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# PAPERS

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## Universities as Centers of Research and Knowledge Creation: An Endangered Species

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**The keynote presentations and the abstracts of authored papers in the parallel sessions are listed in alphabetical order. Please consult the program for the times of presentations and sessions.**

**Keynote presentations in English and abstracts in the language of origin**

## KEYNOTE PAPERS

## ABSTRACTS OF PRESENTATIONS IN PARALLEL SESSIONS

## KEYNOTE PRESENTATIONS

### Bienenstock Arthur

The Honorable Arthur Bienenstock (USA) has served Stanford University in a number of high-level posts. From 2006 to the present, he has been Professor of Applied Physics, Vice Provost and Dean of Research and Graduate Policy. He has chaired the university's Materials Council and directed the Geballe Laboratory for Advanced Materials as well as the Stanford Synchrotron Radiation Laboratory, SSRL, (1978-97). Between 1972 and 1977, he was Vice Provost for Faculty Affairs. He was Associate Director for Science of the White House Office of Science and Technology Policy (1997-2001) and is Vice President of the American Physical Society. Professor Bienenstock holds a PhD from Harvard in Applied Physics in and honorary doctorates from Lund University, Sweden, and from the Polytechnic University of New York. He has published widely in his areas of expertise.

### *"Essential characteristics of research universities"*

In discussing the essential characteristics of research universities, I will draw heavily on the experience of American and some European universities. Before detailing those characteristics, however, it is worthwhile to consider the great extent and variety of American research universities. The Carnegie Classification of Institutions of Higher Education describes two types of doctoral/research universities: extensive and intensive. Both offer a wide range of baccalaureate programs and are committed to graduate education through the doctorate. The extensive institutions are those that award 50 or more doctoral degrees per year across at least 15 disciplines. Intensive institutions award at least 10 doctoral degrees per year across three or more disciplines or at least 20 doctoral degrees per year overall.

In its year 2000 report, the Carnegie institution classified over 4,000 U.S. higher educational institutes, of which 261 universities were classified as research universities, with 151 being extensive and 110 being intensive. There is enormous diversity among these 261 universities. Some are strongest in the liberal and fine arts, others are strong in science and technology, while others are best known for their agricultural research. Some are private while others are supported by the 50 states that make up the United States.

This diversity of institutions is illustrated by my home state, California, where there are several high quality private research universities. These include the California Institute of Technology, which specializes in science and technology, and Stanford University, which offers advanced degrees in the humanities, social sciences, natural sciences, engineering, law, medicine and business. The private universities receive no direct support for their operations or instruction from the federal or state government. Instead, endowment yield, gifts and tuition provide the

income for general operations and instruction. Some are established by, and partly funded by, religious organizations. Research is funded partly by these sources but more importantly by research grants from, and contracts with, the federal and state governments, private foundations and industry. The bulk of these research funds are obtained via competitive systems discussed below.

The State of California does fund large portions of the general operations and instruction, as well as some research, directly at over 20 universities with considerable diversity. One of these is the world-famous University of California, Berkeley that consistently ranks with Stanford among the top five research universities in the United States. Even though the State of California provides support for instruction and operations, most of the research funding at these state universities also comes from the same sources supporting research at the private institutions.

The California research universities contribute heavily to the San Francisco Bay area's having the highest per capita productivity in the world. Stanford University and the University of California, Berkeley have played major roles in the development of Silicon Valley as a center for information technology. They are joined by the University of California, San Francisco in providing support for the development of the biotechnology industry. The less well known, but superb, University of California, Davis has played a major role in the constantly increasing quality of California wines.

While these universities are known throughout the world for their contributions to the economy of the San Francisco Bay area, it is important to point out that they excel in fundamental research and scholarship. A hint of that is provided by the fact that these four institutions collectively have more Nobel laureates than virtually all of the world's nations. (That is also true of the Harvard-MIT complex.) They provide scholars for the faculties of higher educational institutions around the world and professionals to meet the needs of the State, the nation and the world. Although government "management" of them is essentially chaotic compared to the management of other research universities throughout the world, they succeed on a grand scale and attract students and scholars from around the world. Their ability to make economic contributions is directly related to their excellence in fundamental research and scholarship.

There are no federal universities included in the Carnegie list of research universities. There is no federal ministry governing the U.S. research universities. Yet, these universities perform approximately 60% of government-funded basic and long-term applied research. The nation's economy, health and security depend critically upon them. As a consequence, the relationship between the government and the universities is managed by means of a complex and often contentious partnership.

One must necessarