same time theoretical and practical; patentable and publishable.

(4) The rise of an entrepreneurial university model that incorporates classic ivory tower and Humboldtian elements with a culture of entrepreneurship, innovation and technology transfer.

The Endless Transition

The triple helix of university-industry-government relations is emerging as a common format that transcends national boundaries. As this takes place there is a shift from bilateral to trilateral interactions from single and double helixes to university-industry-government joint projects. For instance, in Ethiopia this involves the upgrading of traditional industrial clusters by connecting them to foci of government funded research located at universities and research institutes. This is aimed at making them more entrepreneurial. Other regions have also responded to these changes with similar but different approaches. Examples include the land grant universities in the US, the research schools program in Sweden and the incubator movement in Brazil. It is clear that whether one starts from a statist or a laissez-faire regime, the movement is to a midpoint of relative autonomy of institutional spheres, on the one hand, and stronger interrelations and creation of new hybrid formats embodying elements of two or more institutional spheres, on the other. (Viale and Etzkowitz, 2005).

Nevertheless, practical knowledge continues to arise from the context of discovery in the "meandering stream of basic research" just as theoretical knowledge appears in the context of application. In countries where the government has previously dominated the other institutional spheres, there is a need for differentiation of institutions and the establishment of clear boundaries among the institutional spheres so that they can begin to interact from a position of independence and relative equality. The emergence of university-industry-government relations (a tri-institutional model of society) is the great transformation of late 20th and early 21st centuries. This transformation includes a shift from: manufacturing to service occupations, the individual firm to strategic alliances, tacit to codified knowledge, technical to organizational innovation.

The triple helix transition followed from the emergence of government-industry relations, (a bi-institutional model of society) that constituted the great transformation of the 19th century (Polanyi, 1957). The Speenhamland law in England placed limits on exchange relationships in wage labor, guaranteeing workers a living wage. On one hand, the market became the organizing principle of social relations. On the other hand, the government moderated exchange relationships to guarantee a living wage. Government-industry relations thus created a compromise that ensured social stability in the wake of an industrial revolution that opened up new social chasms and conflicts. It also encouraged a shift in social relations from status to contract, Gemeinschaft to Gesellschaft, mechanical to organic solidarity and the invention of the social sciences to elucidate these transitions (Durkheim, [1893] 1997).

All societies are in transition in the 21st century, with no fixed endpoint to change in sight. The functional differentiation of institutions in the early modern era is being displaced by integration and hybridization of functions in the post-modern era. Although this process begins from different starting point of relationships among institutional spheres, a secular trend toward a common triple helix can be identified. An open civil society paves the way for triple helix actors to organize and overcome blockages to the transformation of knowledge into innovation. The university will become ever more central to the innovation process and it will supersede many functions of the industrial enterprise. This transition reinforces the global role of universities; it brings with it the development of less specialized universities with a wider inter-disciplinary scope, and the birth of a new scientist who integrates knowledge and innovation.

The first and second academic revolutions introduced research and then economic and social development as academic missions. These revolutions fundamentally changed the nature of the university from its medieval foundation focused solely on the conservation and reproduction of knowledge (Rashdall, 1896). The third academic revolution integrates forward and reverse linear models in a programmatic and regulatory framework, synthesizing knowledge, organization and institutions: the endogenous, exogenous and mesogenous drivers of innovation. The university thus becomes an increasingly important platform for societal transformation (Viale and Etzkowitz, 2005).

Conclusion: The Renewal of the African University

The notion that African development and redevelopment has to follow traditional staged development models by replicating the development experience of the industrialized countries has affected the ability of African universities to take up the challenge of encompassing an economic development function into the mission of universities. We propose a triple helix development model that moves away from staged to a spiral model of education because a continuous flow of science to the economy can occur more effectively under a triple helix of university-industry-government relations. This model takes the Schumpeterian endogenous development model further by looking to institutional sources outside of the economy, in particular the university, as a driver of innovation.

For us, a triple helix of university-industry-government interactions is especially crucial to developing organizational innovations that help reinvigorate a depressed regional economy. The formation of science-based firms from university research should be the centerpiece of this economic development and redevelopment strategy. This stems from our observation that traditional development models do not take into account the unique role of universities in generating innovations. A triple helix development model based on a spiral process that is university led, in cooperation with other institutional spheres is necessary to leap-frog trajectories of industrialization that are now disappearing in their countries of origin. The triple helix model provides a flexible framework for the transition of the African university from educating post-colonial elite to playing a more direct role in development, pointing the way for least developed countries to make the transition to a knowledge-based society.

Rather than development and redevelopment being the sole responsibility of central governments, a meta-innovation system is emerging from bottom up, top down and lateral initiatives in which science, technology and innovation policy is the outcome of the interaction among university, industry and government. A triple helix of university-industry-government relations is emerging as a common format that transcends national boundaries. The first and second academic revolutions have brought research, economic and social development together with education as academic missions. The integration of these functions is changing the nature of the university and its role in society. The potential for regional development in Africa, and elsewhere, resides in entrepreneurial universities taking the lead in infusing knowledge, innovation, technology and enterprise into the entire society.

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An Assessment of the University-Industry Relations in Israel: The Experience of the Magnet Program and Implications for Ethiopia

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Abstract

Social and economic networks determine the economic success of nations and thus play a prominent role in explaining the wide-range of economic growth and performance in especially knowledge-based economy. Reasonably networking between the users and producers of knowledge thus the achievement of the *synergy* among the networking participants has been argued as an efficient way for the better utilization of the benefits of the knowledge-based economy (Sinha and Cusumana 1991). Correspondingly, innovation networks and national innovation systems have been acclaimed as accurate models for science, technology and innovation systems of the twenty-first century (Edquist et al. 1997).

The notion of networking has been deeply rooted in the Israeli system earlier than the transition to knowledge-based economy or even before establishment of the Israeli State in 1948. The research focuses on the Israeli Magnet Program for pre-competitive generic technology production within the consortia of university, government and industry (UGI). The analysis of the Magnet Program reveals the importance of the interaction of *domestic and international factors and typical organizational setting of* Magnet for the formation of innovation networks successful in Israel. On the other hand, we will try to abstract the lessons of Israeli case and come up with implications for a developing country such as Ethiopia.

Consequently, a network-based innovation system, which provides the communication linkages and basis among the actors of innovation, leads to the *achievement of the synergy* among these actors of innovation. Such production system is believed to bring about much more economic and industrial development to the Israeli nation than the sum of these participants individually.

Keywords: innovation networks; Magnet; synergy creation, entrepreneurial university, implications for Ethiopia

Introduction

The paper aims to study the notions of several theoretical approaches on the innovation networks within the context of the Israeli Magnet Program and try to come up with implications for a developing country such as Ethiopia. The discussion gives an overview of the distinguishing features of the Israeli innovation networks between university, government and industry (UGI). The qualitative determinants for the formation of the networks are reviewed from the literature to find out such linkage phenomena among the academic, industrial and public participants of the Magnet Program. Over the past decades, the world economy and the innovation systems of countries have shifted paradigmatically from linear models of science-technology relations to non-linear systematic models of innovation due to the pressures of globalization, liberalization, dematerialization and technological revolution (Galli and Teubal 1997). As a result, there have been a growing literature and policy-making, which put greater emphasis on systematic relations among the agents of innovation networks. Then the question arises whether a program as Magnet could provide lessons for developing countries in this case Ethiopia.

The components of the national innovation systems (NIS) include several organizations political bodies such as (i) ministries for industry, trade, education; (ii) bureaucratic bodies and offices implementing science-technology and innovation policies; (iii) regulatory bodies for standardizations, certifications and norms; (iv) educational bodies, universities; (v) social bodies professional organizations; (vi) public research centers, hospitals (vii) non-profit organizations, industrial associations (viii) profit oriented firms, joint ventures, R&D consortia and (ix) bridging bodies between science and industrial bases of the nation (North 1994). Additionally the NIS approach has strongly stresses the role of institutions, which are made of formal procedures and rules such as; patent laws, peer review procedures, technical standards and various codes of conduct set up the rules of the game for the national innovation generation and management (Edquist and Johnson 1997).

Complementarily, science policy scholars have claimed the importance of the interaction and the formation of innovation networks between these aforementioned components of NIS as a reliable policy tool for the knowledge production and utilization as a technological good (Kline and Rosenberg 1986, Rullani and Zanfei 1988, Metcalfe 1990, DeBresson and Amesse 1991, Lundvall 1992, Skyrme 1992, Dodgson and Rotwell 1994, Gibbons et al. 1994, Steinmueller 1994, Pavitt 1997, David, Foray and Steinmueller 1997, Leydesdorff and Etzkowitz 1996-2000, Porter 1998, Gilbert et al. 1999, Kim 1999, Jacob et al. 2000, Jacob et al. 2000) state these relations brought about the emergence of the knowledge-based society and a new paradigm between the academia and industry relations. They describe it as the knowledge partnership phase. The academic studies have increasingly emphasized the close interrelatedness between innovation, competitiveness and socio-economic growth of nations (Schmokler 1966, Rosenberg 1972, 1976, 1994, Nelson and Winter 1982, Jorgensen 1996, Bertuglia et al. 1997, Shefer et al. 2000).

Therefore, the non-linear innovation networks between the users and producers of knowledge can be considered as a reliable framework for the management of the interaction and the interface between the organizations and institutions of the NIS. The trends of the knowledge-based economy and society have made governments to utilize innovation-networking policies by linking the different partners of the society for innovation.

Networking operates on across organizational boundaries; it needs to develop networking structures and bridging mechanisms. The participants of innovation networks can be integrated vertically or horizontally. The traditional structures and rules need to be modified into less hierarchical structures to allow innovation to prosper. In some occasions, even it reshapes the institutional, political and societal setting of nations completely.

According to the literature on innovation networks, partners need to share collaborative cultures for further learning and mutual production. Gilbert et al. (1999) stated networks are complex, self-organizing multi-level structures, generally having no central control. They are characterized by elements of *trust, cooperation, openness and self-organizational forces.* Beyond the traditional theories of pluralism and corporatism, networks require close interactions between politicians, scientists, technologists, industrialists and customers.

By the same token, Himple 1987, Hamel et al. 1989, Lynch 1990, Powell 1990, Levy & Samuels 199, Koschatzky and Kulicke 1994, Gibson and Rogers 1994, NBIA 1997, Kim, 1999 referred to the conditions that may impede the functioning of networks. They stated when (i) there is no adequate trust among the participants; (ii) there is no convergence on the long term goal among the participants; (iii) participants expect no interactions for future projects; (iv) there are communicational barriers in sharing information-knowledge and conflict over the intellectual property and financial benefits, it seems unlikely for the actors of society to form innovation networks.

Amidon (1996) and Skyrme (1994) mentioned the intense *application of information communication technologies* to amplify the share of knowledge among the participants as well as diffusion into the society and economy. Thus for a proper functioning of innovation systems, the necessary changes in institutional structures of the system regarding all the internal and external factors need to be done. Besides this, the obstacles that might impede the establishment and persistence of networks should be eliminated and conducive conditions and key institutions need to be secured.

Indisputably innovation capacity of a nation is socially embedded; it depends on the social networking and coordination among the knowledge producers and users. In the light of these arguments the reliability and the sustainability of the Magnet "Generic Pre-Competitive R&D Consortia Program" is analyzed in the next section.

The Exploration of Innovation Networks in the Magnet Context

As a small country of six and half million people with limited natural resources and encircled by some unfriendly neighbors, Israel always needs to create synergy between its people and organizations to utilize its productive capacity at the highest level to be competitive on the global markets. Israel stands out as a highly successful country in meshing the national scientific, technological and political pools. This can be attributed to two main interrelated factors (i) *domestic and international conditions*; (ii) *institutional frameworks formed by the Office of the Chief Scientist under the Ministry of Industry and Trade (MOIT).* While the former feature reflects the reasons for the initiation of networking, the latter feature confirms the functioning of networks require a systematic management and organization.

Data Collection

The data on the framework of the Magnet Program have been collected from the survey among the members of the Board of Managers. It was sent to ninety-two participants from twelve different consortia, during one of the authors' one-year research in Israel. It was responded to by forty participants from nine different consortia with a 43.47% response rate. Twenty-two responses are from industrial participants and eighteen responses are from non-industrial participants (academics or government representatives). On the hand, data for Ethiopian part was collected (by one of the authors, Keskin) from the published sources due to lack of time for conducting such a comprehensive study.

Reasons for the Initiation of the Magnet Program

Since the French embargo of the 1960s, Israel has started a massive governmental program to support domestic industry and to reduce dependency on foreign technology acquisition. Israel stands alone among Ireland, Portugal, Greece, Singapore and Taiwan in basing both its civilian and military R&D on indigenously owned companies. The government devotes 3.6 % of the GDP to R&D, which ranks it at the top of the world (CBS Israel 2002). The government's strategy rests on two pillars: (i) decentralization to promote initiative, (ii) coordination to promote efficiency (EU MNC Report 1997). This has been accomplished through (i) the introduction of the Law Encouraging Capital Investment; (ii) establishment of science parks; (iii) provision of research grants (Tilles 1987, Frenkel et al. 2000).

However, in the 1990s it was observed that Israeli industry was too fragmented and the companies were too small to handle the rising costs of R&D and global competition (Trajtenberg 2000). Moreover, the capacity of the Israeli universities and researchers for generating economic wealth was not fully utilized. Consequently, the Israeli government introduced a comprehensive "matchmaking, investment and consultative" support system. The programs' aims were to (i) bring companies together; (ii) provide direct or indirect financial support for the development and marketing of innovations; (iii) provide free management; and (iv) give legal and financial advice to industries.

For this objective, the Office of the Chief Scientist (OCS) initiated the Magnet Program in 1992 to support the formation of an innovation network and reservoir of industry and academia, in order to remedy failures in these areas, and to tackle the global challenges. (Berry 1998). The main rationale of Magnet is the pooling of national physical, financial and intellectual resources. The survey confirms the main rationale of Magnet as the realization of a "critical mass of six and half million" for building new technologies and competitiveness, by aiming to improve interaction through joint programs between knowledge, financial, industrial and professional centers rather than aiming to immediate financial gains (Berry 1998).

According to Table 1, remarkably 85% of the respondents considered the achievement of the better interaction between science and industry as the most crucial factor behind the initiation of the Magnet Program by the Israeli government. Similarly, pooling of national resources was regarded by 82% of the participants as another crucial rationale of the initiation of the Magnet. Even though better utilization of academic potential came as fourth crucial factor, after the increasing of high-tech export capability, it had lesser variation among the respondents. The relatively higher deviation in the responses given for the assessment of high-tech export capability is because of the straightforward participation of non-high-tech firms as much as the high-tech firms in the Magnet program.

The industrial reasons to participate in the Magnet program overlaps with the rationale of government for the Magnet. As shown in Table 2, the main reason of industry is to access to the knowledge pools rather than cost reduction, immediate financial gains or market control. This provides industry with access to the academic knowledge and research pools while providing knowledge sharing and interactive learning between the each institutional setting. The pooling of national resources accelerated the process of technological development, turning innovation into products more rapidly, shortening the time to market cycle of new generation products.

Even though the responses on the reasons for the participation of academicians have greater variance, industry committed research is stated by the 67% of participants as the most crucial factor with a lesser deviation than the other parameters. For instance, the higher variance for the matter employment opportunities for graduates is explained while some of the academicians especially from Be'er-Sheba University seek for this point; academicians from Technion consider it less important but emphasize the importance of applied research.

Strengthening the responses for the rationale behind the formation of the Magnet program, the Table 3, specifically points out that the respondents ascertain the level of interaction between academics and industrialists is outstandingly successful. Additionally, most of the respondents consider the triple interaction and government-academy relations as successful at average level.

Relations between Academy-Industry-Government

An important feature for the successful coordination and relation within the consortia of the Magnet Program is the fact that Israel is a small, compact country with a relatively small population where stable and trustful personal linkages play great roles. Specifically, the close-knit nature of the scientific community is stated to facilitate good liaison and co-ordination in the society (EU MNC Report 1997). On the other hand, the interaction between the customers, which is the fourth component of the network systems, is stated to be less successful compared to the multilateral and bilateral relations among the other actors of the system. In fact, Magnet is designed as a pre-competitive R&D support program, in which the application of generic technology into marketable goods depends on the participants themselves. Therefore, the information centers of the each consortium are advised to inform the participants about the market trends and needs more comprehensively than the current application. Consequently, the results would be applied more relevant to the market needs and less risky than current mechanism. This feature should be considered as an important actor for innovation systems or fourth aspect of the triple helix mode of innovation networks (see Table 4).

Apparently, the domestic and international contexts have forced Israel as a state and society to rely on its own resources in a networking system. However, the motivations and appreciation of these partners for the networking are not sufficient reasons for the networks function properly and yield the desired economic impacts. Innovation networks require a systematic management approach that incorporates the institutional setting culture and mode of different participants based on the aforementioned notions of networking theories.

The Organizational Framework of the Magnet Program: *Office of Chief Scientists & Balance of Powers*

The Israeli Government (MOIT) has initiated the Magnet framework; it seemed to have a top-down structure with a new legislation and institutions. Israel derives great strength and technological excellence from its human capital along with the academic and technological infrastructure it has developed. The Office of the Chief Scientist (OCS) within the Ministry of Industry, Trade and Labor is responsible for executing the government policy relating to industrial R&D support. The OCS is part of the Ministry of Industry and Trade, operating since 1973. The OCS is responsible for implementing government policy regarding support and encouragement of industrial research and development. Law for the Encouragement of Industrial Research and Development - 1984 constitutes the general mandate of the OCS.

The OCS tasks include:

- Expansion of industries technological and scientific infrastructure,
- The development of science intensive industry,
- Employment placement for scientific and technological manpower,
- Improvement of the competitiveness of the Israeli industry,
- Increase national industrial production and balance of trade.

The OCS objectives are to support industrial R&D, encourage entrepreneurs in high-tech start-up companies, leverage Israel's highly capable scientific and technological labor force, facilitate the academic industrial interface for the transfer scientific know-how and technology and in general to stimulate cooperation in state of the art R&D at national and international levels.

The OCS also offers a range of additional support programs within the framework of directives from the Director-General of the Ministry of Industry, Trade and Labor. The revised law allows, but does not encourage, the transfer of both know-how and manufacturing rights abroad under clearly defined costs and conditions.[56]

[56] The Chief Scientist's Office employs three mechanisms to support R&D efforts: MOP fund, Magnet/Nofar and high-tech incubators. The total amount of funding available for all types of R&D ranges between NIS 900 million and NIS 1.2 billion annually.

On the other hand, as the initial demand has emerged from the industry which is looking for academic knowledge and financial support to undertake longer-term and larger projects the bottom-up demand coming from the industry is taken into account for the policy setting of the Magnet program. Indeed according to the results of the field survey, the Magnet framework is considered successful in ascertaining the existence of these societal features among the consortia members and harmonious relations (Table 5).

In addition to incorporation of these societal elements, the new institutional framework of Magnet is based on the systematic management of a committee, which is composed of several participants from governmental agencies, high-tech industry and academia.[57] The Chief Scientist of the Ministry chairs the Committee. The Committee allocates the Magnet budget among different consortia it also appoints representatives to board of consortium, users associations, and steering committees. The board of each consortium is composed of one representative from academia and two representatives from industrial participant (Magnet Report 1998). Specifically, according to Table 6, most of the surveyed participants considered the *application and use of information communication technologies (ICT), funding and research stability, efficient management of the board of the consortium, and consensus over intellectual property rights* as successful building blocks of the Magnet structure. The incorporation of these factors into network has been stated to be crucial for the functioning of networks and achieving higher performance in innovation (Skyrme 1994 and Amidon 1996).

The OCS allocates the R&D funds following three main schemes: (i) adjustment of support rate or the eligibility criteria to meet the budget constraint; (ii) randomization; *(iii) implementation of a competitive ranking system*. The last option is typical of the Magnet Program. Projects need to be ranked, and the funds will be allocated from top to down until the Magnet budget is fully exhausted (Trajtenberg 2000). It allocates a budget of $60 to 70 million per year on a competitive basis to the winning consortium. Magnet finances two thirds of the R&D budget of the consortia with direct grants for which there are no payback obligations. The criteria for this competitive mode of selection depends first on the quality of generic, pre-competitive research with a broad spectrum of common technologies, components, materials, design and manufacturing methods and processes, standards and protocols that have wide-ranging applications in numerous industries. Second, project proposals are evaluated based on increasing export and employment opportunities and enhancing the quality and intensity of academy-industry relations. Finally, the technology referred to here cannot be acquired from abroad on reasonable commercial conditions; it cannot have been developed previously and it must not be in use in Israel currently (Magnet Report 1998).

According to the evaluation report of a private consulting firm[58], the optimum number of firms in each consortium should be around five or six and must not exceed seven firms along with research institutes, universities and hospitals participating in the Magnet consortia. (Trajtenberg 2000). Firms having sufficient financial and human resources, and which are ready to devote substantial amounts of time and resources are preferred. On the other hand, neither the start-ups, which not only have insufficient financial and human resources, but which are also in the process of establishment, nor the big companies which are not committing enough time and attention or which may become the monopolistic power in the consortium are preferable for innovation networks.

[57] It is composed of the Deputy Chief Scientist of the Ministry, Representatives of the Budget Division, Ministry of Finance, and Ministry of Defense, two representatives from both the high-tech industry and academic research organizations and the Program Manager of the Office of the Chief Scientist.

[58] ENOSH Consulting Firm Evaluation Report in 2001 originally in Hebrew translated to English by the author and a Native Hebrew Speaker.

The management of intellectual property rights (IPR) developed within the framework of the Magnet assigns IPRs for a given technology to the party that develops it; but all of the partners must share the results equally. The sale or transfer of IPR to foreign parties is subject to the approval of a committee, since the domestic dissemination is seen as crucial and it is observed carefully. A five-year limit is suggested for the operation of consortia. These features eliminate the risk of monopoly and anti-competitive behavior.

Magnet operates through two channels. The *Technology R&D Channel* is the team of researchers, scientists and industrialists, who work cooperatively for the generation of new knowledge and technologies for further development into new products. The *Distribution and Implementation Channel* aims to enable "User's Associations", which are composed of members of the same industrial sector, and which work to provide access to the latest scientific and technological developments from abroad by implementing and integrating them into their members' activities. This information exchange is accomplished through the *financing of lectures, seminars and professional get togethers*, which take place under the aegis of Magnet Users' Associations (Magnet Report, 1998). Additionally, *information centers* provide consortia members with the latest scientific and technological developments. The coordinators are responsible for the management of these centers and the coordination of the relations between different participants. These methods decrease scientists' isolation and facilitate sharing of resources, tasks, and information (Davis and Carden 1999).

The domestic and international circumstances have brought about much more personnel contacts and linkages in the Israeli society than most of the other countries have. The stabile and reliable relations between Israeli policy makers, academics and industrialists bring about the formation of successful R&D networks among these three specific actors. Thus, it amplifies dissemination of the results of these networks into the society and economy more efficient than the conventional R&D supports such as grants, tax subsides. There is a considerable mutual benefit and synergy between the industrialists, researchers and scientists, which would have been otherwise lost. The next section assesses the impacts of Magnet type networking on the Israeli economic performance.

Results of Networking and Magnet Structure

This section elaborates on the supportive relationship among the impacts of innovation networks, Magnet's budget, and growth rates, increases in high-tech exports and patenting activities. The discussion seeks to clarify how innovation networks contribute more than the conventional methods to the industrial and economic growth. Indeed, according to the analysis of R&D expenditures and growth rates of different sectors given in Table 7, the R&D expenditure in business and higher education sectors display rather stable growth rates due to the positive influence of the OCS R&D grants (Mani 2000, Trajtenberg 2000). Furthermore, the networking of business and higher education sectors in the contexts such as Magnet is believed to provide more stable and rapidly increasing growth rates for Israel.

The total budget of the OCS increased steeply from 1988 to 1995, then increased slightly, and has changed little since then. According to Table 8, with the exception of Magnet, the budget of each OCS program has been increasing at declining rates, or even displaying budget shrinkages. Magnet shows a constant rise without any reduction in its budget. The stable increase in the allocation for Magnet's budget and even the doubling of its budget in the 1995-1996 period strengthens the case for innovation networks as the structures for optimum use of resources and thus increasing trust in the Magnet type of R&D funding.

The high-tech sector is considered as to be one of the indicators revealing the relation between the R&D expenditures and R&D outputs. In view of the fact that many of the research grants are given to the high-tech companies, it is not unreasonable to assume that an increase in the OCS support programs corresponds to increased high-tech exports for Israel. Then the steady increase in Magnet's budget (Table 8) may possibly correlate with increases in high-tech exports. Such a correlation is shown in Table 9.

However, even if the research grants have gone to high-tech exporters, the sector is diverse and thus the support budget is divided into small firm shares. The disposal of grants for the same product via different firms could very well prevent the achievement of better R&D and innovation results. Therefore, instead of a multitude of small research grants, Magnet type allocation schemes should be preferable, especially for catch-up countries, in terms of better allocation and optimum utilization of national resources.

As shown in Table 10, the number of patents (in the USPTO) barely increased during the 1987-1991 period. However, the rate of increase was impressive during the 1991-1997 (Trajtenberg 1999). This performance in the latter period can be attributed to the increasing budget allocation to the Magnet program, with which it coincided.

According to a recent evaluation report of Magnet, there have been 12 consortia controlling a budget of $60 to $75 million. In each consortium, at least 250 researchers work jointly in a suitable environment. At least 63 scientific articles were published, more than 30 patent applications were made, and more than 88 different products were introduced because of the interaction between industry and academy. The establishment of several new companies was reported, but the exact number was not available during the survey. Due to the limited data acquisitions on patents and exports, the statistical analysis of the study cannot reveal much about the specified impacts of Magnet on the Israeli economy. However, the survey provides a presentation of the accomplishments of Magnet regarding the better optimization of R&D inputs and achievement of improved R&D outcomes as related to the participants' individual achievements shown. The results are shown in Table 11.

The participants' assessments of their achievements are quite revealing. Even though they do not indicate that most participants have experienced a net change towards exporting, or patenting, they do indicate that most participants have become more cooperative; more science oriented and more able to carry on the long-term process of research. Consequently, significantly fewer cultural differences between academy and industry can be expected in future programs. Such achievements confirm the success of the Magnet program and networking as a critical contribution to the Israeli research system. The long-term prospects for innovation-based competitiveness are now overweighing the immediate short-term expectations.

In the light of previous observations, it can be safely assumed that the OCS support programs and the Magnet program in particular have produced more than the sum of what their individual participants would have achieved otherwise. The OCS support programs have been very useful in encouraging innovation. However, the Israeli industry is not big enough in size to compete against the background of emerging world trends. The Magnet program effectively accomplishes the unification of resources for multilateral commitment to an advantageous positioning in world markets. It demonstrates that the unification of resources for the common goal of economic and industrial growth is a reliable strategy for small countries such as Israel or countries with limited R&D budget and personnel. Magnet has proved to be a unique Israeli approach to economic and industrial development.

The structure of Magnet has modified the traditional R&D and innovation generation into a less hierarchical one, which operates across institutional boundaries. Magnet has a bridging mechanism between knowledge and industrial capacities of Israel. The domestic and international conditions closely linked with to the societal features of the Israeli society and the institutional set-up of Magnet have important roles on the formation and functioning of successful networks in Israel and thus achievement of synergy of participants without absorbing the energy of them. Magnet has the characteristics of a Triple Helix innovation networking system; it confirms the importance of networking for the successful innovation generation and management. Significantly, the *modus operandi* of Magnet, which has been operating fruitfully since its inception, has been already integrated into the Israeli society. Therefore, Magnet is an institutional framework that not only regulates but also reflects the Israeli S&T and innovation system at the micro level.

University- Government and Industry (UGI) Relations in Developing Countries

As a result of many historical experiences and due to their colonial past, which had still adverse effects on the economic growth, today's developing countries (especially those in Africa) had followed a different path of economic and social development. Democratic capitalism in western countries led better and more dynamic environment for interaction of economy, technology and science (Koslowski 2000). Concerning the research administration there has been lack of efficiency, order and connection to the environment. In the absence of well-defined economic and social development programs, science, technology and innovation programs have subsequently became vague and unresponsive to the needs of industrial and economic development. Public institutions have no missions or plans, its functioning rules were formed in the communist era. Despite some reforms these public bodies are still tend to repeat the same routine behavior and far from forming a web of coordination within the whole system.

The secret and golden thing in the efficiency of the public administration in western countries is the fact that both officials and politicians apply certain basic reasoning just like scientific researchers or scientific process. Policy plan for innovation or innovativeness, -which is the main concern of this paper, - includes phases of: preparation, identification of the problem, implementation, monitoring and assessment. These phases are all actualized in the implicit or explicit form of trilateral relations of UGI. Concerning the other organizations for innovation, such as universities, technology agencies, research councils and research organizations there are also diversity and lack of coordination within these organizations. There are no institutional frameworks bridging the knowledge centers to the industrial level.

Implications for Ethiopia: What could be done in Ethiopia based on the Magnet Experience?

The aim of this section is not to provide a profile of Ethiopia but to highlight the particular factors which will have an affect on the networking and innovation systems of Ethiopia. We will start with the political and economic context briefly and then discuss the possible implications.

Ethiopia is one of the largest countries in sub-Saharan Africa (SSA) and its population of over 70 million is rapidly growing. It is also one of the poorest countries in the world, with a GNI per capita of about USD100. Ethiopia has a unique cultural and political history and with no history of colonial rule. A key point to emphasize is that an imperial regime was succeeded by a socialist totalitarian one which was overthrown in 1991 by a coalition of rural resistance movements, the Ethiopian People's Revolutionary Democratic Front (EPRDF). Moreover, Ethiopia fought a border war with Eritrea between 1998 and 2000. There is now a United Nations buffer force between the two sides, but time to time there are still tensions.

The Ethiopian economy is highly dependent on agriculture; about 85% of the population gains their livelihood directly or indirectly from agricultural production, including livestock. Looking at the private sector, Ethiopia does not have a reputation for routine bureaucratic corruption, but the existence of close links between the officials of the ruling party and firms owned by members of the party does not foster a culture of accountability and transparency (EIU, 2006) Moreover, According to World Bank project documents, Ethiopia's private sector has a low number of firms; small-sized firms; low labour productivity (50% lower than China, although local wages are only 30% lower); and little propensity to export (most private firms produce for the local market). Apart from the obvious problem of high transport costs, the World Bank identifies several related constraints to private sector development, including:

- the dominant role of the state,
- an absence of fair competition,
- weak institutional support for business,
- low skill levels in the private sector, and
- a lack of external integration.

Despite some deregulation, the state runs all major utilities, dominates the financial sector and accounts for the bulk of manufacturing value-added (72%). The local private sector suffers from skills shortfalls and difficulties in accessing credit. Public- and private-sector institutions, such as professional associations, chambers of commerce and standards agencies, also have limited capacity (EIU, 2006).

Mytelka and Oyeyinka (2003) point to a number of systemic barriers in developing countries that provide a rationale for interventions to build competences and promote greater systemic cohesion. Firstly, there may be rigidities at the organisational level that resist change in the face of new conditions and challenges. Secondly, existing knowledge networks may be underutilised with links between critical actors sparse or inappropriate for various reasons. Thirdly, organisational performance may be path dependent, with the accumulation of inefficiencies arising from membership of an obsolete self-reinforcing network. Fourthly, the organisational ineffectiveness referred to above manifests itself as system inefficiency. In the absence of strong market coordination this leads to a situation in developing countries in which policy coordination is largely politically driven. Table 4 shows a simple model of the poor coordination between actors in the system of innovation and the policy coordinating functions in Ethiopia. Finally, "Institutional Gaps", systemic weaknesses that characterise innovation systems in developing countries are partly related to fundamental weaknesses of political-policy institutions and processes. There are institutional inadequacies that manifest themselves as lack of rules of the game, poor enforcement of contractual laws, and inadequate intellectual property laws, which may constitute disincentives to innovation and technological learning.

Table 12: Coordination and Linkages between Selected Technology Support Institutions and Regional States in Ethiopia.

Technology Support Institution	Nature of, and Coordination Mechanism with Region	Linkage with enterprises and other centres
1. Micro and Small Enterprises Development Agency (MSEDA)	No links with regional states for now but expected to train and assist in technical services for similar regional bodies	Ad-hoc
2. Ethiopian Authority for Standardization (EAS)	No regional bureau on standards quality control assurance and certification. Propose to train personnel from regions in the future	No systematic mechanism for service delivery; presently seeking capacity for greater effectiveness
3. National Computer and Information Centre (NCIC)	No regional centre on computer and information	Industry has little capability in information technology limited linkage with enterprises
4. Research Development and Technology Adaptation Centre (RDTAC)	No counterpart in regions and impact limited to Addis Ababa and environs	Ad-hoc interaction, based on demand from users, underutilized machinery capacity high turnover of staff
5. Leather and Leather Products Training and Development Institute	No regional counterpart but will start training in early 1999	N.A

Source: Mission visit, Oyelaran-Oyeyinka, 1998

Looking back in the history to see what has been done in terms of university industry relations we come across two examples.[59] First, a number of meetings were held at the highest levels to establish a university-ministry cooperation program in mid 1980's. It culminated in the formation of the Addis Ababa University-Ministry of Industry Cooperation Programme (UICP) in February 1986 through a formal agreement between the Addis Ababa University (AAU) and the Ministry of Industry (MoI). The overall objective of UICP was to bring together Addis Ababa University and the Ministry of Industry so that they can accomplish their respective goals to achieve different aims. On the part of industry, these aims included solving technical and managerial problems; injecting new processes, technologies, etc; maintaining and improving productivity and efficiency; and facilitating further training of existing staff, etc. On the other hand, the aims of the university included practical training of students; making R&D relevant while maintaining independence of staff; augmenting its R&D resources with those from UICP; and obtaining feedback on the direction of R&D, curricula, teaching approaches and consultancy services, etc.

Further, to establish a sustainable University-Industry Linkage; the Faculty of Technology, Addis Ababa University, started a Technology Faculty–Industry Linkage Unit (TFILU) on its premises. "The main objective of this unit is to pave the way for the establishment of sustainable University-Industry Linkage. It had the responsibility of conducting need and capability assessment of the Technology Faculty and the industrial sector at large so as to form a strong foundation for a reliable linkage. The Unit examined the activities carried out by the Addis Ababa University-Ministry of Industry (AAU-MOI) co-operation program to learn from the success and shortcomings of their experiences."[60] Moreover, TFILU run its activities in collaboration with the National Advisory Body (NAB) of the Unit and the Addis Ababa University Research and Publication Office. NAB is composed of members from the Ministry of Industry, the Ethiopian

[59] The information is taken from the webpage Ethiopian News Agency. It is prepared by Dagim Mersha's interview with Dr.-Eng. Daniel Kitaw, Associate Professor of Mechanical Engineering Department at Addis Ababa University. http://www.ena.gov.et/Articles/Benefits%20of%20higher%20institutions-industry%20linkages.asp.

[60] Again, the quotations belong to the same interview on he Ethiopian Manufacturing Industries Association (EMIA) on January 11, 2006 in Ethiopia.

Science and Technology Commission (ESTC), the Public Enterprises Supervising Authority, the Chamber of Commerce, private companies and the Faculty of Technology.

The activities to be carried out by the Unit towards meeting its objectives include: study on survey on skill needs and capabilities of Technology Faculty and the Industrial Sector; lay the foundation for (IT) technology information dissemination; prepare and conduct summer courses for industrial personnel; organize seminars and workshops on recent industrial issues; organize educational visits and vacation jobs for students; and conduct research activities on already identified problems of industry and promote and co-ordinate research activities in the Faculty. The Unit began its operation in July 2000, soon after the grant had been obtained from ESTC. Some of the main functions of TFILU include Training, Research and Consultancy, Industry-Job core whose primary objective is to introduce students into the workplace early on their academic studies, Workshops and Seminars, and Information Technology. The proposal has the main objective of establishing a "Higher Education-Industry Resource Integration Centre" (HEIRIC).

The activities to be carried out by the Centre include but are not limited to: assess the needs and capabilities of the Higher Education Institutions and the industry at large; establish a sustainable University-Industry linkage; assess research priority areas of industries and co-ordinate research activities in the University; organize thematic seminars and workshops annually; prepare summer courses tailored to the needs of the industrial personnel; promote appropriate Technology Transfer; and promote university/industry cooperative research projects. According to Dr.-Eng. Daniel Kitaw, such activities and interactions are expected to benefit to both industry and university by enabling them to establish multidisciplinary programs that are responsive to industrial needs, carry out specific company-sponsored projects, strengthen team-based, cross-disciplinary, problem solving industry-university exchanges by placing faculty and students at industry sites and industry scientists-engineers at the university, and provide a real world and a high-caliber educational experience for graduate and undergraduate students.

In conclusion, Dr.-Eng. Kitaw recommended three things based on the experience of other countries, AAU-MoI cooperation program, TFILU, and the felt need that exists in the industries. In his view first a nation wide Higher Education-Industry Resource Integration Centre should be established at first. Secondly, all higher education Institutions should start linkage units in their premises at their earliest convenience. And those who have already started should properly appreciate the efforts made and strengthen the initiatives. Thirdly, Ministry of Capacity Building, Ministry of Education, Ministry of Industry and Trade, the Ethiopian Science and Technology Agency, Public and Private Higher Education Institutions and the business community should make a coordinated effort to establish and strengthen Higher-Education-Industry Resource Integration Center.

Lessons Learned in Magnet Program: Readiness for International Collaboration

In this section, some of the indicators and guidelines for a successful cooperation analogous to the Triple Helix based UGI relations are identified. These indicators are gathered from a comparative perspective on the general indicators derived from innovation programs in developed countries the current University-Government and Industry (UGI) relations in countries in transition.

i. Governmental Indicator: "An active participant government"

As international cooperation starts at the governmental or institutional levels, a developed country (S&T body) seeks out the facilitator bodies that operate on similar basis. Successful country cases and Israel reveal the existence of administrations by which science base and productive base are integrated. They have absolutely identified ST&I bodies that are dedicated to the management of UGI relations. Thus after having an administrative reform and restructuring the S&T bodies Ethiopia will become a more eligible partner for cooperation.

ii. Academic Indicator: "Entrepreneurial university"

The existence of a history of highly qualified academic culture and more strikingly the entrepreneurial academy of 21st Century, with the mission of economic development is the general indicators that initiate a propitious cooperation at the domestic and international levels. On the other hand, it would be imaginary to expect an attainable relation between a university with a number of independent interdisciplinary centers, and programs where the staff following the latest developments, and a university where faculty assumes basic research and education on traditional areas as its exclusive mission and can not follow the recent scientific developments. As a second point, Ethiopia needs to reform its higher education system not only to have more industry-oriented universities but also to have internationally attractive higher education institutions.

iii. Industrial Indicator: "Science-based industry"

A significant number of technology-based industries that have the ability to integrate internal R&D, production and commercialization process with external partners are the preferable business types of knowledge-based economy. Therefore in order to be an eligible partner in international programs, Ethiopia urgently needs to initiate a framework that encourages its industry to generate technological innovation via networking and partnership.

iv. Work Force: "Skilled human resources"

Well-educated human resources capable of developing and implementing innovation are critical national assets that attract other nations for cooperation. Ethiopia on the other hand has an advantage of young population compared with European countries' ageing population and declining birth rates.

v. Stability of Program: "Research missions & plans"

Rather than the amount of R&D expenditure, the financial and political stability of the program are more positive indicators to initiate a successful cooperation. Additionally, if can not expand its GERD, Ethiopia needs to convince the international participants about the stability and commitment to the measure. Innovation policy must be immune from the short-term political and interest considerations. It must be embedded into the national system and culture.

vi. Well-defined Market: "Rich consumers"

All of these programs are aimed at producing goods that have the potential for commercialization; even they may have existing markets. The forecasts of future consumer trends and needs decrease the risks of marketing. Moreover, existence of sufficient market-pull with increasing demands for the application of technology in the products is also important incentives for collaboration. Compared with other countries, the low-income rates and life standards in Ethiopia make it necessary to increase average income level, as indicated in the previous sections.

vii. Trust-Building in Networks: "Social network"

As the literature survey and the case studies elucidate the mechanisms of innovation networks, more specifically Triple Helix system works on an evolutionary selection mechanism that is enacted by its members. In the system there is no central control dictating them what to do or not to do. Since the participants are linked through the elements of trust, cooperation and close interaction, they prefer to select those with whom they can achieve these elements and have mutual benefit. Thus assuredly, while they have inclination to select the ones who has the qualification of a beneficial partnership they have disinclination to cooperate with the ones who does not carry the characteristics that are defined as indicators for collaboration.

Network is the forum for collective learning, communication, and synergy creation. The analysis on the cases bears out that the main success of networks is based on the achievement of energy of *critical mass*[61], establishment of trust among the members. Involvement of end-users, customers and potential networkers enable the system to have the understanding of their customers' needs (SPRU, SAPPHO Study, in WAMP, 2001). Pertaining to conditions of catch up countries the trust and reliance between neither within the industrialists nor between industry and university even to state sector is difficult to achieve. Thus the governments are obliged to assure trust among the partners and their commitment to the system; they must pledge to continue the system despite of the political instabilities.

Generally, networks are the virtual, symbolic places of cooperation embody the image of a big company. In as much as the management of a big company is hard the administration of networks is arduous and requiring concessions, trust endurance and determination. Thus, the catch-up country should persuade the potential partners based on Lutz's[62] assertion for consortia as none of the partner is calculating individual gains, but this is a matter of belief and devotion for the national competitiveness and development. It is not a win-or-lose individual competition, but achievement of exceptional R&D results. The impacts of networks are greater than the sum of its parts, because they are benefiting from the synergy of the system.

Historically, while capitalists-liberal economies used to cooperate between themselves, communists-socialist states used to form their networks on the other hand. Currently, however studies reveal that cross-cutting arrangements like the Triple Helix are becoming the mode of cooperation. Thus it is not illogical to assume the foundation of cooperation between countries now have the characteristics of Triple Helix in their innovation or more generally in their production system. International networking can be successfully achieved among states whose R&D programs are designed on similar base and whose potential partners not only seek the opportunities to gain, but also contribute to the system.

The aim of international cooperation is to co-development of technology rather than establishment of multinational companies or transfer of technology from one company to another. Analogous to national level, international cooperation aims the pooling of multinational resources either industrial, academic or human resources. The aim is also similar endogenization of knowledge production into the system and reduction of technology transfer costs and applicability risks of new technology products. On the other hand, not only developing countries are in need of cooperation, but also developed world needs cooperation since even if they can generate innovation endlessly, they will not be able to find innovation demanding young and rich consumers to sell their products. As a case to the point while Finland is considered the center of

[61] The amount of substance that is needed for a nuclear chain reaction to take place.

[62] Chief of Chrysler and partner of Chrysler-Ford-General Motors consortium.

ICTs and cell-phones, the consumers of cell-phone are mainly from developing countries with their larger population.

Concluding Remarks

Especially since the 1990s, innovation has become a social process that depends on external, competitive centers of knowledge and funding, requiring the commitment of each participant free of individual loss-win considerations. The motivation is the endogenization of knowledge generation into tripartite network of university, industry and government. However, sole motivations of the partners are not sufficient conditions for the formation and functioning of innovation networks. They need a systematic management approach that integrates the industrial strategy, knowledge resources, organizational cultures and sociological patterns of nations. In this context the Triple Helix model becomes more than a policy-tool; it is accepted and validated as a general vision of innovation network generation and governance. It aims to synchronize the chaotic behaviors of economic actors into an innovation system. Although networks may enter crises, lack superior technologies, and absorb energy instead of generating it, the dynamic structure of the Triple Helix model is complex enough to harmonize their chaotic behaviors and achieve the synergy of participants.

This short review has put forward the idea that replacing the traditional understanding of science and technology generation with the Triple Helix model can be used to eliminate the dichotomies at both national and international levels. One such dichotomy is the one drawn between the *producers of knowledge: "academia and developed countries"*- and *users of knowledge: "industry and developing countries*". International harmonization of the culture of innovation generation and management can enhance international and regional stability, welfare and development. Israel and its Magnet program illustrate how synergy of the participants contributes more than the sum of the individual partners. All in all, it is now more important than ever for Ethiopia to make concerted efforts towards moving ahead in this direction. In so doing, it will also be positioned to take an active part in the global scene. Therefore, it is imperative that people in Ethiopia are willing to cooperate, to take part and to trust one another and other parties so that the essential elements of *trust, cooperation, openness and self-organization are* satisfied. At the end, it will be for Ethiopia's benefit to make it able to accomplish much more than where this is lacking.

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Appendix:

Tables and Figures

Table 1: The Reasons for the Initiation of the Magnet Program by the Israeli Government

Factors	Very important	Important	Slightly / not important	Mean	Std.
Better interaction between S&I	85%	12,5%	2,5%	4,17	0,957
Better utilization of academic potential	62,5%	30%	7,5%	3,65	0,975
Demands of industry	35%	40%	25%	3,15	1,050
Increasing high-tech export capability	82,5%	7,5%	10%	3,92	1,020
Pooling of National resources	82,5%	15%	2,5%	4,1	0,955
Reduction of relying on foreign technology	45%	30%	25%	3,32	1,340

Source: Results of questionnaire among Magnet participants (2002)

Table 2: Industrial Reason for Participation in the Magnet Program

Factors	Crucial	Important	Slightly/ not important	Mean	Std.
Access to knowledge centers	82,5%	10%	7,5%	4,07	0,859
Competence gap	80%	12,5%	7,5%	3,92	0,888
Market Control gap	37,5%	37,5%	25%	3,07	0,971
Cost reduction	50%	37,5%	12,5%	3,62	1,078
Information gap	52,5%	42,5%	5%	3,67	0,859
profit maximization	50%	35%	15%	3,35	1,166
Risk reduction	67,5%	27,5%	5%	3,65	1,051

Source: Results of questionnaire among Magnet participants (2002)

Table 3: Academicians Reasons for the Participation in Magnet

Factors	Crucial	Important	Slightly / not important	Mean	Std.
Financial Constraints	60%	30%	10%	3,65	1,160
Industry committed research	67,5%	27,5%	5%	3,75	1,000
Employment opportunities for graduates	45%	20%	35%	3	1,330

Source: Results of questionnaire among Magnet participants (2002)

Table 4: Relation between Academy-Industry & Government

Relationship between participants	Outstandingly Successful	Successful	Slightly / not Successful
Interaction between government & industry	50%	42,5%	7,5%
Interaction between government & academy	27,5%	50%	17,5%
Interaction between industry & academy	67,5%	30%	2,5%
Triple interaction between industry academy & government	32,5%	55%	12,5%
Interaction between customers & consortium	22,5%	22,5%	55%

Source: Results of questionnaire among Magnet participants (2002)

Table 5: Societal Features

Factors	Very Successful	Successful	Slightly /not successful	Mean	Std. Dev.
Commitment & devotion of partners	62,5%	35%	2,5%	3,62	0,9251
Confidence Security & trust	65%	30%	5%	3,72	0,7506
Convergence for longer-term cooperation	40%	50%	10%	3,65	0,7355
Equity & balance between the partners	37,5%	50%	12,5%	3,3	0,8533
Similar objectives of partners-collective belief	60%	37,5%	2,5%	3,62	0,6279

Source: Results of survey among Magnet participants (2002)

Table 6: Features of the Magnet Framework

Factors	Very Successful	Successful	Slightly / not successful	Mean	Std.
Application and use of ICTs	70%	22,5%	7,5%	3,77	0,811
Bridging different group interests	57,5%	40%	2,5%	3,67	0,729
Consensus over IPR management	77.5%	22.5%	0%	3,97	0,6597
Efficient role of the Board of the consortium	90%	5%	5%	4,1	0,7089
Funding and research stability	67,5%	12.5%	10%	3,77	0,8619

Source: Results of survey among Magnet participants (2002)

Table 7: Growth Rates in the Israeli Academy-Industry-Government & Non-Profit Sectors

Year	PNP	Growth Rate	Gov.	Growth Rate	H.edu	Growth Rate	Ind.	Growth Rate	Ind & H.edu	Ind. & H.edu. total G. Rate
1988	164	...	260	...	636	...	2266	...	2902	
1989	173	5,49	245	-5,77	678	6,6	2319	2,34	2997	8,94
1990	176	1,73	265	8,16	706	4,13	2536	9,36	3242	13,49
1991	180	2,27	292	10,19	748	5,95	2733	7,77	3481	13,72
1992	205	13,99	292	0	781	4,41	2921	6,88	3702	11,29
1993	200	-2,44	282	-3,42	812	3,97	3143	7,6	3955	11,57
1994	224	12,00	276	-2,13	842	3,96	3280	4,36	4122	8,32
1995	223	-0,45	301	9,06	863	2,49	3577	9,05	4440	11,54
1996	230	3,14	294	-2,33	903	4,63	3796	6,12	4699	10,75
1997	243	5,65	299	1,7	945	4,65	4046	6,59	4991	11,24
1998	252	3,70	299	0	992	4,97	4361	7,79	5353	12,76
1999		4,50		1,55		4,55		6,79		11,34
2000										

Source: www.cbs.gov.il; (PNP: Private non-profit sectors, H.Edu: Higher Education, Gov: Government, Ind.: Industry, G. Rate: Growth Rate)

Table 8: OCS R&D Funding 1988-2000

Year	R&D grants	Paybacks	Paybacks/ Grants	Net Grant	Magnet	Incubators
1988	120	8	0,07	112	...	...
1989	125	10	0,08	115	...	...
1990	136	14	0,1	122	...	...
1991	179	20	0,11	159	0,3	3,6
1992	199	25	0,13	174	3,7	16
1993	231	33	0,14	198	4,6	23
1994	316	42	0,13	274	10	28
1995	346	56	0,16	290	15	31
1996	348	79	0,23	269	36	30
1997	397	102	0,26	295	53	30
1998	400	117	0,29	283	61	30
1999	428	139	0,32	289	60	30
2000	395	128	0,32	267	70	30

Source: Trajtenberg p. 15. 2000 (in 2000 $ million)

Table 9: Israeli High-Tech Export

Year	High-tech Exports in $	% of High-tech share in exports	Rate of growth
1988	831,382	9,93	...
1989	998,353	10,69	20
1990	1,111,525	10,66	11
1991	1,170,933	11,26	5
1992	1,366,108	11,71	17
1993	1,609,098	11,99	18
1994	2,008,376	13,03	25
1995	2,719,332	16,03	35
1996	3,184,664	17,06	17
1997	3,844,893	18,56	21
1998	4,259,555	19,8	11

Source: Compiled from Mani, 2002

Table 10: Israeli Patents Registered in the USA

Year	Raw Applications	Patents issued, by application year	Rate of Success	Patents issued by Grant Year	Growth Rate	Industrial R&D
1987	503	295	0.59	244	27.7	550.3
1988	490	281	0.57	238	-4.7	423.2
1989	624	318	0.51	324	25.5	396.6
1990	608	325	0.53	298	2.2	468.6
1991	633	**312**	**0.49**	**304**	-4	**510.7**
1992	780	355	0.46	335	13.8	559.3
1993	803	421	0.52	314	18.6	574.7
1994	1,040	576	0.55	349	36.8	631.3
1995	1,072	613	0.57	384	6.4	614.4
1996	1,042	609	0.58	484	-0.7	**668.6**
1997	1,185	**664**	**0.56**	**529**	9	
1998				741		
total	12,962	7,013	0.54	6,432		5397.7

Source: Trajtenberg, 1999

Table 11: Accomplishment of Magnet Program

Success criteria	Outstandingly Successful	Successful	Slightly / not Successful
Access to Knowledge & Research Pools	77,5%	20%	2,5%
Access to State Funds	80%	15%	5%
Allocation of resources other than R&D	35%	55%	10%
Assisting knowledge sharing-learning	52,5%	42,5%	5%
Better R&D results	35%	62,5%	2,5%
Contribution to higher education	27,5%	65,5%	7,5%
Decrease in R&D equipment costs	32,5%	57,5%	10%
Decrease in R&D personnel costs	32,5%	57,5%	10%
Decrease in time-span for R&D	47,5%	47,5%	5%
Eliminating the duplication of R&D inputs	50%	35%	15%
Higher potential for firm creation	47,5%	47,5%	5%
Improvements in human capital	70%	17,5%	12,5%
Increase in product quality	42,5%	42,5%	15%
Increase in product variety	77,5%	15%	7,5%
Increase in R&D capacity & capability	42,5%	55,5%	2,5%
Increase in the number of patents & scientific papers	29,5%	67,5%	2,5%
Reduction of Risks & Costs of innovation process	67,5%	30%	2,5%
Speed-up commercialization of Knowledge & technology transfer	57,5%	35%	7,5%

Source: Results of survey among Magnet participants (2002)

EXAMPLES OF MAGNET-ICT CONSORTIA

- ISIS – Information Superhighway in Space Information Superhighway in Space
- LSRT – Large Scale Rural Telephony Large Scale Rural Telephony
- STRIMM – Streaming Rich Media Messaging Streaming Rich Media Messaging
- OPTIPAC – The Optical Packaging Consortium The Optical Packaging Consortium
- KITE – Knowledge Inferring Technology Knowledge Inferring Technology
- RIMON – 4G 4G
- ISRC – Israeli Short Range Communication Israeli Short Range Communication

A mission impossible?
A tri-partite cooperation in an international context
(Summary)

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Editors' note:

The paper which is the subject of the following summary is published in the *Journal of Developmental Entrepreneurship* of 3rd January 2008 under the title "TRIPLE HELIX NETWORKS IN A MULTICULTURAL CONTEXT: TRIGGERS AND BARRIERS FOR FOSTERING GROWTH AND SUSTAINABILITY"

The presentation was delivered at the Ethiopia Triple Helix Conference by Professor Chris Friedrich.

Introduction and Background to the Research Challenge

This paper explores the interaction between three entities--university, industry and government in the context of entrepreneurship development with regard to a developing country. Etzkowitz and Leydesdorff (2000) coined the phrase “Triple Helix” to refer to this dynamic relationship. The purpose of this paper is to adapt the existing Triple Helix model to the South African context, and secondly to identify facilities and impediments for working according to the Triple Helix in South Africa, in the context of a developing country where the model does not receive the same degree of attention as in the West.

The South African government has formulated a national policy framework (White Paper, 1995) to guide existing and potential role players about the development and promotion of small business. The national policy framework has six objectives, including the creation of an enabling environment for small enterprises. It emphasises a differentiated support system, indirectly calling for the Triple Helix, and designates target groups such as women and previously economically disadvantaged groups.

Since 1994, no significant improvement has taken place in the SME sector. According to the 2004 Global Entrepreneurship Monitor Report (Orford et al., 2004: 25), deficient entrepreneurial capacity is a consequence of weaknesses in the educational system, as well as the lack of government support and the difficulty of accessing financial resources. The Triple Helix is presented as a nexus in the discourse of entrepreneurial development. The paper provides a theoretical overview of the Triple Helix model. It then presents the South African case with three case studies, followed by an examination of the theory based on the empirical evidence, and concludes with implications to facilitate entrepreneurship according to the Triple Helix in South Africa, together with a future research agenda.

Triple Helix: A Theoretical Overview

The Triple Helix model with academia, government and industry each identified in the model as helices, is proposed by Etzkowitz and Leydesdorff (2000) as essential for national and multinational innovation strategies, and will be useful for overcoming communication barriers between the three helices. The paper discusses three different Triple Helix models according to Etzkowitz and Leydesdorff (2000), and suggests that the third model is the one to strive for. In this model, academia, government and industry have overlapping institutional spheres with hybrid organisations spinning off from them. With each helix interacting with the other(s) rather than controlling it/them and thus each helix taking the role of the other(s), knowledge is mutually constructed.

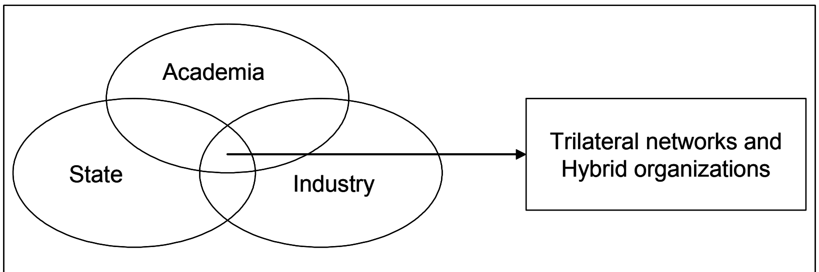


Fig. 1. The Triple Helix model of university-industry-government relations

Innovations are non-linear, and common learning takes place in networks between different actors (Tödtling, 1998). The paper suggests that the Triple Helix is a prerequisite for managing the innovation process nationally or regionally, since it is an interactive process. It is further suggested that the Triple Helix be understood at a regional level, which is the focus of this paper, and thus should contribute to understanding the value of tripartite cooperation on a regional level in a developing country. The model has been applied in other developing countries, for instance in Brazil (Etzkowitz et al., 2005), where academics formed businesses, industry partnered in training, and government contributed to research and development. Another example is Croatia, where the model has not developed totally, and exists as two helices, government and university (Laznjak and Svarc, 2004). In South Africa, the model is applied in small business development, a very important sector for the country (Orford et al., 2004) and in one region only, the Western Cape.

Institutional theory

Organisations are embedded in institutional environments (Di Maggio and Powell, 1983; Tolbert, 1985; Greenwood and Hinings, 1996; Teo et al., 2003) to keep legitimacy and be seen as trustworthy by their audience. Legitimacy will make it easier to acquire resources, but institutions must be subjected to the pressures of technical and institutional control (Scott and Meyer in Powell and Di Maggio, 1991). Organisations adapting to these pressures follow a three-step process, thus becoming an institutionalised and "taken-for-granted entity" (Tolbert and Zucker, 1996).

Technical controls		Institutional controls: Weak	Institutional controls: Strong
	Stronger	Industry	Banks Hospitals
	Weaker	Public day-care centres	University, Government, State

Fig. 2. Scott and Meyer's matrix

The paper discusses the relative positioning of each institutionalised entity i.e. university, government and industry, within Scott and Meyer's 2 x 2 matrix, fig. 2, with respect to technical controls and institutional controls. These writers argue that universities and governments are subject to institutional isomorphism, while industry is subjected to competitive isomorphism (DiMaggio and Powell, 1983, 1996). Institutional control can be exercised through coercive, mimetic and/or normative pressures (Oliver, 1997; DiMaggio and Powell 1983).

Institutional legitimacy is important, and once achieved, it is revered, and resistance to change is likely to exist. It is suggested that rigid embeddedness of an institution makes it hard for change to occur; instability is created through change (Scott and Meyer, 1991). Change involving economic growth and innovation systems is complicated by the fact that it is linked to permanent institutional change (Dalum et al., 1992).

The South African case with particular reference to the Province of the Western Cape

The role of universities, government and industry in entrepreneurship development

It is expected of higher education institutions to engage in teaching, research, consultation, and community outreach projects. Entrepreneurship education has received more attention during the last three decades. Brijlal (2005) has identified four universities and a technical college in the Western Cape involved in entrepreneurship development in varying degrees through formal and outreach programmes. For the study, this paper focuses on a specific unit, the Entrepreneurship Development Unit of the University of the Western Cape, established to provide training, consulting, and engagement in research, in order to improve the quality of life of the SME community.

The Department of Trade and Industry, which is responsible for creating an enabling business environment, published in 1995 the National Strategy for the Development and Promotion of Small Business in South Africa. Subsequent small business development mechanisms have been established to support the national strategy. The Department of Trade and Industry (2004) reported an increase in SMEs from 800,000 in 1995 to 2.5 million in 2004. The Department of Economic Development and Tourism, a sub-directorate of the Provincial Government of the Western Cape, is an essential element of the Triple Helix model; it facilitates small business development and support of entrepreneurship.

Industry also initiates business development via industry associations. In the Western Cape, associations such as the Cape Town Chamber of Commerce and Industry (CTCCI), Western Cape Business Opportunity Forum (WECBOF), Western Cape Minibus Taxi Association, Business Opportunities Network (BON) and Clothing and Textile Association (CLOTEX) are significant role players (Brundin et al., 2006).

Evidence of cooperation between universities, industry and government: survey and case illustrations

In search of evidence to assess the applicability of the Triple Helix model, a survey was conducted in which respondents were drawn from the executive management level of the three institutions. The survey showed that cooperation among the actors exists. Three cases of cooperation between university, industry and government were selected to demonstrate problems, weaknesses and successes in tripartite agreements when the Triple Helix model was applied.

Case 1: Implementation of a training programme for the owners of minibus taxis in the province of the Western Cape.

Apartheid resulted in the relocation of the majority of the population away from central business districts. The primary means of transport are minibus taxis, considered as part of the informal sector. Most minibus taxi owners have poor educational backgrounds. It is thus important for them to be educated, and trained in business and entrepreneurship.

This industry is very lucrative, but crime is rampant and service delivery is poor. The University of the Western Cape conducted a skills audit in 2004, commissioned by the Department of Transport. The audit revealed that the management committee members of the taxi industry lacked management skills. The project, costed at €125,000 (€ = ZAR 8.00 at the time) was awarded to the university. A tender process was not instituted because of the confidence instilled in the manager of the Provincial Department of Transport by the quality of research produced by the university. The project was awarded to the university. Subsequently the training responsibility was transferred. No training has taken place.

This analysis shows two institutions well known to each other with well-established legitimacy, and with the intent to create an enabling small business environment, being stifled. The impediments identified were that the rules of the game changed with the shifting of responsibility. Subsequent managers preferred guidance by institutional pressure. The industry, keen on gaining legitimacy, wanted to conform to technical and institutional pressures. Neither the university, nor the government, nor the taxi industry derived any benefit. The government, being driven by institutional pressure, was not able to recognise technical pressure.

Case 2. Evaluation of a "real enterprise development" project: RED Door

During the post-1994 era, the government developed a "one-stop" business support service close to needy communities. The Department of Economic Development and Tourism proposed to open 35 RED Doors (Real Enterprise Development) across the Province of the Western Cape. This concept proved successful in Brazil, Northern Ireland and Israel. The capital investment was approximately €30,000, with an annual operating budget of €120,000 (Department of Economic Development and Tourism, 2005). Prompted by the university, an evaluation project was asked for; funding was approved, but again transfer of responsibilities within the government department resulted in the project being withdrawn. One of the managers attended a seminar at the university, where the seminar leader mentioned that many government initiatives were not successful. This statement caused her to be dissatisfied with the university as a service provider to her department. Even after due tender process, the project was not awarded to the winning bidder. The RED Door project was not evaluated; the three parties - university, government and industry - lost an invaluable opportunity for joint learning and entrepreneurship development.

Analysis of the case reveals that the actors had good intentions to cooperate; impediments such as personal preference are one possible explanation for delays. The first replacement resorted to organisational control; the second replacement, it seems, revered the legitimacy of the government department. The government department did not understand the value to be gained from the evaluation of the programme; tacit knowledge possessed by the university was not shared, so collective learning did not take place.

Case 3.Employment creation at the Bot River mini-tunnel farming

Bot River is a typical rural town where the majority of the people are unemployed; job opportunities are scarce, and most people work on fruit and wine farms and in nearby towns. High unemployment gave birth to the idea of starting a mini-tunnel farming business. These tunnels are built for rapid cultivation; they are one metre high and made from plastic material. The government, in the form of the local municipality, provided the land and financial support. Research and fund-raising support came from the Foundation for Contemporary Research (FCR), who also initiated the project. A researcher from the university acted as research consultant to the FCR. The business operations were performed by Eco-tunnel. Distribution to the local business community was limited by capacity. The project was built on informal contracts, according to which each party performed according to its assigned role. Six women were employed, earning €75 per month. The joint project started in 2003, with 90 tunnels operational in 2004. 180 tunnels were operational in 2006, and future growth plans are in place.

Analysis of this case shows that each role player recognised his/her role and responsibilities, and made tangible contributions. No key persons were changed. The project led to an expansion, with a potential increase in job creation.

Discussion, implications and future prospects

Cooperation: In the South African context, two cases showed interaction between two helices, similar to what Laznjak and Svarc (2005) found in Croatia. The functions performed by these institutions were not well defined. The first two cases demonstrate that institutional barriers can obstruct cooperation between the helices, thereby preventing innovation.

Planning and structure: The cases show that planning and structure can be a missing link in the South African context. No evidence of a formal contract was found in the three cases, only informal verbal agreements.

Institutional theory and change: Institutional change had taken place to some degree in accordance with BBBEE (Broad Based Black Economic Empowerment), hence the sedimentation aspect was not evident here (Greenwood and Hinings, 1996); incoming people did not stay in their positions long enough to develop structure and feed-back loops for continuity; there was no time to conform to mimetic behaviour (Tolbert and Zucker, 1996).

A focus on the entrepreneur: When actors from different institutions cooperate, it is important that they have a shared understanding and a language for effective transfer of knowledge.

When the actors are involved in activities such as entrepreneurship and assessments, the three institutions--university, industry and governmental bodies--are supposed to cooperate and jointly foster innovations and growth in the Triple Helix model. A shift in the core beliefs and purpose of the institutions is required; mindsets are so deeply rooted that inertia may hinder change. Entrepreneurs suffer because the three helices are victims of institutional control and they resist radical change. Institutional barriers do not promote cooperation and facilitate achievement of a common focus on the entrepreneur. Therefore an important addendum is the incorporation of the entrepreneur in the Triple-Helix model, fig.3.

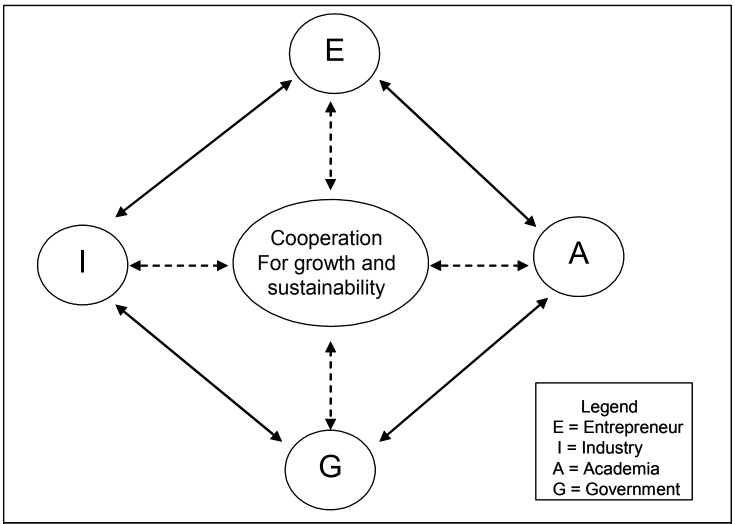


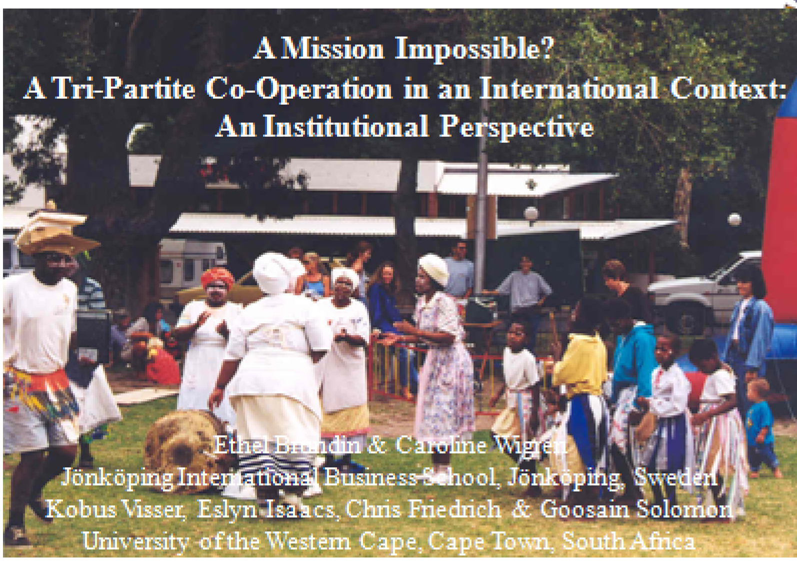
Fig. 3. A proposed model for cooperation between the stakeholders in a South African context

In the South African context, the Triple Helix model has potential for introducing innovative practices and procedures for SME growth, and South Africa is perceived as strong on policy development, but the weakness of implementing policy is a negating factor.

This paper proposes implications based on the study which are: universities should act only on written agreements; government civil servants should be properly trained in procedures for dealing with individuals outside governmental structures; industry should apply its influence more effectively to bring about the required changes; institutions should exert strong leadership and presence; and institutions should experiment and learn from them, and collectively monitor progress.

Prospects for future research could be: to better understand the relationship of partners while engaged in cooperative activities, and to investigate other actors such as donors and the non-governmental sector to assess how they could add value to the Triple Helix cooperation.

Annex



Background

- South Africa – 11 year old democracy
- Dualistic economic system
- Population – 44,8 million
- 11 official languages
- Unemployment – 30% of workforce (11,2 million)
- A National Strategy for the Development and Promotion of Small Business in South Africa:

  create an enabling environment for small enterprises; create long-term jobs; stimulate growth; strengthen the cohesion between small enterprises; facilitate greater equalization of income, wealth and economic opportunities

Purpose & Method

- An adaptation of the triple helix model to a South African context (Western Cape)
- To identify impediments for the triple helix concept in the same context
- Experiences from a 2-year research project about the Triple Helix concept in South Africa (and Sweden)
- A pilot survey to 5 respondents each of Government, University and Industry

The Triple Helix Model

- Co-operation and co-action between the three actors: academia, industry, and government
- A change from a linear perspective on innovations to a system approach
  - Innovations are non-linear; both codified and tacit knowledge are important; reduced uncertainty, thanks to institutions, benefits the innovation process (Tödtling, 1998)
- The concept has received little attention in developing countries, in this case RSA

… Proposition a:

- Overlapping institutional spheres of university, government, and industry increase co-operation and co-action

Institutional theory

- The goal is to stand up to standards of "desirable, proper, or appropriate [behaviour] within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995:574) = to gain legitimacy
- Different pressures (institutional and technical) on university, government and industry lead to different ways to gain legitimacy.
- Adaptation to the pressure often follows i) mimetic behaviour, ii)objectification and iii) sedimentation and the three follow different rules-of-the game depending on the pressure
- All three subject to isomorphism but of different kinds
- The rules of gaining and keeping legitimacy thus differ between the university – government – industry …

… Proposition b:

- Institutional barriers obstruct co-operation and co-action between university, government and industry and thereby innovation

Conclusions

- 31% of businesspeople know of university training in entrepreneurship; 4.3% made use of it; 6% were satisfied with the service delivery
- Only 8% of businesspeople in former disadvanteged communities aware of it
- Co-operation exists between two of the three parties
- Co-operation is ad hoc and isolated islands
- Govermental resources but not required result

Conclusions, cont.

- Academia mainly interested in research
- Government makes grand policies but is weak on implementation
- Industry focuses on profit-maximisation and take little interest in SME failures or successes

Proposition a:

- *Overlapping institutional spheres of university, government, and industry increase co-operation and co-action* is confirmed but

  - not clear cut

  - overlaps

  - often on a short term basis

  - often characterized by urgency or opportunity scanning

Proposition b:

- *Institutional barriers obstruct co-operation and co-action between academia, government and industry and thereby innovation* confirmed:

  - institutional barriers as vision, organisational structures and attitudes hinders co-operation

  - attributed to institutional incompetence?

Missing links: the entrepreneur and donors

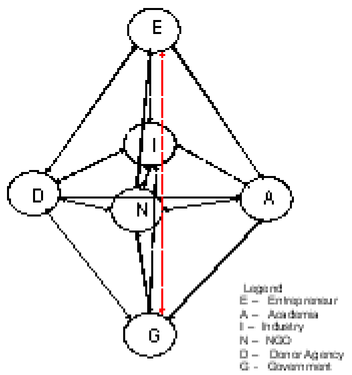


Diagram 1: A proposed model for co-operation between the stake-holders in a SA context.

Mobilizing University Resources to Create and Support Firms

The Case of University of Zambia's Computer Centre and Technology Development and Advisory Unit

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Abstract

Universities could serve as engines of economic growth by supplying skilled human resource needed to manage increasingly sophisticated systems, and developing new knowledge that stimulate industrial growth. However, the ability of African universities to incubate and support firms is possibly weak. African universities are generally under funded, poorly staffed, small in size, ill equipped and relatively young although they are the only institutions in many African countries likely to have a concentration of expertise. Turning these universities into vibrant centres capable of generating and diffusing new technologies as well as creating firms that meet the development aspirations of their people remains a challenge.

This paper uses the case of the University of Zambia (UNZA) to highlight possible ways of mobilizing university resources - manpower, national and international links, and close cooperation with partners - to create and support businesses, through specialized units. It highlights the important role of "linker units", such as UNZA's Technology Development and Advisory Unit (TDAU) to utilize university expertise to support small and emerging entrepreneurs. It also uses the Computer Centre to demonstrate the ability of African universities to incubate and commercialize firms and provide premier network support to industry, government and donor.

Although UNZA cannot be described as an entrepreneurial university by the standards of universities in some advanced developing economies, it exhibits entrepreneurship traits that, if harnessed, could help deliver services to industry and the community at large. It presents an interesting model of how universities could mobilize their intellectual capital and social capital to create and support businesses, as well as contribute to development even with meager resources.

Introduction

The domestic knowledge base of a country is often composed of research and development, financial, manufacturing, professional and regulatory institutions, among others, that influence the generation, dissemination, use and marketing of new knowledge products and services. These institutions, among others, make up what has been termed national system of innovation.

In order to accelerate technology development and diffusion, countries have developed specialized institutions often termed centres of excellence. Although there is no single agreed definition, centres of excellence are supposed to be well-established institutions with a critical mass of skilled personnel, stable and adequate funding base, highly motivated staff and state-of-the-art facilities. In addition, it has a clear objective and mandate as well as good links with its clients and other specialized centres, in and outside the country, and act as technology generators and transferors.

Universities generally have a high concentration of qualified and skilled individuals in diverse areas of interest, a clear mandate, well-equipped facilities and a stable funding base. Industries, especially in developing countries, are unlikely to pool enough skills in any one area of technology to provide sufficient innovations to remain competitive in emerging interdisciplinary fields. It is for this reason that the relationship between industry, university and government has changed. Universities have become partners to industry by producing new innovations that have become the basis of new firms and industrial competitiveness.

There are at least three different types of universities: teaching, research and entrepreneurial universities. These generalized classifications are based on the nature and scope of university programs, staff time allocation and weight attached to research and teaching activities, and the objectives and relationship of the university with industry and government. These characteristics, among others, affect how the university operates, is managed, and how it responds to the needs of its clientele.

Teaching universities are generally designed to produce (train) manpower for the private and public sectors and their programs place more emphasis on teaching rather than research. By contrast, research universities place nearly as much emphasis on research as on teaching. In general, faculty is expected to undertake research activities, compete for research grants, publish original peer-reviewed articles, supervise post-graduate and post-doctoral students and, in some cases, participate in outreach programs. Research excellence is squarely at the heart of the university mission and substantial resources are committed to research activities.

Entrepreneurial universities expand the roles of research universities by undertaking roles that promote contract research, commercialization of research outputs and incubation of firms. In a way, they enable departments and/or members of staff to organize themselves and form research teams that exist almost as "quasi-firms". These universities view knowledge they generate as potential economic and social assets. They may have technology transfer managers that screen research products to identify those that can be patented, published and commercialized.

Therefore, it may not seem possible for African universities to serves as centres of excellence or to develop and support firms. Staff, at many African universities, is often demoralized by the lack of basic teaching and research tools, support from management, red tape and poor salaries, and overwhelmed by the large numbers of students. Sometimes, they do not have research teams or research facilities likely to produce technologies of interest. It seems impossible and perhaps misconceived to assume such universities could play the same role as their equivalents in developed and advanced developing countries.

It may also be possible that the comparison of universities using the same indicators (e.g. numbers of patents, publications and post-doctoral students) do not take into account the differences in economic, social and political realities. In poor countries a university that helps communities improve their living standards and marginalized individuals become entrepreneurs or create jobs may be just as entrepreneurial as those inspiring the development high technology products and firms.

2. The University of Zambia's Entrepreneurial Activities

University of Zambia (UNZA) has a longstanding tradition of working with industry and public institutions. The School of Mines and the former Zambia Consolidated Copper Mines (ZCCM) cooperated on training and research in the mining sector. The Mines supported most of the students in the School of Mines and some students in the School of Engineering that wished to work for them after graduation with tuition fees and attachments. Similarly, the School of Agriculture and the Zambia Seed Company have worked together on many projects.

The University also run several business ventures (e.g. farms, bookshop, guesthouse and clinic). For instance, UNZA owns about 49.9 % of the share of York Farms, one of the countries largest horticultural producer and exporter, with an annual turnover of about $13.5 million and brings the UNZA roughly $1 million in dividends a year (2000 estimates).

York Farms was conceived by Mr. Charlie Youngson in the early 1970s who later sold it University of Zambia as a teaching and experimental farm on high-value products. The University got a loan from the Ministry of Finance to purchase the Farm. The UNZA was also developing the UNZA horticulture nursery (often called UNZA Nursery) and UNZA farm during this period. The firm got financial support from the CDC Capital Group and started export of high-value/low volume agricultural produce in 1989. Today, it is Zambia's second largest exporter of fresh vegetables, baby corn, sugar-beans, flowers and onions to Europe, South Africa, Australia and New Zealand.

York Farms covers about 1,800 hectares of which 600 hectares of irrigated land for production of vegetables and 110 hectares is certified organic land. The farm employs about 3,300 workers, all of who receive on-the-job training and some participate in formal training courses in Zambia and overseas. The Farm has gained accreditation with EUREPGAP and Tesco's 'NATURES CHOICE GOLD' certification.

In 2001, CDC sold its 50.1% shares in a Management Buy Out Team (MBOT) schemes named the "Lattice management consortium". UNZA did exercise its pre-emptive rights over the CDC shares which permitted the sale of CDC shares.

The Department of Physics is spearheading a project to fabricate sophisticated laboratory equipment (such spectrophotometers) for research purposes and materials for home solar systems. One of its recent products is the microprocessor-based charge controllers for home solar systems (See ATDF Journal). The team includes staff from the departments of chemistry, computer sciences and engineering.

This project was necessitated by the limited of investment in laboratory equipment needed to perform scientific experiments by students and researchers. In addition to the engineering expertise in the School of Engineering, the Department of Physics has workshops for electrical, metalwork and woodwork repairs and maintenance, and the Department of Chemistry has a glass blowing and equipment maintenance workshops. This project benefits from the combined expertise within the University to meet the need for laboratory equipment.

UNZA is also structured to operate with minimal skilled professionals by encouraging interdisciplinary and interdepartmental interaction. Few schools at UNZA, if any, could operate independently. For examples, students admitted to the Schools of Engineering, Agriculture, Medicine, Mining and Veterinary Medicine spend a year or more taking courses in the School of Natural Sciences. Many lecturers also teach in more than one school or department as part of their normal duties. The contracting department is generally required to place a written request, where the course is not normally offered by the contracted department. This enables staff and students to interact across schools and departments.

These characteristics are important in understanding why interdisciplinary teams seem to form without formal agreements by the units and why UNZA has good working relation with the Government and the private sector, even though it is often seen as a purely teaching university. Although it does not have an established technology or business incubator, the university plays an important role in technology adaptation and transfer.

3. The case of the Technology Development and Advisory Unit (TDAU)

3.1. Background

TDAU was set up in 1975 as an intermediate technology development and consultancy unit within the School of Engineering. Its main objective is to help small-scale producers in the urban and rural areas access skills and technologies that can help them generate wealth and jobs. TDAU adapts advanced mature technologies to develop effective but simpler products that use locally available resources, skills and knowledge.

TDAU was originally established to promote agricultural and industrial development by serving as a channel through which the School of Engineering could provide its services to the local community. Its main objectives are to help:

a) Promote use of technologies by entrepreneurs and/or enterprises to generate income and create employment in the private sector,

b) Serve as a centre for the manufacture of business equipment and small scale goods for emerging entrepreneurs in Zambia,

c) Provide consultancy services in the fields of appropriate technologies and its areas of competence.[63]

Most of the projects of TDAU fall in three broad categories: 1. Design and fabrication, 2. Consultancy and advice, and 3. Training. Although it addresses a broad range of areas, it has a bias for technologies used in agriculture, food processing, energy, construction (housing), water and sanitation, and rural transportations.

Following changes in the university management in the 1990s, TDAU became a semi-autonomous unit. At the time, and for financial reasons as well, the university was shedding a number of "non-core" units as "self-sustaining" units. These included the UNZA bookshop, nursery (horticulture), farm and the Institute for Economic and Social Research, among others. In a nutshell, these units were expected to meet their operational expenses, and where possible, share any benefits accrued with the university.

3.2. Nature of Projects and Partners

TDAU does not invest in development and production of new or advanced technologies but rather adapts mature and freely available technologies to meet local operational conditions. For instance, UNIDO and COMESA requested TDAU to adapt a seed-treating machine for use in rural areas without electricity to improve the quality of seeds served by farmers. TDAU developed a machine that could be used to treat seed, food grains and pulses with preservatives before storages.

Most of its projects are demand-driven. In general, an interested party - e.g. government/donor agency, private firm, research institute or NGO - may request TDAU to undertaken or participate in a project. In other cases, TDAU may bid for advertised projects just like other service providers. Therefore, TDAU does not develop products that are not requested by an interested party.

[63] UNZA (1999), Strategy to improve the operations of the university, Chapter 5 see: http://www.unza.zm/news/IOTA/UNZAStrategy.htm

Although most of its projects are donor-funded, TDAU has good working relations with several private and public institutions. For instance, the National Institute for Scientific and Industrial Research (NISIR) contracted TDAU to develop a fruit-pulping machine for wine production, a team of investors hired TDAU to investigate the commercial feasibility of introducing a private airline in Zambia, a bank requested TDAU to look at the design and potential of paint-mixing for their client, and two church organizations contracted TDAU to design, fabricate and install mini-hydropower stations as well as train local people to manage them.

3.3. TDAU as a Linker and Marketing Unit of Unza

Although the unit represents a very small fraction of the University, it is better known outside the UNZA community than larger departments. Its advertisements have been on television, newspapers and billboards, and it participates in national trade fairs and exhibitions.

TDAU cannot afford to hire a large pool of full-time or part-time staff skilled in its areas of interest to serve industry, donors and government effectively. Its location in the school of engineering is ideal in enabling it to design, fabricate and market products that require engineering knowledge. However, a number of consultancy projects may require knowledge of other professionals outside the School of Engineering.

For instance, TDAU is investigating options for producing affordable agricultural lime for farmers. In this project, it is working with colleagues from School of Agricultural Sciences, School of Mines, Mount Makulu (Agricultural) Research Station and the British Geological Society. The project, sponsored by United Kingdom's Department for International Development (DFID), is an example of TDAU acting as a link between different UNZA departments and with other key players outside the university community.

The units benefit from other university departments to meet the needs of its clientele and enhance its reputation. In return, university departments get the chance to contribute to national development and benefit from monetary gains associated with the projects (e.g. as consultants). By so doing, TDAU brings the University closer to society and society closer to the University.

3.4. Why TDAU seems to be Successful

TDAU is not unique. For example, the University of Dar-es-Salaam (Tanzania) formed the Institute of Production Innovation (IPI) in 1981. Although the objectives were similar, IPI was supply-driven, largely as a channel to deliver new products/technologies to industry. When it was perceived to have failed, the School of Engineering formed another unit called the Bureau for Industrial Cooperation (BIC). The two bodies competed for the same clients with varying degrees of successes but remained supply-driven.

By contrast, when TDAU became semi-autonomous, it abandoned the supply-driven strategy partly because its products, like those of IPI in Tanzania, were not of interest to major industrial players but rather small and emerging firms. This strategy made it a natural partner for donor agencies, international organizations, NGOs and government agencies that target marginalized groups and small firms.

Based on the memorandum of understanding (MOU) it signed with UNZA, TDAU is required to repay the university the salaries it draws each year, where possible. In return, it is allowed to declare bonuses for its members of staff, spend and invest any money it generates to meet its objectives. Such financial freedom and regulatory incentives (ability to recruit staff outside the university and operate without express approval from the university) may have played a catalytic role in making the unit successful.

As its reputation and confidence has increased and marketing capabilities improve, its products and consultancy services are increasing in sophistication. It has moved from simple solar dryers, manual block presses and oil presses to more sophisticated projects such as incubators for the poultry industry and consultancy for the larger firms. It is, therefore, conceivable that in the near future, its involvement in technologically demanding projects is going to increase.

TDAU is not viewed as a competitor by firms but rather as a facilitator. It seeks industrial partners to take up the developed products as it does not have the facilities and resources for mass production of any products. For example, the manual oil press, designed and produced on the request of AfriCare and sponsored by USAID, is now produced by an industrial partner and hundreds of units have been sold to clients.

TDAU had to change management and recruit people with skills in its core areas of interest – obtaining and negotiating contracts, outreach and public relations, design and engineering and management. It employed people from the private sector and those familiar with government and donor operations. This mixture of skills, expertise and experiences has perhaps been the driving force behind its success.

3.5. TDAU as a Model

There are many who rightly believe that university staff in Africa is already too overburdened by their teaching obligations to take on extra duties. In some cases, departments may not even have dedicated research and experimental development laboratories, or funds to sustain projects likely to develop or support firms. In addition, many professional are preoccupied by personal ventures that supplement their meager salaries.

As TDAU demonstrates, a small non-teaching unit could help bring in official contracts that put to good use the diversity of skill and experiences associated with universities. It could help researchers develop vital links with industry and other partners as well as a financial reward associated with such projects. More importantly, it does not interrupt or affect normal operations of the universities as experts may be hired on their personal or departmental basis.

TDAU has helped the development of several small income generation ventures. A similar model could focus on emerging firms seeking to establish themselves in poorer countries on limited budgets. In this case, it could offer design, administrative and management skills, either implemented at premises of the client as is done currently or, incubated by TDAU within university corridors (just like development of prototypes).

TDAU's model of facilitation as well as being demand-driven is perhaps key to limiting losses or huge marketing costs. Rather than focus on simplifying technology, it could start to address the needs of firm in new and emerging fields such as information and communication technologies, biotechnology and material sciences. For instance, members of staff from the departments of Physics, Computer Sciences, Chemistry and School of Engineering are collaborating in a project to design and produce reliable but cheap version of expensive laboratory equipment. There may be a potential need for measuring and monitoring tools for industry as well. If TDAU was to focus on both low and high technology products and services, it will attract and serve a wider base of the Zambian industry, and perhaps the emergence of a machine tool industry.

The question is not whether it is wise for universities to promote units that serve industries and the community but rather whether it is wise to remain indifferent to the economic realities of their people and industries. Universities that depend largely on patronage (by government and donors) are unlikely to be seen as relevant or attract research funding from government, industry and donors. TDAU demonstrates that it is possible even in the poor countries for universities to serve industry and the community.

4. The case of the Computer Centre in the Development of Zamnet

4.1. Background

In 1990, the Director of the Computer Centre (CC) at University of Zambia, Mark Bennett, connected a few personal computers that could exchange emails within the institution, and with Rhodes University in South Africa, and from there to the rest of the world. By 1994, most Schools had at least one email point available to all members of staff. The University network was serving health institutions, NGOs, governmental, and development and aid organizations, with a total of at least 270 email points.

The Computer Centre (CC) was managing, on behalf of several parties, at least three projects: 1. The HealthNet project funded by SatelLife, covering Africa, Asia and Latin America, 2. The ESANET (Eastern and Southern African Network), funded by IDRC, promoting connectivity among universities in the region and 3. ZangoNet (Zambian NGO network), was designed to connect local NGOs to their parental or sister NGOs within the country and abroad. Due to limited skilled and experienced manpower in networking, the projects were housed and co-developed at the University of Zambia (UNZA) Computer Centre. This created a culture of mutual understanding, trust and interest.

4.2. Combining Resources to Achieve Depth

ESANET provided the first microcomputer and modem which served as a host for the first University email system, while the link between Lusaka and Rhodes University was paid for by UNINET due to their interest in interuniversity connectivity. Suggestions to separate the three projects were abandoned, due to scarce qualified human resources.

The collaborative spirit within the university community was also important in the development of the networks. For example, the School of Engineering manufactured a unit, according to Bennett, "*a device that allows the central PC to be connected to both internal and external phone systems and answering whichever calls first*". Skilled staff in computing, other than computer centre, at the time were in electrical engineering department of the School of Engineering.

4.3. Sourcing Funds for Commercialization

The connectivity projects were enthusiastically supported by Government, donors and regulators. However, all donors refused to fund direct internet connection as of 1993. The high level of interest in information technology may have deceived UNZA management to assume that support for the Internet connection will be obtained easily. Mark Bernett summed it up as follows:

> *"By 1993, we had decided that we wanted 'the real thing': we wanted full Internet access,.. There were plenty of people who said that Africa had other priorities - after all, wasn't Fidonet working (e-mail) -or that Africa needed its own systems of communication...but with the relevant bits of*

> *string and sticky tape (and hopes that it didn't rain too often and cut off the phone lines), ..The continent has gone from Zambia being one of the only countries with a connection to no country being without".*

Early in 1994, UNZA decided to establish a campus-based company called Zamnet (Zamnet Communication Systems Limited) to link the institution to the Internet and provide service to commercial customers. The UNZA provided space, management and most of the manpower for Zamnet while the World Bank provided a $122,000 loan through the Institutional Development Fund in 1994 - covering 80% of the cost of the first year.

The Director of Computer Centre became the first managing director of Zamnet while the Vice Chancellor and the Deputy. The number of commercial accounts grew from 5 to 165 between January and June 1995. Seven months before the end of the World Bank loan, Zamnet was making enough money to buy new equipment.

4.4. Importance of Good and Effective Relations with Government

The University of Zambia did not experience the problems other universities faced in establishment of ESANET (Eastern and Southern Africa Network; included Universities of Nairobi, Zimbabwe, Dar-es salaam and Mozambique). For example, University of Nairobi in Kenya was initially denied a license to operate the radio link to the satellite. In Zambia, the government was interested in HealthNet and represented at a high level (deputy minister). For example, HealthNet was inaugurated by the Republican President of Zambia.

The goodwill that government showed towards HealthNet benefited other projects and the development of Zamnet. For example, the Computer Centre operated the radio-link to the satellite (picking and dropping emails) without a license but with Government knowledge. Zamnet was the first firm to be allowed to operate private satellite links for data transfers, cutting off the national telecommunication operator. Mobile phones and other telecommunications service providers that followed much later had a tough time convincing government they needed to operate independent satellite links. Therefore, good working relations with government are possibly one of the university's main assets and advantages.

4.5. The Role of Partners

Other institutions also helped the young project "learn to stand". According to Mark Bennett "Rhodes University, on behalf of UNINET [64], generously offered to bear the cost of sufficient polls each day to allow picking up and dropping of mail…..effectively providing a free e-mail service to UNZA". This support allowed UNZA a learning and experimentation period.

It was evident that most projects entered and exited the CC through the intersection sets of the three parties: University, Government and Partners. ZangoNet entered through the ***Partner***-University intersection while HealthNet entered through the ***Government***-Partner intersection. The government interests were high (represented by the Deputy Minister of Health). Lastly, UNZANET entered through the ***University***-government intersection.[65] The initiatives produced no losers as the different teams were at CC to meet their needs.

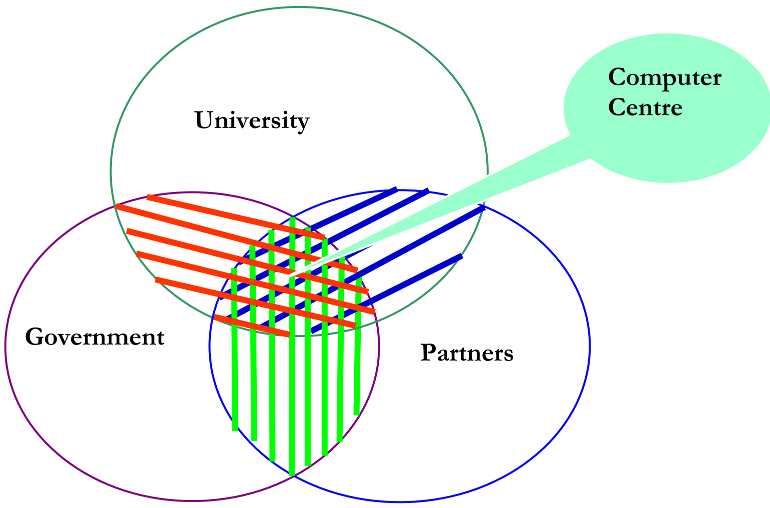
Once the projects were completed, HealthNet exited from Computer Center to be based at the Medical School, ZangoNet exited to be managed by a network of NGOs, and UNZANET

[64] UNINET is a South African Universities Network funded by the Foundation for Research and Development (FRD).
[65] In bold letters is the main beneficiary.

remained the main networking unit of the University of Zambia community and the country. However, the Computer Centre remained the main gateway for the three networks.

Each of the project it coordinated or participated in brought new challenges and opportunities as well as partners and technologies and resources. For instance, UNZA implemented a project termed Computers for Administrative, Management and Academic Support (CAMAS) that laid fibre optic cables throughout the university and provide every office with a digital telephone line and internet point, and each department with computers, a scanner and printer (1994-1996). This project gave birth to the Consultancy and Training Unit at CC.

Figure 1: The Relations between the Different Partners



4.6. The Demonstrative Impact of Zamnet Commercialization

The commercialization of Zamnet demonstrated that provision of Internet services was good business even in poor countries. Other institutions soon followed the example of Zamnet. CopperNet, formerly a networking unit of the Zambia Consolidate Copper Mines (ZCCM), and the national regulator, Zambia Telecommunication Corporation, developed Internet services.

The computer Centre too, following the successful commercialization of Zamnet, turned the vacated room - which *once served* as a lecture room - into "The Consultancy and Training Unit" (CTU). The CTU was initially formed to train and support university staff and departments with IT services. Once that was achieved, it opened its doors to the wider public. It has carried out training for organizations such as Common Market for Eastern and Southern Africa (COMESA), Chilanga Cement PLC, Zambia Sugar PLC, Zambia Telecommunication Cooperation and Caltex, and software systems support to a number of organisations, such as Micro Banker's Trust (MBT) and the Dutch embassy.

5. Concluding Remarks

It is important to emphasize that the existence of specialized and well-funded research centres is only the first step in enabling universities to develop and support existing firms. Other factors equally play an important role in enabling university provide support to existing firms or help the emergence of new enterprises.

According to Burton, there are at least five main characteristics of entrepreneurial universities:

- Independent, strong and efficient managerial systems,
- Interdepartmental cooperation and increased collaboration with the outside,
- Wider funding resource base,
- Stimulated and strengthened academic units, and
- Integrated entrepreneurial culture throughout the university.

Of these, few apply to the University of Zambia. Its leadership is appointed by Government and is not described by staff as "efficient", its funding base is very narrow and cannot be described as having "an integrated entrepreneurial culture throughout the university". At first glance these characteristics do not apply to UNZA.

However, a careful examination reveals that these characteristics are associated with the units that support private firms. It is these units that undertake entrepreneurial activities and have all the characteristics associated with entrepreneurial universities. In many ways, they exist almost as private firms within the university. For example, TDAU is headed by a Manager supported by two Project Engineers, a Business Advisor, an Information Officer and a Chief Technician. It is a hierarchy that mirrors those of private engineer units rather than a university department.

Therefore, a few key characteristics are important at the university level:

- Ability of staff to work across schools, especially when supported by regulations,
- Efficient utilization of existing, and/or developing, relationships with government and industry, and
- Existence of units dedicated to support enterprise development.

The existence of units, whether incubators or consultancy centres, should serve as channels through which the rest of the university community could potentially contribute to national development. Universities whose regulations promote teaching and research across schools/department may facilitate participation and involvement of a wider range of university professionals in projects that specialized units may undertake.

It is also important to have clear guidelines on commercialization of university developed technologies and firms. Neil Robinson, an IT consultant at UNZA wrote (in 1995):

> *"[Zamnet] has been set up as a campus company by the University of Zambia, The establishment of a company itself has both legal and financial implications and we have involved accounting and legal advisors to assist us."*

For example, the Vice-Chancellor was alleged to have owned shares in Zamnet and also held the University shares in trust. Such shares, including those of the University Bursar at the time, were returned to the University following the Supreme Court of Zambia ruling. The lack of clear regulations on commercialization and incentives for entrepreneurial individuals may represent a major challenge. Although UNZA owns firms, its staff do not own shares in such ventures. Some have left to set up their own private firms based on their experience at UNZA. As a consequence, the university loses out on expertise and revenue.

The University is developing the office of the Business Venture Controller. The position will be located within the Office of the Vice Chancellor and will manage all the investment ventures and take care of UNZA's interests in firms/units it has invested, such as the University Nursery, Zamnet, York Farms, TDAU, Marshalnds Guest House and UNZA farms. This will help coordinate mature initiatives and firms.

However, this does not address the core issues that could enable the University act as a catalyst for entrepreneurship and firm formation. To achieve this goal, the university may wish to: 1. develop or expand the proposed office of the Business Venture Controller to include identification of emerging initiatives, 2. establish clear mechanisms and regulation for accelerating the development and commercialization of new ventures and 3. implement freedom of operation of the business or technology manager(s) to invest or seek investors interested in University initiatives and 4. provide awards for entrepreneurial individuals.

A way out is to request Department to designate an interested individual to act as a technology transfer officer. Each officer will then encourage and identify emerging activities that could be considered for funding or award of recognition. For example, such awards could be considered favourably when considering promotions and funding departments.

The University could also consider to developing mini-consulting centres where students provide consulting services to established and emerging firms. It could help trainees create crucial social network and learn real business challenges or opportunities in Zambia. It also helps students learn how to set up their own companies in future and work in multidisciplinary teams.

While developed countries debate whether universities should spend so much effort in promoting technology and developing firms, most African universities may as well help create jobs for the thousands of graduates they channel out each year- many of who may not find jobs or the right jobs. Above all, if vocational colleges are equipping their students with skills needed to manage firms, universities may not choose to be indifferent to the prevailing socio-economic situation. They may have to equip all their students, irrespective of profession, with basic skills to, at least, write a business proposal, register a firm, attract funding and collaborate with others in development and marketing of their ideas/concepts. This could easily be achieved through a forum or an entrepreneurship clinic that bring business experts, government units (e.g. tax and business registration authorities) and business consultants in a non-credit earning session that could be run once or twice a week.

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The Oxfordshire Economic Observatory project: Relevance of the Model to Developing Countries

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1. Introduction

A number of consistently occurring interlocking themes represent the consensus on the targets of policy-makers with responsibilities for raising the level of regional economic and social development. These include innovation, skills, clusters, university-industry interaction, infrastructure, sustainability and urban structure. These can be seen for example in the draft regional economic strategy for one of the UK's regional development agencies, SEEDA (www.SEEDA.co.uk). While these are components of common objective, numerous agencies at regional and sub-regional level have responsibilities for delivery of policy. Hence there is a need for a holistic approach to data collection and analysis within multi-agency environments to overcome fragmentation of information, hence improve the policy-making process. Not only is it essential for the data to be up-to-date, it should provide more than a snapshot of current local specificities, it should also provide indications of trends over the short and longer timescales and be benchmarked against other regions. Analysis should also reflect different interests and their agendas: the individual, the firm and the region.

The Oxfordshire Economic Observatory (OEO) was established to undertake world-class research providing data and analysis first to major stakeholders in the Oxfordshire region and second to broader communities – at regional, national and international scales. OEO is an independent research centre, based both in the School of Geography, Oxford University and the Department of Planning, Oxford Brookes University. It provides up-to-date information and analysis on economic trends primarily on the Oxfordshire and London economies, benchmarked against regions in the UK, Europe and similar regions in the USA. OEO is an exemplar of a university-based research centre that is located at the nexus of academic, business and government interests – the triple-helix model (Etzkowitz and Leyesdorff, 1997).

This paper develops three themes. The first is the process of developing the Observatory, organizationally. The second is the research portfolio of OEO. The third is how the findings are being utilized for regional development purposes within the UK's South East, and highlights the relevance of OEO to regions in developing countries.

2. What is OEO? Developing the Observatory

The observatory in its five-year history has undergone three stages.

Stage 1: Identification of the Need for the Observatory.

The Observatory's origins are in the research conducted by this author over three decades, beginning with my doctoral thesis at Oxford University, School of Geography begun in 1984. The research was immediately high-profile, taking shape at around the time of the publication of *The Cambridge Phenomenon: The Growth of a University Town* published in 1985 by Cambridge-based consultants Segal Quince & Partners. Although this work has been academic, it has always had support from external agencies. In particular it was funded by a local charitable trust, The Oxford Trust, established in 1985 to support science and technology enterprise by the founder of Oxford Instruments, one of Oxfordshire's most successful high-tech firms. From the beginning it had the support of Oxfordshire County Council and Oxford City Council. Hence it has always been embedded in the local system of governance.

The Observatory came to be established following a chance remark in 2000 about the need for my academic work on Oxfordshire's high-tech economy to be institutionalised within Oxford University. The intention was that funding would be raised to ensure that research would be continuous rather than piecemeal and being located within Oxford University would provide an authoritative position from which to address a wide range of audiences. It was in discussions with the then economic development officer of the County Council that it was decided that the research centre should draw on the complementary strengths of academics in Oxford's other university – Oxford Brookes. Colleagues there were experts in planning, transport and high-tech economies in other parts of the South East. At that time, the comprehensive database I had established for my thesis on Oxfordshire's high-tech economy was out of date because there was no one organisation responsible for collecting the data – unlike in Cambridge where Cambridgeshire County Council's statistician, Jill Tuffnell, has maintained a high-tech database for over two decades. As in Cambridge, the Oxfordshire high-tech economy had been growing rapidly since the mid-1980s thus presenting considerable challenges to the urban infrastructure (transport and housing) and was creating pressures within the labour market from skills shortages. The timing was therefore right for an Observatory. Moreover, the political agenda post-1997 with the election of the Labour Government prioritised universities' role in economic development in the 1998 White Paper *Our Competitive Future: Building the Knowledge-Driven Economy*; the region with the creation of the Regional Development Agencies (RDAs) in 1999 and clusters (White Paper on Business Clusters published in 2001).

OEO was founded in January 2001 and is now a three-way collaboration with Birkbeck College, Department of Management, University of London, where I am employed full time. The team comprises four top academics: Professor John Glasson (Oxford Brookes University) and myself – the two lead academics, plus a senior colleague from each departments. These four comprised the Management Board. This board was set up to determine strategy – research and funding and to engage with local stakeholders. OEO also had the services of two research assistants at Oxford Brookes, one of whom is responsible for maintaining the database. The division of responsibilities is that I manage OEO and am in charge of the research strategy and research management. Professor Glasson is responsible for the database management, and the seminar programme. Professor Glasson and I work very closely, meeting frequently to discuss OEO's overall direction and co-author both OEO reports and academic papers.

It was agreed at the outset that the focus should be the high-tech economy, building on our expertise and using our limited resources, with the intention of expanding the portfolio of activities to encompass trends in the Oxfordshire economy as a whole. Initial funding, of around £30,000 came from The Oxford Trust, Oxfordshire's County Council and the district councils.

As a key element in OEO's mission to engage with local and regional stakeholders, an Advisory Council (which meets now annually) was established. The Advisory Council comprises representatives from major local and regional organisations. These include the regional and local public authorities, key local entrepreneurs such as the founders of Oxford Instruments and Research Machines, the head of The Oxford Trust, politicians (an MP and the Leader of one of the district councils) and representatives from Oxford University: the Chief Executive of Isis Innovation, the university's technology transfer company, the Head of Regional Liaison and the Director of the Science Enterprise Centre, OxSEC. Other senior academics include the Head of the Said Business School and the Head of the Rutherford Appleton laboratory, one of the UK's major scientific research laboratories. A subset of the Advisory Council now forms the Strategy Group which meets three times a year and discusses research agendas. The ways in which these stakeholders have influenced the shape of data collection and what kinds of data have been useful to policy makers is discussed in the following sections.

Stage 2: Developing the Research Agenda: What is OEO's Research Portfolio?

At the outset, eight core themes were decided and which remain OEO's research portfolio as they reflect both the major priorities within the Oxfordshire economy and Oxfordshire's position within broader economic and political contexts. It was also agreed that outputs would take three forms: (i) high profile reports, (ii) briefing papers and (iii) seminars and other speaking engagements. The eight core themes, outputs and funding are next discussed, along with other developments. These are to be found on the OEO website http://oeo.geog.ox.ac.uk.

Early funding for OEO's research activities came from the initial and follow-on general funding and from funding for particular research projects. A major impetus to OEO's activities was the award of funding from the UK Government's Higher Education Funding Council for England (HEFCE) (which operates under the jurisdiction of the Department for Education and Skills). In 2004, Oxford University and Oxford Brookes were awarded £38,823 to fund OEO for two years. The funding maintains OEO's high quality research activities, funds workshops for public authorities and local businesses at which economic intelligence on the evolving economy is disseminated, and is used to develop the website.

The eight research themes and their outputs are:

(i). Creation and Development of a Database of Enterprise in Oxfordshire

(ii). Benchmarking Oxfordshire

The database, the core activity of OEO catalogues enterprise births, deaths, mergers, acquisitions and employment change, by sector and technology. The database provides the platform for investigations across the spectrum of the high-tech economy. International comparisons, which are essential to understanding processes of entrepreneurship, technological advance and economic development in Oxfordshire, are made using information in the database.

- In 2003 OEO produced a two-volume report: "*Enterprising Oxford: the growth and anatomy of the Oxfordshire high-tech economy". Enterprising Oxford* was launched by the UK's Minister of Science, Lord Sainsbury, in March 2003 at the Royal Society.

This professionally published, bound report explained how the Oxfordshire's high-tech economy is now one of the largest and fastest growing in the UK, with an estimated 1,400 high-tech businesses currently located in the county. These companies have a combined workforce of over 36,000 and most have been formed during the last decade. Along with the neighbouring counties of Berkshire and Buckinghamshire, Oxfordshire forms part of one of the highest concentrations of high-tech employment in Europe. Although the companies operating within this sector are mainly small companies, nevertheless it is the larger firms that account for the bulk of the high-tech jobs. The county is the highest-ranked EU region for high-tech services, and is the fastest growing high-tech region in the UK.

Volume 1 records how Oxfordshire's high tech economy grew within an old economy dominated by the manufacture of automobiles, blankets and food. It highlights the actions of key individuals who had set the agenda and were instrumental in bringing about change, the changing roles and fortunes of the universities and the county's seven government laboratories, the county's most successful enterprises, the networks of supportive organisations, the planning system and key planning decisions. The Report also looks to the future. The Report argues that it is a particular concern that there should be more support for skills development to enable the region to continue to develop the economy at an optimum rate. Problems and issues of sustainability and the environment are also highlighted.

Volume 2 provides a complete breakdown of the database and benchmarked Oxfordshire against other UK and European regions. It begins by defining high-tech and discusses various definitions such as used by the OECD and Eurostat. The definitional issue is crucial to establishing the extent of particular kinds of activity, hence the design of policies to support or ameliorate particular problems associated with growth/decline. For example, using a board definition of high-tech (Eurostat), Oxfordshire would have 2000 high-tech firms employing 50,000 people but this would include the production of the Mini (BMW) and other automobile related production such as component manufacture. The definition used by OEO is a narrow Butchart + definition based on the 1987 Butchart definition developed for the UK's Department of Trade and Industry (DTI) which defined high-tech sectors on the basis of the R&D intensity. The report benchmarks Oxfordshire's high-tech employment against regional and national averages, and makes comparisons with other English counties and competitor European regions. Recent trends in high-tech employment levels in the county are also analysed. The data on the high-tech economy has been the most useful to all the stakeholders. There is a continual demand for robust data. OEO data has been widely cited in policy documents and in presentations by all of the stakeholder organisations, often abroad. It appears on the websites for example of OxSEC, The Oxford Trust, OEP and Oxford University and Oxford Brookes main pages. The reports were also cited in HM Treasury's 2003 *Lambert Review of Business and University Collaboration* (The Lambert Report). Until report on the database, the growing extent of Oxfordshire's high-tech economy was not documented. It now accounts for some 12 per cent of the county's workforce. Leading sectors include biotechnology, ICT and engineering.

- The database is currently being updated. The new data will be published in Enterprising Oxford (III) in December 2006.

(iii). Employment: Supply and Demand

What is the changing mix of labour by skill, age, gender and education? How is the nature of work in different sections of the high-tech economy changing? What will be the future of work?

The academic argument is that clustering of innovative industry both demands and creates a local highly-skilled labour market. The growth of agglomerations of labour has been argued to benefit both individuals and firms by providing the opportunity for matching labour demand with labour supply, which is crucial to sustaining innovation. Additionally, mobility within the local labour market is argued to be of collective benefit as the movement of the highly-skilled within the cluster is a key mechanism for technology transfer and fostering of inter-firm links. Social networks (social capital) are argued in the literature to be the medium by which these activities are facilitated and their development key to innovation-based local economic development. This is exemplified by Silicon Valley (Saxenian 1994, Benner 2003).

OEO has undertaken two studies of labour markets and is about to conduct a more extensive study which will examine the supply side of the Oxfordshire labour market.

- Milton Keynes, Oxfordshire and Buckinghamshire Learning and Skills Council (April 2002-August 2002) "The labour market potential of over 50s Scientists and Engineers in the MKOB region".

- Technicians: "Planning for the next generation of skills" The Oxford Trust/Oxford2Cambridge Arc (January to August 2004).

The first established the extent of scientists and engineers aged 50+ in Oxfordshire's universities, government laboratories and large high-tech firms who might be recruited into the high-tech economy to overcome skill shortages. This is in the context of considerable downsizing in the late 1990s in the laboratories combined with an increasing age profile in the laboratories and the universities. Early retirement reduces the skill base of the county. The policy implication of this research is that there is the opportunity to establish a mentoring network that would advise younger entrepreneurs, providing advice on scientific projects and management and/or a science and engineering consultancy network whereby smaller firms could draw on this pool of expertise.

The second addressed the changing labour market for technicians and explored whether Oxfordshire's training institutions have established an appropriate strategy to address new career paths. Technicians traditionally had "jobs for life", but now technicians who have only ever worked for one or two employers constitute a dying breed. The trend is increasingly for short-term contracts, or rapid turnover within jobs, such that the average tenure of jobs is less than 5 years. As a result, people need to be more adaptable with the skills they have, and be prepared to acquire new skills to respond to the changing labour market needs. There is a need for a platform of generic skills (i.e. transferable skills that can be used across occupational groups), on which to build a range of more technical and job specific skills. The recommendation of this study was that there should be far greater cooperation between training providers in the county.

The third study will be undertaken in conjunction with the County Council and OEP. This will contribute to the Oxfordshire Learning Partnership's Learning Plan. Following consultation with the Learning & Skills Council and the County Council, OEO proposes that the key questions for Oxfordshire are:

1. does Oxfordshire provide the right kinds of skills to attract and retain firms in key sectors such as engineering and IT?
2. are the channels of communication sufficiently well developed to match supply with demand?

The objectives of the proposed study are therefore:

1. to identify the current patterns in the employability of human capital in key sectors of the Oxfordshire economy's 16+ sector of the workforce.
2. to suggest policy implications emerging from the patterns identified by this study at the local and regional level.

(iv). Evaluating the significance of clusters for technological development:

How does clustering of activity contribute to technological change in established and emerging technologies? How does Oxfordshire compare with other regions as a pioneer region?

The justification for this focus is that geographic clustering of high-tech firms is associated with rapid innovation-led economic development. Proximity is argued to increase information flow and rate at which innovations diffuse – the "innovative milieu" concept (Camagni 1991) and Porter's (1998) cluster thesis. In this line of argument, the innovative firm creates and uses networks and interdependencies which allow companies to innovate more quickly and to develop innovations that are beyond their individual capabilities (Rutten and Boekma 2004). Indeed many studies have shown that regional innovation intensity and technology transfer as measured by inter-firm cooperation is positively and significantly related to innovation success (Love and Roper 2001, Frenz and Oughton 2005). Thus the interest to The Oxford Trust and local and regional policy makers is in the overall extent of clustering of high-tech activity and in which sectors and how networks can be improved.

These issues formed a central theme of *Enterprising Oxford*. In addition to the report, the Government Office of the South East commissioned OEO in January 2004 to undertake "The Oxfordshire Case Study". This was a further breakdown of trends within the Oxfordshire high-tech economy.

A current OEO project is focusing on the R&D activities of multi-national companies in Oxfordshire. This is part of an eight country comparison funded by the European Commission. The first task is to establish who owns Oxfordshire. The second task will be to consider the implications of technology transfer networks of these companies – and whether the universities and the county can provide a better environment than which currently exists.

- Locomotive "Dissemination of knowledge concerning current R&D localisation of large regionally important private sector organisations" (European Commission Sixth Framework Priority Programme) (January 2006).

(v). Mapping university/national laboratory interaction

What is the true extent of university-industry and national laboratory-industry interaction within the county? How does this compare with industry and science base links in the most successful cases?

This theme reflects UK and European Union concerns about the low levels of innovation in the economy. The argument is that knowledge-based economies are innovation driven: there is a widespread agreement that knowledge, technological innovation and industrial competitiveness are linked (Oughton et al 2002). In the context of concerns in countries such as the UK that economic performance is held back by a lack of innovation, universities have assumed a central role in the delivery of policies designed to drive economic development. Universities, as producers of knowledge are a resource that can be used by firms to close to universities. Moreover, governments throughout the world have instituted incentives for universities, their staff and students to be more entrepreneurial and contribute directly through economic development through business activities such as the formation of spin-off companies, patenting and licensing technology (see Etzkowitz et al 2000). Universities are also increasing participating in local and regional governance structures.

OEO's contribution to the debate about universities' and government laboratories' contribution to innovation and economic development is twofold. The first is a chapter in *Enterprising Oxford Volume 1* that explores the technology transfer activities of Oxfordshire's academic and research institutions and the development of partnerships in innovation.

The second is the form of a study:

- Measuring the performance of Oxfordshire's academic spin-offs (2004/2005).

The findings of this study were published in December 2005 in the Report *Public Research High-Tech spin-offs: measuring performance and growth*. This Report, another report professionally produced, was launched to an invited high-level audience of 200 people from academia, business and policy-makers at the Said Business School in December 2005.

The study found that 114 spin-offs originated in Oxfordshire's three universities and seven research laboratories employing 9,500 people (3.5 percent of the County's workforce). The largest sectors were biomedical sciences and information and communication technologies. 12 companies have been launched on stock exchanges. These include Oxford Instruments, Research Machines, Psion, Powderject (now part of Chiron and Medisense. The study also shows that it takes on average ten years before firms start to grow to any substantial size – generating significant employment. Unlike other studies of spin-offs, it records spin-offs dating back to the 1950s and records patterns of growth. The findings on growth trajectories have implications across the county, for example for future housing and dedicated property developments.

This study had considerable input from Isis Innovation. The results of the study have been used widely within Oxford University, to demonstrate its success in spinning off new firms. The national importance of this study is indicated by the report being featured on the UK government's eGov website, under the heading, "Excellence in new venture creation: the Oxfordshire model".

A further study, this time of London University spin-offs is scheduled and will be funded by London Higher, which represents the 42 London University colleges:

- Measuring the performance of London University spin-offs.

(vi). Infrastructure and Policy Networks

A key task of the Observatory is the periodic assessment of the effectiveness of the policy system as it evolves, in terms of Oxfordshire's ability to sustain its position as a leading centre of innovation. What is Oxfordshire doing to ensure that its economy is sustained by world class hard and soft infrastructure?

These issues have been addressed in the form of seminars organised in conjunction with the County Council. Attendees are from business, local and regional government and academia.

Stage 3 Broadening OEO's Portfolio

The maturing role of OEO is indicated by the scope of work on the seventh of the key themes.

(vii). The Oxfordshire Economy

What is the impact of the growth of the high-tech sector on the demand for products and services in the local area? What are the connections between the high-tech sector and other major industries such as the car industry? What are the impacts of global competition on these industries? What is the role of exports in driving the local economy?

Five briefing papers, produced quarterly, have been prepared on trends in the Oxfordshire economy. These provide up-to-the-minute analysis of recent trends across the Oxfordshire economy as a whole. The content of the reports includes information on labour market trends and in the performance of the economy. The reports are first presented to the meetings of the Oxfordshire Economic Partnership, "a network of public and private sector partners committed building a world-class economy in Oxfordshire". Economic partnerships are mandatory in the UK, and are designed to bring together major local interests with the purpose of conducting constructive policy-making dialogues. The reports are then published on line on the website.

(viii). Urban Structure and the New Economy

What is the interaction between the organisation of the built environment and the development of the new economy? How is this related to changes in the regional, national and international economy?

This topic was also featured in *Enterprising Oxford*, in the Briefing Reports, and forms part of the current portfolio of work at the Oxford Brookes arm of OEO.

Alongside these reports, the team publishes academic articles on the studies. These include:

- Universities, Innovation and territorial development: A review of the evidence Environment and Planning C (Forthcoming);
- Lawton Smith, H and Ho, K W ,Measuring the performance of Oxfordshire's spin-off companies' Research Policy (August/September 2006);
- Glasson, J, Chadwick, A and Lawton Smith, H., The growth of Oxfordshire's high-tech economy, European Planning Studies (In press April 2006);
- Lawton Smith, H, Glasson, J, and Chadwick, A, (2005), The geography of talent: entrepreneurship and local economic development in Oxfordshire; Entrepreneurship and Regional Development 17, 449-476.

3. OEO's Regional Role and Relevance to Developing Countries

The OEO model is one which engages with a wide range of local, regional and organisations. Its research agenda and dissemination strategy are an essential part of policy-making activities within political, economic, academic and scientific spheres of interest. The relevance of the OEO model to developing countries is fivefold.

The first, and by far the most important, is the need to create a database of activity, maintain it and provide analysis of the data with a view to identifying trends and their potential consequences. This provides a sound basis for policy-making and business decisions.

The second is that embedded engagement with stakeholders is crucial. OEO demonstrates that collaboration between local universities and with key local partners – in both public and private sectors - is the best model. Collaboration increases efficiency and provides legitimacy for the research agenda, locally, regionally and nationally. OEO is directly involved in the main policy-making bodies and vice versa. OEO is represented on the board of OEP (and vice-versa), on the Executive Committee of the Oxfordshire County Community Data Observatory (an observatory of observatories) for which it is the economic intelligence provider, and the Steering Committee of The Oxford Trust Networks activity (which undertakes sector studies). It is therefore embedded in local systems of governance. Moreover, OEO is unique in that it through its Advisory Council, it brings together politicians with local development officers as well as business people.

At the same time, it is an outward looking model. As with cluster development and technology transfer networks, the key to innovation is for firms is to link up with global flows of knowledge

(Malmberg and Power 2004). This equally applies to policy-making. This model therefore shows that academics can play a fundamentally crucial role in policy-making through their data-collection and analytical skills and their key local as well as global knowledge. Far too often in the UK, expensive consultants are paid to undertake reviews of local trends and who very often have no local knowledge, hence take time to get up to speed with local issues.

Third, well presented and frequent output is essential. OEO's publications and seminars serve the following purposes: (i) to provide independent analysis on key trends in the economy which are relevant to the needs of policy makers, industrialists looking to locate in the region, service providers and venture capitalists looking for business opportunities and so on and (ii) to raise the profile of the region. *Enterprising Oxford* has been widely circulated at the highest levels of government and by Oxfordshire's local government agencies, The Oxford Trust and so on as evidence of Oxfordshire's role in the international economy. Both *Enterprising Oxford* and *Public Research High-Tech spin-offs: measuring performance and growth* are given to visitors from around the world by all of Oxford University's technology transfer departments to publicise the University's success as an entrepreneurial university. Part of that dissemination strategy is OEO's high quality website. This is maintained within Oxford University's School of Geography. It has pages on news, research output, events, key staff, the Advisory Council and our sponsors.

Fourth, it is important to have the right mix of skills and good working relationships between the key players. OEO's management team comprises economic geographers and planners, all of whom are expert in undertaking detailed analyses of economic development at the regional level, but from different perspectives. These complementary assets, for example in understanding locational factors relating to high-tech industry, regional systems of innovation, technology transfer, factors influencing the formation and growth of firms, labour market dynamics, planning issues relating to urban structures and transport, underpin OEO's capacity to identify the nature of specific issues, develop methodologies for addressing their causes and produce conclusions that are relevant to the needs of local stakeholders. In addition, the research assistant in charge of the database is a statistician by training. He compiles the database from a wide range of local, national and international sources such as local newspapers, databases held by other local organisations and data produced by Companies House, the Office of National Statistics and Eurostat.

OEO also draws on research assistance from within the respective universities. For example, the data collection and analysis on the Oxfordshire spin-offs study was first undertaken by a fourth year engineering, economics and management undergraduate at Oxford University. This formed the content of his final year dissertation at the Said Business School. His placement was for six months. Follow-up work has been conducted by a Masters student at Birkbeck. This student will undertake the data collection and analysis on the London Spin-offs project. Other students will be employed on future projects, such as the labour market study.

Fifth, observatories of this kind need to be funded by central sources as well as through competitive bidding. Long-term funding (three years minimum) allows freedom to plan activities and lead the research agenda, rather than being dependent on short-term projects.

4. Conclusions

Local observatories such as OEO can improve local policy making by delivering relevant information and analysis at a relatively low cost. Unlike consultancy companies, academic research centres such as OEO are established out of the long-term interests and passions of their founders. A principal advantage of such a model is that its management team builds up long-term relationships with local stakeholders in both the public and private sectors. Through these relationships a dialogue is maintained about the key issues, the questions that need to be addressed and the methodologies for developing the analysis and the means of dissemination. The reciprocal benefits are that national, regional and local governments obtain theoretically informed analyses and data on priority topics while academics get to publish on contemporary issues, fulfilling a broad rather than narrow academic function. The independence of academics is crucial in this role.

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Universities as Innovators in the Israeli Biotechnology Industry

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Introduction: Governments' Science Orientation, Universities, Industries and Innovation

Governments and national political institutions can have a significant impact on the rate of technological innovation. As argued recently by Spencer, Murtha and Lenway (2005), that governments in developed, capitalist economies can help, hinder, or avoid doing harm to firms engaged in new industry creation. In their argument they link countries' political institutional structures, innovators' approaches to technological entrepreneurship, and government's technology policy orientations. In addition, we have learned that from Kogut (1991) that knowledge resources have proven more difficult to separate from national context than many models of MNC strategy might have predicted (see also Ghemawat 2003, Rugman & Verbeke 2003). Thus, for understanding national innovation systems and the role of universities within them it is important to start with a focus on the role of the government.

Technology policy can have various orientations (Ergas, 1987). Governments can apply mission oriented policy to enhance "big science" which is based on radical innovation in small numbers generally linked to national objectives. On the other hand, diffusion oriented technology policies aim to create large base technological capabilities through the industrial enterprise of small, medium and large firms. Israel can be classifies, similar to Germany, Switzerland and Sweden as a country in which technology policy does not aim at targeting specific technological objectives, but relies more on firms' funding and links between firms and the public research organizations.

A four-cell typology is suggested to differentiate between social corporatists, state corporatists, liberal pluralist and state nation states take into account the nature of the collective agency (society to state centric) and organization of society (associational to corporatist) (Spencer, Murtha and Lenway 2005:326). Israel can be classified (similar to Sweden, Denmark and Finland) as a social corporatists state in which the state plays a facilitating role, the government acts as a partner but does not lead to new industry emergence, the focus is on diffusion policy orientation and implementation and there is a tendency for bricolage in which entrepreneurial approaches are reinforced.

Universities play a key role in entrepreneurial regional development. Etzkowitz (1998) argues that universities are undergoing a second revolution in which economic use of their knowledge creating research is integrated into their ongoing basic research and teaching domains. He coins this entrepreneurial behavior of universities as the capitalization of knowledge. Indeed, in recent years we observe a trend in which universities and academic scientists become more entrepreneurial than in the past (Etzkowitz 2003; Oliver 2004). Etzkowitz (2003) maintains that the entrepreneurial university takes a proactive stance in putting knowledge to use and in broadening the input into the creation of academic knowledge. Thus it operates according to an interactive rather than a linear model of innovation. As a result, we can trace significant differences between entrepreneurial and non-entrepreneurial scientists in terms of their collaborative patterns in the area of biotechnology in universities (Oliver 2004).

Finally, it is important to emphasize the structure of exchanges in systems of innovation. The creation process of high-technology industries, such as biotechnology, depends more on knowledge creation and acquisition processes than on ownership of physical assets (Murtha et al. 2001). Garud and Karnoe (2003) introduce an important distinction between bricolage and breakthrough approaches to technological entrepreneurship. The bricolage approach refers to mutually adaptive systems in which emergent processes are collective and gradual leading to multiple network actors in which series of small wins create and improve the technology. The emphasis here is on the **impact of informal networks of learning**. On the other hand, a breakthrough approach is based on a competition between actors in order to achieve a technological innovation in one great leap. The focus of this distinction is in the degree of collective action in the scientific-technological community. The bricolage entrepreneurship approach is consistent with cooperative networks while the breakthrough approach is consistent with individualism and competitiveness.

In this paper, I argue that rigor academic research and innovation coupled with effective networks with the local knowledge intensive industry, supportive government policies and funding for the creation of a new industry generate the know-how and the ability to:

- Capture both basic and applied research in biotechnology,
- Motivate scientists to see the link between their academic research and its applied possible outcomes,
- Establish strong Technology Transfer offices that are perceived efficient and rigorous by the academic and industrial community,
- Acquire research funds from academic, governmental and industrial sources,
- Facilitate the participation of their scientists in various government sponsored R&D initiatives, and
- Provide the resources for establishing on site academic spin-offs.

The paper starts with an introduction of the biotechnology industry in Israel, then describes academic research in biotechnology and provides examples of government and university initiatives to encourage the emergence of this innovative industry. Further, two biotechnology firms that emerged from university research will be described, followed by insights as to the important links between government, universities and industry in the emergence of an innovative industry such as biotechnology. Finally, the paper portrays an emerging university spin-off and suggests a few elements of inherent complexity in university spin-offs.

The Founding of the Industry in Israel:

"Star scientists", who are conducting research in universities and who have made some breaking through discoveries, were found to have the power to facilitate the establishment of biotechnology firms (Zucker and Darby 1996, Zucker et al. 1998). In Israel, the discovery of the Interferon by Prof. Ravel from the Weitzman institute in Rehovot was probably the leading catalyst for the emergence of the biotechnology industry. This industry founding event starts with a sweet taste and ends with a bitter flavor. Both have implications for understanding the links between academia, industry and the State. These will be discussed further.

A second biotechnology related drug developed in Israel for Multiple Sclerosis – Copaxone. Copaxone is produced and sold by Teva, an Israeli Therapeutic firm that is known for its central role in the Generic Drug Market. The market includes the USA and worldwide in which the returns in the year 2005 exceeded $1 billion for the first time, making Copaxone Teva's first blockbuster.[66]

Other successful Israeli biotechnology firms include Biotechnology General (BTG), a firm that sells recombinant Growth-Hormone, a Hepatitis B vaccine and viscoelastics for joints and eye applications. Pharmos, a firm registered in the USA, sells new ophthalmic drugs and developed medication for strokes and head traumas (which recently failed an advanced trial phase). In

[66] Based on information from Teva's website.

addition, many other products are under development including drug delivery systems (D-Pharm, Omri), human monoclonal antibodies (XTL Pharmaceuticals), structurally shaped peptides (Peptor), recombinant heparanase (Insight) and cell therapies promising for spinal cord traumas (Proneuron).

Platform technology companies, especially in Genomic Bio-informatics (Compugen, QBI) and in computer-aided molecular design (Synergics, Peptor, BTG, Green Care), are also active and develop new drug generations.

For diagnostics, developments are less financially demanding, but the market is also more limited. In Israel, Diagnostics amount to 4% of Biotech sales, mainly from genetic and immunological assays for viruses and other pathogens (Orgenics, Savyon, Rahan Meristem, Gamida-Gen).

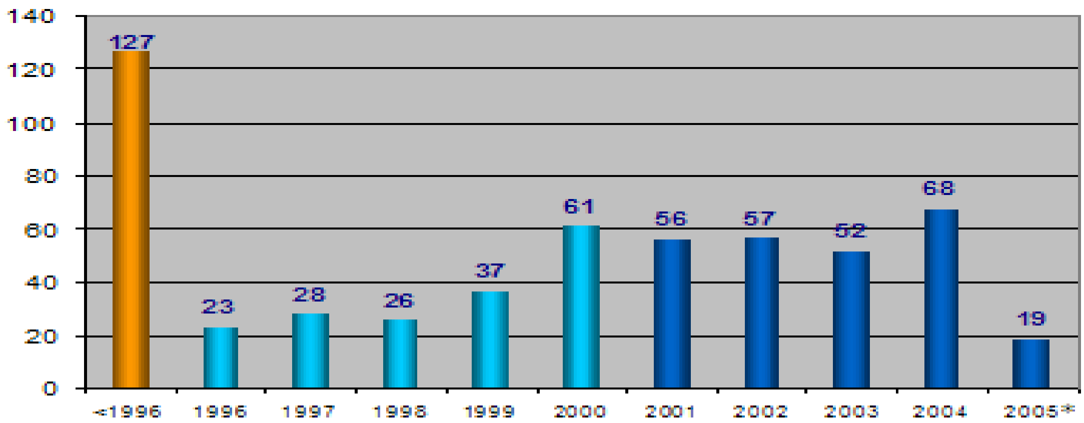
Agro-Bio and veterinary products amount to 23% of sales. The bulk is genetically-developed hybrid seeds for vegetable, crops, fruits and cotton, with resistance to pathogens, herbicide and adaptation to environments (Hazera, Zeraim Gedera, Rahan Meristem,Vitality). Poultry and farm animal vaccines (Abic), insects to fight plant parasites (BioBee) and new cellulose-based technologies (CBD) contribute to Agro-Bio and environment control.

1999-2005: A Decade of Growth[67]

Over all, the Israeli Life Science Industry is young but rapidly growing. Of the existing 557 companies, 77% were founded during the last decade. A closer look reveals that almost half of the Industry (45%) was established in the last five years. Figure 1 depicts the trend and growth experienced by the industry in the 1996-2005 period. One hundred and twenty seven companies were established prior to 1996, with the oldest one, Teva Pharmaceutical, founded in 1901. From 1996 to 2000, the industry experienced significant annual growth equalling 19%. In 1996, the life science industry grew by 23 companies while in 2000 the industry saw its number increase by an additional 61 companies. In total, the industry grew by an additional 175 companies in the period of 1996-2000. In the past five years, industry growth has remained stable with approximately 50-60 new companies, annually. Altogether, the industry experienced a 16% compounded annual growth in the decade of 1996-2005. It is important to note that Figure 6 depicts the number of companies established in each of the year and exist today.

[67] Data exerted from the ILSI data presented in 2005.

Figure 1: The Israeli Life Science Industry Number of Companies Founded

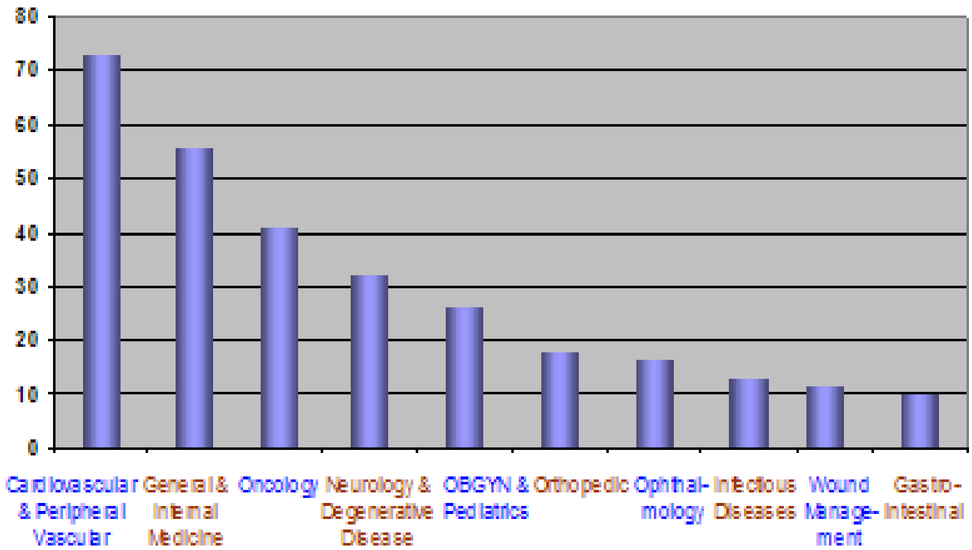


* Incomplete data

Source: ILSI Database – 2005

The Israeli industry focus is on unique opportunities of major diseases for which existing therapies are largely ineffective. Thus many Israeli companies are working on treatments for cardiovascular and peripheral vascular disease (73 companies), oncology (41), neurodegenerative disease (32), and other age-related diseases such as ophthalmic (16) and orthopaedic (18).

Figure 2: Main Medical Fields. Number of Companies (296 Total)

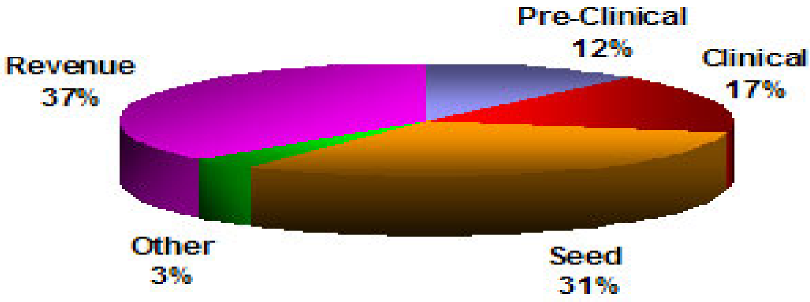


Source: ILSI Database – 2005

Companies at the Developmental Stage

As noted above, 77% of the companies were established within the last decade. Yet, only 37% or 205 companies are revenue generating entities. Of those, 83 companies are mature and were created prior to 1996. More impressive is the fact that 20 companies or 12% of all revenue producing companies were established within the last five years. Approximately 30% of the life science industry or 175 companies are at the seed stage, 12% or 65 companies are at the preclinical stage and 93 or 17% of the companies are at the clinical stage.

Figure 3: Companies Developmental Stage



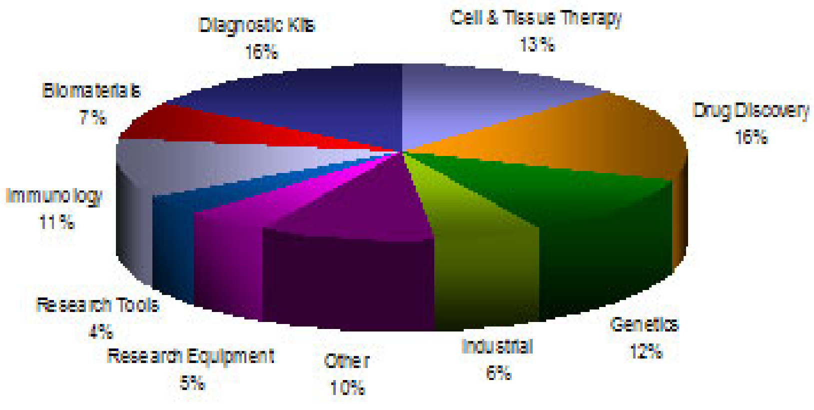
Source: ILSI Database – 2005

The Biotechnology Sector

The biotechnology sector is the second largest with 129 companies. The sector is fluid with new companies being established and old one being abandoned. Of the universe of 129, 38 companies, or 29% of the total, are revenue generating. Most companies are selling diagnostic kits or research equipment. 46 companies or 36% are in the seed stage, 23 companies in preclinical stage and 16 in clinical stage.

Figure 4 depicts Israel's biotech companies categorized by sub sectors. Bioinformatics/Drug Discovery is the largest sub sector with 22 companies or 16% of the total biotech sector, followed by Diagnostic Kits – 20 companies or 16%, and Cell & Tissue Therapy with 17 companies or 13% total.

Figure 4: Israel's Biotech Companies – Sub-sectors



Source: ILSI Database – 2005

Table 1: Number of Companies in the Life Sciences Industry

No. of Employees:	1-10	11-20	21-30	31-50	More than 50	SUM
Ag BioTech	11	4	1	3	2	21
Biotech	88	13	6	13	9	129
Medical Devices	183	44	18	13	28	286
Pharma	48	8	4	3	11	74
IT	10	3		3	2	18
Service	3	2	1		3	9
Other	12	3	1	2	2	20
Total Number of Companies	355	77	31	37	57	557

Source: ILSI Database – 2005

Most life science firms are still small and have a small number of employees. Table 1 shows that most biotech firms have less than 10 employees and that the largest firms in the life sciences are medical devise firms. Only 9 biotech firms have more than 50 employees.

The Monitor Survey

Research in Israel is carried out at seven universities, five colleges, 10 specialized institutes and the major hospitals. Yet despite a world class academic infrastructure and a flourishing venture capital sector, Israeli biotechnology is far from realizing its full potential.

In the recent years, the Office of the Chief Scientist (OCS) of the Ministry of Industry and Trade in its aim to create a supportive environment for the ongoing development of this sector, and to better understand the industry and its needs, conducted in 1998 an in-depth study of Israel's biotechnology sector. Monitor Company Inc., an international survey firm, conducted the study, which was set out to evaluate the type of support required to facilitate accelerated growth. The survey was commissioned as part of the Israeli government's ongoing support for biotechnology.

The consequent report revealed encouraging trends but also issued a long list of recommendations to fully exploit what the country has to offer. The government has adopted the recommendations of the report through the OCS. The recommendations are:

- task forces creation with private sector leadership,
- support selective applied research projects and technology transfer,
- provide incentives to upgrade industrial infrastructure,
- reinforce regulatory infrastructure,
- implement a tracking system.

In addition, the report included a recommendation that two world-class incubators specializing in biotechnology be established. These incubators should have first rate business and management support and the involvement of overseas interests. Through these incubators promising projects in biotech will have access to adequate pre-seed funding.

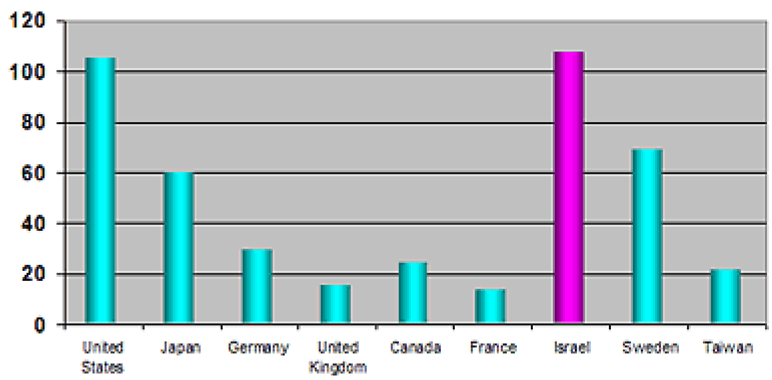
The report also recommended that the physical infrastructure supporting the industry be upgraded. This infrastructure will provide integrated services and equipment in pharmacology and animal testing, analytical services and GMP pilot batches manufacturing facilities. The industrial infrastructure should be enhanced and coordination intensified by the private sector and government. The main challenge is in the early commercialization stage where more pre-seed funding must be introduced. Moreover, links between academia and industry must be deepened, managerial skills improved, the regulatory infrastructure strengthened, and the flow of data on the industry intensified. Another important recommendation was that a new fund be established to support academic R&D with an applied orientation.

Patents

Patents are considered an important measure for the degree of innovativeness of national systems. Israel's patent position is relatively strong and impressive. In the next section, I will highlight a few related facts based on government publications:

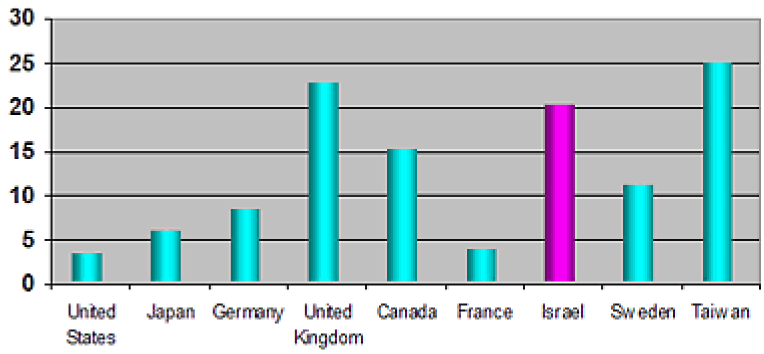
- Israel's total number of granted patents in the medical device area positions it in first place, worldwide in patents per capita and number seven in absolute number of patents (see Figure 5). Moreover, the number of medical device granted patents increased at a compounded annual growth rate of 20% during the years 1999-2003, placing Israel number three globally after Taiwan (1st) and United Kingdom (2nd). This high growth rate is indicative of the innovative activity in the Israeli medical device field (see Figure 6).
- Israel's total number of granted patents in the biopharma field puts it in fourth place worldwide in patents per capita and number 12 in absolute number of biopharma patents (see Figure 7).
- Israel's total number of Life Science patents as percent of total patents written by Israeli inventors, places the country in first place worldwide (see Figure 8).

Figure 5: Medical Devices Patents per Million



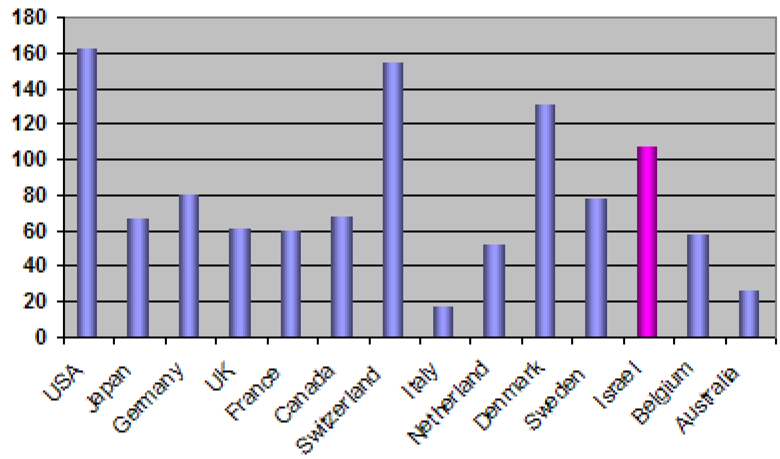
Source: www.uspto.gov, Analysis: ILSI©

Figure 6: Medical Devices Patents Compounded Annual Growth Rate (1999-2003).



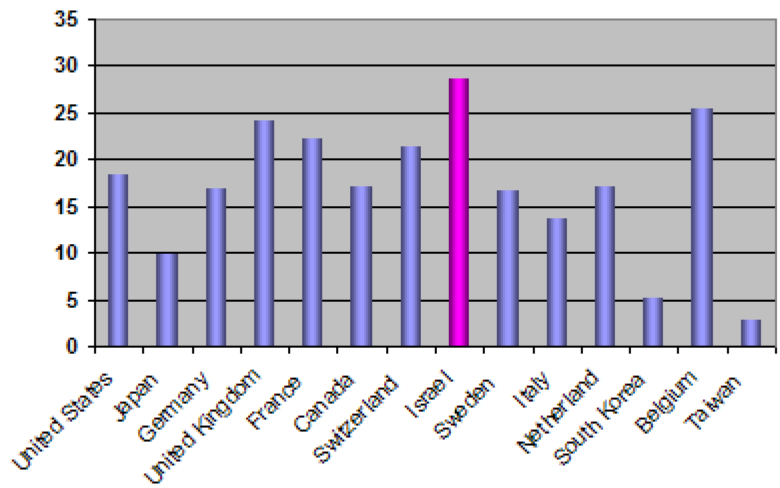
Source: www.uspto.gov, Analysis: ILSI ©

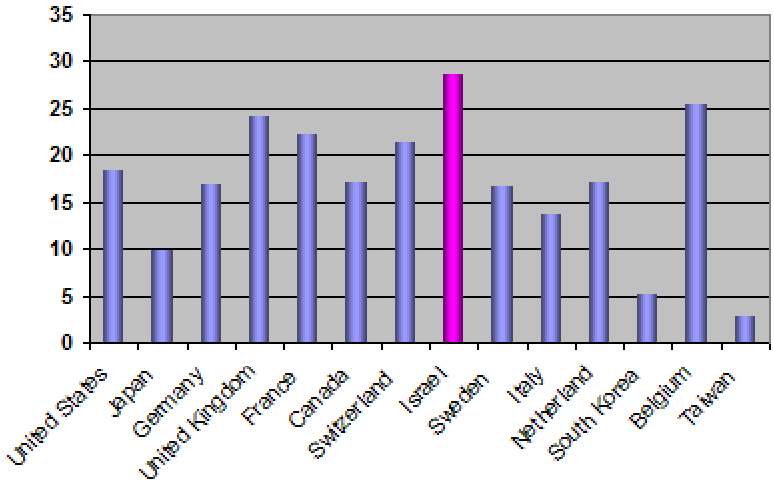
Figure 7: Number of BioPharma Patents per Million Capita



Source: www.uspto.gov, Analysis: ILSI ©

Figure 8: Life Science Patents % of Total Patents Registered





Students

Higher education is another component that has a significant impact on innovativeness of national systems. Most relevant information is related to research universities and the life sciences programs. Table 2 shows the most recent information published. The number of Israeli students who seek and receive higher education and degrees reached approximately 27,000 in the 2001/2002 academic year. Of those 1,386 or 5.1% are graduates of biology, which includes biochemistry, microbiology, genetics, physiology and biotechnology. It is interesting to note that 13.8% of biology graduates have received their PhD. However, these 191 students comprise 22.1% of all PhD receivers in Israel, suggesting that a larger proportion of life sciences students continue their studies towards a PhD degree.

Table 2: Number of Graduating Israeli Students in Life Sciences. Academic Year 2001/2002

	Total Num. of Students	% of the Total	**Biology**	% students of the Total	**Medicine**	% students of the Total
BA	18,018	67	764	4.2	401	2.2
MA	8,170	30	431	5.3	481	5.9
Ph.D	863	3	191	22.1	39	4.5
Total	27,051	100	1,386	5.1	921	3.4

Source: Israel Central Bureau of Statistics – 2002/2003One should keep in mind that total number of students in the Life Sciences is estimated to be 2.5 times larger as students spend an average of three year completing their undergraduate studies, and 2-3 years completing their advanced degree.

Life Sciences studies take place primarily (65%) in seven academic universities and institutions: Hebrew Universities, Technion, Tel Aviv University, Bar Ilan University, Ben Gurion University and the Weizmann Institute.

Biotechnology Based Academic Research

It is common understanding among organizational scholars of biotechnology that it requires rich academic soil in which to grow (Liebeskind et al. 1996, Powell et al. 1998). More than any other high-tech industry, it must be nurtured carefully by the often long and expensive process of research. This characteristic makes Israel well placed to succeed in biotechnology with an estimation of 35% of the country's researchers involved in the life sciences, and thus it may not be of surprise that there have already been some remarkable university-driven commercial applications for Israeli biotechnology research.

In general, Israeli universities are very active in biotechnology are considered to have a competitive advantage due to the potential synergies with other disciplines such as computer science and physics.

It is worth noting that from its beginnings in the early 1920's, Israel's academic community has been characterized by a strong bent toward the life sciences. Israeli universities have established a high profile life science research institutes, including a medical system actively involved in clinical investigation. Israeli researchers and academics publish their work in both Israeli journals and international publications. Almost 60% of academic publications are in bio and clinical medicine and related fields. Recent surveys by the distinguished British biomedical periodical, The Lancet, ranked Israel #1 in the world in per capita publication of technical and research papers.[68]

Biotechnology research in Israel is carried out at seven universities, five technical colleges and other research institutes and hospitals. In the next section, I will review the major activities of the leading research universities and their technology transfer offices.

The Weizmann Institute of Science in Rehovot pioneered biotechnology in Israel and continues to do so today. As indicated already, InterPharm's leading product, bulk recombinant human interferon-beta-1a for the treatment of multiple sclerosis, was developed the Weizmann Institute's Department of Molecular Genetics. InterPharm, owned by the Swiss-based-corporation Serono, enjoyed significant profits from this product and this kind of success that has persuaded many international companies to perform significant elements of their product development in Israel. As a result of the Weizmann Institute's endeavours, the neighbouring Kiryat Weizmann Science Park has become the national centre of the country's biotechnology industry with the largest companies based there.

The Weizmann Institute participated in the international Human Genome Project. One of the contributions of the Bioinformatics Unit in the Department of Molecular Genetics is the study of mutated genes which cause such disorders as Down's Syndrome and Alzheimer's Disease.

All universities in Israel established a technology transfer company. Weizmann Institute has established its own technology-transfer company - Yeda Research and is also associated with the Pamot Venture Capital Fund, which holds rights of first opportunity over any project under development by the Institute. Current biotechnology investments include Gamida Cell, developing technologies for ex-vivo expansion and manipulation of stem cells in bone marrow and BALM Pharmaceuticals, developing a proprietary platform technology utilizing peptides.

The Hebrew University of Jerusalem also allocates major resources to the Life Sciences. The University's Biotechnology and Fermentation Laboratory is often held up as a model for a new generation of Precompetitive Industrial Research Centres (PRIC), in which industrial and academic scientists can work together on problems of scale-up and feasibility testing. Among successes in recent years a team of HU researchers has created a new material - bioactive sol-gel glass - for immobilizing enzymes and other bio-organic molecules. The immobilized enzymes can even acts as biosensors in medical or environmental applications. Another HU success is in the

[68] Information from OCS report 2004.

area of steroids. Researchers in Jerusalem have encapsulated steroids in microscopic vesicles where they are more accessible to chemical interactions.

Yissum Technology, established in 1964, is the University's technology transfer company. Yissum submits more than 100 patent applications each year, with its over all portfolio of 1,400 registered patent families earning an income of $37 million in 2004. As a technology transfer company, Yissum asserts that they seek to find the best partners to maximize the commercial potential of innovative technologies developed by the university's researchers. Yissum grants licenses to local and international corporations who develop the discoveries and bring them to market. They also initiate the formation of start-up companies such as Atox Bio (more on this start-up later). One recent biotechnology commercial success in the area of bio-informatics based on HU know-how is Keryx. This Jerusalem start-up has developed a mathematical formula that harnesses raw genome data.

The Technion, Israel Institute of Technology in Haifa is also one of the country's leaders in creating new industrial biotechnologies and moving them into industry. Among recent endeavours a process has been developed for the elimination of toxic metals for drinking water and industrial effluents. The Technion R&D Foundation is responsible for technology transfer agreements at the university has been Rademate Ltd., which is developing RBHM - a hydrophobic, strong, inexpensive and fully compostable, biodegradable composite material that is environmentally friendly.

Tel Aviv University's Department of Microbiology and Biotechnology also conducts prolific research in these disciplines. Recombinant microbial biopolymers have been developed for treating oil pollution and metal contamination in natural water, while new classes of antibacterial and antifungal drugs have been devised based on novel pathogen biochemistry. Another key link between the University and industry is exemplified by studies in bioprocessing in which enzymes are used for the controlled degradation of cellulose. In diagnostics research cell sorting technologies are used to enable rapid identification of human microbial pathogens. Tel Aviv's technology transfer company is Ramot.

One of the country's youngest biotechnology centres is at Ben Gurion University of the Negev in Beer Sheva. The Institute of Applied Life-Sciences (scheduled to become the National Research Centre for Biotechnology) specializes in bio-materials, bio-sensors and bio-environmental projects.

Many regional colleges in Israel are also engaged in biotechnological research. The Migal Galilee Technology Center in Kiryat Shmona in the country's far north is part of the Tel Hai Academic College. The college has its own mini biotechnology incubator. Start-up companies include Galim, which has developed platform generic technologies for libraries of monoclonal anti-bodies, Sensis (together with Tel Aviv University), which is developing sequencers for DNA which are smaller, cheaper and more portable than existing devices, and Bioview, which is developing diagnostic equipment which uses image processing. In the past Migal has developed recombinant vaccines for the treatment of Gambero disease in poultry, which is being sold by Abic.

Bar Ilan University has developed, among many projects, a drug delivery system for Alzheimer's disease and has an active technology transfer company. Other research institutes involved in biotechnology research include the country's leading medical centers as well as the Ministry of Agriculture's Vulcani Center - Agricultural Research Organization near Tel Aviv.

Government Incentives to Biotechnology

Government initiatives have added resources to academic and industrial research in biotechnology. The Office of the Chief Scientist (OCS) at the Ministry of Industry and Trade evaluates the viability of innovative ideas and offers financial incentives through matching funds that share in the high-risks intrinsic in the earliest stages of new projects. The very approval of a grant by the OCS bestows a legitimacy, which subsequently helps locate investors. These grants must be repaid through royalties if the project reaches a successful end.

The OCS also enhances international strategic cooperation between Israeli and overseas communications companies by negotiating bi-national international R&D frameworks and funds. These include the US-Israel Bi-National Foundation (BIRD) as well as similar funds with Canada, Britain and Singapore. In addition there are bi-national agreements with Austria, Belgium, France, Holland, India, Portugal, Ireland, Italy, China and Hong Kong, Spain and Germany. Agreements are about to be signed with Sweden, Finland and Korea. Israel also participates in the Fifth Framework Program of the European Union.

Another OCS initiative includes sheltered "incubator" environments and other programs for scientists without entrepreneurial skills. A national network of 24 technological incubators was set up nine years ago and since then over 900 projects have been initiated, many of them in the field of biotechnology. About 40% of Israel's biotechnology enterprises were initially nurtured in these incubators.

In addition the OCS and this is especially crucial for the future of biotechnology, places great emphasis on promoting the broadening of high-tech know-how accumulating in Israel by closer cooperation between industry and academia. This is accomplished through programmes that are titled: MAGNET and MAGNETON. These "collaboration enhancement" programmes encourage universities and private companies to work together on the development of generic pre-competitive technologies (more details on these programmes are given below).

Such consortia have recently completed projects on algae, DNA markers and hybrid seeds. Projects are underway on technologies for drug development, Image Guided Therapy and Agro-Bio genomics. A new topic being developed, pharma-logic, will seek to make better decisions about compounds for drug development in the early stages of the R&D process. This will assist in determining whether an active molecule has other features that render it more attractive for further development.

The government has acknowledged the importance of biotechnology and continues to assist in its rapid development through direct financial support and other incentives for R&D activities, via both the Office of Chief Scientist of the Ministry of Industry and Trade and the Ministry of Science. Over 10 years ago, the Israeli government decided to establish an Inter-governmental steering committee to promote the biotechnology area as a national project. The Ministry of Industry and Trade, Ministry of Science, Ministry of Health, Ministry of Agriculture, Ministry of Environment and Ministry of Finance are participating at this committee.

The National Biotechnology Committee was established when the Government of Israel recognized that biotechnology needed to be a priority area for development and, as a result. The Committee, headed by Professors from academia or the industry, provides continuing consulting services both the Ministry of Industry & Trade and the Ministry of Science. In broad terms, its purpose is to promote biotechnological research and entrepreneurial activities in Israel and to advise various government offices as to the development of biotechnology in Israel. The Committee is composed of equal representation from both industry and academia.

Government assistance in the form of grants and other incentives from the Ministry's Investment Centre are available beyond the R&D stage, and include assistance in building production facilities, marketing, and start-up costs. The Israel Biotechnology Organization also works to support and promote development of the field.

Of particular importance to biotechnology is the MAGNET programme operated under the auspices of the Ministry of Industry and Trade. The MAGNET programme is designed to spur the development of innovative generic technologies by encouraging collaboration both within the scientific community and between industrial companies. To do this the programme underwrites up to 65% of a consortium's budget based on joint projects of merit.

A relatively new programme, MAGNETON, is another government initiative which began in 2001. The MAGNETON's purpose was to investigate the manner by which a scientific discovery becomes an industrial product. The aim is to increase the access of Israeli industry to the achievements of academic research and its economic potential, through cooperation between research groups and industry on single R&D projects. To date, many such university-industry two years technology-transfer collaborations were founded and some have been highly successful in bringing academic inventions into the market place.

According to the OCS this ongoing support and the implementation of the proposed recommendations of the recent report are expected to create a biotechnology industry in Israel generating annual revenues of between $2 billion - $3 billion by 2010. Over this period supporting industries should enjoy a fivefold increase in revenues.

Local Organizations

The Israel Biotechnology Organization (IBO) operates within the Manufacturers' Association of Israel in order to promote the interests of the Biotechnology Industry in Israel, and to create a supportive business environment for the development of the Biotechnology Industry. The IBO comprises approximately 50 biotechnology companies that are divided into two branches: Pharmaceutical Biotechnology and Agricultural Biotechnology. The IBO operates in collaboration with the Israeli Government Ministries and other sectors in order to advance the Biotechnology Industry in Israel.

University Spin-offs in Biotechnology – Illustrative case studies

In the next section, two successful spin-offs of academic research will be described. This will be followed by initial findings from an ongoing study on a more recent phenomenon – university based spin-offs. These are biotechnology firms that are founded by universities in order to facilitate their initial seed stages close to the scientist's laboratory.

1. InterPharm – Rebif

The establishment of InterPharm in Israel is marked as the founding of the industry, InterPharm Laboratories Ltd. (SERONO Israel) was founded in Ness-Ziona In 1978, by Ares-Serono, a multinational pharmaceutical concern based in Switzerland, as a subsidiary, to conduct research and development projects and to manufacture bulk biological pharmaceuticals. InterPharm has focused its R&D efforts on the production of cytokines, the body's biological messengers, while maintaining extensive research ties with experts in this field – especially the person responsible for the discovery of the Interferon – Professor Michele Ravel at the Weitzman Institute of Science based in nearby Rehovot.

The year 2005 was good for the Swiss pharmaceutical firm Ares Serono and its Rebif product as sales reached 1.2 billion dollars. This impressive achievement was for a therapeutic product that was invented by Prof. Ravel of the Weitzman Inst. In 1979 the Weitzman Inst. Agreed to license the development rights to Serono under the condition that the product would be developed in Israel (Globs, Feb. 27, 2006). Prof. Ravel stated in this recent interview after Serono closed its facilities in Israel that maybe the rights for development should have been given to another firm. Serono also acquired the rights for three other molecules that were developed also in the Institute but decided not to develop them further. This decision reduced the innovativeness of their pipeline but also prevented the further commercialization of these molecules by other firms. Prof. Ravel also argued that the firm failed to maintain an ongoing consulting dialogue with the scientists at the university and did not keep the scientists involved in the development process. He also indicated that in order to have the full involvement of the scientist, one needs to leave his academic position and most scientists are not willing to do so. It is crucial that the scientist will have a central role in the development process while remaining in academia.

The State has an important role on biotechnology innovation – in Ravel's view, the state was about to approve tax reduction for Serono that may have saved the facility in Israel, but this support was not sufficient for Serono. Rebif is now developed in Switzerland.

The closedown of the research facility in Israel came as a big surprise. Different explanations were assigned to the decision, yet the bottom line is that the firm was established through the government initiative to retain the returns from academic intellectual property and to provide opportunities for local scientists to work on the development of products resulting from the local discovery. After many years in which the government provided support to InterPharm, the knowledge was exported and the returns to the State have ceased.

2. Teva – Copaxson

Another team at the Weitzman institute developed Copaxon – commercialized by Teva – an Israeli pharmaceutical firm that was known as a Generic Drug Developing firm prior to the introduction of Copaxon. The following information is taken from Teva's published records. The first innovative drug to be developed in Israel and to receive FDA approval, Copaxone® is a unique immunomodulator therapy for the treatment of Relapsing-Remitting Multiple Sclerosis. Copaxone® is the only non-interferon agent available for MS.

Form the published records of Teva we learn that Copaxone® was originally discovered by Professor Sela, Professor Arnon and Dr. Teitelbaum at the Weizmann Institute of Science in Israel. Teva was granted world-wide exclusive license for Copaxone® and became the developer of the product. The efficacy and safety of Copaxone® were demonstrated in three main clinical trials: The first trial, led by Professor M. Bornstein, was performed in a single centre, double-blind, placebo-controlled trial and included 50 patients.

The second trial was a 2-year, multi-centre, randomized, double-blind, placebo-controlled trial and was performed in eleven US centres involving 251 patients. This study was led by Professor Kenneth Johnson, Chairman of the Department of Neurology, University of Maryland Medical Center, Baltimore. The third trial, a double-blind, multi-centre, multi-country MRI study, involved 29 MS centres in six European countries and Canada, with the participation of 239 patients. This study was led by Professor G. Comi, Department of Neuroscience, Scientific Institute Ospedale San Raffaele, University of Milan.

Teva has invested heavily in the preparation of production capacities in two main production sites: the Copaxone® chemical manufacturing facility, a modern, high-tech, computerized manufacturing plant in Netanya, Israel, as well as the fully automated sterile pharmaceutical filling operation in Kfar Sava, Israel. Both are highly advanced facilities.

The InterPharm and Teva cases are evidences of a successful transition of academic knowledge into profitable biotechnology products. However, the role of the universities in the product development phase was in these cases relatively small and the knowledge was transferred through licensing agreements. A current trend, documented by Etzkowitz (2003), argues that entrepreneurial universities are seeking a more active role in the entrepreneurial and commercialization process and establish start-ups in the form of university spin-offs. The following paragraph will introduce a few initial findings on such spin-offs founded by entrepreneurial universities in Israel.

3. University based spin-offs in biotechnology – initial findings

An exploratory follow up study is currently conducted by me on university based spin-offs in biotechnology. In this study, I focus on seven university-based start-ups which emerged in one university in their first and second year by interviewing the inventors who are university scientists, the investors (if available), the managers (if available), the collaborators (if available) and the technology-transfer officers associated with the spin-off. At this point, there are only initial findings. Out of the seven projects none has reached a financial breakthrough and most of them did not emerge far beyond the laboratory stage. Two projects have made some significant progress. Atox Bio is one of the successful spin-offs:

Atox Bio:

Atox Bio is a biodefense drug development start-up, operating under the aegis of the University Technology Transfer Company. The formal spin-off was established in 2004, and is still under the basic science phase.

After many years of research in the area of infectious diseases, an NIH grant of $5.6 million via the National Institute of Allergies and Infectious Diseases, was granted to a professor from the faculty of medicine. This is the largest competitive NIH award for development ever made to an Israeli institution. The drug development is done in collaboration with Atox Bio, which holds the license for the technology and manages its development. This grant expresses the appreciation and confidence in the founder of Atox Bio and his collaborators on his scientific standards and achievements. The professor and his collaborator discovered the molecular mechanism triggered by superantigens and with the aid of the US Defense Advanced Research Projects Agency

(DARPA) (research funds of $6.5 million), they spent the past decade developing a peptide that acts as antagonist to superantigens.

The new drug will enable Atox Bio to develop a biodefense drug that further down the line, will have applications as a treatment for naturally occurring septic shock. Since phase II and phase III are not required in the realm of biodefense, they hope that by the end of the decade have an effective biodefense drug. They envision that the final stages of development for the market will be based on a partnership with a large pharmaceutical firm with sales and distribution facilities and resources.

With this massive funding, Atox Bio operates out of the research laboratories of scientist at the university, and manages the worldwide collaborative research headed by the entrepreneurial professor. This is an illustrative case of an academic scientist who had a clear strategic agenda. His entrepreneurial vision has been to postpone, as much as possible, the entry of venture capital into the scientific development stage. Thus, he has chosen the public funding venue and has been very successful so far. The follow-up study will focus on the next stage of the development of the drug, once the academic stage will be finalized.

Complexities Associated with University Spin-offs

In order to highlight some complexities associated with university-based spin-offs, I will suggest a few initial explanations that can account for the relative slow progress of developing university-based spin-offs and highlight illustrative complexities:

- The role of the scientists – the inventors in the study were all keen on having a central role in the coordination of the business and economic aspects of the spin-off. Some of these scientists have expressed business entrepreneurial vision, but others claim that the lack of their experience and understanding is a major hurtle for success. This lack of business experience became a hurdle at times.
- The lack of experienced managers – technology transfer offices are not always capable of offering the needed managerial guidance for the spin-off. Yet, without early investments, it is expensive to hire experienced managers.
- Dilemmas regarding the use of funding – public versus private funding have important implications on the independence of the inventor scientist. Public funding offers the intellectual freedom for the academic scientist, while private (venture capital or strategic alliance partner) funding is associated with lesser flexibility, dependency, transaction costs and more constraints. Yet, private funding is more readily available than public funding that is sufficient for R&D stages.
- Personal networks versus new collaborative partners – personal networks of previous collaborative partners, especially when they yield successful collaborations, are seen as more attractive than new collaborations. However, new projects require new collaborations and different networks of strangers. Scientists tend to wish to continue working with past successful collaborators that are not always appropriate for the needs of the spin-off.
- Uncertainty regarding the location of the research laboratory – the research starts in the scientist's laboratory at the university, but at a certain stage has to move beyond the laboratory to a new location. Yet, the timing and the consequences of the move are not simple to determine, and so is hard to define clearly the exact role of the inventor scientist as the project moves to advanced stages.

- The flow of scientific research – problems of transformation or the research from basic to applied, issues associated with the scale-up of the study and complexities associated with cross national collaborations that are needed for the testing stages.
- Problems in cross institutional collaborative work – different institutional environments operate under different norms and expectations. Therefore, inter-institutional university-industry collaborations are complex and entail strains and unanticipated hurtles.

Discussion

In this paper, I argue that universities are the engine of innovation in biotechnology research. Yet, using the example of Israel, it is clear that such innovation can be a product of a bricolage (Garud and Karnoe, 2003) of enhancing factors and strong networks of information and collaborations of many forms and scope.

Such innovation starts with strong universities and academic research. It must be based on an infrastructure of academic education of high research standards, especially in the life sciences area but also in the exact, medical and agriculture sciences for supportive academic capabilities. Such academic system should benefit from highly supportive government initiatives that provide both funding for risky early-stage research as well as facilitate collaborations between universities and the industry.

In addition, academic based innovative systems must allow for networks of scientists to collaborate and exchange ideas and knowledge. Entrepreneurial universities can not succeed without a governing environment in which academic intellectual property rights are secured and universities have the ability to value the market potential of their in-house basic and applied research (Oliver and Liebeskind, 2006). The industrial environment should be well established in order offer collaborations related to scaling up research, provide needed technologies, offer developing funding and vertical integration facilities such as testing, production and marketing. Finally, the entrepreneurial spirit as a cultural aspect should be facilitated not only within the industry but also in universities and research laboratories. This can be gained through supportive and capable technology transfer offices and specialized managers and consultants for advancing university spin-offs.

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Management of Technology Transfer Offices: Lessons for Brazilian Universities

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Introduction

During the last decades, university-industry relationships have become a central subject, due to the essential role played by technological progress in the economic development of the countries.

The development of an innovative system based on the interaction of academy with industry has promoted different ways to optimize the link between science, technology and economic development.

In this context, the association between universities, industries and government constitutes one of the best ways to establish links between technology and economic development.

From the theoretical point of view, the linkage of these three agents - university, industry and government - has been the object of different analyses, ranging from the macro perspective to the establishment of conceptual models of technology transfer from the university to industry.

The system established by this joint, has as its primary target the complementarities between the agents: universities, as producers of the scientific and technological knowledge; industries, as promoters of the development and innovation of new technologies; and the government, acting as regulator and promoter of such relation. The complementarity of these three agents provides stability to the system and realizes the information potential generated by each one of its parts (Etzkowitz, 1996).

In sharp contrast to the situation of innovations based on the contribution of individual inventors, the need to increment institutional relationships is a result of the increasing complexity of research and of innovative activities, which demand the creation of formal structures and a more propitious atmosphere for the production of innovations (Dosi, 1988).

As a starting point for enhancing their participation in these institutional arrangements, specific mechanisms have been devised by universities, such as Technology Transfer Offices (TTOs), created with the objective to stimulate and to facilitate their interrelation with the other two agents of the innovation systems: industries and government.

In Brazil, although the creation of this mechanism represents the institutional recognition of the importance of incorporating technology transfer as a formal function, the introduction of new routines, that are "imported" from private sector practices, in the academic environment has not been fully accepted, due to different perceptions from the university community about the university's mission as well as to a lack of capabilities to deal with business activities that are new for universities' managers. Those institutions where such offices have been adopted assign them the duty of administrating all the services related to the interaction activities, including management of intellectual property and licensing.

Within this context, this paper analyzes the importance of the role performed by Brazilian university TTOs, from the point of view of their organization, policy and performance. The diagnosis carried out has the purpose of determining: a) the main functions of the offices, (b) the position they must have within the university structure and (c) it's the pattern of internal relations and with the market. With the purpose of strengthening this diagnosis of Brazilian offices and drawing recommendations for their sound management, the case of the Office of Interaction and Technology Transfer (EITT) of the Federal University of Rio Grande do Sul (UFRGS) is presented.

1. The Technology Transfer Office Model

The technology transfer office constitutes an institutional mechanism created with the aim of promoting interaction of the university with the productive sector, especially with companies, and the government. The setting-up of TTOs derives from the necessity to improve the effectiveness of university performance in order to better correspond to social demands, particularly through research results transfer and licensing of proprietary technologies and know how.

According to Solleiro (1993), management of university services includes development and establishment of common objectives that serve as a guide for the interaction process. In a general way, activities developed by this institutional mechanism are similar in most institutions, with small variations depending on the emphasis that orients their creation (Dos Santos, 1990; Albornoz, 1993; Solleiro, 1993; Cunha, 1998).

In this section the main concepts involved in the subject will be presented.

1.1. Concept

Before defining the TTO model, it is necessary to draw some considerations about the concept of technology transfer, because the more precise the concept, more focused will be the activities developed by the TTO.

1.1.1. Concepts of technology transfer and their implications in the concept of TTOs

Initially, it is necessary to establish the basic assumption that the primary mission of the university must be education and research, and that technology transfer can be used to support this primary mission (Mejía, 1998). Technology transfer is not a new phenomenon in universities. Historically, research universities have transferred technology using traditional methods, like publications, student education and extension programs. Technology transfer through intellectual property and know-how licensing added a new educative dimension and research opportunities to professors and students (COGR, 2000, p.3).

Thus, technology transfer is made through several ways: oral communication, physical transfer of a tangible research result or through the licensing of intellectual property. Under this point of view, technology transfer, for Parker and Zilberman, "is any process by which basic understanding, information, and innovations move from a university, an institute or a governmental laboratory to individual or firms in the private and quasi-private sectors" (Parker and Zilberman, 1993, p. 89). For these authors, the scope of the definition is based on the essence of the university mission as creator of public good and includes information transfer (conferences and publications), educative activities and qualification, consultancy, patenting, licensing of innovations and creation of start-up companies.

For Berneman and Denis (1998), the immediate goal of technology transfer is to facilitate the movement of academic research discoveries from the laboratory towards the market, aiming public benefit. Observing cultural differences between the university and the company, the authors define technology commercialization as a bridge that links both cultures through university-company interaction.

Thus, the institutions, which adopt a narrow concept of technology transfer, based on the commercialization of intangible assets, the offices activities are centred in commercialization of intellectual property. The definition of TTO adopted by OECD expresses this conception:

> *"Technology transfer or technology licensing offices are those organizations or parts of an organization which help the staff at public research organizations (PRO) to identify and manage the organization's intellectual assets, including protecting intellectual property and transferring or licensing rights to other parties to enhance prospects for further development. A PRO may have a single centralized TTO, it may have several TTOs associated with it (e.g. for different schools or departments), or it may outsource to an external TTO which has several clients organizations " (the OECD, 2003, p. 80).*

Under this definition adopted by the OECD, we can identify TTOs which operate since the second half of the XXth century: the TTO of the Fraunhofer Society of Germany was created in 1952 and those from the University of California, in the United States, in 1926.

Nevertheless, these are exceptional cases, because most of the TTOs are young, having an average of 12 years in the United States, and less than 10 in the other countries of the OECD, according to the referred reports.

The most diverse TTOs experiences can be identified in different parts of the world, from offices that are inserted in the university organizational structure itself to those which constituted independent instances and put into practice a technology transfer process in the university's name.

The OECD concept points out that the main activity of the TTO is intellectual property and the activities related to its disclosure, protection, and licensing operations.

Rogers et al. (2000) defines technology transfer as a process that consists of several stages, from the invention disclosure until patent licensing. It can take several years, after a technology is protected, until the university receives royalties (income obtained by the sale of products) originated by the licensed technology. For that reason, to measure the efficiency of technology transfer, it is important to consider all stages, and not only one.

Also considering technology transfer as a process, Friedman and Silberman (2003), define it as "a process whereby invention or intellectual property from academic research is licensed or conveyed through use rights to a for-profit entity and eventually commercialized" (Friedman and Silberman, 2003, p. 18).

Siegel et al. share this same concept, when they argue, "the primary motive of the TTO is to protect and market the university's intellectual property. Secondary motives include promotion technological diffusion and securing additional research funding for the university, via royalties, licensing fees, and sponsored research agreements" (Siegel et al., 2003, p.31).

The adoption of these strict concepts has characterized most of the TTOs. Nevertheless, as it will be observed ahead, in some universities, the role played by the TTOs is not restricted to the activities related to the management of the intellectual property only, but it is characterized by broader objectives, including the management of projects and technological consultancy.

It has also been observed in the Brazilian experience, as appointed by Terra (2001) in the analysis of the role of the university offices in technology transfer to the market. She identifies a multiplicity of ways that universities carried out technology transfer, as for instance, through the results of applied or experimental research, the dissemination of information, consultancy, training and continuous education, support to supervised practices, start-up companies, business incubators, development centres, technological parks and technopolis (Terra, 2001, XVII).

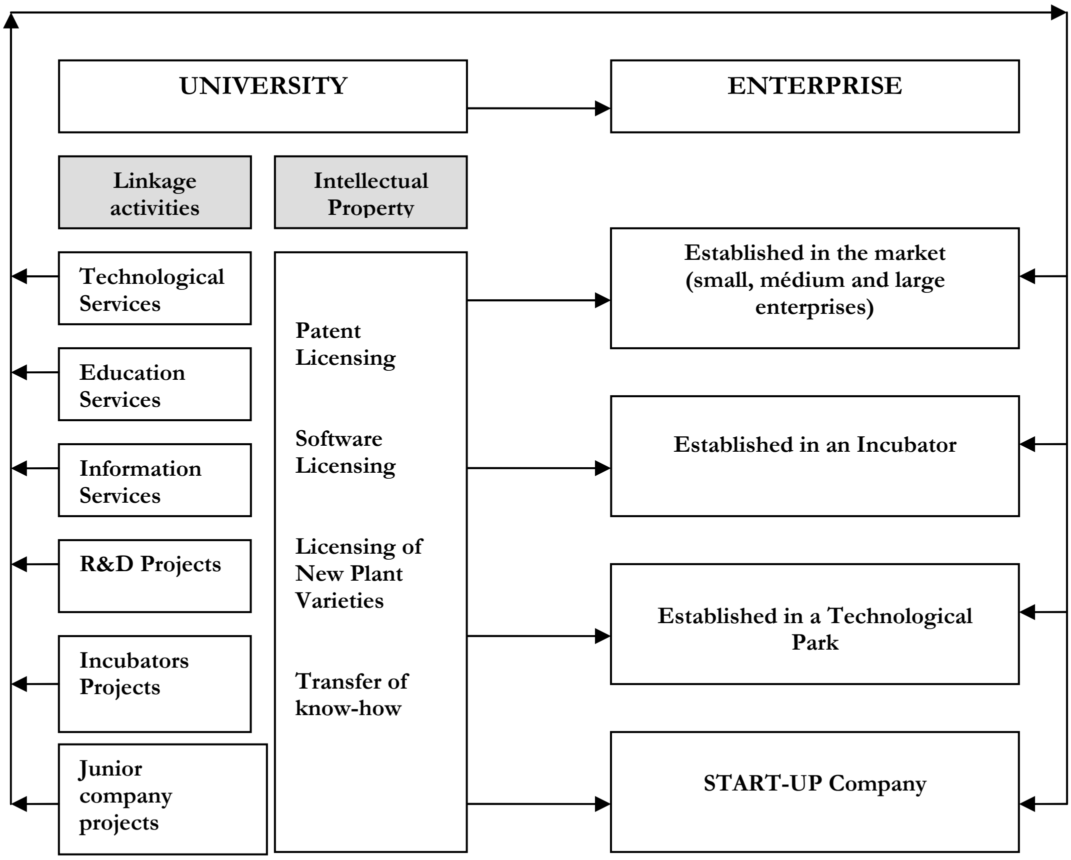
Thus, considering the diversity that characterizes TTOs in Brazilian universities, management of intellectual property is an activity that has only recently been incorporated to the other ways adopted by the university institutions to put technology transfer activities into practice. So, the concept of technology transfer adopted in this study expresses these elements, including this diversity of ways in which the interactions happen. Under this point of view, technology transfer cannot be centred exclusively on intellectual property matters, as it has been observed in TTOs of developed countries (OCDE, 2003), because that would constitute an analytical bias, not considering other ways of technology transfer predominant in the Brazilian scenery and necessary to address domestic industry's needs.

In this specific context, we understand the technology transfer as the process characterized by the passage of knowledge generated by the university to a company, allowing it to innovate and extend its technological capacity, making possible to obtain a competitive advantage in the market. Thus, technology transfer from the university to an enterprise includes (see Figure 1 below):

1) Interaction activities: a) technological services - technical analyses, calibrations, measurements, certification of conformity, tests and verifications, consultancies and others; b) education services: courses "in company", seminars and qualification, among others; c) information services: searches in national and international patent databases, technological information in general; d) R&D projects: basic research, applied research, experimental development and others; e) projects carried out by companies in incubators; f) projects of junior companies[69]: consultancy and services. 2) Knowledge transfer through intellectual property licensing: patents, software, and others, and transfer of know-how (non-protected knowledge) to companies already established in the market or in incubators and technological parks or through the creation of start-up companies.

[69] A junior company is a non-profit consultancy company that provides services to companies, through an academic unit, at a low cost. The management of this kind of company is done by the students themselves, and the technical support is provided by academicians.

Figure 1 - The university-enterprise technology transfer process



In this perspective, the creation of an office in a Brazilian university has to take into account the diversity of forms in which technology transfer happens, in order to fit it the university's necessities and local conditions. Mainly, the adopted concept must be reflected in the objectives and the activities that will be carried out by the TTO.

2. TTOs in Brazil: a brief history

The precursor university was the Federal University of Rio de Janeiro, which created, in 1971, the COPPETEC, the Technology Transfer Office of COPPE - Coordination of the Graduate Engineering Programmes:

"The preoccupation with the full time regime and the certainty that the institution would have to participate in the process of development of the country, led COPPE to create a structure oriented to the management of studies and technological projects, with the objective to constitute itself in the exclusive channel of interaction with the productive sector." (Institutional Presentation of COPPE, www.coppe.ufrj.br/coppe/apresentacao-c.htm, consulted 04/03/04).

Later, in 1990, the State University of Campinas – UNICAMP created its TTO - the "Escritório de Transferência de Tecnologia - ETT". The main objective of ETT was to organize and to disclose the potential of scientific and technological knowledge of the University, in order to transfer products and processes and to provide services. Some years later, the name of ETT changed to "Office of Diffusion and Technological Services" (EDISTEC), and more recently it changed again, adopting the designation of Agency of Innovation - INOVA, with a strong link with the business world. Putting into practice a market-oriented strategy, INOVA has hired professionals with industry-related experience, with the aim to reinforce the licensing activities.

Another important example is the University of Sao Paulo (USP), which created, in September 1991, the service "Disque-Tecnologia" (Call-Technology), with the purpose of taking care of consultancies of micro and small companies that, in general, do not have internal conditions for R&D. Years later, this program originated the Executive Coordination of University Cooperation and Special Activities (CECAE), who acted as a liaison office attending the demands of companies, interested in university services. More recently, USP followed the UNICAMP example and creates its Agency of Innovation. The objective of the Agency is to transfer the knowledge generated in the University to the society, in order to stimulate the social and economic development.

Following the initiatives of USP and UNICAMP, several Brazilian institutions have created their TTOs: the "Coordination of Innovation and Technology Transfer" (CT&IT) of the Federal University of Minas Gerais, the "Regional Center of Innovation and Technology Transfer" (CRITT), of the Federal University of Juiz de Fora, CERTI Foundation (Federal University of Santa Catarina), the "Office of Technology Management" (EGT), of the University of Rio dos Sinos Valley - UNISINOS; the "Interaction and Technology Transfer Office" (EITT), of the Federal University of Rio Grande do Sul, among others.

In the Brazilian universities, the TTOs have been created, in general, in a centralized model tied to Extension and Graduate Studies Vice-Presidency. According to Dos Santos (1990), the main advantage of the centralized offices is that they can have a general follow-up of all technological research projects carried out by the university in collaboration with industries. Nevertheless, this does not occur in all cases. Given the complex nature of the university, in which researchers and employees, far from constituting a "sprit des corps", form a set of individual autonomies, the control of activities can only be made if the office has institutional legitimacy.

The situation is still more complex in those universities, mainly the public ones, which have created foundations, in order to simplify and make the bureaucratic proceedings more agile. In these cases, information control becomes more difficult due to the autonomy of the foundation in managing the research resources.

Also a great ambiguity is observed about the role performed by the TTOs. Brisolla et al. (1998), in a study carried out in UNICAMP, considered the performance of the TTOs very low. It seems to be a non-exclusive situation of Brazil, because, as stated by Dierdonck et al., analyzing the Belgian experience: "there is no clear definition of the role of the offices in contracts and in the university's research strategy, and there is no consensus on the tasks that they must carry out" (Dierdonck et al., apud Brisolla et al., 1998, p. 427).

For the Brazilian case, the great responsibility that TTOs have to overcome the gap that separates them from their international pairs contributes to this lack of definition, having to act as promoters of the university-enterprise interaction, and, at a same time, as managers of intellectual property, including the patent licensing activities and other forms of technology commercialization. All these activities have to be put into practice in a not very favourable environment, where consensus is still far from being reached.

3. Method

The data were collected through a survey that involved 143 Brazilian universities[70], which answered a questionnaire to collect detailed information about the established TTOs, their form of operation and their main activities. With a return rate of 18%, 25 TTOs in operation in the Brazilian universities were identified. Table 1 shows the list of institutions that answered the questionnaires.

Table 1: List of Brazilian University TTOs

Name of University	TTO	Date of creation
Federal University of Rio Grande do Sul (UFRGS)	Interaction and Technology Transfer Office (EITT)	03/03/1997
University of Rio dos Sinos Valley (UNISINOS)	Technology Management Office (EGT)	18/09/1997
Pontifícal Catholic University Católica of Rio Grande do Sul (PUCRS)	Technology Management and Intellectual Property Agency (AGT)	13/09/1999
Universitarian Center of FEEVALE (FEEVALE)	Bureau of Inovation and Technology Transfer (BITT)	01/03/2002
Federal University of Santa Maria (UFSM)	Nucleous of Intellectual Property (NPI)	05/03/2001
University of Santa Cruz do Sul (UNISC)	Office of Technology Transfer (ETTEc)	20/04/1999
Catholic University of Pelotas (UCPEL)	Nucleous of Projects Support (NAPI)	19/12/1991
Federal University of Santa Catarina (UFSC)	Intellectual Property Management Coordination (COGEPI)	25/06/2002
State University of West of Paraná (UNIOESTE)	Nucleous of Technological Innovations (NIT)	01/03/1991
State University of Londrina (UEL)	Nucleous of Technological Innovation (NIT)	27/10/1987
University of São Paulo (USP)	Executive Coordination of University Cooperation and Special Activities (CECAE)	24/07/1986
Federal University of São Paulo (UNIFESP)	Nucleous of Intellectual Property (CMI-NUPI)	03/05/2000
State University of Campinas (UNICAMP)	Office of Diffusion and Technological Services (EDISTEC)	28/08/1990
Federal University of São Carlos (UFSCAR)	Nucleous of Extension UFSCar-Enterprise (NUEMP)	01/09/1996
University of Paraíba Valley (UNIVAP)	Vice-Presidence of University-Society Integration (UNIVAP-PRIUS)	02/12/1992
Fluminense Federal University (UFF)	Office of Knowledge Transfer (ETCO)	30/07/2001
Federal University of Rio de Janeiro (UFRJ)	Coordination of Projects, Researches and Technological Studies Foundation (COPPETEC)	12/03/1993
State University of Rio de Janeiro (UERJ)	Office of Technology Transfer (ETT)	23/09/1996
Pontifical Catholic University of Rio de Janeiro (PUCRJ)	Development Office of the Technical-Scientific Center (ED do CTC)	03/01/1994
Federal University of Minas Gerais (UFMG)	Transfer and Technology Innovation Coordination (CT&IT)	16/06/1997
Federal University of Viçosa (UFV)	Permanent Comission of Intellectual Property (CPPI)	19/10/1999
University of Salvador (UNIFACS)	Research and Extension Coordination	03/01/2000
Federal University of Pernambuco (UFPE)	Innovation and Entrepreneurship Directory (DINE)	01/01/2000
Federal University of Ceará (UFCE)	Scientific and Technological Diffusion Coordination	08/08/1981
Federal University of Pará (UFPA)	Technology Transfer and Intellectual Property Sector (SPI)	01/03/1999

[70] The set of institutions was obtained from the registers of the Brazilian National Universities Presidents Association (Associação Nacional de Dirigentes das Instituições Federais de Ensino - ANDIFES) and from de Council of Brazilian Universities Presidents (Conselho de Reitores das Universidades Brasileiras -CRUB).

Beyond the 25 TTOs described, three others have been identified - the Technology Transfer Office – ETT, University of Caxias do Sul (UCS), the Innovation and Technology Transfer Regional Center– CRITT, Federal University of Juiz de Fora (UFJF), and the Technological Development Center – CDT, University of Brasília, that did not answer the questionnaire and, therefore, did not participate in the survey.

In order to have a clearer understanding, the concepts used in this study are defined as: a) Segment - group to which the university belongs: federal public universities - sponsored by the federal government; provincial public universities - sponsored by the provincial government; private universities – privately funded institutions of higher education, sponsored by the fees paid by its students; communitarian universities - private institutions of higher education; b) Agency to which is subordinated –includes the instance to which the TTO is hierarchically subordinated in the structure of the institution; c) Budget - indicates if the TTO is maintained by the institution's budgetary resources; d) Own resources - they are the resources generated by the TTO itself in the performance of its activities (through technical services, projects or percentage of the royalties obtained in licensing activities); e) Centralized structure - it indicates if the TTO acts in a centralized way or if it is the only instance designated by the institution to interact with the productive sector and to put the technology transfer process into practice; f) Support Organism - informs if the OTT uses the services of a support organism, like a foundation, to manage the projects; g) Projects management - it indicates if the TTO uses some mechanism of projects management, including some type of projects evaluation.

On the other hand, the activities carried out by the TTOs were analyzed, including: a) Attention to technological demands; b) Management of technological services; c) Negotiation of technological projects; d) Elaboration of agreements and contracts; e) Intellectual property register; f) Technologies and patent licensing; g) Training of human resources; h) Technological diffusion events.

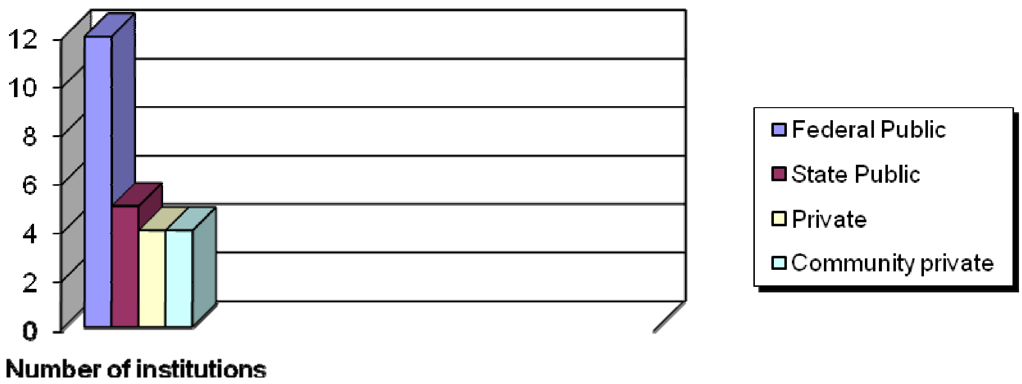
4. Data Analysis

In order to analyze the main surveyed aspects, the same sequence adopted in the questionnaire will be used, which included the creation of the offices, the organizational structure, staff, budget, and services.

4.1. Creation of the TTOs

The first aspect analyzed was related to the segment to which the 25 identified TTOs belong. It was observed (see Figure 2) that there is a predominance of TTOs in public universities (68%). This fact is not a surprise, since it is exactly in the public universities where the greater volume of Brazilian scientific investigation is concentrated (MCT, 1992), and the accomplishment of research in the institution is an indispensable condition to promote technology transfer, once the research results are the main inputs of a TTO.

Figure 2: Segment to which the Brazilian TTOs belong



It was also observed that most of the TTOs were created during the 90s, in tune with the international trend. As appointed in an OECD study (OECD, 2003) most of the recently created TTOs are, on average, 12 years old, in the United States, and less than 10 in the other countries of the OECD.

As to the designation of the structures found in the universities that fulfil the functions of a TTO, several different designations have been observed, from nuclei, coordination, agencies and offices themselves. This may be explained by the lack of a federal legislation similar to countries such as the United States and Spain, where the legislation induces to a homogenous designation – TTOs in the American case, and Oficinas de Transferencia de Resultados de Investigación (OTRIs), in the Spanish case. Consequently, the TTOs have been created by decision of each individual institution, from its own perceptions on the need and relevance of an instance with such purpose.

With respect to the hierarchic subordination, the TTOs are, in general, linked to a Research and Graduate Studies Vice-Presidency. There are few TTOs linked directly to the Presidency of the University, and none of them constitute an autonomous entity.

Concerning the budget, of the 25 TTOs, only 7 can count on their own budget. The other 18 depend on resources of the university budget. Only 28% of the TTOs generate their own resources through services or percentage on projects or royalties obtained by technology and patent licensing. In those cases, the greater volume of income obtained by the TTOs comes from services and returns generated by the projects. The amounts obtained by royalties through licensing activities are still insignificant, which demonstrates the gap between Brazilian TTOs and their equivalents in developed countries.

4.2. Organizational Structure

We have also verified a great diversity in the organizational structure:

In 60% of the institutions the structure is not centralized, and there are other instances that fulfil the same function in managing university-enterprise projects;

In only 20% of the institutions the structure is centralized. In those cases, TTO is the only instance in charge of the formalization of the university-enterprise and intellectual property activities;

In the other 20%, the structure is centralized only for some activities.

Although this diversity can be associated, in the Brazilian case, to the indefinite role that most TTOs play in the whole organizational structure, or to a lack of institutional legitimacy to perform their functions, the analysis can lead to a different interpretation if compared to their international counterparts. A great diversity has also been observed in the institutional adjustments adopted by universities in the OECD countries, where the following instances are mentioned: (i) TTOs dedicated to identify, to protect, and to operate intellectual property; (ii) administrative departments whose main function is not intellectual property management; and (iii) external (public or private) providers of intellectual property management services (OECD, 2003). Therefore, the diversity observed by this study, more than a local characteristic, reflects the lack of clarity in the understanding of such activities both in the university scope and in a broader context as well.

The investigation revealed that the vast majority of the institutions rely on a support foundation for managing their activities (76%). These data inform the need for agile, flexible procedures, once bureaucratic routines are incompatible with technology transfer processes. Only 52% of the TTOs use project evaluation mechanisms, indicating the still incipient preoccupation with the effective institutionalization of university-enterprise interaction activities.

4.3. Staff

From the staff's standpoint, our investigation reported that the TTOs present a very small structure. The smallest identified structure was formed by only one person performing all the activities, and the largest staff had sixteen professionals. The average number in the Brazilian TTOs is similar to their USA and OECD counterparts, that is 3.5 workers.

As far as staff specialization is concerned, some points deserve to be underlined. A specialized staff either in a technological or in a management area, in which they develop a specialized knowledge, characterizes the majority of the TTO professionals. Nevertheless, in the Brazilian case, the TTOs staff is still far from specialization or expertise. The presence of a high number of temporary workers (scholarship holders) reveals the difficulty to constitute a professional staff. The temporary character of the personnel work hinders the consolidation and improvement of the activities performed by the TTOs, and slows down potential advances that a better trained staff would certainly promote.

Different from what we can observe in the international experience, where the TTOs are managed by professionals, in Brazil there is a significant number of professors in the coordination of TTOs. On the one hand, this means that there is an institutional recognition of the importance of the role played by the TTO, since professors are the professionals with the greatest prestige and status in the university; but, on the other hand, it may hinder the professional performance required for the management of the interface with the productive sector. However, due to excessive workload that professors carry in accomplishing the tasks of teaching and researching, it certainly becomes hard, on top of that, to manage a TTO with the required professionalism and commitment.

4.4. Activities Performed

The activities performed by TTOs, are, in general, very similar. The activity that presented the lowest performance was patent licensing. Although 16 TTOs are mostly in charge of patent licensing, only 5 institutions have, indeed, succeeded in this activity, totalling a total of 14 licensed patents.

Considering the lack of specialized staff in the technology transfer management, around 80% of the offices are also involved in educational activities, such as courses and seminars, with the aim of training their staff in intellectual property and technology transfer matters.

The data presented and analyzed in this study lead us to the conclusion that diversity is the main characteristic of the Brazilian TTOs. Although such diversity may result from the institutional need for adjustment to the local conditions, it may reflect a relative incomprehension of the specific TTO functions. Those functions are not always very clear. Some of the TTOs described as such do not fit into this category, proving that the specificity of the TTOs is not clearly understood by the other university instances.

Although the variability in the denomination of the TTOs can be seen as a lesser question, if analyzed comparatively with the experience of other countries, for instance, United States and Spain, the uniform designation reflects an underlying governmental policy - in the American case, the Bayh-Dole Act, and in the Spanish case, by the National Plan of R&D. Thus, what we propose here is not a uniform denomination, but the necessity for a governmental policy to endorse, legitimize and define the role that these structures must fulfil in the context of the Brazilian universities. A much stronger exchange of technology transfer experiences among universities would be necessary to advance towards a Brazilian model of good practices that would establish procedures and useful tools to increase TTO's effectiveness.

Related to the activities developed by the TTOs, there are some gaps as perceived by Terra: "the Brazilian TTOs act not like managers of the valuation of the generated knowledge, but like administrators of contracts of academic services" (Terra, 1999, p. 171). Nevertheless, through the data collected in this study we can perceive the reconfiguration of this scenario, with the introduction of intellectual property management. We cannot be unaware of the advances obtained by some offices in their aim to protect and license their patents, mainly those inserted in universities with a greater volume of research results. It demonstrates their effectiveness in the valuation of intellectual capital and the knowledge generated by the Brazilian researchers.

At the moment, the Brazilian TTOs perform a triple function: 1. Management of university-enterprise interaction activities; 2. Intellectual property register; and 3. Technology transfer through technologies and patent licensing. With respect to the first two functions, it is possible to state that the universities have taken great steps. Nevertheless, the greatest challenge lies in the third one. Some universities have been able to generate funds through patent licensing activities. Others, however, although they produce a reasonable volume of research, are still in a very incipient stage towards the licensing of research results and need a great institutional effort to put the technology transfer processes into practice.

In this context, the next section will present a case analysis - the TTO of the Federal University of Rio Grande do Sul, describing and analyzing how a Brazilian Public University TTO put into practice its activities, comparing its particular performance to the general ones. The analyzed case of the TTO of the Federal University of Rio Grande do Sul demonstrates, among other aspects, the importance of institutional technology transfer strategies, and shows how the institution put its experience into practice, following a *learning by doing* method.

5. Case Analysis

The Federal University of Rio Grande do Sul – UFRGS is a federal, public university, founded in 1934. It is located in Porto Alegre, the capital of the State of Rio Grande do Sul, and is the largest university in southern of Brazil, with around 30,000 undergraduate and graduate students. Today, it is also one of the most outstanding research institutions in Brazil, carrying out almost 3,000 research projects in around 900 different areas.

More than 400 laboratories and about 500 research groups express the research capacity of UFRGS. The excellence of its graduate programs can be measured by the national evaluation realized by CAPES[71], in which UFRGS is ranked as the second best university in the country, in terms of the quality of its courses, and constitutes the only Brazilian university that did not have any of its programs reproved.

The management of technology transfer and university-enterprise interaction is carried out, mainly, through the support foundations and by the Secretariat of Technological Development, to which the Office of Interaction and Technology Transfer (EITT) is linked since October, 2000.

5.1. TTO Antecedents

The Office of Projects Consultancy – the previous name of EITT – was created in March, 1997, as a strategic option of the University to improve its relationships with society as established in its institutional policy. Besides, the creation of this office attended to a commitment that UFRGS had taken with FINEP (Financier of Studies and Projects), through the FINEP-TEC Program, to "maintain a permanent structure for management of R&D Projects with enterprises" (Agreement nº 8.6.95.0323.00).

The core business of EITT was projects management, and for this reason the interface with enterprises was seen as a result of the faculty activities. It was, in fact, a linear management model, in which the role played by the University was limited to its research and education functions. Besides, the proposal of interaction with society was too timid, limited to the organization of seminars, courses and workshops. It did not include, for instance, the promotion of sponsored research projects, technology transfer, and intellectual property licensing.

Due to the amount of research projects and the increasing number of contracts, a dynamic was established that did not fit to this Office model. It was necessary to create a "tailor made" model, putting new emphasis in the connection of the University with the market.

On the other hand, the configuration of a new national scenario in the technology transfer , particularly, the new intellectual property Laws - Industrial Property (9.279/96), New Plants Varieties (9.456/97), Software (9.609/98), Copyright (9.610/98) and, more specifically, the Decree nº. 2.553/98, that regulates the sharing of the economic profits derived from licensing activities, instituting, as a prize, the limit of 1/3 to the researchers - imposed new requirements to universities, in terms of internal procedures, in order to integrate these new activities to the institutional context.

These combined factors – the opportunity of new national legislations and the necessity to change the office's focus – did create better conditions for the performance of the EITT as the

[71] Coordenação do Aperfeiçoamento do Pessoal de Nível Superior - CAPES is the organism that, in Brazil, is responsible for the evaluation of the graduate education.

main institutional mechanism to manage university-enterprise interactions and to put into practice technology transfer and intellectual property procedures. As well as the institutional mechanisms created based on the concept of the Triple Helix (Etzkowitz, 1996), the nucleus of EITT activities is to join science, technology and economic development, stimulating and facilitating the interaction of UFRGS with enterprises and government.

The fact of having been the first university technology transfer office in the State of Rio Grande do Sul imposed several challenges to its organization, specially due to the lack of references to follow. Everything was new, because there was no sector in the institution that performed, at least, some of the office's proposed functions. The references were from foreign institutions and the very few national experiences were inserted in other contexts that did not always fit to the local conditions.

Thus, the internal endorsement by the different instances in the university administration, and the external recognition expressed by the financial support, created the necessary conditions for EITT to start working.

5.2. Main Functions

To carry out its activities, the EITT adopted a very simple structure that put the institutional policy and mission into action. In addition to administrative support and legal consultancy, there is an ad hoc Committee, which has the purpose to support the decision making process in matters concerned with the office's activities.

The main functions of EITT are divided into three areas: Intellectual Property, Business Division and Technological Diffusion.

The Intellectual Property area takes care of all the steps involved in the protection of intangible assets, from the invention disclosure to the patenting and licensing. A monitoring system is used to accompany all the processes and to ensure the meeting of deadlines in all stages.

The Business Division encloses the negotiation of sponsored research projects, as well as the elaboration of technology transfer agreements and contracts. The Technology Licensing Sector carries out, among other activities, market and economic valuation of the technologies to be licensed; identification of potential licensees; elaboration of licensing contracts; supervision of technical assistance involved in the technology transfer process. The Technological Consultancies is another sector in the Business Division and has the main purpose to meet demands of SMEs. These consultancies can comprise a range of activities, from simple technological services to more complex research projects.

The Technological Diffusion area plays a double role: internally, it constitutes an information channel about technological research projects opportunities; externally; its role is to spread the university technological products, as well as the specialization of its faculty members, and the technical resources that are available in the institution. With this aim, the Information System Sector keeps a database with the main institutional competences in different areas of knowledge carried out by its more than 400 laboratories. The Divulgation and Events Sector is responsible for promoting events with the aim to bring the internal community closer to external partners, looking for partnership opportunities.

Despite the formal structure EITT has, with clearly defined functions, it is important to point out that the staff is small, and for this reason, the sectors are mostly defined by the activities rather than by the limits that the organizational configuration can suggest. There is a permanent connection among the team members.

5.3. Position of EITT in the University Structure

From 1997 to 2000, the EITT was hierarchically subordinated to the Research Vice-Presidency, as an administrative department. Since October 2000, it has been integrated to the Secretariat of Technological Development, which was created as an organ of the Presidency of the University.

In order to give agility and to make possible its technology transfer activities, the EITT contracts the services of the University foundation.

In spite of being recognized as the institutional instance responsible for technology transfer activities, the attributions of EITT are not formally described in the University Statements. There is only an Administrative Act, signed by the President, creating the office.

This lack of formality brings about advantages and disadvantages. The main advantage is linked to the flexibility that it confers to effectuate changes, especially because of the dynamism inherent to technology transfer. On the other hand, the disadvantage is related to the weak institutional legitimacy due to the “nonofficial” character of its actions. For this reason, the office can become very fragile, because it strongly depends on the leader who is governing the University.

The autonomy in the decision making process is limited to routine matters or to the subjects to which the office has exclusive competence. Subjects like hiring specialized professionals are strongly limited by the bureaucratic procedures of the University. This is a very important restriction in the Brazilian context that has to be faced by offices like EITT.

Therefore, even when it is considered strategic for the university to keep an office, there are many obstacles to be faced by the managers to put daily activities into practice. In the EITT’s case, these limitations have been punctually identified and the most important is that the high administration has given the needed support and has allowed some advances that situate EITT among the most important Brazilian technology transfer offices.

5.4. Relationship with the Market

The portfolio of services of the EITT has always been conditioned by the internal capacity of attention to the demands. This fact has determined the adoption of a “step by step” strategy for services supply, that is, the supply has been extended as soon as the office gets the technical requirements to do it.

The EITT is oriented by a differentiation strategy, supplying services that are not done by other instances inside the University. So, there is a focus on intellectual property management services, an area in which only EITT has worked. To sum up, we can say that the intellectual property management is the opportunity window of EITT. Here is situated its “internal market monopoly”, and, therefore, its main source of legitimacy.

Externally, the action of EITT aims to stimulate partnerships with different sectors of the productive sector, through different institutional arrangements. So, many activities address this objective as, for instance: a) Participation in specific networks, as the Intellectual Property and Technology Commercialization Network (Rede de Propriedade Intelectual e Comercialização de Tecnologia – REPICT), of Rio de Janeiro; b) Participation in international committees, as the Technological Development Committee, created in the context of the Montevideo Group

Universities Association (Asociación de Universidades do Grupo Montevideo- AUGM); c) Participation in Industrial Forums, linked to the Regional Industrial Federation, in specific groups like the Technology Group at the Federation of Industries of the State of Rio Grande do Sul (FIERGS) and the Technological Committee at the Chemistry Industry Syndicate.

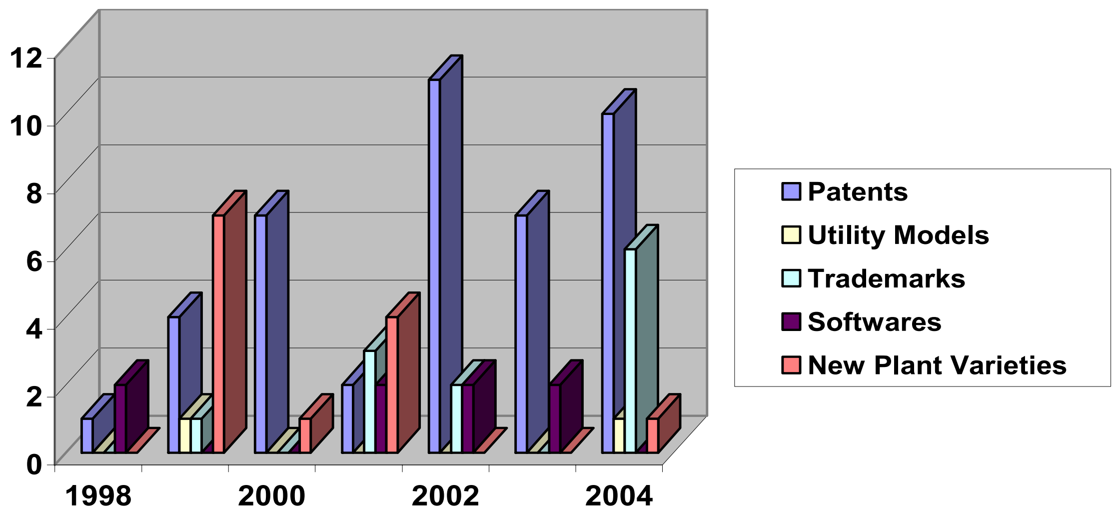
Related to the negotiation strategy with its partners, the EITT adopts the win-win approach and trust is considered the fundamental element for a successful relationship.

5.5. Results

The EITT is oriented towards results. In this context, time is a very important variable, because, in general, a technology transfer task becomes fruitful only after a long time and involves some factors that do not depend directly on EITT's action. Therefore, a prudence strategy has been adopted side by side with constant evaluation in order to allow, if necessary, a change of route.

So, after seven years, EITT has presented some results, which reflect its performance. In terms of intellectual property management, Figure 3 shows some data related to this subject.

Figure 3: Applications on Intellectual Property, per year.



As shown in Figure 3, from 1998 to 2000 there was a regular increase in patent files, followed by an abrupt decrease in 2001, which was compensated in 2002. From this year on, an annual average of 6 filed patents has been kept.

The adoption of more rigorous criteria in the patent file decision-making and a systematic procedure of searching for novelty in patent databases lie among other reasons for the observed decline.

These quantitative indicators totalled, in December 2004, 44 filed patents, 8 requested trademarks, 8 issued softwares and 12 new plant varieties registered. It is necessary to emphasize that 3 (three) patents were also filed abroad - in South Africa, France and Uruguay, having already been issued in the first two. In Brazil, only 2 patents have been issued to date.

Another area in which EITT has acted very intensively is the professional training in intellectual property and technology transfer management. The courses and seminars carried out by EITT, have allowed around 150 people to be trained per year, not only from UFRGS but also from other academic institutions and local and regional companies.

The technology licensing activities have demanded a great effort by EITT's staff. Despite this fact, the results are not significant, in terms of both licenses and the amount of royalties, which until December 2004 was around US$ 50,000. Nevertheless, the impact of this activity is inexpressive, considering the high potential of the institution.

Meanwhile, it is worth considering that the most important result can be measured not by the quantitative impact, but by its qualitative results in terms of the learning process, allowing a better knowledge about companies' practices and also a clearer perception of the complexity involved in the technology transfer process. Despite the importance of quantitative indicators in the performance measurement, in the case of EITT the qualitative aspects surpass the quantitative ones. The promoted changes in the University, related to an adequate valuation of the intellectual patrimony and the creation of better conditions for the university-enterprise interaction, constitute the main results obtained by EITT.

In order to evaluate its performance, in 2003 a survey was carried out in order to measure the EITT customer's satisfaction. The results of this survey indicate that the majority of the customers are completely satisfied with the services supplied by EITT. However, it is important to point out that as important as it is to survey the internal client's opinion, it is also relevant to know what the external clients are thinking, especially the companies.

The qualitative evidence of this case supports to the idea that the organizational performance is the result and reflection of the way people put activities into practice. In the case of EITT, although the great effort has been made in terms of training, and the great motivation of the staff in order to "do the right things" and "do the things right", the technology transfer tasks are still developed in an amateur way. To keep a motivated staff is essential, but good will is not enough when we have to face such a complex subject as technology transfer.

6. Conclusions

It is important to point out that the success of technology transfer activities at universities depends, fundamentally, on the way they are inserted in the institutional context. It is essential that university's top management perform a visible leadership in the conduction of the policies and the operation of the programs of interaction with enterprises, in order to guarantee the necessary institutional resources for its execution.

Surely, the most important condition for advances in this area is the need for the university to explicitly takes part in the economic development, adopting the idea of the technological management with all its consequences thoroughly, i.e., not only in the institutional policy, but also in matters related to the infrastructure and the managerial practices, including fund raising. It is of fundamental importance that the university leaders, including the President and the first level of the administration, assume their commitment with university-enterprise-government interaction, as a function of the university. In the present stage of development of the majority of Brazilian institutions, this is still an objective to be reached.

Unfortunately, the advances that many offices have been able to obtain result from individual initiatives, more than from institutional commitment with the subject, a fact that may eventually jeopardize the maintenance and consolidation of the experiences. The institutionalization of the matter, thus, stands out as an urgent issue. Fortunately, on the other hand, after the

Technological Innovation Law has been signed, some advances towards the legal recognition of the nuclei of technological innovation can be foreseen, as an institutional mechanism for the management of the innovation policy in scientific and technological institutions.

Nevertheless, it is necessary to point out that the legal devices alone are not enough to guarantee that the advances will be reached. Governmental policies only reach their objectives if accompanied by mechanisms that induce to cultural changes in the university community and to the deepening of their understanding on the role of the university in the innovation process.

A more professional approach to technology transfer is needed to achieve a greater degree of effectiveness. Conformity with a model of good practices based on WAITRO's proposal (WAITRO, 1997) would integrate a set of functions that need to success, as it was confirmed by the authors of this paper through the analysis of the sample and the case study.

The role of informal relations should also be underlined as a very important variable in the process of diffusion of technology transfer practices in the country, fundamental for identifying opportunities of cooperative projects with companies, and for exchanging ideas among TTOs managers.

Finally, it is important to emphasize that, in spite of the difficulties inherent to their incipient conditions, the TTOs are gradually introducing a cultural change in the technology transfer processes, open to the innovations that must be integrally explored.

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ICT Business Incubation: Evidence from Mauritius

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Abstract

The purpose of this paper is to examine the development of the ICT sector in Mauritius and the ICT Incubator Centre managed by the National Computer Board that has been successfully initiated and implemented.

The ICT sector in Mauritius has witnessed major development and undergone rapid and sustained growth over the recent years. The vision of the government to transform Mauritius into a Cyber Island in the year 2000 and making ICT the fifth pillar of the economy is gradually taking shape. One of the determining factors for the rapid development of the ICT sector is the high-level of political commitment through the ICT Ministerial Committee chaired by the Prime Minister. Under this Committee, three task forces were set up to manage the (i) Cyber City and Business Parks (ii) E-Education & Training and the (iii) E-Government. To this effect, the Government strategy has been fully geared to create an environment conducive to ensuring unparalleled development of this sector.

As part of the ICT Development strategy, the National Computer Board had undertaken a feasibility study in May 2001 for the setting up of an ICT Incubator Centre, and submitted its recommendations to the parent Ministry. The document was instrumental to promote business incubation as an economic strategy and for securing funding to kick-start this project. In the Government Budget Speech 2001/2002 the following paragraph was noted "*In our drive to make of Mauritius a Cyber Island, we are not ignoring the need to promote Mauritian entrepreneurship. Our young people are endowed with talent and potential for innovative ideas in ICT. They need to be provided with the necessary support and facilities. The National Computer Board will set up an ICT incubator to promote start- ups.*". The mechanisms for the procurement, commissioning were initiated thereafter, and the Centre was fully operational in January 2003 with initially four tenants. The project was customised for the local context while paying special attention to the main recommendations of the feasibility report. The document also elaborates on the stages of development of the ICT Incubator Centre since its conception as an idea to its implementation.

As an integrated effort to nurture ICT start-ups, the centre offers business support, logistics and infrastructural facilities to youngsters with innovative business ideas. The objective is to promote entrepreneurship and to create fledgling enterprises in the ICT Sector. The unit occupies a surface area of 500 m^2. and can accommodate nine start-ups. Besides the services and facilities provided, the Centre has developed a local network to promote and nurture its start-ups and to promote entrepreneurship. The Incubator Centre was initially conceived to help local entrepreneurs and gradually the joint venture undertakings comprising of local and foreign enterprises have been accommodated.

Since its operations eighteen enterprises have benefited from the business support, logistics and infrastructural facilities offered by the ICT Incubator Centre. As at date five enterprises have successfully graduated from this facility. As a case study, three enterprises' business track records during their tenancy at the ICT Incubator Centre will be examined namely M-ITC Co Ltd, Innovative Creative Lines (ICL) Ltd and AM Web Solutions Ltd.

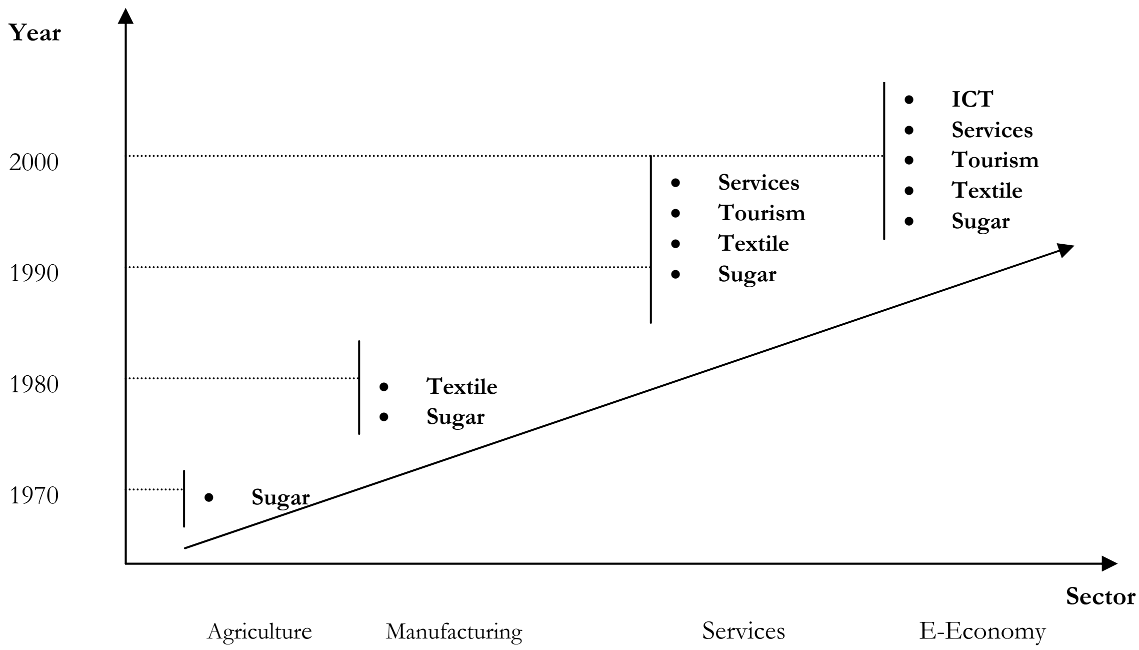
1. Economic Landscape

Since its independence in 1968, Mauritius has developed from a relatively low-income, agriculturally based economy to a middle-income diversified economy with growing industrial, financial, tourist and ICT sectors. For most of the period, annual growth has been in the order of 5% to 6%. This remarkable achievement has been reflected in more equitable income distribution, increased life expectancy, lowered infant mortality, and a much-improved infrastructure. Sugar cane is grown on about 90% of the cultivated land area and accounts for 25% of export earnings (CIA - The World Fact book – Mauritius 2005). Mauritius has achieved one of the highest per capita gross domestic products in Africa; about US$ 4,600 in 2003, up from about US$ 320 in the early 1970s. (IMF, 2005).

Notwithstanding its economic success, Mauritius has to reckon with several challenges to ensure sustainable development, which includes the rapid pace of technological progress, the increasing integration of global commodity and financial markets and the emergence of new low-cost competitor countries. The strengthening of major trading blocs, the likely erosion of market preferences under the WTO regime, and the increase in non-tariff barriers in the form of "green" and "social" protectionism have all called for innovative, flexible and determined responses.

After two decades of remarkable export-led economic growth, the economy has been redirected towards higher value, knowledge intensive products and services. The government's development strategy centres on expanding local financial institutions and making Information and Communication Technology a fifth pillar of the economy. The evolution of the economy over the past 30 years is shown in Figure 1.

Figure 1: Mauritius: An Open Economy



Source: Central Statistical Office (CSO)

2. Development of the ICT sector & ICT Strategy

The ICT sector in Mauritius has witnessed major development and undergone rapid and lasting growth over the past five years. The vision of the government to transform Mauritius into a Cyber Island in the year 2000 and making ICT the fifth pillar of the economy has gradually taken shape. One of the determining factors for the rapid development of the ICT sector was the high level of political commitment through the ICT Ministerial Committee chaired by the Prime Minister. Under this Committee, three task forces were set up to manage the (i) Cyber City and Business Parks (ii) E-Education & Training and the (iii) E-Government. To this effect, the Government strategy had been fully geared to create an environment conducive to ensuring unparalleled development of this sector.

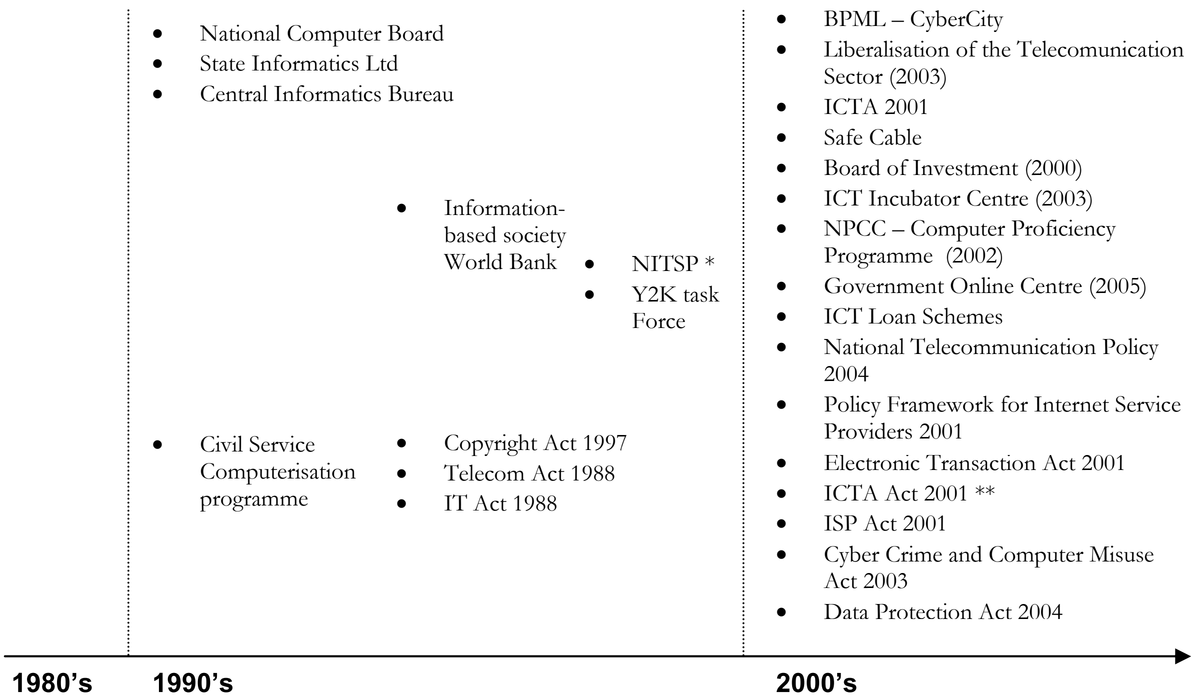
The ICT industry in Mauritius has evolved towards export-oriented services. An increasing number of foreign ICT companies have setup their development centres in Mauritius to conduct software development, multimedia, BPO and ITES activities for the export market. Key players already in Mauritius include Microsoft, Infosys, Accenture, Oracle, Infinity BPO among others.

2.1. Changing ICT Environment

The Changing ICT environment can be summarised as follows and shown in Figure 2:

a) The creation of relevant IT bodies in the late 80's and the introduction of the Civil Service Computerisation Programme
b) Late 80's saw the enactment of IT laws to regulate and promote this sector
c) The Millennium witnessed the creation of several bodies, financial schemes and improvement of the existing legal structure to promote ICT.

Figure 2: ICT Sector - Changing ICT Environment



* National IT Strategic Plan
** Including the ICT Appeal Tribunal, ICT Advisory Council

2.2. Early ICT Development – 80's

The evolution of the ICT sector in the late 80's has been gradual with the creation of the following institutions: - National Computer Board, State Informatics Ltd and the Central Informatics Bureau.

a. National Computer Board

The National Computer Board was set up in 1988 as a para-statal organization under the Ministry of Information Technology and Telecommunications. The mission of the National Computer Board is to promote the accelerated diffusion of Information Technology in every socio-economic sphere of Mauritius in line with the national goals and policies.

b. Central Informatics Bureau

The Central Informatics Bureau (CIB) was created in 1989 as a unit of the Ministry of Telecommunications and Information Technology. Its main functions are to plan and coordinate computerisation in the Civil Service.

c. State Informatics Ltd

State Informatics Limited (SIL) was established in 1989 as a stated owned company and could be considered as one of the largest ICT solutions provider in Mauritius. SIL has brought major contribution in the evolution and application of ICT in Mauritius over the last fifteen years. With its position at the forefront of technology, the state-owned company has continuously developing skills and expertise in state-of-the-art technologies to computerise both public and private sector institutions. Its successful strategic partnership with giants of the IT industry, namely Oracle, SUN, IBM, Microsoft and Veritas have extended the transfer of technology to Mauritius and the African region. SIL constantly concentrates its efforts in adopting the best technologies to meet the growing demands of the local and African markets.

2.3. ICT Legal Framework

The enactment of the following laws laid the first milestones for the development of the ICT sector: (a) Copyright Act - 1997 (b) Telecommunication Act - 1988 (c) The Information Technology Act - 1988. This effort was further reinforced with the enactment of the following laws:

(a) The Electronic Transactions Act 2000; (b) The Information and Communication Technologies (ICT) Act 2001 (repealing the Telecommunication Act 1988 and the Information Technology Act 1988); (c) ISP Act (2001) for the regulation of ISP operators; (d) The Computer Misuse and Cyber Crime Act 2003, and (e) The Data Protection Act 2004.

2.4. Policies for the ICT Sector

The National Telecommunications Policy 2004 outlined the objectives and targets for the Telecommunications sectors and set out strategies to be adopted. It also set out the methodology that would ensure fair, effective and sustainable competition for the new market paradigm.

The Policy framework for Internet Service Providers (2001) has set out the policy framework for the provision of the Internet Services in Mauritius. Government policy was to create an investment-friendly environment to enhance fair competition through a level playing field and to ensure Internet access at all affordable costs.

2.5. Creation of New ICT Institutional Framework

The implementation of the ICT Strategy has witnessed the creation of several bodies to facilitate, promote and regulate the ICT sector.

The Government created Business Park of Mauritius Ltd (BPML) in 2000 to spearhead the development, construction and management of the state-of-the-art Technology and hi-tech Business Parks in Mauritius. The Cyber Tower; a 12-storey building of 42,274 m^2 equipped with ultramodern features was inaugurated in April 2005. A second tower was under construction, scheduled to be operational in March 2006. More business parks would be located in strategic areas in the island.

The Board of Investment (BOI) was set up under the Investment Promotion Act of 2000, which was reviewed in 2004. The main objectives of the BOI are to attract investment and act as a facilitator to all investors. It has also encouraged ICT Development through the following schemes: - (a) ICT Development (b) The Pioneer Status Certificate. Both schemes offer fiscal and non-fiscal incentives to investors operating in the ICT sector.

The Information and Communication Authority (ICTA) was set up under the ICT Act 2001. It provides for economic and technical monitoring of the telecommunication industry in accordance with recognised international standard practices, including the promotion of fair competition and efficient market conduct within that industry, and ensuring appropriate control, inspection and regulation of the industry. It is the main regulatory body for the Information Communications Technology and Postal services sectors. It also grants operator licenses, allocates frequencies and ensures safety and quality of every telecommunication service.

The ICT Appeal Tribunal was conceived through the ICT Act 2001. Its role is to hear and dispose of any appeal against a decision of the ICT Authority regarding disputes on ICT Related matters. Similarly, the ICT Advisory also complemented this Act to advise the Minister of Information Technology and Telecommunications on specific issues. These include the promotion of interested of consumers, purchasers and other users in respect of quality, variety and improvement of ICT services, tariff policy and the promotion of research and development of new ICT Techniques.

The National Productivity and Competitiveness Council (NPCC) was created in 2002 and has promoted ICT as tool for improving productivity. It has used the existing resources including existing IT school laboratory and resource persons after normal school hours to impart basic IT skills. NPCC had trained 37,000 people from different backgrounds and age groups (Source: Le Mauricien - 18 May 2005). As part of its IT culture promotion programme, the National Computer Board through its two IT Coached has trained up to 44,000 people in its ICT Literacy Programme.

The Government Online Centre (GOC) was set up in May 2005. The Government Online Centre (GOC) is a centralised data centre, which supports e-Government initiatives. It is equipped with the state-of-the-art IT Infrastructure. The government web portal (www.gov.mu) provides secure online government services round the clock. It also provides Internet access and email facilities to employees of Ministries and Departments, offers website publishing and hosting services and host common and back-office applications amongst others.

2.6. Telecommunications Infrastructure

The SAT-3/WASC/SAFE submarine optical fibre cable links Europe to the Far East through Mauritius and provides connectivity to worldwide destinations through ADSL, ISDN and high bandwidth international leased lines.

Mauritius Telecom, the national operator, has a Point of Presence (PoP) in Telehouse, Paris where major international bandwidth providers and key telecom operators are present for interconnection, thereby providing end-to-end service at very competitive rates.

The Government of Mauritius has brought forward the liberalisation of the telecommunications sector by one year, thus ending the exclusivity of the incumbent operator as from December 2002. The Telecommunication Sector is regulated by virtue of the ICT Act 2001 through an independent regulatory body, the Information and Communications Technology Authority (ICTA).

The sector comprises of (a) 2 fixed line operators (b) 3 mobile operators (c) 13 Internet Service Providers and (d) 8 International Long-Distance Operator. The table below summarises the services offered by various companies.

Licence	Company
Fixed Line Telephony-Public Switch (Fixed) Telephone Network (PSTN)	**1. Mauritius Telecom** **2. Mahanagar Telephone (Mtius) Ltd**
Mobile Telephony- Public Land Mobile Network (PLMN)	**1. Cellplus Mobile Communications Ltd** **2. Emtel Ltd** 3. Mahanagar Telephone (Mtius) Ltd
International Long Distance (ILD)	**1. TLC (Mauritius) Ltd** **2. City Call Ltd** **3. Data Communications Ltd** **4. Emtel Ltd** **5. Hot Link Co. Ltd** **6. I-Telecom Ltd** **7. Mahanagar Telephone (Mtius) Ltd** **8. Mauritius Telecom Ltd**
Internet Service Provider	**1. Africa Digital Bridges Network Ltd** 2. City Call Ltd 3. Clusterway Ltd **4. Data Communications Ltd** 5. Emtel Ltd **6. Harel Mallac & Co. Ltd** **7. I-Telecom Ltd*** **8. Mauripost Net Ltd** **9. MFDC Ltd*** 10. Paging Services Ltd **11. Rogers Telcom Ltd*** **12. SITA*** **13. Telecom Plus**
Internet Telephony Service	**1. Paging Services Ltd**
Facsimile Services	1. City Call Ltd 2. Telecom Plus Ltd **3. Van Tel Ltd**
Unified Messaging Service (UMS)	1. Africa Digital Bridges Network Ltd
Value Added Services	**1. Mauritius Telecom Ltd** 2. Telecom Plus Ltd

Source: ICTA
Note: Companies in bold are already operational.

* In the Internet Service Provider category, I-Telecom Ltd, MFDC Ltd, Rogers Telecom and SITA are operational but are not offering their services to the public.

2.7. The ITES-BPO Sector

IT-Enabled Services-Business Process Outsourcing (ITES-BPO) is seen as a very strong segment for the local ICT industry. Over the recent years, this sector has experienced an exponential growth. According to the BPO Secretariat, as at October 2005, 90 ITES-BPO companies were operating in the ICT sector and were employing 3,801 people. Call centres remains the highest generator of employment in the ICT sector with 2,071 people. The major BPO players currently operating in Mauritius include Accenture, Hinduja Group, Cendris (TPG Group), Centrefile, Berger-Levrault, Teleforma, Infinity Group and Victoria Group, amongst others.

The 90 companies operating in the ITES-BPO sector have generated a cumulative proposed investment level of Rs 1,445,162,274[72] with Call Centres and BPO companies having the highest levels of investment. Based on a recent survey carried out by the BOI, it appears that half of the proposed investment value has already been realised, i.e. Rs 726,445,492.

On the international scene, according to the NASSCOM McKinsey Study 2002, the global market size estimate of BPO was US$ 127 bn in 2001 and is expected to grow to US$ 234 bn in 2005 and US$ 310 bn in 2008. The main outsourcing destinations include Ireland, Australia, India, and the Philippines while China, Russia and Mexico are considered as upcoming destinations.

2.8. Financial Schemes for the ICT Sector

The Development Bank of Mauritius Ltd announced the following financial schemes to facilitate investment in the ICT sector:

(a) ICT Loan for setting up of enterprises engaged in ICT-enabled services. The ceiling for the loan is Rs 5 million bearing an interest of 8% p.a, which is repayable over a period five years.

(b) Under the Equity participation Fund a maximum amount of Rs 300,000 is provided to enterprises operating in the ICT and other high value-added sector, The scheme can be accessed at an interest rate of 8% per annum, which is payable out of dividends received by the borrower or otherwise during the previous financial year of the company. The loan will be guaranteed by a charge/pledge on the proposed shares to be acquired and a general floating charge after existing charges, if any, on the assets of the borrower.

(c) Under the Venture Capital Fund, maximum amount of Rs 1 million is provided to enterprises operating in the ICT sector. The purpose is to support start-ups and SMEs operating in the ICT sector including joint ventures with foreign partners. Interest Rate is not applicable and after a period of 6 years, the existing shareholders will have the choice to buy back the equity at a negotiated price.

(d) To simplify access to finance by SMEs engaged in the ICT and high value-added activities, which are unable to provide the traditional collaterals, an SME Loan Guarantee Fund has been set up to guarantee 50% of qualified SME loans. The Fund will guarantee 50% of the loan amount granted by the Development Bank of Mauritius. The maximum amount provided under this fund is Rs 500,000.

The bank periodically reviews the schemes to align them with government objectives to promote different sectors.

[72] Source: BPO Secretariat, Board of Investment

2.9. Key ICT Indicators

Over the year Mauritius has experienced sustainable growth in terms of ICT usage as depicted in the table below:

Key indicators	2000	2001	2002	2003	2004
Estimated Population (Millions)	1.193	1.205	1.217	1.228	1.233
Number of Households	296,300	305,900	311,300	321,000	n/a
Fixed Line teledensity	24%	26%	27%	28%	~29%
Cellular Mobile Phone teledensity	5%	25%	28%	38%	50%
Estimated household Internet penetration	12%	13%	16%	18%	n/a
% Household with a telephone	80	80	80	91	92

Source: CSO, National Computer Board, Mauritius Telecom

The growth of the ICT culture coupled with the liberalisation of the ISP Sector has contributed to the exponential growth of Internet users during the past years. The number of Internet users has increased from 87,000 in 2000 to 275,000 in 2004. The number of fixed-line subscribers increased from 262,000 in 2000 to 355,000 in 2004. The number of cellular-phone subscribers has grown from 180,000 in 2000 to 600,000 in 2004.

Capacity building at the tertiary level through its enrolment has grown at an average rate of 14% during the past four years with more students taking ICT and ICT related subjects. The following table indicates the enrolment in ICT at tertiary level from 2001 to 2004.

	2001	2002	2003	2004
Local institutions	1046	1506	2162	2141
Distance Learning	2158	1962	1543	
Overseas	365	618	804	
Total number of students enrolled in ICT	3569	4086	4509	

Source: Tertiary Education Council

The IMF Report (2005) has highlighted the following competitive advantages for the ICT Sector

(a) *Strong political commitment and social consensus.* The vision of the government and the public is to transform Mauritius into a "Cyber Island".

(b) *Knowledge spill over from India.* The successful experience of the Indian ICT sector is being transferred to Mauritius. The Indian ICT sector is advising the Mauritians on a development strategy and will also be sub-contracting some of its operations to Mauritius and investing in the domestic sector.

(c) *Bilingual nature of the labour force.* The ability of the Mauritian labour force to speak both English and French is an important competitive advantage.

(d) *Infrastructure improvement.* The government is embarking on substantial capital outlays to set up the physical and communication infrastructure. As a springboard, the Ebene Cyber City started operating from December 2003 with much of its space for private investors already taken up by global ICT firms.

As ICT production becomes a larger share of total output, The ICT sector would play a greater role in driving Mauritian medium-term growth. The contribution to overall growth might amount to 10 per cent starting in 2004/05. However, the job creation of the ICT sector is expected to be limited.

Baseline Projection of the ICT Sector (In percent, unless otherwise indicated)						
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Share of nominal GDP	2.1	2.3	2.6	2.9	3.2	3.5
ICT real growth	10.0	17.0	20.0	16.0	15.0	15.0
Overall GDP growth	3.3	5.5	5.1	4.9	4.6	4.6
Contribution to growth	6.4	7.1	10.2	9.5	10.4	11.4
Total employment	2,000	5,000	8,000	9,000	10,000	11,000

Source: IMF 2005

3. ICT Business Incubation

The second part of this article deals with the business incubation experience in Mauritius.

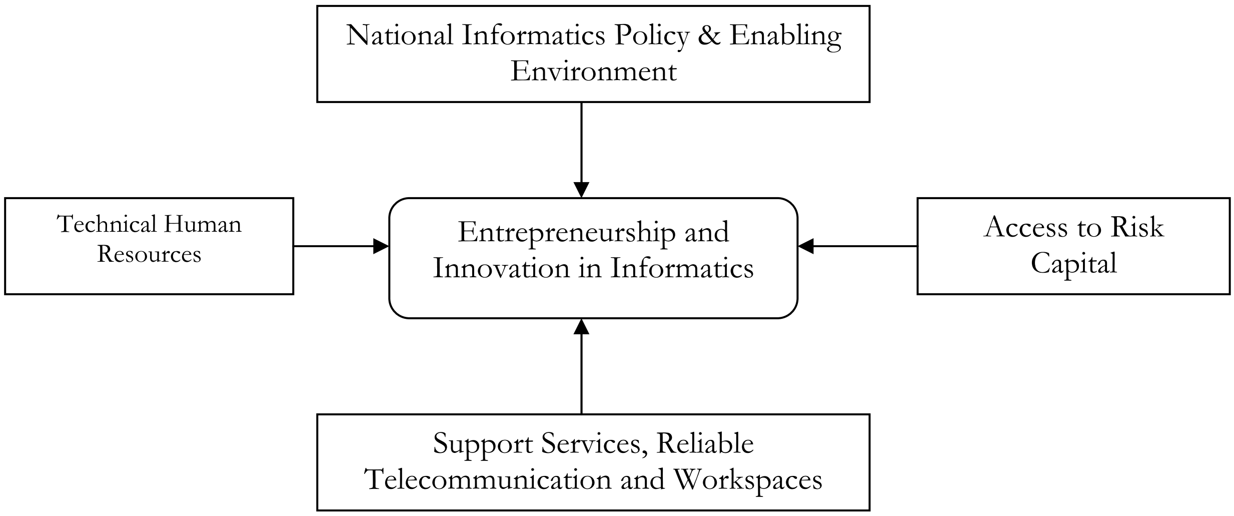
3.1. First Attempt – Technology Business Incubator

A first attempt to set up a technology business incubator was tried through a consultancy exercise conducted by the Ministry of Industry and Industrial Technology with the assistance of UNIDO in 1991. The objectives of the study were (a) to explore the possibility of establishing a mechanism to provide support services to informatics activities in Mauritius (b) to assess the interest in forming a sub regional centre for Informatics training.

The economic situation in the 1990's called for intensification of work on enhancing quality, factor productivity and cost competitiveness existing product lines and for diversification into value-added, knowledge-intensive goods and services and for creating effective linkages between sectors as well as EPZ and non-EPZ industries. The informatics sector was considered as a potential sector for the creation of value, wealth and employment generation. The government had repeatedly stated its intentions to give informatics related activities a central role for the next industrial phase.

One of the recommendations of the study was to set up a Technology Business Incubator for Informatics business and tackling the following issues at the outset (a) Creation of a National Informatics Policy & Enabling environment (b) Ensure availability of technical Human Resources (b) Access to Risk Capital (d) Support Services such as reliable telecommunication network and workspaces.

Figure 3:



3.1.1. Technology Business Incubator

The Technical Business Incubator as per the study would be as follows:

A micro-facility with a small trained motivated management staff, which would provide start-up companies with the following types of services:

(a) Affordable workspace;

(b) Share facilities (such as receptionist, conference room, office equipment, and secretarial help);

(c) Focused support services (particularly on the software of business development such as management, marketing, legal, accounting and similar support;

(d) Access to seed money (often through an internal revolving fund, which would provide small loans on commercial terms but without significant collateral;

(e) The synergy of sharing (entrepreneurs working close to each other would be able to share experiences and also buy/sell form each other;

It was also emphasised the characteristics of an incubator would differ significantly from the usual workspaces in the following manner:

(f) The incubator would primarily be for start-up companies;

(g) It would provide focussed management and technical assistance to tenants, from helping them to write business plans to securing working capital;

(h) It would have rigid entry requirements (only one in 10 applicants would usually be selected);

(i) It would have stipulated exit rules, so after 2 or 3 years the tenant must leave the space to make way for a new entrepreneur;

(j) The incubator would also serve important social functions such as (a) creating new self-owned businesses, particularly among youth, women and other disadvantaged groups, (b) helping disperse economic activity to non-metropolitan towns and rural areas, and (c) bridging the culture gap between university-research-laboratory-private/ state enterprises;

The technology incubator model proposed was as follows:

Gross space	1,000 m2 (starting with 500 m2 in first year)
Rentable space	750 m2 (balance being for common facilities)
Average space rented	675 m2 (due to partial vacancies)
No. of tenants	20 (in the 4th year, with 5 tenants in the first year).

Operational structure: A small management group would provide technical and management services to tenants, and further secure other specialised assistance in marketing, legal and accounting matters from an informal network of outside professionals. On this basis, the staff in the fourth year of operations would consist of (i) Manager (preferably an entrepreneur with a wide circle of contacts in the local community) (ii) Deputy Manager (to cover administration, building services and financial management assistance) (iii) Technologist (part-time, with full familiarity in software engineering and informatics services) (iv) Secretary (v) Receptionist (starting in fourth year) (vi) Messenger/Clerk.

Building lease: In order to save capital costs and time, it would be preferable to secure a vacant factory-type building space from the Government on a low (or no) rental basis.

Advisory services: Incubator management would provide general support to all tenants. In addition, specific training, managerial, marketing, accounting and financial services will be provided on a cost-recovery basis.

Other incubator income: The incubator management could provide technical/managerial services to entrepreneurs outside the incubator, such as "sick companies" in existing industrial estates, etc and generate additional income for this venture.

Capital costs: It was assumed that the space rented would be in fair shape, and would require painting and partition work. In addition, provision for furniture and office equipment (computer, fax, photocopies, and telephones) and pre-operational expenses, such as incubator promotion, etc would also need to be budgeted. (Possible grant technical assistance for preparing the feasibility study, training of incubator management, etc is not included in capital costs). The total capital investment for this venture was estimated at $100,000 and with a contingency expenditure of additional $75,000 was made.

Investment structure: It was proposed that the Development Bank of Mauritius would provide a revolving line of credit to be given as soft loans through the incubator management. The project would be funded through the creation of trust or foundation sponsored by various local agencies. The sponsorship for this project would be partly in the form of a grant and the balance in terms of soft loan from the bank.

3.1.2. Non-realisation

This project was not realised for various reasons and summarised as follows:

a) The business incubation concept was not internalised by policy makers during this period;
b) ICT was still in its earnest and the convergence in the business community was more oriented towards the provision of business support services;

c) The Telecommunication infrastructure was not well developed;

d) Financing for the ICT sector was not present;

e) The ICT legal framework was still in its infancy;

f) The incentive framework and policies was focussed to the development of the manufacturing sector, which was generating high employment and income;

g) The technical know-how in the ICT sector was focussed to the implementation of business solutions in enterprises rather than enterprise creation;

3.2. Second Attempt – Technology Business Incubator

A delegation from the National Computer Board visited the Incubators/Technology Centres in Aachen Germany in April 2001, following which it was proposed to undertake a feasibility study to assess the viability of setting up an ICT Incubator Centre in Mauritius. The services of an international consultant were retained for this purpose. Dr Ulrich Dalrup from GFE Consulting Worldwide based in Germany undertook a three-day mission and a detailed work plan was presented to put in place an ICT Incubator Centre under the auspices of the National Computer Board. The main recommendations as per the feasibility report were as follows:

(i) *As the Mauritian Government decided to go ahead with developing the digital industry in the country and to invest in a cyber-city infrastructure, the Incubator should be implemented at the earliest as this Incubator would serve to "breed" the ICT companies needed for the cyber city programme;*

(ii) *The need, to quickly close the technology gap with the OECD countries in the ICT sector;*

(iii) *Seeing the Indian ICT sector developing, Mauritius should develop its own resources to benefit from the high value added sector. With a highly qualified population and some outstanding IT-experts Mauritius should be able to quickly reach the running train of IT- business development and get its share of that emerging market;*

(iv) *The Mauritian economy would need highly qualified computer skilled workers;*

(v) *Investing in this sector would generate new employment with relatively high revenues;*

(vi) *Once this sector progresses, so called "linkage" industries should show up and "spin-offs" should give an auto-development to the sector;*

(vii) *Other sectors of the Mauritian economy should benefit from the new qualifications of the ICT sector;*

(viii) *Deregulations in the Telecom-sector, that might come one day also in Mauritius, would boost IT-business;*

(ix) *A co-operation with one of the successful Incubator programmes in Europe would facilitate this new venture. A two-year cooperation with GFE/Technology Centre of Apache is proposed.*

The ICT incubator programme would be as follows:

a) *an organisation, in the form of a private company, a public entity or an existing public or para-public institution, would manage the Incubator programme*

b) *an Incubator building;*

c) *a venture or / and risk fund, a bank or any other appropriate financial institution;*

d) *a consensus of relevant institutions and politics;*

e) *a technology producer (e.g. a Technical University), whose output would be skilled technology experts;*

f) *the individuals going into a start-up;*

g) *a network of helping, coaching and assisting institutions and individuals;*

The organization or the company/entity in charge of the Incubator programme would have to fulfil a number of activities/services:

(i) to identify potential start-uppers;

(ii) to cooperate with technology developers or owners to promote and facilitate to identify suitable candidates;

(iii) to set up a "Technology Transfer" with suitable technology developers, e.g. Universities, etc.;

(iv) to "screen" among the candidates those considered fit for entrepreneurship and whose technology idea has a market chance;

(v) to help the start-upper to set-up the financial foundation of its future company;

(vi) to help the start-upper to formulate the companies Business Plan, statutes, opening balance and to assist to register the new company;

(vii) to assist to find an appropriate office or production site (if no Incubator building is available);

(viii) to assist with advice in legal, bookkeeping, marketing matters;

(ix) to organize missions to fairs and exhibitions;

(x) to organize in house or local exhibitions;

(xi) to supervise/coach the management;

(xii) to advice the company in difficult situations, but also in periods of growth;

(xiii) to make available "Business Angels";

(xiv) seminars on diverse business subjects;

(xv) management of the Incubator building.

The proposed organisational structure was as follows:

(a) The creation of a new private company by stakeholders interested by the programme. The stakeholders would have to fund the budget of that company.

(b) Identify an existing entity or Governmental authority that could get additional mission this Incubator programme / or:

(c) To implement a new public or para-public institution in charge of the Incubator programme or to start the programme, the NCB would certainly have an interest to carry out the ICT-Incubator programme. In that case, NCB has to recruit the necessary new staff and enlarge its mission.

The proposed business incubator model was as follows:

Incubator building	**:**	**4000 to 5000 m²**
Facilities	:	Networked office with access high bandwidth, IT infrastructure to support this centre; common services such as telephone, fax, photocopy services, meeting room and conference facilities, restaurant, secretarial facilities, technical equipments (digital projectors).
Business support and counselling	:	Preparation of business plan to new and potential start-ups and on-going business support to enterprise within the centre; offers in-house facilities, as an auditing company, a bank and other service providers.
Rental charge	:	Graduated charges up to a five year period the start-ups pay in their first year only 60% of the calculated commercial rent - but in their last in fifth year they have to pay a full commercial rent.
Finance	:	Creation of a venture/risk fund for this new target group
Board representatives	:	(a) National Computer Board (b) Small and Medium Industries Development Organisation (SMIDO) (c) Development Bank of Mauritius (DBM) Ltd(d) Board of Investment (e) Joint Economic Council (f) Mauritius Research Council (g) University of Mauritius (h) Industrial and Vocational Training Board (IVTB) and (i) Mauritius Standard Bureau.
Networking	:	A Memorandum of Understanding (MOU) between National Computer Board (b) University of Mauritius and (c) SMIDO
Sector to be encouraged	:	Bio-technologies, medical-/pharmaceutical-technologies, marine-technologies and the crafts sector.

3.3. Financial Assistance for the programme

a) SMIDO would be a co-investor in an Incubator Building (with 3.5 million Rs). SMIDO would also co-finance (50%) the business plans of the start ups as it has a long experience with SME development;

b) Development Bank of Mauritius could fund the investments of the start-ups up to 60%. DBM could also evaluate the start-up candidates prior to become accepted to the programme;

c) The University of Mauritius would be the "technology producer" and is a "producer" of start-up candidates;

d) The Mauritius Research Council would be a facilitator for research work and could finance studies and research and development of the start-ups;

e) Board of Investment and the Mauritian Embassies abroad could promote the programme overseas to identify returning start-ups;

f) Private Banks might realize a venture/risk fund;

g) Elder highly experienced VIPs of Mauritius could become Business Angels;

h) A network of competence, from the island and from abroad could assist this programme;

3.4. The National Computer Board – ICT Incubator Centre

Following the recommendations made by Professor U. Dalrup in the feasibility report for the setting up of an ICT Incubator Centre, the National Computer Board requested funding from the Ministry of Information Technology and Telecommunications for this project. The document was instrumental to promote business incubation as an economic strategy and for securing funding to kick-start this project.

In the Government Budget Speech 2001/2002 the following paragraph was noted, "In our drive to make of Mauritius a Cyber Island, we are not ignoring the need to promote Mauritian entrepreneurship. Our young people are endowed with talent and potential for innovative ideas in ICT. They need to be provided with the necessary support and facilities. The National Computer Board will set up an ICT incubator to promote start-ups". The mechanisms for the procurement, commissioning were initiated thereafter, and the Centre was fully operational in January 2003 with initially four tenants. The project was customised for the local context while paying special attention to the main recommendations of the feasibility report.

As an integrated effort to nurture ICT start-ups, the centre offers business support, logistics and infrastructure facilities to youngsters with innovative business ideas. The objective is to promote entrepreneurship and to create fledgling enterprises in the ICT Sector. The unit occupies a surface area of 500 m^2 and can accommodate nine start-ups. Besides the services and facilities provided, the Centre has developed a local network to promote and nurture its start-ups and to promote entrepreneurship. The Incubator Centre was initially conceived to assist local entrepreneurs and gradually the joint venture undertakings comprising of local and foreign enterprises have been accommodated.

The National Computer Board Incubator Centre came into operation in January 2003 and was officially launched on the 21st April 2003. The ICT Incubator Centre provides infrastructural, logistics and business support to start-ups in the ICT sector. It covers a surface area of 5,534.24 sq ft and can accommodate up to nine start-ups.

The vision of the ICT Incubator Centre is to be a centre of excellence where ideas and entrepreneurship are transformed into successful and viable business ventures. It mission is to boost entrepreneurship in the ICT sector and to provide start-ups with the necessary business advisory services and financial support with viable business ventures.

The objectives of the ICT Incubator Centre are to:

a) Promote entrepreneurship in the ICT sector;
b) Boost job creation in the ICT sector;
c) Develop linkages with other institutions;
d) Market its start-ups.

The Centre offers infrastructure, logistics and business support to the start-ups in the ICT Sector.

Each office unit occupies a surface area of 20 m^2 and is networked with ADSL, data and telephone points, electricity and air-conditioning system. Access to premises is provided through an automated secured system. The Centre is equipped with a meeting room and provides a shared administration service include fax, photocopy and secretarial support.

The Incubator Management Team provides business support and advice to start-ups at the Centre. Training programmes are organised regularly at the Centre for capacity building of start-ups. Informative sessions are organised by the National Computer Board with key support institutions such as the Board of Investment, Development Bank of Mauritius Ltd amongst others. Regular meetings are organised with start-ups by the Incubator Management Team on issues related to enterprise development and marketing.

A start-up can benefit from the facilities and services offered by the ICT Incubator Centre for a maximum period of three years.

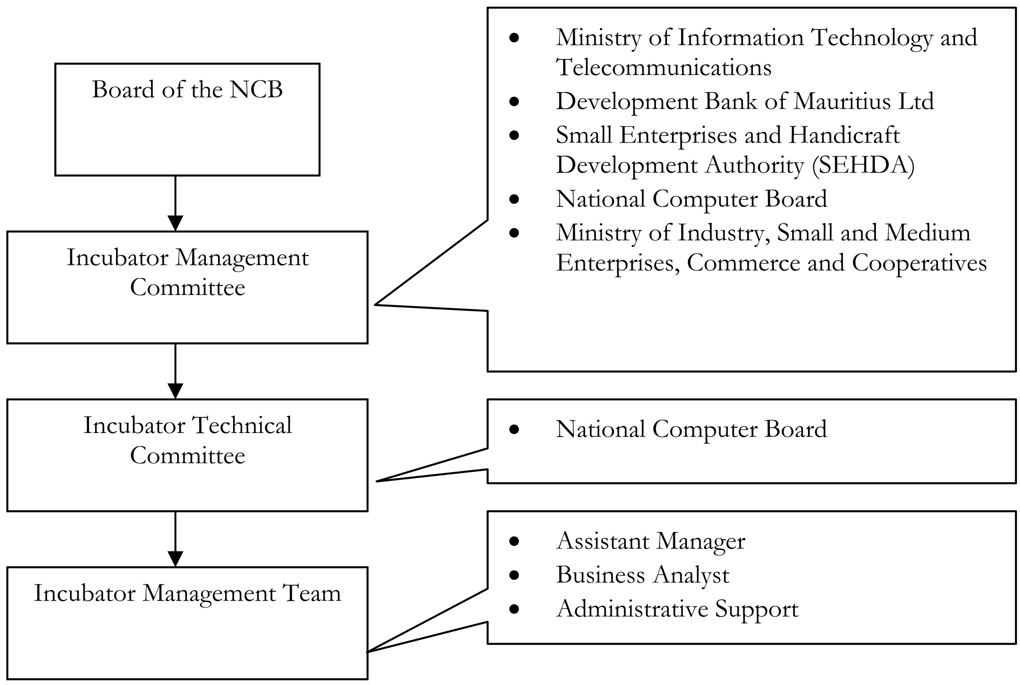
The charges for the centre are as follows:

Period	Monthly Charge (Rs)	Equivalence in US$
Year 1	6,000	194
Year 2	7,500	242
Year 3	8,625	278

3.5. Management of the ICT Incubator Centre

i) Incubator Management Committee

The activities of the ICT Incubator Centre are being monitored by an Incubator Management Committee. The membership to this committee includes the representatives from the Ministry of Information Technology and Telecommunications, the Development Bank of Mauritius (DBM) Ltd, Small Enterprises and Handicraft Development Authority (SEHDA) (formerly SMIDO), National Computer Board and the Ministry of Industry, Small and Medium Enterprises, Commerce and Cooperatives. The committee meets on a regular basis for policy decisions and approval of projects. The organisation structure is as follows:



ii) Staffing

The National Computer Board – ICT Incubator Centre is managed by one Assistant Manager and a Business Analyst. One Word Processing officer provides Secretarial and Administrative support.

iii) Technical Team

A technical team comprising of members of the NCB screens and reviews the project proposals received from potential start-ups for the ICT Incubator Centre and make recommendations to the Incubator Management Committee.

3.6. Cost Benefit Analysis – Investment, Turnover and Employment creation

i) Investment and running cost

The ICT Incubator Centre was set up with an initial investment of Rs 2.15 million.

The capital expenditure included the setting up of the necessary infrastructure and logistics for operating the Centre. It included cabling, wiring for broadband Internet connectivity, setting up of network points and setting up of the IT infrastructure. Meeting room facilities is available which is equipped with one multimedia projector and one laptop for visual presentation.

The National Computer Board meets the running cost for the ICT Incubator Centre through its yearly grant secured from the Ministry of Information Technology and Telecommunications. The running cost for the ICT Incubator Centre is estimated to be Rs 3.2 million per annum and includes rental cost of the building, staffing costs, electricity, telephone, ADSL Connection, and shared administration services such as photocopy and fax facilities among others.

The Centre also generates some revenue from the facilities and services offered to the start-ups located on the premises and include rent, fax and photocopying services. The revenue collected from these services is estimated at Rs 600,000 per annum.

ii) Investment by start-ups and job creation

One of the main objectives for the setting up of the ICT Incubator Centre was emphasis on employment creation.

Employment created in the financial year 2002/03 was 27, and 27 new jobs have been created Financial year 2003/04. For the financial year 2004/05, 33 new jobs were created. Similarly, the start-ups at the Incubator Centre have invested an amount of Rs 15.7 million in their business venture up to date.

3.7. Start-ups at ICT Incubator Centre

1. Since the ICT Incubator Centre became operational, the Centre has supported 17 start-ups in the ICT sector.
2. Out of these 17 start-ups, 5 companies have successfully graduated from the Incubator Centre.

Key indicators on start-ups at the ICT Incubator Centre are as follows:

	2002/03	2003/04	2004/05	Total
No of Companies hosted / Supported	6	11	13	18
Employment Created (New)	27	27	33	87
Investment made by these companies	Rs 2,440,000	Rs 5,217,400	Rs 8,042,600	Rs 15,700,000
No of Companies going out of the Centre				
Successful *	-	1a	4b	5
Unsuccessful	-	3	1	4
Total	-	4	5	9

Source : National Computer Board

Note: (a) Alliance Réseaux Ocean Indien Ltd (Dec 2003) (b) Innovative and Creative Lines Ltd (August 2004), Active Connect Ltd (February 2005), M-ITC Ltd (June 2005) and AM Web Solutions Ltd (June 2005).

* "Successful" here means graduating from the Incubator centre to a new location.

Based on the regular meetings with the start-ups (formal and informal) at the ICT Incubator Centre. A SWOT Analysis was formulated to this effect .The SWOT analysis captures the key strengths and weaknesses and also describes the opportunities and threats facing the start-ups at the National Computer Board – ICT Incubator Centre.

a) Strengths	b) Weaknesses
❑ Access to services provided by the Incubator Centre. ❑ Access to common logistics and shared administration facilities. ❑ In-house business counselling and timely advice. ❑ Secured workspace and subsequently flexible working hours. ❑ Access to various institutional network support and contacts through the National Computer Board. ❑ Easy access for media and events coverage. ❑ Networking with start-ups at the Incubator Centre is an added advantage for enterprise development. ❑ Flexibility - The ability to meet the customer's needs with a customized, flexible solution. ❑ Access to pool of graduates from the University of Mauritius for short-term assignments.	❑ The difficulty of building brand equity. ❑ Management training for promoters and employees. ❑ Loans facilities by banks not easily accessible. ❑ Specialised skills in ICT difficult to find. ❑ Absence of the local infrastructure for conducting online transactions and real time credit card validation mechanism.
c) Opportunities	**d) Threats**
❑ Increased business opportunities through outsourcing and potential joint ventures with the development of the Cyber City. ❑ Declining cost of Internet connectivity will create business opportunities for the start-ups. ❑ A period of three years of incubation increases the survival prospect of the start-ups.	❑ Future/potential competition from large ICT companies and multi-nationals. ❑ Given the nature of computer technology, investment in skills development and new software impedes on the cash flow of the start-ups.

Source: National Computer Board

3.8. Success & Failure

The ICT Incubator Centre has nurtured eighteen enterprises out of which some have successfully graduated while a few ones have closed down. The success rate has been attributable mostly to the perseverance, qualities of the entrepreneurs and the business network developed by the Incubator Centre. Failures of enterprise have been characterised (a) technical deficiencies (b) Inability of the entrepreneurs to properly market the product.

Under the technical deficiencies category, the absence of the local infrastructure for conducting online transactions and real time credit card validation mechanism was a major handicap to promote online transactions. At the same time, the purchasing habit of local consumers has been largely been limited to cash, cheque and with few credit card facilities.

On the other hand, the inability to properly market the product and services has also contributed to some extent to the downfall of some enterprises. The added burden of the rising cost of the facilities & services used by the enterprises at the Centre plus the salaries of employees accentuated the demise of these enterprises.

As a case study the business track records of M-ITC Co Ltd, Innovative and Creative Lines (ICL) Ltd and AM Web Solutions Ltd are detailed in Annex I, II, and III respectively.

3.9. Partnership and International Co-operation

The National Computer Board is working in close collaboration with local stakeholders in the areas of business development and capacity building. It includes the University of Mauritius, SEHDA amongst others. At the international level, the National Computer Board – ICT Incubator Centre has benefited of UNDP and the World Bank for technical assistance.

i) University of Mauritius

The National Computer Board had signed a memorandum of understanding with the University of Mauritius in the year 2002. The agreement had clearly set up guidelines for areas of cooperation, which includes provision for training, consultancy, marketing and mentoring to start-ups and to encourage Entrepreneurship Development in the ICT sector. In this context, a series of activities were organised jointly by the National Computer Board and the University of Mauritius.

ii) UNDP Assistance

The National Computer Board had prepared a project proposal to support new and potential start-ups incubators in the field of ICT. The aim of the study was be to appraise the existing facilities and services offered to start-ups and examine ways for enhancement. The study also assessed the capacity needs of start-ups and of the incubator management team, while paying special attention on the business and marketing perspectives for long run sustainability of the Centre. The exercise also considered the existing links between institutions (local and International) and advise on the long term planning of the Incubator Centre addressing issues such as clustering and networking with International institutions. The project would be carried out in two phases. Phase I dealt with a study and recommendations, while Phase II would deal with the implementations of the recommendations. For Phase I, the NCB has benefited the financial assistance of UNDP for an amount of US$ 19,200. The Phase I of this project has been completed. The main recommendations included the following:

Creation of critical mass for sustaining the ICT Incubator Centre. The consultant has recommended that a critical mass of 20-30 start-ups were required to make this project sustainable. To this effect, the Centre needs to be relocated outside the city of Port-Louis.

Creation of a Virtual Incubator Module. It was also proposed that a Virtual Business Incubator Network be created to support start-ups not physically located at the Centre. It would supported through a web portal and would include training, counselling brainstorming and mentoring activities.

Capacity building programme. Under this component the capacity building of (a) the Incubator Management Team (b) Start-ups (c) potential start-ups have been addressed.

Pre-incubation Cell. To re-enforce the collaboration between the National Computer Board – ICT Incubator Centre and the University of Mauritius, it has been proposed to set a pre-incubation within the latter premises. Faculty members and students would also be able to contribute and benefit from this initiative. The aim of the project would also be to commercialise the research undertaken at the University. This initiative will also help to bridge the gap between research undertaken and its commercial use with the industry.

iii) InfoDev ICT Incubator Initiative

The National Computer Board has received funding under the Info*Dev* ICT Incubator initiative of the World Bank for an amount of US$ 100,000 in June 2004. The funding would be used to provide technical assistance and capacity building of the ICT Incubator Centre for Phase II of the above-mentioned project.

Conclusion

The ICT Incubator Centre has been implemented within a conducive environment whereby policies have been oriented to the development of the ICT sector. It is believed that the business incubation policy would be successful if it is an integrated strategy of the economic development process and supported by all the stakeholders.

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(Exchange rate 1 US$ = MUR (Rs) 31)

Annex I

Start-up	**M-ITC Ltd**	
Date of Entry	1st October 2004	
Date of Departure	30th June 2005	
Promoter Name	Mr Michael José Motet	
Activity	IT Consultancy The enterprise is currently providing software development and consultancy services to enterprises operating in Denmark. The contracts are obtained from companies based in Denmark, which are actually outsourcing part of their software development to M-ITC Ltd. The IT solutions are developed using C++, C# (.Net), Linux, Unix, Mac and Windows.	
New Location	34, Remy Ollier St, Port-Louis	
URL	http://www.m-itc.net/	
New Office Space Area	60 sq mts	
Useful indicators	**Initial**	**Actual**
Investment	Rs 100,000	Rs 600,000*
Labour	4	11
Turnover	Rs 1,1 m	Rs 3 M
	* Investment has been made on hardware and open source software has been used mostly for development purposes. The new location will easily accommodate the additional staff recruited by the enterprise. In-house training has been undertaken by Danish trainers.	
Investment Certificate (if any)	The company has acquired an ICT Certificate from the Board of Investment for the "development of customised secure business solutions such as the public key infrastructure (PKI) modules for export only" on 6th January 2005.	
Target Market	Denmark contractors which outsource major government software development contracts to small companies	
Benefits obtained from the ICT Incubator Centre	The company has acknowledged the contribution of the ICT Incubator Centre during the enterprise initial and critical phase of development. The infrastructural support including office space, fast Internet Connection via the ADSL connection and shared facilities – telephone, fax services and logistics were essential for the growth and expansion of the company. The enterprise was able to focus on its core competencies i.e software development	
Challenges	The main challenge of the enterprise as at date was to be able to get the right candidate and providing on the job training.The company has earlier advertised in various newspapers to attract candidates with expertise in Java, C++ and Linux. Interviews were conducted on the premises of the Centre. The Ministry of Labour had contacted them and sent a number of potential candidates for consideration.(~ 100 C.V's). These people have been registered with the Ministry recently.	
Comments	*"Without the support of the National Computer Board – ICT Incubator Centre I would not have been able to start a business in Mauritius".*	

Annex II

Start-up	**Innovative & Creative lines (ICL) Ltd**	
Date of Entry	1st April, 2003	
Date of Departure	31st August 2004	
Promoter Name	**Mr Rajiv Juwaheer**	
Activity	Developing Web Applications and providing Web Solutions to enterprises. The enterprise is providing Web solutions and Web applications Development to local SMEs. The allied activities of the enterprise include:- (a) Website Development (b) Setting up, commissioning of Web servers and Database servers for online stores (c) Maintenance of Web & E-commerce sites.The company has diverstified its activities to include training on ICT. To this effect, the enterprise has a training room facility that can accomodate 15 persons. A computer room with 10 personal computers are available. A workshop facility has also been catered for maintenance and software development purposes.	
New Location	5, Octave Sandapa St, Port-Louis	
URL	http://www.iclnetwork.com/	
New Office Space Area	80 sq mts	
Useful indicators	**Initial**	**Actual**
Investment	Rs 400,000	Rs 0.9 m*
Labour	3	8
Turnover	Rs 775,000	Rs 900,000
	* Investment has been made in the renovation of new office and acquisition of hardware for the company.	
Investment Certificate (if any)	none	
Target Market	Mr Juwaheer is targeting local SMEs and individuals for its services.	
Benefits obtained from the ICT Incubator Centre	The promoters and his staff have benefitted from the infrastructural facilities and supports through its training and informative sessions organised by the NCB. The informal meetings have benefitted the enterprise in acceding the appropriate information on a timely basis.Through the participation at the InfoTech , an annual event organised by the NCB, the company has profiled potential enterprises for its services.	
Challenges	The main challenge has been marketing its services, as clients are constantly looking for competitive prices.	
Comments	*The ICT Incubator Centre facilitates the early stage of business development through its various support systems.*	

Annex III

Start-up	**AM Web Solutions Ltd**	
Date of Entry	1st March 2004	
Date of Departure	31st June 2005	
Promoter Name	Mr Remy Grandpierre (French National)	
Activity	Provision of website development services, website-hosting services, 3D animation and multimedia content development.	
New Location	Grand Baie, Business Park	
URL	http://www.amltd.net/	
New Office Space Area	60 sq mts	
Useful indicators	**Initial**	**Actual**
Investment	Rs 697,000	Rs 1.15 m*
Labour	3	10
Turnover	Rs 0.5 m	Rs 1.5 m
	* Seven additional staff have been recruited as the existing office space at the ICT Incubator Centre was not able to accommodate the new staff.	
Investment Certificate (if any)	The company has acquired an ICT Certificate from the Board of Investment for "website development and multimedia content development services" on 23rd March 2005.	
Target Market	Mr Grandpierre is already in contract with approximately 40 clients in Mauritius. The target market include small and medium businesses and small hotels.The foreign market includes France, Réunion Island, Mayotte / Comoros, Madagascar, Seychelles and South Africa. Mr. Grandpierre has established contracts with potential clients in some of these countries. Some of these contracts include Isorol and Leader Club (France), Mayotte's Edition Grand Public (business directory & booking portal) and the Réunion-based communication agency Yasib.com.	
Benefits obtained from the ICT Incubator Centre	The company has benefited from the infrastructural facilities, logistics and the business support provided by the ICT Incubator Centre during its stay. Mr GrandPierre has participated in the InfoTech 2004 event organised by the National Computer Board. The event was an opportunity to market its services to the local SMEs and to establish network contact. The informative sessions on the various facilities, incentives, and legal framework and obligations organised by the National Computer Board have been helpful to the promoter given that he was not well versed with the existing legislation system for business in Mauritius.	
Challenges	The company has interviewed many candidates with specific experience in PhP and most of them had little working experience. Following several advertisement in the newspapers and lists obtained from the manpower database of the NCB, some reruitments have been made.	
Comments	*"Besides logistic and infrastructural support offered by the Centre, I have been obtained appropriate information regarding business development in Mauritius"*.	

Academia-Industry-Government Relationship: Experience of the College of Engineering and Technology, University of Dar es Salaam Tanzania

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Abstract

The three basic objectives of CoET have a very strong bearing on the relation with the industry. Achievement of these objectives hinges on the synergic interaction of the three pillars of CoET (namely the three Faculties, TDTC and BICO), the government and the industry itself. Collaboration with Tanzania Gatsby Trust (TGT) has fostered closer linkage between CoET and many technology based SMEs in Tanzania though technology development and transfer. Though the same collaboration CoET has to interact with the responsible ministries in the government to ensure our SME intervention does not contravene existing and future SME policy.

SME survey conducted throughout the country showed that the sector is largely informal and very much under-performing due to a multitude of barriers and constraints facing it. CoET in collaboration with TGT and Carnegie Foundation of New York has identified a number of SMEs to work with under business/technology incubation project aiming at improving their production and competitiveness. The project is proceeding very well and it involves also the local district government where the entrepreneurs are located. It is envisaged that graduating incubators would form or join innovative clusters to continue being competitive.

The competitiveness element required of the SMEs and Incubators goes well with the Innovation Systems and Clusters Programme in Eastern Africa (ISCP-EA), which CoET has spearheaded since 2003, with a view to fast-tracking socio-economic development in this region. The programme advocates triple helix operation for its success.

Whereas academia-industry relationship looks reasonably strong, the government-industry or government-academia relationship has not been equally strong. Government involvement in the triple helix is, however, improving as a result of a series of awareness campaign, spearheaded by CoET, through workshops, conferences, exhibitions, publications and direct interaction with responsible officials. CoET awareness campaign is now directed to the financial institutions to ensure SMEs are funded in order to be competitive.

Introduction

The College of Engineering and Technology is aimed at:

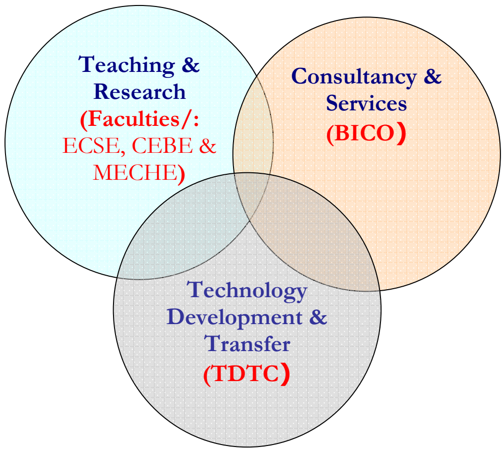
(i) Supplying the country with sufficient middle and high level engineering human-power as agents of development and change, thus contributing to the indigenous development of infrastructure, industry and trade;

(ii) Performing research in the interest of suitable exploitation and local processing of natural resources in Tanzania, ultimately leading to the innovation of technical products and production processes for the local industry; and

(iii) Providing expert professional services in the form of consultancy to industry as well as public and private organisations and institutions.

Achievement of the abovementioned objectives hinges on the synergic interaction of the three pillars of CoET shown in Figure 1.

Figure 1: The synergic interaction of the three pillars, viz. the three Faculties, TDTC and BICO



The three Faculties of CoET, viz. Civil Engineering and the Built Environment (CEBE), Electrical and Computer Systems Engineering (ECSE), and Mechanical and Chemical Engineering (MECHE) are responsible for academic training and research through the 13 academic Departments. All laboratories and most workshops belong to teaching Departments. Thus the three Faculties are the custodians of most of the techno-ware and human-ware available at CoET. Because the curriculum requires that students must spend eight weeks in industry at the end of first, second and third academic year, respectively, the faculties have maintained a traditional contact with the industries that provide such training places. The same industries are also invited to contribute their views during curriculum reviews.

The College recognizes its role towards achieving national socio-economic advancement through the proper selection, adoption, adaptation and further development of technological solutions as well as development of appropriate and sustainable technologies. It is thus intended to involve all academic disciplines of the College in prototype development and technology transfer. All technology (prototype) development by College staff, technology brokerage as well as the subsequent transfer to industry is being coordinated by the Technology Development and Transfer Centre (TDTC).

TDTC aims primarily to impact on the development of SMEs, on the lives of the general public through the development and dissemination of technologies that have direct relevance to the Tanzanian society.

The Bureau for Industrial Cooperation (BICO) is mainly aimed at enhancing the capability of College to contribute effectively in the industrial development of Tanzania through the provision of consultancy, expert professional services and professional advancement (or development) of engineers and technologists. Through these consultancy and professional services the college generates funds for its various activities, among which is to provide incentives to staff.

The three basic objectives of CoET are directly linked to industry. The objectives also address the Tanzania Development Vision 2025 through which is envisioned that Tanzania will have graduated from a least developed country to a middle income country by year 2025 with a high level of human development. The economy will have been transformed from a low productivity agricultural economy to a semi-industrialised one led by modernised and highly productive agricultural activities, which are effectively integrated and buttressed by supportive industrial and service activities in the rural and urban areas. A solid foundation for a competitive and dynamic economy with high productivity will have been laid.

For Tanzania to indeed realize this vision, all able bodied and mentally sound members of her society have to subscribe towards the establishment of the expected "solid foundation for a competitive and dynamic economy". This assertion is based on the realization that innovations in the form of new or improved products, services and processes are the basis for sustainable growth and prosperity in today's knowledge-based society. And the success of an innovation system is very much dependent on the triple helix relationship, where the government main role is provision of conducive policies and environment.

This paper underscores the importance attached to university-industry-government linkages in ensuring that training of engineers at the CoET impacts optimally to the development of the local industry and sustainable national development.

The case of CoET collaborations with Tanzania Gatsby Trust (TGT), Carnegie Corporation of New York and the Swedish Development Corporation (Sida/SAREC) are used to demonstrate CoET's resolve to stimulate and promote innovativeness and growth among SMEs in the country as part of improving university-industry relationship. The government on its part has put in place several interventions to ensure growth among SMEs. The paper attempts to describe a process that will provide building blocks for a strong foundation for a competitive and dynamic economy, and to contribute to the process of actually laying the foundation.

SME Contribution to the National Economy

Majority of Tanzania's population is estimated to be making their living on subsistence agriculture and Small and Medium Enterprise activities. It is estimated that SMEs contribute 35% to GDP and 20 % of the total labour force. A number of studies indicate that SME entrepreneurs in Tanzania are considered to be potential in creating jobs and contributing towards economic growth.

In addition, the government has emphasized the importance of the informal sector as part of SMEs in the war against poverty. In October 2004, a Peruvian economist, Prof. Hernando de Soto, was commissioned by the government of Tanzania to prepare the ground for the implementation of a programme to formalize properties and businesses in Tanzania, popularly known by its Kiswahili acronym MKURABITA. The programme, which is a clear link between the government and industry, is aimed at integrating the Tanzanian informal sector into the mainstream economy.

However, it is important to highlight that the report for the first phase of MKURABITA, has indicated that 98% of all businesses and 89% of all assets, especially buildings and land of Tanzanians are in the informal sector. This gave a challenge to researchers, politicians, financial institutions and development stakeholders in general, to help in making the programme a success, in order to make the properties and businesses formal so that they could be used in fighting poverty for the majority of Tanzanians.

COET - SME Relationship

The College of Engineering and Technology in collaboration with the Tanzania Gatsby Trust (TGT) conducted a survey of a total of 2'225 entrepreneurs country wide. Most of these were in the food sector, textile, metal work and woodwork. On a smaller scale there were also other sectors such as construction, electrical works, agriculture, shoe makers, car seat cover makers, solar equipment, mattress makers, pottery, fishing and fishing boat makers, car garages, handcrafts, detergents, plastics, etc. Woodwork is the largest sector, holding about 30% of the SME activities, followed by metal work with 23%. Food processing is the next in line at 18% followed closely by textile having 14%. All other sectors mentioned above combined have a total share of about 15%. The dominance of woodwork as an occupation for most SMEs could be attributed to continued expansion of cities and towns that demands bigger supply of construction materials as well as furniture. The trend is also aggravated by availability of raw materials save for the environmental destruction.

The survey has also shown that almost 67% of the businesses are relatively new, having been established in the last 10 years. The longer the time from when the business was established, the fewer are the businesses that still exist. This suggests that a large percentage of businesses have failed to survive due to different reasons, and one of the reasons could be that of lack of proper business planning at the start.

With regards to the number of employees, most of the SMEs had less than 5 and out of the total number of employees, the majority of the respondents, about 40% claimed that 80-100% of them were skilled. It is also known that most of the small businesses are run by family members, but the survey found that only about 15% of SMEs had 75-100% family members, while the majority, about 35% claimed to have no family members at all working in the business.

The issue of packaging was also investigated and it was found that, only a few entrepreneurs, about 15% of the respondents, do package their products. This could be attributed to the nature of the products themselves, since some do not need packaging. When the data was filtered to analyse only those in the food-processing sector, it was found that almost 50% of the respondent food processors do package their products.

The survey has shown that most of the SMEs are not happy with the way their enterprises are running due to, among others, the following reasons:

a) Lack of market for their products;
b) Lack of capital to expand their business; many are depending on meagre personal funds;
c) Lack of appropriate equipment as well as technology;
d) Lack of awareness of sources of financing as well as technical advice;
e) Lack of cooperation among and networking of similar SMEs.

Compilation of survey findings from the different zones to produce a country report has been completed (CoET, 2006) and the launching of the same will be done soon.

Student Projects and Practical Training

Linkage with some of the SMEs has been continued through final year undergraduate projects, with TGT financing. So far, a total of 25 student projects have been executed, 10 projects in 2002 and 15 in 2003. In 2002, all the projects were in the food processing area. In 2003, however, the scope was widened to cover other disciplines while emphasizing stronger SME collaboration. Further, five projects (out of the 15) were specifically for low cost housing related projects. For the year 2004, 28 student projects were submitted for TGT funding, out of which 15 were selected. All the projects have been completed and a compilation of the same has been done.

An impact assessment on the 2001/2002 student projects was made and revealed that results from two of the ten projects have been adopted by SMEs. These are on Clarification of Juice/Wine Using Pectrinase Enzymes, which has been adopted by M/s Solar Innovations, and Quality of Soymilk as Influenced by the Blanching Conditions which has been adopted by M/s Abantu Food Products as well as M/s Soya Halisi Foods. These two cases demonstrate some degree of success in the transfer and utilization of technology developed by CoET to SMEs.

Linkage with some of other SMEs is also maintained through students' practical training. This provides additional training places on top of the traditional ones, which is a positive move as we are experiencing expanded enrolment. Depending on the year of study, the students' can do small research work of benefit to the firm thus increasing their employability.

Business/Technology Incubation

Having studied and understood SME needs from the survey, it would make no sense to end there without doing something to alleviate the gravity of the problems observed. TGT, Carnegie Corporation of New York and CoET have agreed to work on a number of interventions aimed at addressing these needs, be it directly or indirectly. The Business/ Technology Incubation Project is one of the ongoing projects under these collaborations.

Decisions regarding these interventions were reached after soliciting views from the SME stakeholders. This was done by conducting workshops, following the completion of each zonal survey. In total, four workshops were held, one in Dar es Salaam for the Eastern zone in December 2002, a second one in Mwanza for the Western and Lake zone, in December 2003, a third one in Arusha for the Central and Northern zone in February 2005, and the last was held in Iringa for the Southern and Southern Highlands zone, in March 2005. The workshops attracted a good number of participants, which included SMEs themselves as well as relevant institutions, e.g. Small Industries Development Organisation (SIDO), Tanzania Chamber of Commerce, Industry and Agriculture (TCCIA), Confederation of Tanzania Industries (CTI), etc.

Following the first stakeholders workshop held for SMEs from the Eastern zone, incubation was deemed to be the best intervention to be implemented in the zone. Therefore three localities were selected, namely Kibaha, Lushoto and Morogoro. Initially, Zanzibar was also selected however it was later dropped due to the fact that there already is a similar initiative in Zanzibar being undertaken by the government. Therefore, focus was placed on the three locations in Tanzania mainland.

The specific objectives of the project are as follows:

a) To promote the concept of technology incubators;
b) To identify locations where pilot incubators could be successfully established and confirm their feasibility;
c) To establish the identified incubators;
d) To provide ongoing support to the incubator tenants;
e) To ensure business sustainability of SME after graduation from incubators; and
f) To disseminate the outcome of the pilot phase.

The establishment of the identified incubators involved the following major activities:

i) Preparing business plans for incubators;
ii) Assisting potential tenants to prepare fundable business plans;
iii) Establishing promotional partnerships;
iv) Identifying mechanisms for tenants' support and corresponding support providers;
v) Recruiting incubator management teams;
vi) Securing physical facilities for incubator operations;
vii) Procuring equipment and machines for the incubators;
viii) Preparing tenants' admission and exit criteria; and
ix) Admitting/signing contracts with tenants.

In the year 2006, the focus of the project is in the fourth objective i.e. "to provide ongoing support to tenants". The major activities involved are as follows:

(a) Business skills/Entrepreneurship training;
(b) Specific tailor-made trainings;
(c) Technology incubation;
(d) Enterprise counselling;
(e) Information;
(f) Legal advice;
(g) Internal networking to encourage business relations; and
(h) External networking for business advice, technology support, access to finance/loans and markets.

The University of Dar es Salaam through CoET, in collaboration with TGT are considering establishing an "incubator with walls", to be based at the University. This is envisaged to be the hub of all the incubators of the University. Following agreement reached in the TGT - UDSM Committee meeting held in July 2005, regarding the establishment of the incubator with walls at the University of Dar es Salaam, preparatory plans are being made to decide on the mode of the incubator, the costs involved as well as the financing mechanism for the whole venture. A proposal for the undertaking is being prepared for submission to possible financiers. Gatsby Charitable Foundation (GCF) has offered to support this initial phase in terms of expertise, while NEPAD has also shown interest and may avail some funds for the purpose. The University of Dar es Salaam has agreed to provide land for the incubator.

Role of CoET in Innovation for Industrial Development

Innovation can be defined as the capacity of a nation to adapt to worldwide changes in nature, technology and economics as well as influencing them. In this connection, population growth will trigger search for new solutions towards better chances of survival.

In a world characterized by globalisation and competition, continuous innovation is a necessary condition for every country. Absence of innovation in a country means that domestic producers will continuously lose market shares to others who are continuously innovating. As a result such countries that are not innovating will in the end also loose incomes and are therefore prone to poverty.

The fundamental factors for development of innovations include skills, the exchange of knowledge and opportunities for mutual learning as part of the interaction between businesses, research institutions and political bodies. Research produces new knowledge, but in order to promote growth it must be converted into innovations which produce new and improved products, services and processes for which there is clear demand.

i) The innovative potential of a nation is determined by the following, among others:
ii) The intellectual infrastructure of the population;
iii) The technical infrastructure, i. e. the capacity to transform theoretical scientific findings into technically feasible solutions;
iv) The historically developed tradition of skilled trades and technical know-how in large sections of the population;
v) A well-coordinated education system and a consensus between educational institutions, science, the economy, and society; and
vi) People's basic mental attitude towards the development of science and technology.

Thus, an **innovation system** is constituted by interaction between production, diffusion, and use of new and economically useful knowledge. *An innovation system serves as a framework for the creation of capabilities for firms in a variety of sectors and activities.* Further, the concept of innovation systems focuses on the mechanisms that promote the synergy for generating innovations, including both the overriding macro framework and incentive structures between institutions that are highly specific for innovation. Innovation is about adapting to changing circumstances and making new things in new ways. As new ways to do things always emerge locally, the need for an innovation system hinges on the desire to stimulate adaptation to changing circumstances.

Joint strategies and actions motivated by the anticipation of mutual benefits are greatly important in clustering. It follows from this that clusters are geographically proximate groups of interconnected companies and associated institutions in a particular field linked by commonalities and complementarities. Clusters encompass an array of linked industries and other entities important to competition including governmental and other institutions such as; universities, standard setting agencies, vocational training providers and trade associations.

Whereas all clusters may have properties that serve to speed up innovation, some can be observed to perform particularly well and hence be classified as *innovative clusters*. An innovative cluster innovates in the broadest sense of the definition, where the innovation can emanate from improvements in the way actors organize themselves, products are developed, produced, commercialised, distributed, etc.

The innovative cluster is, in principle, evolving constantly, learning from experience and able to adjust to changing circumstances. It is likely to be well-positioned to explore new opportunities beyond its present boundaries and, at the same time, combine flexibility with inner strength, stability and a sense of direction to achieve the following:

- Continuously changed traditional boundaries to knowledge generation and diffusion, by establishing linkages to wider and alternative sets of knowledge inputs;

- Re-conceptualised products and markets;
- Upgraded mechanisms for seed-funding, risk-taking and entrepreneurship;
- Transformation of old institutions and organizations through learning as well as unlearning of earlier habits and practices.

Cluster development has attained considerable attention over the last decade, not least as an operational means to enhance the competitiveness of firms and regions. This is largely due to its responsiveness to the demands of the new economy for; speed, quality, flexibility, innovation, networking and building critical mass. Thus, early establishment of the clustering behaviour is particularly important in supporting the development of competitiveness of emerging industries, and hence laying of a solid foundation for a competitive and dynamic economy with high productivity. CoET thought that through clustering even SMEs can gain the necessary critical mass to service world markets, hence establishment of the Innovation Systems and Clusters Programme in Tanzania (ISCP-Tz).

Innovation Systems and Clusters Programme

The CoET has spearheaded Innovation Systems and Clusters Programme in Eastern Africa (ISCP-EA) since 2003, with a view to fast-tracking socio-economic development in this region. The programme advocates triple helix operation for its success. In this endeavour CoET has been collaborating with the Faculty of Engineering at Eduardo Mondlane University in Mozambique and the Faculty of Technology at Makerere University in Uganda. In February 2004, CoET organized and hosted the 1st Regional Conference on Innovation Systems and Innovative Clusters in Africa, and in March 2005 the Faculty of Technology in Uganda organized and hosted the 2nd Regional Conference on the same theme.

In September 2005, with the support of Sida/SAREC of Sweden, weeklong and intensive training courses on the development of Cluster Initiatives (CIs) were held in Bagamoyo, Tanzania and Jinja in Uganda. The training drew participants from the triple helix, namely academia, government and the industry. Following success of the training, which was reflected by the enthusiasm and momentum exhibited by course participants, eight pilot CIs each composed of members from the triple-helix were established in Tanzania and seven in Uganda. Each of the eight CIs in Tanzania prepared action plans for a low budget implementation of the initiatives, which were harmonized in a workshop held in Dar es Salaam on February 09, 2006 and launched on the same day. These clusters will present their progress in the third Regional Conference on Innovation Systems and Clusters in Africa slated for September 2006.

The ISCP-EA programme has five major objectives, namely:

(i) Research and innovation systems policy reviews;

(ii) Implementation of pilot innovation systems and/or cluster initiatives;

(iii) Awareness creation and publications;

(iv) Competence building;

(v) Coordination and follow up forums.

The intervention programme is expected to stimulate and facilitate the development of innovation systems and innovative clusters in Eastern Africa. The achievement of this purpose will be measured in terms of; enhanced innovativeness among firms and farms, enhanced competition and cooperation among firms and farms within clusters and sectors, and acquisition of competitive mindset.

The expected outputs, among other things, are:

(a) A network of capable individuals interested in innovation systems and clusters formed;

(b) Innovation systems and clusters identified and characterized for possible in-depth study (mapping of clusters and innovation systems);

(c) In-depth study of selected clusters and innovation systems carried out, including:

- Assessment of extent to which they are innovative and bottlenecks for growth;
- Determination of mechanisms that will make innovation systems in the various sectors stronger and sustainable, and clusters innovative and sustainable.

(d) Consolidation of potentially innovative clusters stimulated;

(e) Innovativeness of firms and farms within pilot existing and new clusters and innovation systems stimulated;

(f) Various advocacy initiatives implemented;

(g) Short and long-term training in innovations, and innovation systems and clusters established;

(h) National Steering Committees (NSC), National Coordinating Offices and a cluster development monitoring system established.

Expected Impacts

The expected impacts arising from the implementation of the proposed programme can be summarised as follows:

i) Poverty reduction

With acquisition of competitive mindset and adoption of the innovative cluster approach, productivity will increase, quality of products and services will improve and Small and Medium Enterprises (SMEs) will grow thereby generating more jobs and employment. These developments will trigger national socio-economic growth which will enable Tanzania to cope with the rigours of international competition accompanying globalisation. The resulting financial empowerment will lead to acquisition of adequate nutrition, clothing, housing, etc. and thereby subscribe to poverty reduction.

ii) Enhanced value addition of local agricultural products and natural resources

Through enhanced innovativeness and acquisition of competitive mindset, value addition will be applied to all agricultural products and other natural resources, including minerals, before they are exported abroad. Foreign currency earnings will thus be boosted and the economy will grow.

iii) Preservation of the Environment

Entry into international markets demands consciousness of various environmental aspects as echoed by the World Summit on Sustainable Development in 2003. Thus, enhanced innovativeness and competitiveness that qualifies for entry into international markets, will also lead to more environment friendly products and services.

iv) Gender

Farming and nearly all home-care activities are mainly done by women. Further, most small scale food processing is also done by women. Thus, value addition of agricultural products, cheap and readily available energy saving and alternative energy sources will lead to financial empowerment of rural women and facilitate the growth of their businesses, thereby enhancing gender relations in rural communities.

v) Capacity building

Local capacity building will result through:

- Enhanced internal research capacity;
- Strengthened national innovation systems and enabling policies;
- Postgraduate training in innovations, innovation management and related aspects;
- Enhanced innovativeness and competitiveness of businesses.

This programme component is intended to establish the extent to which innovation systems and clusters, and innovation policies exist in Eastern Africa. The programme component shall also establish deficiencies of existing innovation systems and clusters. Finally, an attempt will be made to establish the extent to which firms and farms are innovative in the three countries.

Implementation of Pilot Cluster Initiatives

Cluster initiatives are organized efforts to increase the growth and competitiveness of respective clusters that involve cluster firms, government and the research community. Thus, doing research and identifying gaps in the systems of innovation and clusters is not an end in itself. The ultimate goal is to have a system within which firms and farms are innovative. This programme component is to conceptualize and support, improve, or introduce innovation systems for specific sectors or clusters in a practical way, showing short-term results, while fitting into a national long-term innovation policy framework. This programme component actually seeks to put in place systems that are innovative, and initiate innovative clusters. It will also save as a practical learning process on what works and what does not. This entails getting teams of competent and committed individuals representing the whole triple helix sphere to facilitate respective cluster initiatives.

The selection of the eight pilot Clusters Initiatives in Tanzania was based on presentations of various potential clusters during the Stakeholders Workshops held in January 2005. They were subsequently discussed and approved for implementation. The following criteria were used for the selection:

- Current activity level;
- Availability and potential for effective use of resources (human and physical);
- Existence of actors committed to bringing about change;
- Responsiveness to expressed needs from the society;

- The strategic idea and its growth potential (e.g. job creation);
- Existence of future market potential;
- The ambition for renewal within the initiative;
- Potential for collaboration between academia, business and political bodies (including the government) within the initiative; and
- Geographical focus, viz. the functional region of the initiative.

The following are the eight pilot Cluster Initiatives in Tanzania:

1) Bagamoyo cultural heritage tourism cluster;
2) Eastern region mushroom cluster;
3) Morogoro metal works and fabrication cluster;
4) Morogoro small scale fruit and vegetables food processors cluster;
5) Arusha seeds and seedlings cluster;
6) Sisal cluster;
7) Zanzibar seaweed cluster; and
8) Nutraceuticals cluster.

Competence Building and Research

Technology development is one of those things that cannot be left to be stirred by market forces alone because of the possible occurrence of the market failure phenomenon and other externalities, which are beyond the control of innovating firms and farms, especially for the less developed countries. There is, therefore, a need to inhibit market failure effects by putting in place policies for technology development. Proper policies in turn require prior investment in policy research. This programme component intends to contribute to this through capacity building in various aspects of innovation, including innovation studies. Innovation is a dynamic and context specific concept, and the different strategies that can be adopted by countries or sectors in those countries depend on their own specific development advancement and other in-country factors as well as on developments in innovation systems in the global economy to which the national economy is increasingly linked. It therefore calls for continuous researching, and capacity building in the area to achieve a critical mass of experts in innovation research.

Establishment of short-term and long-term (MScs and PhDs) training on innovations and related aspects is one of the key specific objectives of this programme component.

Triple Helix Status in Tanzania

A quick look at Tanzania's Triple Helix constellation (academia, industry and government relationship) reveals a number of issues that need to be addressed in order to facilitate economic development drawing on an increased university-industry interaction but also on how policy can feed into the discussion and stimulate industrial innovativeness. Economic reality has made consultancy linkages the main communication channel between university and industry.

Starting with industry and its present status, regardless of the criteria chosen for analysis, there has been little progress over the last decades. Tanzania remains basically a non-industrialized country heavily reliant on agriculture. The ongoing transformation has had little effect on business start-ups and expansion in the SME sector whereas the parastatal sector has literally been phased out. The low level of technological capabilities is a key bottleneck to responding positively to ongoing liberalization.

Secondly, industrial firms' relations to other firms and/or organizations are not optimised for knowledge transfer and joint learning. A strict division of labour between firms in the value chain is in most cases absent leading to poor specialization. In recognition of the fact that it would have been difficult and impractical for each industry to establish its own Industrial Research and Development unit, the Government decided to set up specialized Industrial Research and Development Institutions. The Industrial R&D institutions were entrusted with the noble objective of providing support services to industry through research and knowledge dissemination. The institutions include, among others Tanzania Industrial Research and Development Organisation (TIRDO) established in 1979, Centre for Agricultural Mechanization Rural Technology (CAMARTEC) established in 1981, Tanzania Engineering and Manufacturing Design Organisation (TEMDO) and SIDO. However, the level of industrial R&D is still low because the Government spending on industrial R&D is very limited, which has left the few R&D institutions in an insecure situation having to rely on consultancy, training, and services offered to industry. These revenues do not cater for R&D activities but solely meet operational costs of the institutions.

On realising the importance of SME contribution to the economy, the Government approved the Small and Medium Enterprise Development Policy in 2003. The policy comes up with a number of interventions in support of the SME sector, including the improvement of the legal and regulatory framework, addressing issues related physical infrastructure, improving access of financial and business development services to SMEs as well as putting in place a supportive institutional set-up for the sector. However studies have shown that policy is not linked to any financing mechanism; a situation which business analysts say might hamper its implementation. This is due to the fact that the implementation of various portions of the policy was left to government ministries and agencies, parastatal organisations, NGOs and associations. The study also revealed that the policy did not adequately address issues of the poor infrastructure, high cost of utilities and communication system, all of which are crucial for the development of SMEs. It is also true that the taxes imposed on SMEs are numerous and high, thus deterring SME development and growth.

In another move the Government launched the National Trade Policy in August, 2003 whose main objective is to facilitate Tanzania's smooth integration into the Multilateral Trade Systems (MTS) so as to take advantage of opportunities inherent in the free flow of resources in the current wave of globalization. This policy has identified the need to utilize innovative industrial clusters of Export Processing Zones as an effective policy instrument of building robust export driven growth of the economy. The outcome of this is yet to be seen.

Despite all the government efforts, there is neither appreciable innovation nor an innovation systems policy in Tanzania, but there are various government policies that emphasize the role of Science and Technology (S&T) in development. Thus, S&T is discussed in the National Science and Technology Policy of 1995 issued by the Ministry of Science, Technology and Higher Education. But what is probably more relevant to the development of innovative clusters is government's awareness and dedication to build a scientific platform that may contribute to industrial progress.

A clear derivative from the aforementioned is that there is dire and urgent need for change if Tanzania is to achieve what is envisioned in Vision 2025. Peoples' mindset has to change towards a competitiveness mindset, enhanced quality consciousness and enhanced productivity. To facilitate these, there is also need to develop a mechanism for change.

Need for a Competitive Mindset

Competitive mindset is one that equally welcomes competition and cooperation, and seeks to build competitive advantage. It also entails strategic thinking that leads to a strong distinguished position on a global scale, identifying the needs and wishes of clients, developing products and production processes, and finally employing high international standards when assessing the performance of institutions.

The world economy has entered an era of total competition. There are many examples around the world where the traditional sources of comparative advantage, like natural resources, are less valuable than initially perceived for the development of a strong competitive economy.

At the firm level, competitiveness is the ability to provide products and services more effectively and efficiently than relevant competitors. At the industry level, competitiveness is the ability of the nation's firms to achieve sustained success versus foreign competitors, without protection or subsidies. And, at the national level, competitiveness means citizens ability to achieve a high, and constantly rising, standard of living.

Competitiveness in some industrial segments allows productivity improvement through higher specialization in the respective industries and segments. Consequently exports volume increase for that specific segment in which firms are relatively more productive than firms in other countries.

Competitive advantage grows out of the way firms organize and perform discrete activities. Of course, activities vary in their importance vis-à-vis competitive advantages from industry to industry. All activities contribute to buyer value. Hence, firms create value for their buyers through such activities. The ultimate value a firm creates is measured by the amount buyers are willing to pay for the product or service offered. A firm is profitable if this value exceeds the collective cost of performing the required activities. To gain competitive advantage over its rivals, a firm must either provide comparable buyer value, but perform activities more efficiently than its competitors (lower cost), or perform activities in a unique way that creates greater buyer value and commands a premium price (differentiation).

Need to Develop a Mechanism for Change

Firms gain competitive advantage by conceiving new ways to conduct activities, employing new procedures, new technologies or different inputs. A firm is more than the sum of its activities. The value chain of a firm is an interdependent system or network of activities, connected by linkages. Linkages occur when the way in which one activity is performed affects the cost or effectiveness of other activities. Linkages often create trade-offs in performing different activities that must be optimised. For example, a more costly product design, more expensive components, and more thorough inspection can reduce after-sale service costs. A firm must resolve such trade-offs, in accordance with its strategy, to achieve competitive advantage. Thus, strategy guides the way a firm performs individual activities and organizes its entire value chain.

Linkages also require that activities are coordinated. The coordination of linked activities reduces transaction costs, allows better information for control purposes, and substitutes costly operations in one action with less costly ones elsewhere. Coordinating linked activities is also an important way to reduce the time required to perform them, which is increasingly important to ensuring competitive advantage. Careful management of linkages can be a decisive source of competitive advantage.

Creating competitive advantage requires the management of the value chain as a system rather than a collection of separate parts. Reconfiguring the value chain by relocating, reordering, regrouping, or even eliminating activities is often at the root of a major improvement in competitive position. The value chain provides a tool for understanding the sources of cost advantage. A firm's cost position represents the sum of all costs incurred for performing all the required activities relative to competitors. Cost advantage can occur in any activity. Gaining cost advantage usually requires optimising the linkages among activities, as well as close coordination with suppliers and distribution channels. The value chain also exposes sources of differentiation.

Conclusion and the Way Forward

Given the fact that the majority of the industries in Tanzania fall under the SME category, the SME needs/expectations as shown above are the ones that have to be addressed in order to enhance the performance of these industries. The University-Industry link therefore needs to be stronger than ever. The College is already working on ways to address the SME needs by the establishment of incubators and SME clusters to serve those SMEs which need that kind of support, mostly starting-up enterprises and those that are still in need of assistance. However for much larger industrial set-ups, the College can deliver support services through its two organs, viz. BICO and TDTC, depending on the need.

To sum-up, the University has continuously strived to have a functional linkage with industry. Despite some failures experienced in the past, the goal now is to have a link that will serve all levels of industry, from the micro ones to the largest scale that we may have in the country and even beyond our borders.

The Tanzanian SME sector is, at present very weak and underdeveloped. However, it presents a high potential for growth, leading the nation to industrialisation. The existing government policies, legal and institutional infrastructure is comprehensive enough. The intervention measures that have been initiated so far, including those which are under the CoET - TGT collaboration project are seen to be very supportive and in the right direction towards developing SMEs. However, the resources that are available at present are grossly inadequate to cover the whole country and the needs of SMEs.

It is recommended to have continued and stronger collaboration between CoET, TGT and other stakeholders in order to solidify and extend the efforts that have already been started in some parts of the country as described in this paper.

The Innovation System and Clusters Programme initiated by CoET promises success in triple helix operation and provision of the mechanism for change of mindset in favour of competitiveness, enhanced quality consciousness and productivity, among SMEs. There is, therefore, need to support the eight pilot Cluster Initiatives, established through the financial support from Sida/SAREC, so as to enable them succeed and pave way for establishment of others. There is also need to mobilize resources to finance implementation of the other components of the Innovation System and Clusters Programme conceived by CoET.

In recent years, the overall policy environment has being more supportive to enterprise development as well as private sector development. The Small and Medium Enterprise Development Policy approved and launched last year comes up with a number of interventions in support of the SME sector, including improving the legal and regulatory framework, addressing issues related to physical infrastructure, improving access of financial and business development services to SMEs as well as putting in place a supportive institutional set-up for the sector. The SME Policy recommends development of industrial clusters as one of the strategies for steering enterprise development.

On the other hand, successful development of industrial clusters depends on a number of other interventions including putting in place an effective Industrial Research and Development (IR&D) infrastructure. As elaborated above, Innovative Industrial Research and Development is a core function which must be done to facilitate the development and dissemination of industrial technologies and innovations. Developing countries, like Tanzania, need to put emphasis and devote adequate resources to IR&D activities if they seriously need fast and sustainable rate of industrial growth.

It should also be emphasized that development of industrial clusters should be a collaborative task involving developers of physical infrastructure, financial and non financial service providers as well as the prospective entrepreneurs.

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Research Institutions and SMEs: Trust Mechanism and Partnership

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Introduction

Small- and medium-sized enterprises (SMEs) have been playing an important role in the development of China's national economy in the 21st century. A survey sponsored by Volkswagen Foundation, Germany revealed that in 2002, value of products and services provided by Chinese SMEs accounted for 50.5% of the national GDP. The SMEs also created 75% of the jobs, and contributed 60% of China's exports and 43.2% of taxes. Development of SMEs has become a hot topic in China, receiving attention from all walks of society.

It has been widely accepted that the establishment and growth of SMEs are based on innovations. However, it is very difficult to trace the dynamic process of innovating activities in SMEs, not only because of the diversified forms of SMEs, but also because of the dynamical feature of innovations resulting from the efficient interaction between SMEs and external environment. Anyway, both researchers and practitioners have done detailed researches on innovations in SMEs. In micro level, they have tried to find out the principles and results of innovation in SMEs from directions of entrepreneurship, resources, information and knowledge. In macro level, they have tried to identify and create operational environment suitable for innovations of SMEs in a country or a region.

Undoubtedly, management experts are mainly interested in anatomizing SMEs. Discussions on what kind of operational environment is more favourable to SMEs, however, have attracted more attention from researchers in different subjects, including management, economics and sociology. More and more scholars are advocating the establishment of regional innovation system to support innovation and growth of SMEs. Although they have had enough discussions on the concept, characteristics and features of such a system, they have not yet conducted enough research on deep-seated factors between regional innovation system and growth of SMEs. For example, how the regional innovation system can be established? How and in what way such a system can spur innovation of SMEs? How to define the scope of a regional innovation system? What are the differences in innovation modes and efficiency in SMEs inside and outside the system? To answer the questions, National Research Center for Science and Technology (NRCSTD) in Beijing, China, and Fafo Institute for Applied International Studies (Fafo) in Oslo, Norway started a international cooperated research project named "A Study on the Institutional and Technological Innovation of Small and Medium-sized Enterprises in Western China". The project is financed by a grant from the Norwegian Agency for Development Cooperation (NORAD) under the project number CHN-2086. The project, through on-the-spot investigations in Chengdu, Sichuan Province, and Xining, Qinghai Province, aims to discover the operational situation and shortcomings of the regional innovation system in western China. It is also designed to discover the modes and features of SMEs' innovation inside the system, find out reasons behind the weak innovation ability and poor performance of SMEs in western China, and explore ways to help them improve their innovation ability. Interaction between research institutions and SMEs innovation is a key part in the functioning of regional innovation system. This paper, based on the results of the first round of investigation and case studies, aims to discuss the features and principles of such interactions from the angle of trust mechanism. We also try to find out problems in such interactions and seek for solutions and suggestions to the problems.

Background and Problems

Etzkowitz and Leydesdorff (1998) proposed that in a free economy, innovation contributors included governments, enterprises and research institutions. Although they had different targets, standards and restrictions, they were increasingly penetrating into each other to form the so-called "trilateral network and hybrid organization" relationship. They believed that a more mature relationship among the three helix, the stronger innovation ability in a country or a region. In China, after more than two decades of reform and opening, the government doesn't interfere in resources distribution through administrative orders. Instead, it is controlling the economic operation through macro measures. Research institutions and enterprises have become independent bodies to engage in market activities, which of course include their innovation activities. That means the "trilateral network and hybrid organization" has taken shape in China, and undoubtedly, in such a framework, research organizations are playing an active role in propelling innovations in SMEs. They provide knowledge, technology and information support to SMEs. Such a role is also demonstrated by close interaction and co-operation between research institutions and SMEs.

The essence of cooperation between research bodies and SMEs is trust. For one thing, the cooperation between enterprise and research institutes is characterized by a high information asymmetry and uncertainty. As a result, the trust between them became the indispensable base for their successful cooperation. For another, such cooperation are often linked by personal relationship rather than organizational relationship. In the inauguration and initial periods of SMEs, entrepreneurs often have absolute controlling right on the enterprises, while in the meantime they are also the main persons to represent the enterprises to conduct external co-operation. All the relations linking SMEs and outside world are developed by entrepreneurs. In other words, personal trust between entrepreneurs and outside world is the key for SMEs to obtain resources such as financing, technology and human resources. For SMEs that are in fast growth period and have already standardized their management to a certain degree, it remains to be hard for them to interact with the outside world through organizational exchange (such as through departments in enterprises) as large enterprises do. They also rely on entrepreneurs to explore new relations to expand their interaction with outside world further.

However, in a transitional society, such interaction and co-operation on the one hand must get rid of the influence of planned economy while on the other hand need to seek for new modes compatible with market economy operation. That means trust mechanism in co-operation between research institutions and SMEs must be transformed, too. This study believes that trust mechanism is the deciding factor for efficiency of co-operation between research organizations and SMEs. We aim to theoretically explore principles in the transformation of trust mechanism in co-operation between research bodies and SMEs in the transitional period and demonstrate such principles through case studies. We also try to seek for relevant policy suggestions to improve co-operation efficiency for research institutions and SMEs, push forward innovation of SMEs and improve growth environment for them.

Trust Structure in Chinese Society in the Transitional Period

Luhmann (1979) has distinguished two kinds of trust: personal trust and institutional trust. He noted that personal trust was established on the base of degree of familiarity and emotional links between people while institutional trust was external, using punitive or preventive mechanism such as laws to reduce the complexity of social exchange. Scholars such as Yamagishi （1994） further elaborated that personal trust was a kind of safeguarding trust which existed in personal relations, while institutional trust was a basic trust which was based on people's trust on social mechanism. He argued that the two kinds of trust formed the trust structure in the society. Therefore, the transition in China's social system is sure to bring about transformation of institutional trust from one form to another. In the transformation, personal trust fills the space left by absence of institutional trust and becomes the major part of the trust mechanism in Chinese society. In the meantime, the interaction between personal trust and the forming institutional trust can result in an extremely complicated trust structure in Chinese society. Such a structure in turn affects co-operation between research institutions and SMEs, making the co-operation a dynamic one yielding different impacts on innovation and growth of SMEs in different periods.

1. Special Personal Trust in China

Studies show that personal trust is to some degree affected by culture. Some scholars even described trust as a kind of cultural phenomenon, suggesting that trust was part of a society's culture codes passing generation by generation in some ways. For example, Fukuyama (1998:34) believed that trust came from "inherited ethnical customs" and was a product of moral standards shared by the society. That means trusts in different cultures are different and the unique Chinese culture produces a special personal trust in the Chinese society.

In earlier studies, many western scholars believed that there was only low-degree or limited trust in Chinese society. Weber(1920), in his research on Chinese religions, noted that the people in Confucian culture stressed on "self-restraint", and didn't trust others, which seriously hindered development of China's credit and commercial activities. He argued that trust of Chinese people was established not on the base of common belief community, but on kin community, or on family relationship and quasi-relative relationship. Such a specialized trust is hard to be generalized. Fukuyama believed that in countries such as China, Italy and France, all social organizations were based on kin-linked families. People in such societies lacked trust to people outside their families. In such societies without general trust, it was very difficult to standardize company operations. Family enterprises owned by Chinese would not allow professional managers to manage their companies. They would rather split the company into several new ones or even disintegrate them completely (Fukuyama, 1998:296). Although Chinese American scholar Redding didn't believe Chinese did not trust any other people absolutely, he did point out that there were only limited trust among Chinese people and such trust were mainly on individual level. Chinese people trust family members absolutely, but their trust to friends or acquaintance could only be established when they set up a kind of mutual-dependent relationship. (Redding, 1993:85-86).

However, recent studies, especially investigations made by domestic scholars, revealed that the trust level among Chinese people was not as low as scholars estimated earlier. For example, an investigation conducted by Zhang Jianxin et al. (1993) showed that Chinese university students trusted acquaintances and strangers more than their US counterparts did. Peng Siqing (1999) also challenged the opinion that Chinese people lacked trust. He proposed two kinds of "distrust of outsiders." The first one was people did not trust others because they didn't have deep understanding about them. The second one took place even if people had full understanding to outsiders, they still did not trust them. Logically, only the second kind of disbelief could result in a low-trust-degree society. It was reasonable not to trust people who you were not very familiar with and it also happened in Western countries. In other words, the first kind of disbelief can turn to be trust through interactions.

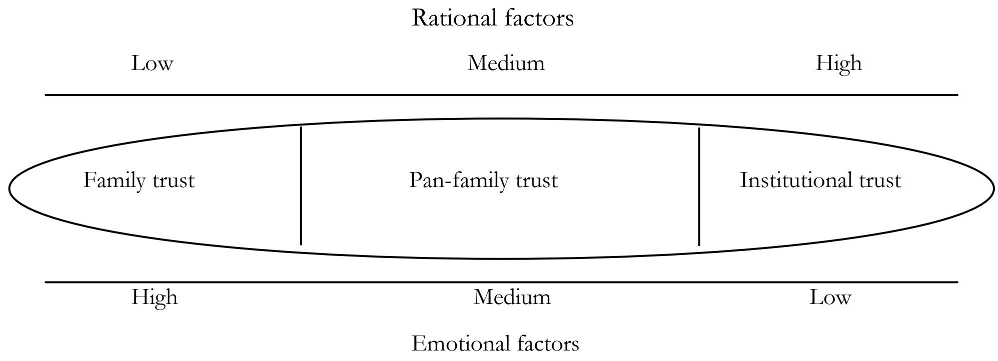
It can be noted that the debates on trust in Chinese society was focused not on the level of trust, but on the special essence of trust in Chinese society. Just like what Weber said, the great contribution made by ethnic and abstinence churches in Protestantism was casting off kin links and building up advantages of belief-based communities over kin-based communities, including families. A popular view is that trust is a kind of expectation on what actions individuals may take to others. If an individual expected another people to take possible actions beneficial or at least not harmful to him/her, s/he would trust that people (e.g. Oliver E. Williamson, 2001). China is a society that attaches great importance to relations, and to establishing and maintaining relations network. People have their own relation networks and relations to a large extent determined trust expectation of individuals.

However, the interacting Confucian culture and agriculture culture in China set up the relation order in the country. Behind the relation networks are the differences in people's trust to outsiders. Family members linked by kin enjoy "starting-point trust", which means individuals have born trust to family members although the level of such trust may change with time and frequency of interactions. Undoubtedly, such trust is based on emotional recognition and helps Chinese family enterprises to achieve efficient operation in their initial periods. Some scholars (Chu, 2003) defined it as family trust. However, Chinese people can also gradually develop relations with people outside their families, such as town mates, colleagues and classmates, into relations similar to that of family members. More people can be included in their trust lists. Such trust comes from good expectation developed after long-term exchange of the two sides and their similar background, which means similar behavior customs. It is easier for people with same background to get mutual understanding and reach consensus in exchange. Chu Xiaoping (2003) defined such trust as pan-family trust.

2. China's Forming Institutional Trust

Under the planned economy, government was the monopolized distributor of social resources and controlled the social and economic development. Administrative orders were major tools in economic co-operation, and thus became scarce resources in the society. It was easier for individuals and organizations with administrative orders to gain trust from others and get co-operation opportunities with other institutions. In other words, institutional trust in planned economy era was a kind of trust based on administrative orders. Since China initiated the reform and construction of market economy in 1980s, the government has gradually stopped interfering in economic development directly. Market principles have replaced administrative orders to play leading role in economic development while laws and systems have become rules guiding people's daily life, as well as personal trust. A kind of trust suitable for market economy has gradually taken shape. Such a trust system is based on individuals' recognition of social system and laws. Individuals believe that laws and systems can ensure that he or she may not suffer losses if other people can not keep their words, which happens very often in transactions, especially in first transactions between the two sides. Contracts become the bridge linking co-operation partners. However, in the process when old institutional trust is gradually fading out while the new one is in the formation, personal trust becomes the main body in social trust structure as people attach more importance to personal relationship rather than laws. In this period, family trust, pan-family trust and institutional trust construct the spindle-shaped trust structure in China, as shown in chart 1. On the left end is family trust under which people are more emotional than rational. Pan-family trust in the middle is the main part in the personal trust in Chinese society. What on the right end is the forming institutional trust under which people are more rational than emotional? See chart 1.

Chart 1: Trust Structure in Chinese society



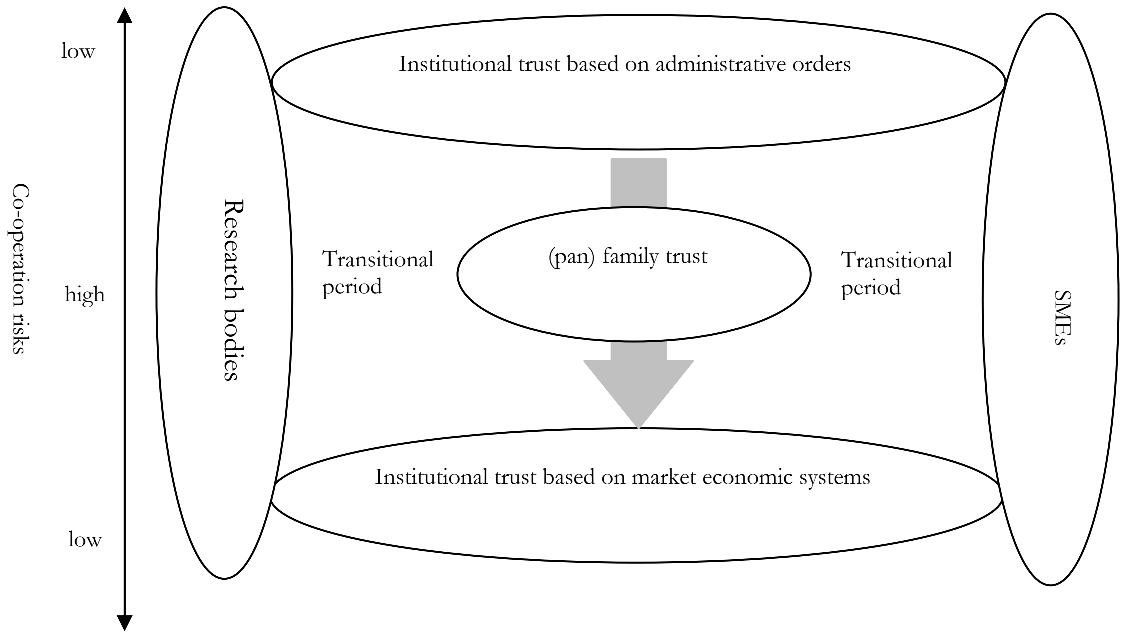
The trust structure in China, which is dominated by pan-family trust and short of institutional trust, has resulted in some dilemmas. On the one hand, although pan-family trust stresses both emotional and rational contacts, the rational fact, however, is often covered in some emotional exchanges. In other words, although people are very serious on some issues but often they do not speak out, taking into consideration of maintaining relations with their partners. In the meantime, it takes a relatively long time to establish pan-family trust, which to some extent restraints companies from harvesting gains through expanding personal relation networks. In Italy, however, SMEs have gradually got rid of the impact of individual personal relations. Instead, an enterprise network has been established providing co-sharing resources, information and knowledge to the companies. Such a network is an important contributor to the advantages of Italian products. In China, although there are regional SME clusters, the SMEs still rely on personal relations and their co-operation is still based on family and pan-family trust, which leads to a high transactional cost to maintain these relationships. Efficiency of such co-operation is relatively low due to a lack of punitive mechanism after some people break their words. Meanwhile, it is also expensive to maintain such trust.

During the transitional period, China's special trust structure has been transferred into relation-based activity standards, which are reflected in all aspects of social life. However, such a structure is in contradiction with legalization demand aroused by market economic operation. A typical example is the limited scale of enterprises owned by Chinese families. Meanwhile, such structure also determines the modes and features of interaction between research institutions and SMEs, and demonstrates the internal demand for a transformation in trust structure and its formation mechanism in China's transitional period.

3. Transformation of Trust Mechanism between Research Institutions and SMEs

In planned economy era, administrative distribution of resources was the decisive factor in development of SMEs, especially collectively-owned SMEs. They enjoyed low charge or even free technical support from State-owned enterprises (SOEs) and research institutions. Overall, such distribution mode made the interaction between SMEs and research institutions a linear stable one, with administrative orders from the government bridging the two. However, personal relations of SME managers, based on family trust or pan-family trust, still played a key role for SMEs to obtain administrative orders, which were scarce resources then. What enabled the firms to get the orders were good personal relations between their managers and government officials, SOE managers and staff in the research institutions. Therefore, on the surface, co-operation between SMEs and research institutions depended on administrative order-based institutional trust, but in fact, it was personal relations based on family or pan-family trust that helped the companies obtain the administrative orders.

Chart 2: Transformation of Trust Mechanism between Research Bodies and SMEs in Transitional Period



The Chinese society has been in transition Since 1980s. With the establishment of market economic systems, SMEs began to look for more technical support from research institutions in the market. But capital shortage made it hard for them to buy needed information and technologies. Under such circumstances, co-operations based on entrepreneurs' personal relations network has become the major co-operation form, under which research bodies and SMEs join hands and are responsible for the results of the co-operation. As China's legal system remains to be improved, research institutions are more likely to select familiar entrepreneurs as partners in a bid to reduce risks. In such co-operation, pan-family trust acts a good foundation, but it also leads to imbalanced development among Chinese SMEs. Those enterprises with closer relations with research institutions can easily get technical support, while for those without such relations, it is very hard for them to achieve technological breakthrough. However, with improvement of China's legal system, a new institutional trust based on market economic system has been introduced into co-operation between SMEs and research institutions. In this period, such co-operation is built on pan-family trust but institutional trust has been applied in the co-operation since both sides seek for legal protection and more trust through contracts. Since such institutional trust has not yet been established fully, sometimes the aim of people signing contracts is to maintain pan-family trust and to define personal relations. Some contracts are just a kind of memorandums of understanding, rather than legal documents. Sometimes the contracts are not very effective (Cheng & Rosett, 1991).

In the transitional period, changes have taken place in the trust mechanism between SMEs and research institutions, making it more complicated. As shown by chart 2, in the transition from planned economy to market economy, the base for institutional trust between SMEs and research bodies has also been in transition from administrative orders to market economy legal systems. In the meantime, the re-building of institutional trust can sometimes lead to lack of institutional trust, which makes the co-operation between SMEs and research institutions very risky in the transitional period. Under planned economy system, both enterprises and research bodies didn't have to pay for failure of co-operation while in an ideal market economy, perfect legal system can stop both sides from breaking down their words. All these make family and pan-family trust to play a significant role in the co-operation because such trust helps to ward off risks brought about by imperfect institutional trust system. To some degree, both SMEs and research institutions are walking on ropes when seeking co-operation.

Investigation Design and Means

Most of studies on regional innovation system were based on second-hand statistics with few of them conducting on-the-spot investigations. In fact, regional innovation system is a complicated system. Although statistics can verify operational results of the system, figures can't tell deep-seated problems in the operation. Grounded theory is an efficient way when making analysis on complicated issues. Therefore, the project selected grounded theory as its research means and got first hand materials through on-the-spot investigation. The project was designed according to following principles:

We selected Chengdu in Sichuan Province and Xining in Qinghai Province as the two places where the investigation was made because the two cities could represent developed areas and under-developed areas in western China respectively. We could compare the cities with each other.

We selected more than 10 SMEs respectively in the two cities as our interviewees. The SMEs were in different industries and sub-sectors and were established in different times. To each of the enterprise, we conducted at least twice in-depth interviews. The samples could also be classified into two categories: one included well-performing firms in their lines in local cities while the other were poor performers.

We plan to conduct a second round of interview to all the sample enterprises one year later.

We also interviewed local authorities, intermediaries, and bank staffs responsible for granting loans to SMEs.

When doing the interview, we focused on all the innovation steps taken by the firms since their establishment and tried to make the background, process and results of the steps as clear as possible. We tried to dig out factors influencing SME innovations. Undoubtedly, such factors include both internal factors and an innovation support system in which the SMEs interact with outside organizations such as government, research institutions and banks. The project team conducted the first round of investigation in Chengdu and Xining respectively in October, 2004 and April, 2005. We interviewed 13 and 14 SMEs in the two cities respectively. Firms in the two cities are in different industries. In Chengdu where economy is relatively developed, the firms are in diversified industries including service, processing of agricultural products, forage processing, medicine and medical equipment, designing of chemical equipment, electric appliances, auto parts manufacturing, furniture and software development. In contrast, in Xining, there are limited industries. Among our interviewees, six are manufacturers of Tibet medicines while the others are in chemical, machinery and software development. Most of the interviewed enterprises were established in 1990s. Their sales income in 2003 ranged between 400,000 yuan to 2 billion yuan. The project team collected around 200 innovation events happened in the firms in the past over

20 years. The issues include inauguration of the firms, introduction of key talented persons, development of new products, shifting to new businesses and getting certificates. Of the events, around 30 were related to co-operation between the firms with research institutions. However, due to factors such as limited interview time and reluctance of interviewees, the project team got clear information on only 10 innovation events in five interviewed enterprises.

Case Study and Discussions

As we mentioned above, case studies are aimed to reflect the changes taken place in trust mechanism in co-operation between research institutions and SMEs, and to discover problems in practice. To this end, we had two standards in selecting our cases, one was that the enterprise should has completed the transformation of trust mechanism successfully while the other was that interview on the enterprise should contain enough information on its co-operation with research institutions. We conducted detailed analysis on 27 interviewed enterprises in Chengdu and Xining, and found one enterprise most suitable for the two standards. Therefore, we selected Company JT in Chengdu as our case.

1. A brief introduction to the case

Company JT was established in 1998 as a forage company producing premix for forage production. In 2002, it began to brew expansion to other industries and developed a business mode of "company + base + farmer" in breeding of *Ma goat* (a special species of goat in Chengdu). In 2003, it joined hands with a Canadian Enterprise to establish the Chengdu JT Co Ltd.

The company was launched by Li Hui, a graduate from Sichuan Agricultural University. Her major was animal nutrition and breeding. After graduation, she joined Chendu Charoen Pokphand, the subsidiary of world leading forage producer Charoen Pokphand Group. One year later, she was sent to work in headquarters of the group in Thailand. Later she went back to Chengdu to work for the company as a technician. In 1995, she joined a privately-owned forage company and was appointed to be the chief technical officer. Spending three years in the private company, Li re-joined Chengdu Charoen Pokphand as a technician manager specialized in research and making directions for premix. In 1998 when she launched the Chengdu JT Co Ltd, she was dubbed as the employee queen in forage industry in Chengdu. The working experiences in the past years not only enriched her knowledge in the industry, but also helped accumulate personal relations network. For example, she developed good relations with many experts in Sichuan Agricultural University. They jointly conducted many research projects. These experts also encouraged her to resign from Charoen Pokphand and establish her own business.

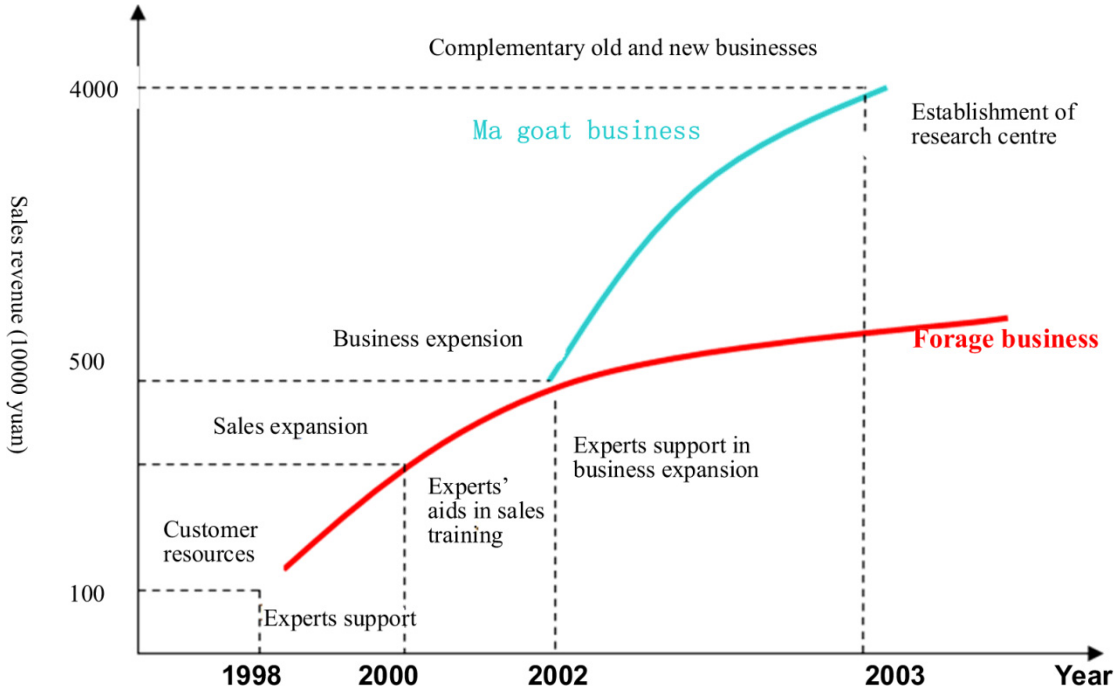
Li's company posted fast expansion in business after establishment. In 1998, sales value of her company was 1 million yuan, which jumped to 5 million yuan in 2002 and 40 million yuan in 2003. Such a rapid growth was owed not only to customer resources built up in the past few years, but also to Li's unremitting innovation efforts. For example, Jintian Forage sought for innovation in sales through co-operation with research institutions: when selling products, the company also sponsored lectures to provide training on breeding process and techniques for potential customers. The company invited five doctorate mentors (who were experts in veterinary and nutrition in Sichuan Agricultural University) to give the lectures. Moreover, it delivered free materials to customers and even invited them to dinners.

With the rapid development of China's forage industry, profit margin of forage production declined sharply, from the 50 per cent in the initial period to 5 to 6 per cent at present. In 2002, the company realized that it could no longer rely on a sole industry and began to look for new developments. At first, it planned to build up a boar plant and Li conducted negotiations with owner of an abattoir. However, the negotiation failed to produce any results due to different management ideas of the two sides. Later, it shifted attention to *Ma goat* project. *Ma goat* is one of the seven varieties included in the State trait gene reserve. However, due to lack of specialized fostering and breeding base, the amphimixis among *Ma goat* has resulted in fading of *Ma goat* gene. It has become an urgent task to preserve the gene. Supported by experts, friends and government leaders, Li decided to enter this business. The company set up a training base for breeding breeder goats. It tries to improve breeder goat varieties through gene research, then provide the goats to farmers to produce more breeder goats and commodity goats. The company is responsible for buying back the goats. On the one hand it can conduct deep processing on goats while on the other hand it can sell live goats. That is the business mode of company + base + farmers.

Li's company has also established an animal gene research institute as its special research and development department. The institute was registered as a privately owned entity affiliated to the company. Li Hui is the legal person of the institute while researchers are mainly teachers and students of Sichuan Agricultural University. The company is responsible for making investment (including both financing and goats for experiment) while the institute can apply for projects to gain profits through gene research. But so far it has not yet got any funding from outside. In the long-term, income of the institute will mainly come from selling gene. With gene breeding a long-term work, it is expected to take at least three to five years for the institute to start the gene business. JT and Sichuan Agricultural University have established good co-operation. At present, the goat breeding guiding group of the university also instructs work of the JT breeding center. Meanwhile, the company can make full use of the technology resources, equipment (for example, a gene test machine worth millions of yuan, but Li's company can borrow the equipment as long as the university has) and human resources in the university. In the meantime, students in the university can take JT as experimental base as JT provides funding for the students in gene test, sample collection, sample analysis, data analysis and anatomization.

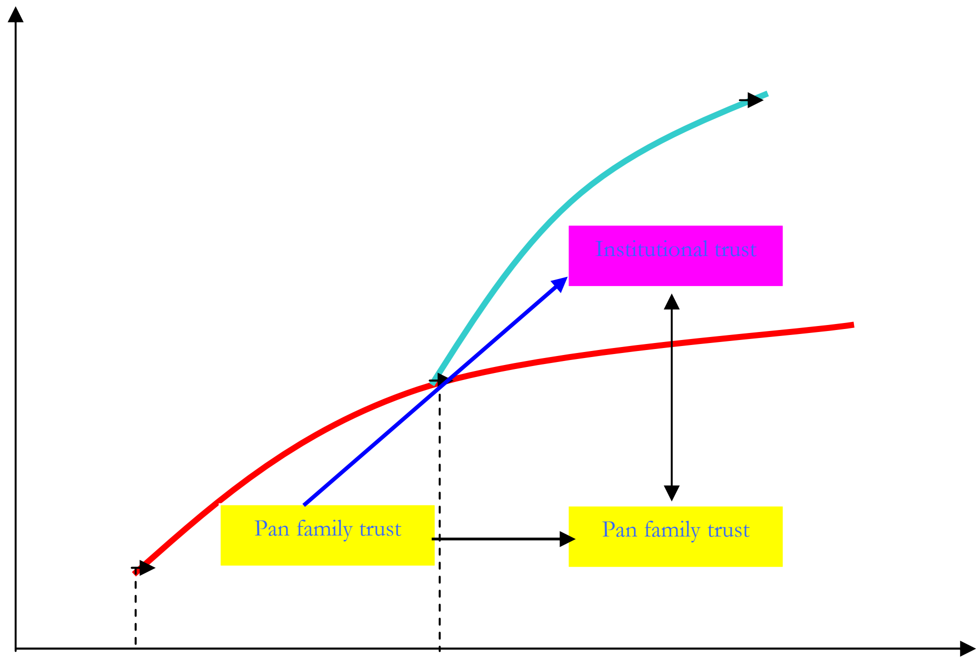
Li Hui believes that ordinary breeding plant can not afford to provide breeding standards for goat breeding farmers and make assessment on improvement of *Ma goat* varieties while universities are also unable to do this because they don't have the big number of goats needed for the experiment. She was majored in this subject and loves to make investment in research. "I am different from other bosses", she said. "I want to make the industry bigger and realize my own dream".

Chart 3: Key Events in JT's Development



The chart 3 shows that as graduate of Sichuan Agricultural University, Li developed pan-family trust with experts of the university, which played a very crucial role in the growth of JT in the first few years. The experts to a large extent persuaded Li Hui to make the decision to start her own business. In the meantime, customer resources accumulated before she started her own business also enabled the company to find existing room shortly after it was launched. Later, the experts also provided great support in business expansion of JT. Confirmed support includes providing free training for farmers in JT's sales expansion. Actually there should have been more supports and we guess that experts might also provide help and instruction in producing technologies and techniques. The year 2002 was a turning point for JT. The declining profit ratio of forage industry forced Li to consider further expansion. In her decision-making process, opinions from experts were crucial in pushing Li to enter the *Ma goat* breeding business. In the meantime, the new business resulted in closer co-operation between Li and the university. The trust mechanism between them has transferred from Li's individually pan-family trust to a kind of institutional trust. The research center launched by the two sides was a result of such trust. Under the new mechanism, the co-operation between the two sides is closer, more target-oriented, and efficient. Their co-operation modes were more diversified, even including renting technology resources and equipment resources from the university at low prices. In the meantime, students in the university can take JT as experimental base as JT provides funding for the students in gene test, sample collection, sample analysis, data analysis and anatomization. Behind key developments of JT, there are changes of trust mechanism between Li Hui and a research institute (Sichuan Agricultural University). See Chart 4.

Chart 4: Transformation of Trust Mechanism in JT's Development



First carve-out 2002 Second take-off

As shown by the chart 4, if taking the year 2002 as a dividing line, JT finished the first carve-out before that. In this period, the partnership based on Li Hui's pan-family trust played a key role in ensuring the business a success. Sichuan Agricultural University provided information and knowledge to JT in an informal way, which reduced JT's cost in obtaining necessary technology, management and information support by a large margin and accelerated JT's fast expansion in the first few years. After 2002, JT started the second take-off. Its pan-family trust was upgraded to a kind of institutional trust and continued to support JT's *Ma goat* breeding business. The two sides began to apply formal and diversified methods in co-operation and jointly set up a research institute. That is because informal support of information, technology and knowledge could hardly meet demands of JT's further development. It required the firm to further consolidate the resources in research institutions to serve its development. That is to say, the transformation of trust mechanism is a natural process and we could also tell that Li Hui played an active role in pushing forward the transformation.

Overall, JT, to some degree, represents a typical example in transformation of trust mechanism in co-operation between SMEs and research institutions. It also embodies the interaction mode between SMEs and outside organizations under market economic systems. Generally, the co-operation starts from pan-family trust. But with deepening of the co-operation and standardization of the enterprises, such co-operation based on pan-family trust is upgraded to co-operation based on an institutional trust. In this way, both sides pay enough attention to both rational trust and emotional trust, and to both efficiency and results of the co-operation. However, in reality, most of the SMEs can not accomplish the transformation by themselves, and the failure often leads to a series of crisis in the growth of the firms, such as trust crisis in management teams and frauds in co-operation with outside organizations. In our interviews in Xining, at least three entrepreneurs complained that their friends and acquaintances cheated them when buying their products, some defaulted and some refused to pay. This problem has become a severe blockage in development of SMEs. With growth of SMEs, transformation of trust mechanism is the key for SMEs to co-ordinate relations with outside organizations.

Conclusions and Discussions

First, interaction between research organizations and SMEs is the crucial part in regional innovation system. Research institutions support development of SMEs through investment in technology, knowledge and information. In the meantime, SMEs' dynamic innovation activities can spur commercialization of achievements of research institutions. However, China's special trust structure results in complicated co-operation between SMEs and research organizations. Pan-family trust leads to lack of credit guarantee in the co-operation. In addition, the imbalanced distribution of pan-family relations in the society makes the co-operation inefficient. It is hard for some powerful SMEs to get support from research institutions because they don't have relations.

Second, laws and systems are basis for market economy, which requires the co-operation between SMEs and research organizations to be standardized and institutional. The pan-family trust based on personal relations of entrepreneurs must be transferred into institutional trust based on organizations, which helps not only push the SMEs to a fast growth track, but also enable SMEs to avoid disputes in interests distribution which often come along with their increasing profits. The institutional trust can also help the two sides avoid losses in case one of them break their words.

Third, entrepreneurs play key role in transformation of trust mechanism. For entrepreneurs, their biggest enemy is their successful experience in the past. Some entrepreneurs are addicted to yielding brought about by pan-family trust to their firms in the initial stage, or even rely on such trust. This not only restrains the SMEs from further expanding their co-operation with research institutions, but also confines them from developing relations with other outside organizations.

Last, the government should improve legal and system environment. SMEs are a dynamic part in China's economic take-off. In the current information age, future of SMEs depends on technical renovation and compatible systematic innovation. China's traditional culture determines its special trust structure, which is not in line with market economy principles. It is an urgent task for the government to strengthen legislation, standardize market economic systems, popularize laws and regulations, and push entrepreneurs to conduct institutional trust-based co-operation.

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Emergence of the Entrepreneurial University and the Future of Higher Education in China

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Abstract

This paper explores the emergence of the entrepreneurial university and future development of higher education in China through the lens of the triple helix model of innovation. University-industry-government interactions may be depicted as a triple helix of one type or another in different societies. The model, with each helix having a central core and a surrounding field space, differentiates between institutional spheres development under various conditions and provides a framework to analyze the university as a sphere. A comparison of university systems and government policies and laws suggests contrasting US and China models of a "university-pushed triple helix" and a "government-pulled triple helix." This analysis indicates different paths toward the entrepreneurial university, albeit with a common objective of promoting economic and social development.

Keywords: entrepreneurial university, government-pulled triple helix, spin-offs, university-run enterprises (UREs), triple helix – field interaction.

Introduction

This paper analyzes higher education development in China during the early stages of transition from a Statist regime. Formation of new firms from university resources became a strategy of Chinese university and regional economic co-development in an era of severe resource constraints. Under contemporary conditions, government is providing increasing resources for academic development; however just two decades ago, academic resources had to be cannibalized to jump start regional development. The exigencies of this situation produced enterprises that were strikingly different from US academic spin-offs in two key dimensions:

1. Chinese firms were typically based on existing technology rather than advanced-edged research. Indeed such firms often began by marketing, rather than manufacturing, "high-tech" products although they soon used the resources accumulated from sales to begin manufacturing and then upgraded to increasingly higher-tech products and extended national to international markets.
2. The university originated firms remained part of the university, were typically managed by university administrators and faculty members, and operated as wholly owned entities of the university. These firms constituted a direct business role for the university in society, rather than representing a separation or "spin-off" process. More recently, as an independent legal system has been established, a "spin-off" process has been introduced, in part, in order to reduce the universities legal liability. Nevertheless, universities typically retain significant ownership and control of these "university-run enterprises" (UREs).

Is ownership of UREs, which have resulted in some firms growing larger than their academic sponsors, a proper focus of the university-industry relationship? In addition, the university traditionally a social commonwealth enterprise, i.e. non-profit, by "social contract" has become profit-making as UREs in leading universities have made them rich. In China, professors who were poor before the end of 1990s are now considered amongst the "Seven Wolves".[73] Nor were UREs a unique development; various government units, including the armed forces, also developed firms as part of a rapid economic development strategy, placing the organizational resources of society in the service of new business development. At the same time, government is

[73] Seven Wolves means the first seven groups of top wealthy.

a huge stockholder, owning many corporations left over from the era of state-controlled enterprises. Thus, there is considerable interpenetration and resulting confusion among the three spheres.

An analogous situation may be identified in the US coming from the opposite direction. In a laissez-faire oriented society outsourcing of traditional government activities to private firms has created flexibility in organizational design but also loss of control and direction by government agencies of some their traditional activities. Moreover, the expansion of university-industry relations in the US from a relatively few schools before the passage of an amendment to patent law in 1980, the Bayh-Dole Act, incentivized the entire range of research universities to become active in technology transfer. Independent versus dependent institutional spheres led to strikingly different outcomes of university run enterprises and spin-offs in the US and China. Both cases represent significant experiments in restructuring the relationship between the "public" the "private" and the "academic" that may be instructive to countries and world regions suffering from institutional and organizational sclerosis.

I. Comparison of University, Industry and Government in China and America

China is different from the US in its political system and cultural tradition. Will Chinese universities follow the US model or take another path? Let's consider this issue through a comparison among university-industry-government interactions in China and the US.

On one hand, there is an innovative and creative spirit in traditional US culture; on the other hand, America has recognized the benefit of technological innovation since World War II. V. Bush's idea that basic science is an engine of technological innovation is strongly rooted. The science policy following from Bush's report, *Science: Endless Frontier* has successfully supported basic research in universities, so that there are spillovers of technology knowledge, resulting in universities' direct participation in innovation through firm-formation and creation of the "entrepreneurial university". At least in Boston and Silicon Valley, and increasingly elsewhere, we can see that university, industry and government have evolved from a laissez-faire to a relatively ideal triple helix.

Nevertheless, there has been strong criticism of the emerging economic role of the university. According to Branscomb et al. (1998), the role of university in a society is determined not only by economic logic, but also by a "social contract" concerning the division of labour, the university as an institution for education and production of knowledge. The tension between the entrepreneurial and ivory tower models has insured that universities clearly define and delimit their economic activities even as they increase their involvement.

The University System

The U.S. and Chinese academic systems differ qualitatively and in their governance. Although there is a long history of academic training in the western sense, including development of research since the mid-20th century; most universities in China focus on teaching and are at a relatively early stage of upgrading to research and entrepreneurial university modes. Nevertheless, progress has been rapid, especially in recent years as government has had the resources to commit to academic enterprise and as universities have generated significant resources on their own to jump-start high-tech development in response to government requirements, on the one hand and to financial stringency, on the other.

US universities began the transition to research in the mid-19th century and an increasing number have made the transition in recent years even as a 2nd transition has been underway promoting the commercialization of research. It is the US government support of research in the post-war era that has fuelled the expansion of academic research through funding from a variety of agencies, with responsibility for military and health, as well as basic research. Moreover, state governments, foundations, private donors, both alumni and well-to-do individuals, play a significant role in the variegated US academic system. Higher education also plays an important role in the national culture, providing sports and television entertainment. Academic purists may decry the extension of university functions beyond the strictly academic, but the loyalty to their alma mater engendered by university sports teams provides a significant impetus for support. Similarly, university technology transfers' contribution to the economy legitimates government support to universities and research.

There are over 3000 universities in the US, including some of the best ones in the world. The top-ranking universities have considerable strength in research. Top-ranking private universities have an average of 910 postdoctoral fellows, top-ranking public universities 690; whereas their counterparts in China only have 300 (Niancai Liu et al, 2002). Since the late 1970s and the early 1980s, higher education in China recovered from the Cultural Revolution. Especially entering the end of 1990s, a "big jump" occurred in higher education. The university system undertook an expansion strategy. To date, there are over 1200 universities and a gross enrollment rate of over 25%. There is a rough equivalence in staff and undergraduate student numbers, structure of student levels, professional curriculum. In other words, the difference is not in educational scale, but in quality; not in teaching, but in research and entrepreneurial capability.

The difference typically embodies: (1) staff: far behind the US, where all professors in top-ranking universities have a PhD; (2) educational quality: in recent years, getting worse, due to rapid expansion; (3) research capability: weak and hard to strengthen from disordered graduate education, i.e. "educational corruption"; (4) the number of postdoctoral fellows should be increased but there is inadequate financial support. These gaps must be filled by accumulation, rather than an "educational big jump".

Academic technology transfer has grown into a recognized profession in the US, with a professional organization, the Association of University Technology Managers (AUTM), complementary to the Licensing Executives Society (LES), which represents its counterparts in industry. Technology transfer has evolved from a marginal academic activity carried out by an intermediary not-for-profit entity, the Research Corporation - serving a relatively few interested universities in the early 20th century, like MIT - into a "decentralized-enhanced" model in which the transfer function has been internalized in individual schools and, increasingly, has devolved down to the school level, especially to medical schools.

Transfer has also expanded from patenting and licensing to include increasingly direct assistance to firm formation, including provision of venture capital and business assistance. Reflecting this expansion of capabilities, technology transfer and related incubation functions are increasingly organized as a higher-level administrative unit co-coordinated by a Vice-President. Research Corporation, having lost its original purpose as its customers internalized the tech-transfer function, has transformed itself into a venture capital firm specializing in university spin-offs.

In China, technology transfer is attracting greater attention as its potential for economic development is realized. However, technology transfer typically means technology transfer in its classic sense, that is movement of technology across national boundaries rather than introducing indigenously invented university-sourced technology to industry. Nevertheless, National centers of technology transfer have been established by government policy in six top-ranking universities, i.e. Tsinghua University, Shanghai Jiaotong University, Xi'an Jiaotong University, China East University of Science and Technology, China University of Science and Technology and Sichuan University. Some universities have even set up international centers of technology transfer by themselves. It seems that a transition to university tech transfer and the entrepreneurial university in China is underway. The problem is how a university can generate technologies by enhancing research, instead of importing technologies from abroad, and subsequently commercialize research from the university campus.

Government Policies and Laws

Government in the US, including at federal, state and local levels, supports innovation in university and industry, through making policies, enacting laws, direct investment or indirectly encouraging (venture) investment, government stock, as well as developing medium and small firms and so on. The development of aviation, electronic computer and semiconductor industry greatly depends on government support. During the 1960s, the government bought 37%-44% of all integrated circuit products, thereby accelerating the development of the industry even though the overt purpose was simple military procurement. In Silicon Valley, one- fourth of orders are from the US government. In conclusion, policies and laws, which have powerfully stimulated high-tech industry in the US, are relatively stable, consecutive and effective, despite the absence of a coordinated industrial policy.

Since the 1980s, China has created policies and laws to promote the development of science and technology, knowledge industrialization and high-tech industry. Some of them are very helpful to three spheres development. For example, the State Council decided to delegate management power of universities which were subordinate to the Educational Ministry to local government. It greatly encouraged these universities to support local growth, accelerating development of the entrepreneurial university in China.

However, sometimes the policies lack stability and continuity. So far there has not been a follow-up to the ambitious promotion of UREs such as was reflected in the Resolution on Accelerating S&T Development, which was jointly promulgated by the State Council and the Chinese Communist Party in 1995. This resolution encouraged universities to establish high-tech firms using their own research results, and promoted the formation of strong linkages between academy and industry. It coincided with a sharp decrease in funds for teaching and research that left entrepreneurial activities as the only recourse for university development. On the other hand, state funds through loans and easy credit made possible the construction of university science parks and rapid expansion of firms. These high-growth firms took advantage of imported technology, low wage rates and expanding local and international markets for their products. However, in November of 2001, the State Council issued the "Circular on the Experiment of Standardizing University-run Enterprises Management at Peking University and Tsinghua University" that seems to restrain university-run enterprises and call for the separation of UREs from universities.

In addition, there has been lack of foresight in policy-making in China. It seems policies and laws in US aim at guidance and prevention in advance, whereas in China greatly they are ex post facto used as tools to control organizations or remedy problems. Moreover, every official who has taken an important action is typically followed by another person who has his/her new ideas to put forward in order to demonstrate achievement in the post, i.e. "official will". This leads to less-consistent policies but is a commonplace of policy and politics everywhere. Nevertheless, it may weaken government's role in promoting innovation. To sum up, unlike US government as a referee, Chinese Government works as a referee, a player and an organizer for sport. However, this broad-brush comparison must be qualified since in key areas of national security the US government also plays a pro-active role in innovation, for example, through DARPA, the Defense Advanced Research Projects Agency, founded in 1958, in response to the Soviet Sputnik success.

Industrial Firms

Industrial firms in the US provide most of the researchers and expenditure to conduct research work, possess broad R&D financial sources and pay more attention to training. Thus they have strong self-innovation capability. Some corporations, such as IBM and General Motors, keep large-scale research labs for basic research, which have made significant contributions to innovation. Some of them work together with other corporations and national labs to develop and improve technology. Most of them have established their own office of technology transfer, in order to track the research in universities and national labs and sell technologies to other companies.

In the US, industrial firms increasingly view intellectual property rights (IPR) as a core element of their strategy for development, and attach importance to protecting IPR. They compel government to protect IPR powerfully, and then protect US enterprises' competitive advantages all over the world.

Most of Chinese industry in which manufacturing is dominant operates at a low-technology level in a labour- and natural resources based economy. Forms are very weak in absorptive capacity and innovation ability in traditional industries. The transition to understanding and respecting IPR requires a longer time. Enterprises are also in transition from a Plan- to a Market Economic System. They are not yet the main sources of technological innovation and that is one reason why government encourages universities to take on innovation tasks. Based on this premise, universities in China play an increasingly important role in economic and social innovation, making the future of higher education in China a significant issue.

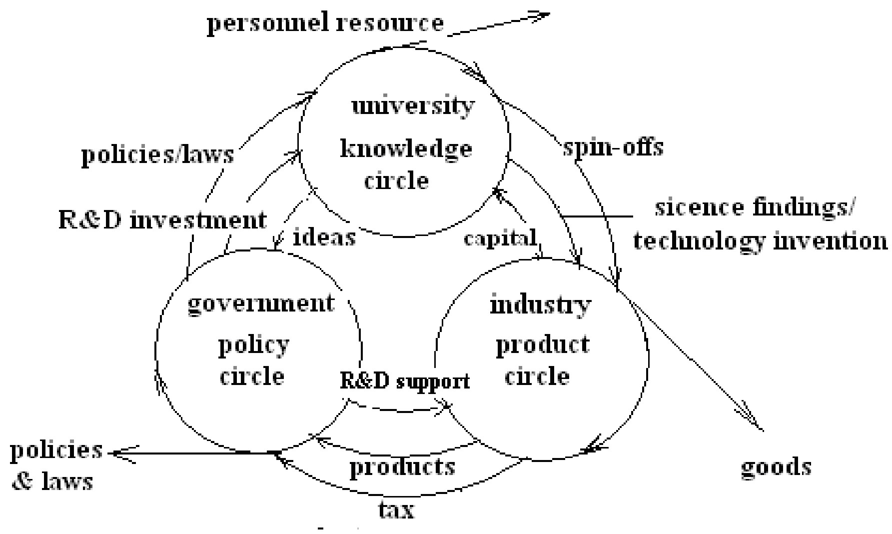
II. Entrepreneurial University: Definition and Characteristics

According to the model of triple helix- field interaction, there is a triple helix (field) space, with various hybrid organizations surrounding the helices. Science parks, spin-off (in the US), university-run enterprises (in China), incubator, etc. arise from the interactions between university industry and government. Why can there be university-industry-government affinity? The radical reason is conformance of the objects or reciprocity, that is, all of them aim at innovation, the first business application for science findings or technology inventions. In a knowledge-based economy, knowledge has replaced material, labour and capital, becoming the most important factor of production. Not surprisingly, the university, as a producer of knowledge, and industry, as user of it, need each other, forming a common goal.

Nevertheless, a relationship to industry is a necessary condition for an entrepreneurial university, but not a sufficient one. An entrepreneurial university is not an only a university with many industrial entrepreneurship activities. It has own meaning and characteristics. In the West, entrepreneurship activities of a university typically include four aspects: (1) entrepreneurship education: to organize teaching through facing to needs of industry, encourage students to form start-ups, tell them how to do it; (2) consultation for industry; (3) technology transfer from university to industry; and (4) spin-offs: firm formation.

In practice, a university has the potential to engage with the development of industry, no matter its level and type. However, different universities have different education goals and missions. Universities in various levels and types meet different societal needs. The teaching university is based on education and engagement with the personnel market; the research university engages production of knowledge, as well as teaching; the entrepreneurial university has three missions: teaching, research and service for society. In fact, only the entrepreneurial university can participate in the whole society's innovation effort to improve the interaction process of the triple helix, to complete a circulation of trilateral cooperation. See Figure 1.

Figure 1: Triple Helix Field Interaction Circles



In our view, an entrepreneurial university embodies the following characteristics:

- Entrepreneurship culture is accepted and supported systematically, with entrepreneurial training a component of general education,
- The university plays a an active role in regional innovation strategy,
- There are interface mechanisms e.g. a technology transfer office, such as Office of Technology License (OTL) and corresponding achievements, and
- There are significant numbers of staff members to form firms, which can receive considerable income to support the university's research and other activities.

Given these general characteristics, the entrepreneurial university model is realized with different emphases in various regional and national conditions.

III. University-pushed and Government-Pulled Triple Helix

The US Triple Helix is a university-led model, according to case studies from MIT, Stanford, and elsewhere in recent years. New England, a "brownfield" region, had a declining industrial foundation in the 1930s; whereas the Peninsular region of Northern California, a "Greenfield" site, lacked a significant industrial base. However, these two universities took the lead in creating new industry and innovation, auguring the emergence of the university as a leading power in regional development. Therefore we call this US model a "university-pushed triple helix." The model operated simultaneously in New England, where all three spheres were available to support high tech development. For example, although manufacturing industry had declined; the region retained a strong financial industry that had been built on the base of the regions previous commercial success. The financial industry supported the invention of the venture capital firm, designed to support firm-formation from academic inventions (Etzkowitz, 2002).

By contrast, a triple helix emerged successively in California where a university-initiated development project, from the late 19th century through the 1930's, was largely university-led, with some industry collaboration as firms were formed by local technology entrepreneurs including those that emanated from Stanford. The project was supported by the federal government in the early post-war; building on the base that was available to attract R&D funding that was newly available on a large scale by military procurement of semi-conductor devices from this growing industry (Lowen, 1997). The project then became industry-led in the 1990's, in response to a recession in what had by then become the world's leading high-tech region (Saxenian, 1994).

From 1949, when the People Republic of China was established, to 1980, the university in China was strongly influenced by the practice of the former Soviet Union and mainly engaged in teaching. Research, especially for the military, was carried out by research institutes. This policy followed the French tradition, influential in Russia, which the Soviets found useful for political purposes. Only ideologically reliable persons were allowed to become university teachers while researchers, of lesser reliability, could still be utilized in Institutes where they would be cut off form influencing youth. The separation of research and teaching, in contrast to the Humboldtian tradition of integration in support of the emergence of the nation state, was imported to China where it similarly had the effect of separating university from industry.

Since 1980, China's universities underwent a sea change as a result of then President Deng Xiaoping's thesis of science and technology as the primary forces of production. The Chinese government inaugurated a series of policies and laws to encourage university research activity in order improve the capacity of the university to contribute to economic development. As a result, university research developed rapidly. In January of 2006, a National Science and Technology Conference, with a goal of creating an innovative state, was held in Beijing. The meeting objective was to increase the capacity of university and industry to contribute to innovation. University and industry, as innovation actors, are both controlled or pulled by government. Such a model can be called a "government-pulled triple helix".

Liaoning Province, in Northeast China, provides an exemplary case of university transition. Before 2000, the two research universities, Northeast University and Dalian University of Technology, were managed solely by the Education Ministry. They paid little attention to local economic development. However, in 2000, some management power was decentralized to Liaoning Province government, placing these two research universities under joint central and local government management control. This arrangement greatly encouraged cooperation between university and industry. Indeed, an increasingly close relationship has improved local new technology and industry development at a surprising speed.

Moreover, the government also controls industrial development. For example, before 2000, the Liaoning Province government undertook a high-tech strategy for development, abandoning old industries in which the region formerly excelled. However, in the face of failure, it decided to change the strategy, to renewing the old industries with the help of new ones. This strategy reorganized the direction of university and industry development and achieved much greater regional growth than the previous one.

IV. Development of Entrepreneurial University and the Future of Higher Education in China

How can Triple Helix theory be used to investigate the specific situations in developing countries? Jong-Hak Eun, Keun Lee and Guisheng Wu "depart from the critique that the Triple Helix and the "New Economics of Science", which assume typical situations of advanced countries, fail to provide a satisfactory theoretical framework to address the university-industry relationship in developing countries" (Eun et al., 2006), to explore university-run enterprises in China. The "New Economics of Science" has revealed the commercialization feature of science, and based university-industry-government cooperation on reciprocal principles. In their new framework, the authors admit the hierarchy of UREs, which can freely use the mother university's resources, including labs facilities, and are controlled by the university. There is an umbilical cord connecting baby to mother. Apparently, the hierarchy was generated by the political system of China. This partly is because most universities in China are public. Therefore, to neglect the government sphere's influence in the study of UREs is improper.

Identifying Industry and University: From UREs to Spin-offs

Although universities in the US and China are both encouraged to create enterprises or form firms, they are spin-offs in the US, whereas they become university-run enterprises (UREs) in China. They are quite different in their ownership. A spin-off by definition is an economic entity of academic origin that becomes an independent entity. A URE is an economic enterprise that remains part of the administrative structure of the university. Spin-offs in Boston and Silicon Valley exemplify that universities have made tremendous contribution to local economic and social development. Many UREs (from some universities such Tsinghua University, Beijing University, have also taken a leading role in Chinese high-tech industry, but can not play a dominant role in regional economy development, although Tongfang, Zheda Wangxin, Northeast Software and Beida Fangzheng respectively established and operated by Tsinghua University, Zhejiang University, Northeastern University and Beijing University, have become the No. 3, 12, 15 and 25 of the Chinese Top-100 S&T Firms in 2002 (Eun et al., 2006). They only exemplify the advantages of UREs as high-tech enterprises.

The rise of UREs in China started from 1980, because old-style enterprises in the planned economy were poor in absorptive capacity, to say nothing of R&D and innovation. Most UREs started from low-tech and then grew up to higher-tech industry. They are neither "spin-offs", nor "start-ups". The research results with commercialization potential were rarely transferred to industry. Thus the university fulfills technology transfer and knowledge capitalization objectives through establishing UREs.

As a whole, UREs have three characteristics: (1) a university takes up an absolute or relative holding status in its UREs assets; (2) those that operate UREs basically come from university staff or students, especially at the very stages; (3) UREs mainly rely on their mother universities for R&D. Therefore UREs are actually "enterprises possessed by universities". This ownership problem is currently being resolved by the Chinese government's implementation of new policies. As ownership right changes, various issues will appear, involving stockholders, managers, operators, as well as intellectual property rights problems. Development of the entrepreneurial university in China will be accompanied by solutions of these problems, including a transition from the URE to a spin-off model.

UREs in China are in the core area of the university institutional sphere, but spin-offs in the US are in the external triple helix field space (Etzowitz and Zhou, 2007), where university and industry interact. As a result, UREs brought confusion in ownership, became one of the sources of corruption and a disordered university system, while they created revenue for the universities in question. The development of UREs has raised the issue of the university's character and missions. They have consumed too much energy and time from faculty in the business of low-tech firms. There have increasingly been complaints that the university is becoming "industry". For example, when a university takes on enterprise actors in innovation, through its advantage in high-tech research; it increases the tension between university and industry. Since universities have their own companies; excessively competitive university-industry relationships will eventually induce a difficult technology transfer from university to industry; and so on.

Based-on interest considerations, universities are reluctant to give up the ownership to UREs. However, as a university expands enrolment opportunities and the absorptive capacity of industry is enhanced and the university improves its capabilities in technology transfer, there is a tendency to devolve UREs and explore other forms of entrepreneurial activity. See Table 1.

Table 1: University-run Enterprises in China (1992-2001)[74]

Year	Number of total UREs	Number of S&T UREs	Number of Non S&T UREs
1992	Not available	850	Not available
1996	Not available	2912	Not available
1997	6634	2564	4070
1998	5928	2355	3573
1999	5444	2137	3307
2000	5451	2097	3354
2001	5039	1993	3046

Source: Year 2001 Statistical Report of University-run Industry in China, 2002, P.10, China University Industry (Zhongguo Gaoxiao Chanye), 2000, No.6, P.10, University S&T Industry News (Gaoxiao Keji Chanye Tongxun), 1998, No.3-4, P.2

Jong-Hak Eun et al. suggest that the absorptive capacity of industry affects the university's decision to establish UREs. When it is weak, the university feels that the only path towards fulfilling its technology transfer or industrialization mission is to set up UREs and make them flourish. As absorptive capacity increases, universities prefer transfer technology and UREs decline.

In addition to the decrease of UREs related to the improvement of absorptive capacity of industry, there are at least three factors: new government policies, development of (venture) capital guarantees and enhanced knowledge production abilities on university campuses. Certainly, another important factor to affect UREs is traditional culture. The solution of the ownership problem is the focus of current policy changes. In the recent past, unstable policies have caused uncertainty in universities. Since 2000, some universities in China have been supported by expanded government R&D investment, the "211" and Innovation Projects and the increase of enrollment (tuition), which greatly reduced financial pressures on universities. Moreover, teaching universities can get enough money from tuition. These factors cause the universities to lose their willingness to establish UREs, even those low-tech UREs that they can set up. Furthermore, no president wants to involve the university in ownership due to the

[74] Eun, et al, 2006.

problems it creates. From the long term views, it seems that university, industry and government want to see UREs disappear. Of course, whether they will be replaced by spin-offs is another issue.

The Starting Point of the Chinese Entrepreneurial University: Professor Consultation

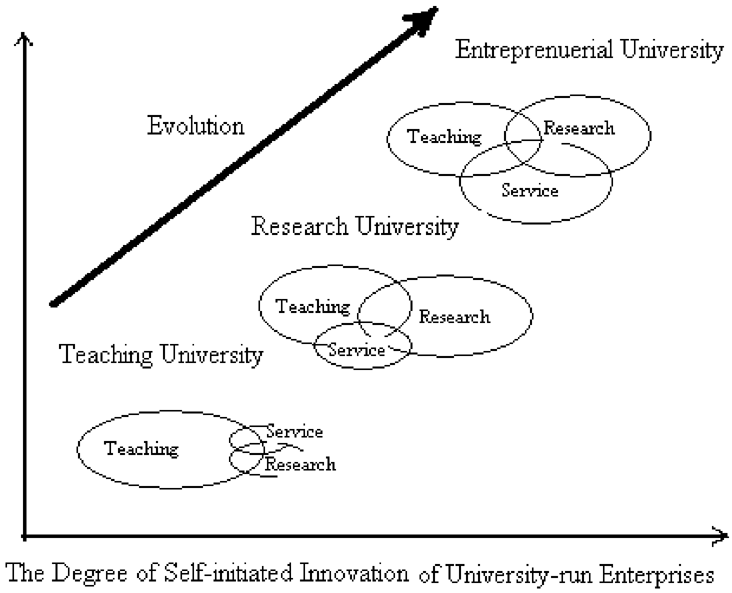
Consultation is the starting point of US entrepreneurial universities, having become an important practice of professors in some US universities as well as bringing a financial return to their faculty members. In MIT's experience, the start of entrepreneurship was consultation by its faculty for industry, followed by spin-offs. In the 1930s, Professors such as V. Bush learned about firm technological needs through consultation. They brought problems back to labs in the university to do theoretical investigation while they dealt with the practical problems. At the same time, teaching was greatly improved by introducing vivid examples from consulting practice to the classroom.

Consultation for industry is rising among a few top-ranking universities such as Beijing University and Tsinghua University, but it is at the very beginning. The resources are concentrated in a few highly-reputed universities. For example, under the leadership of faculty in Beijing University a consultation firm was organized, with more than 200 business or technology experts living in different cities and divided into five groups depending on their expertise. A series of books on consultation edited by authors at Beijing University was recently published by Zhongxin Press. Nevertheless, relative lack of consultation led to teaching and research becoming separated from industry practice. Moreover, there has been a lack of absorptive capacity and self-innovation ability on the part of industry.

From Entrepreneurship Activities of University to Entrepreneurial University

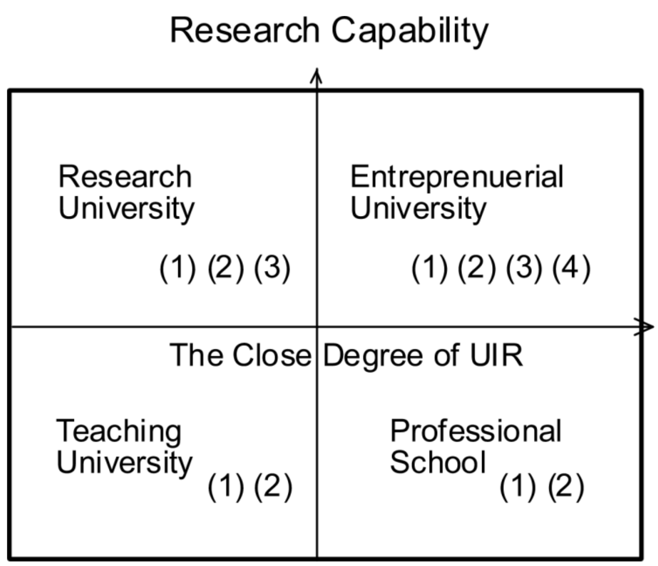
There are various levels of universities, including national, province and city levels, in a hierarchy. Universities may also be categorized as technology academy, teaching university, research university and entrepreneurial university, according to the priority of their objectives. A matrix is formed here. See Figure 2.

Figure 2: The Evolution of the University



In Chairman Mao's era, it was proposed that education should be related to the practice of industry and agriculture. Schools had their own factories, workshops and experimental fields. Intellectuals in universities had to participate in industrial practice. This was mainly done for a political purpose: to change intellectuals, but there is a by-product: to draw university-industry together. Since 1950, there have been a variety of entrepreneurship activities in universities. See Figure 3.

Figure 3: The Quadrant of Universities



An entrepreneurial university conducts basic research and achieves technological innovation from its research results spillover, taking the lead in putting them into practice. On the other hand, a vocational college or professional school may work closely with industry and be focused on meeting its need but is not necessarily an entrepreneurial university unless it innovates from a science base and plays an active role in regional economic and social development.

Conclusion: Policy Implications

All three helices, in China, have serious deficiencies, especially industry. Thus, university becomes an important actor to promote high-tech industry through setting up various university-run enterprises. Government, at national, province and city levels, participates in economic activities through sector bureaus. For example, the light industry bureau is not only responsible for administration of the sector but also has some affiliated enterprises. As a result of economic instability, every sphere entered the market, thus making it disordered. How can government with remit to regulate and supervise the market deal with the firms run by itself? Can universities resolve the tension between teaching, research and creating/running enterprises? What is a university's nature? In other words, is the third mission of university to foster development of industry, or to run some enterprises like industry?

The problems above arise from absence of boundaries among the three core areas. Their lack of independence makes it very difficult for the spheres to create an external field space for interaction undertaken by mutual consent. The confusion of actors inevitably results in each helix's inability to acknowledge its specific missions and play its role very well. Thus, entities which have clear enterprise characteristics may grow in university or government since there is not a clearly defined "spin-off" path.

Such enterprises are quite different from spin-offs in ownership. Indeed, they have been labelled University-run enterprises or UREs to denote their legal status_as part of the university system. More recently government has acted to encourage universities to devolve these enterprises to reduce the university's liability for product defects, as the legal system has strengthened, and opportunities for corruption due to intermingling of academic and firm resources. The URE model is not unique to universities; the Chinese armed forces have engaged in significant firm formation efforts and the URE movement has also spiralled back as some enterprises have established subsidiary higher-education entities, e.g. the software college of Northeast Software, a Northeastern University URE.

Although a few Chinese universities created some of the largest and most successful high-tech enterprises in the country, they remained part of their originating organizations until quite recently, rather than spin-offs as independent entities. This created problems for their sponsors since as an independent legal system took hold, dissatisfied consumers or business partners gained the right to sue for redress. Since the enterprises remained in the ownership of the universities, it placed them at risk. To redress this anomaly, government has recently taken steps institutionally to separate university firms from their academic source.

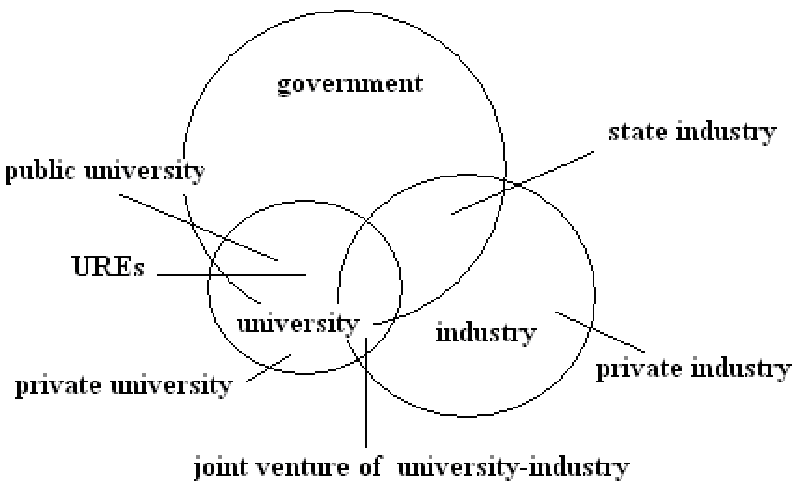
Chinese universities are in the midst of transition from teaching to research and entrepreneurial modes of academic organization. This academic transformation is influenced by transition from a Statist society in which government controls academia and industry to a Triple Helix society in which each sphere is relatively independent of the other. Since the 1990s, existing enterprises are lacking capacity to implement technological innovation and are not able to become real main actors for technological innovation, although the government has completely recognized "the key to enhance the capacity of enterprises' self-innovation is to emphasize the main actor status of enterprises in technological innovation, making them the main actor for R&D, innovation activities and application of innovation results". [75]

This format is hypothesized to provide the optimum conditions for innovation. In recent years, government support focuses on research universities, through Project 211 and Protect 985; other universities, especially those local ones, set up their own enterprises to fill the gap left from lack of government financial support. Universities which were supported by the state also operated enterprises whose business activities remained within the universities rather than being spun off as independent firms. Several universities have successfully operated high-tech companies like Tsinghua Tongfang, Beida Fangzheng and Northeast Software. A similar process of creating enterprises from available resources took place in Eastern Europe after the demise of the Communist regime. However, in the abrupt transition from a statist to a laissez-faire regime the sponsoring organizations lost most of their resources and were typically unable to provide significant support to grow these enterprises.

Although the factors to decide the intensity of each helix are complex, the most important includes the R&D capability and financing ability of university; in industry, investment in R&D activity and absorptive capacity; feasibility and effectiveness of government support by policy and laws, or by direct investment. Among the three helices, industry is closest to the market and production practice. In general, it is the main actor or subject in innovation. Sometimes university can be an organizer or subject for innovation. But government shouldn't be involved in it directly.

In the triple helix – field interaction model, the cores and outside space of the helices are separated. It is helpful to explain China's current state of the art with respect to the triple helix. According to the theory, first of all, China should resolve the problems existing in the core area, i.e. UREs' ownership issue. The present situation of cores of triple helix spheres involves the transition from a statist model. This transformation is shown by Figure 4.

Figure 4: University-Industry-Government Triple Helix in China



[75] Decision on Enhancing the Capacity of Self-innovation by performance of Science and Technology Plan's Outline, by Chinese Communist State Council2006.1.

A policy to develop entrepreneurial universities will raise academic research capacity and strengthen university-industry links. In order to accelerate the construction of entrepreneurial universities in China, several measures for university development should be taken:

(1) actively upgrade research universities and encourage the transition from teaching to research universities, with the help of government policy,

(2) government should greatly encourage consultation practice,

(3) immediately try to change UREs to spin-offs,

(4) make government policies more stable, credible and continuous, and

(5) work with government and industry to develop hybrid organizations like science parks and incubators around the universities in question to enhance industry-university link.

The research ability of universities in China has to be improved. However, the university sector is still secondary to the research institute sector in research funding. This situation does not take full advantage of the human capital flow through and idea generation capability of the academic research group format. Nor does it take advantage of the research capacity of graduate students and post-doctoral fellows as a cost-effective R&D strategy in contrast to higher-paid advanced Institute research personnel.

Universities need more financial support and policy assistance. In 2003, only 16.23 billion Yuan of total R&D outlay, 153.96 billon Yuan, was for universities, 96.02 billon Yuan for enterprises and 39.90 billon Yuan for research institutes. From the investment to science and technology activities, the total amount is 312.16 billon Yuan, including 212.62 billon Yuan in enterprises, 68.13 billon Yuan in institutes and 25.39 billon Yuan in universities. Obviously universities are not seen as main source of research.[76] China also has a long way to go to achieving world-class research universities.

Most universities will continue transforming from teaching to research universities. In addition to this transition, there is also a strong movement towards integration of specialized Soviet-style, specific industry focused universities. In recent years, government, both at the central and local levels, has merged many universities. After the "merging motion", a relatively stable university system will be formed. The next task should be to create their specialties. Furthermore, the professional schools or German-style polytechnic school will increasingly become a complement to the technology universities. A national conference on professional education was held during November 7-8, 2005, in order to enhance the training of technicians. There will continue to be many technology academies in China.

Universities will be increasingly differentiated. Tsinghua University may become an entrepreneurial University; Zhongnan University is trying to be an innovation university. Some foundations may continue as teaching universities, others may persist as polytechnic schools. Nevertheless, an overall movement can be discerned towards development of multi-universities, simultaneously oriented to teaching, research and regional economic development. Thus, regional innovation may take place through a university-pushed and government-pulled triple helix, with a statist or laissez-faire model trending towards to a triple helix of overlapping, yet relatively independent spheres. China, however, still has a long way to go to form an ideal triple helix model for innovation.

[76] http://www.stcsm.gov.cn.

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SECTION 5

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Helen Lawton Smith is Reader in Management, School of Management and Organisational Psychology, Birkbeck, University of London. She is a Distinguished Research Associate at the Department of Geography, Oxford University and a Research Associate at the Centre for Business Research, Cambridge University. She is the founder and Director of Research of the Oxfordshire Economic Observatory, Oxford University. This is a practitioner focused research centre focusing on understanding the South East knowledge-economy (see http://oeo.geog.ox.ac.uk). Her expertise is in the geography of innovation with particular interests in the commercialization of university intellectual property. Helen Lawton Smith has undertaken studies of innovation and entrepreneurship in both high-tech and traditional sectors in the UK, Canada, France and Belgium. She has recently completed a study of the performance of spin-offs from Oxfordshire's universities and public research laboratories and will be leading a study of London University spin-offs funded by London Higher, in 2006.

José M. C. Mello

(Visiting Professor, Production Engineering Department, Federal University Fluminense, Brazil Associated Researcher, NEICT- Nuclei of Studies in Innovation, Knowledge and Work, Federal University Fluminense, Brazil)

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Research interests: Science, technology and innovation policy, local systems of innovation, triple helix of university-industry-government relationship and actor-network theory. Research coordination: Research coordinator of the Brazilian research team, Project UniDev "Developing Universities – The Evolving Role of Academic Institutions in Economic Growth". International project coordinated by Research Policy Institute, Lund School of Economics and Management. Member of the Technical-Scientific Committee of the Centre of Science and Technology Policy (CeS&T), Fondazione Rosseli, Torino, Italy; Member of the Scientific Committee of the "Simpósio de Gestão da Inovação Tecnológica" and of the "Simpósios da Associação Latino-Americana de Gestão Tecnologica" (ALTEC); Member of the Steering Committee of ALTEC 2005, Salvador, Brasil and member of the Steering Committee of the 5th International Triple Helix Conference, Italy, 2005. Brazilian coordinator of the UniDev Project- Developing Universities: the evolving role of academic institutions in economic growths (2005-2007)

Marli Elizabeth Ritter dos Santos

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Marli Elizabeth Ritter dos Santos holds the position of Coordinator of the Technology Transfer Office of the Pontifical Catholic University of Rio Grande do Sul. She has previously held positions as Director of the Interaction and Technology Transfer Office (EITT) of the Federal University of Rio Grande do Sul, Assistant of the Rector of the Federal University of Rio Grande do Sul and General Director of the Pro-Rectory of Post – graduation and Research in the Federal University of Rio Grande do Sul. She holds a Graduate degree in Social Sciences and a Master Degree in Administration, Planning and Management in Science and Technology from the

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Roshan Kumar Seebaluck

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Rosham Seebaluck has worked with the National Computer Board as National Consultant for Support for new and potential start-up incubators in the field of ICT, funded by the National Computer Board and UNDP Mauritius. He has also been working with ICT Incubator Centre as Assistant Manager at the National Computer Board and Assistant Manager at the Small and Medium Industries Development Organisation (S.M.I.D.O). Rosham Seebaluck holds a B.A. (Honours) Economics from the University of Delhi, India and a M.A. Economics from Delhi School of Economics, India.

Other fields of interest are Entrepreneurship & Business Development, SMEs Development, Business Incubators, Marketing, Technology Innovation, Macro Econometric Modelling, Macro Economic Policy, Computer Programming - Assembly, Access & Visual Basic, Web Page Design and Flash Animation.

Abraham Temu

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Abraham K. Temu received his B.Sc. degree in Process engineering from the University of Dar es Salaam, Tanzania in 1984. He received M.Sc. degree in Chemical engineering from the University of Trondheim, Norway in 1987. In 1998 he received his PhD in Mechanical Engineering from the Norwegian University of Science and Technology, Trondheim, Norway specializing in fouling. Since 1998 he has been Lecturing at the Department of Chemical and Process Engineering, University of Dar es Salaam, Tanzania. He has worked on problems relating to industrial energy conservation and renewable energy technologies (biodiesel, bioethanol and solar cooking) beside involvement in Innovation Systems and Clusters.

Chunyan Zhou

(Associate Professor, Business School, Shenyang University, China)

Chunyan Zhou is an Associate professor, Business School, Shenyang University in China. She got a B.Sc. in physics, a Master's degree in science education in Liaoning Normal University, and a Ph.D. in philosophy of science and technology at STS Center of Northeastern University.

She has published her book *Transforming Science to Technology: the Scientific Basis in Technology Time* (Northeastern University Press, 2002.2, Shenyang), awarded the First-class Prize in the Youth Excellent Results by Research Association of Dialectics of Nature in China. This work revealed the relationship between science and technology, especially in contemporary society and systematically argued the important contribution of science research to technology innovation.

She also translated and published *University-Industry-Government Triple Helix* (Henry Etzkowitz, Published by the East Press in China, 2005.6, as well as Pasteur's *Quadrant: Basic Science and Technological Innovation* (Donald E. Stokes, Science Press in China, 1999.10, Beijing, Since 1998, she has published more than twenty papers and held five programmes in science policy and management.

In 2001, she worked for a research project at STS center of Tsinghua University as a visiting scholar. During 2004.8—2005.8, she visited the STS Program at Stanford University also as a visiting scholar. Recently she has contributed to the paper *Triple Helix Twins: Innovation and Sustainability* following Dr. Henry Etzkowitz, as a co-author. Her interest of research now is Innovation Theory and Practice, both in the East and West countries, especially University-Industry-Government Triple Helix Model for innovation, including the relationship between university and industry, university's status and role in regional and industrial innovation.

Yandong Zhao

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Mr. Zhao Yandong studied Sociology in the Graduated School of Chinese Academy of Social Science, Beijing, where he obtained his doctorate. He is currently an associated professor in National Research Center for Science and Technology for Development, Beijing, China. His research area includes social capital and social development, social stratification and mobility, innovation of small and medium sized enterprises, risk society and development of science and technology, etc.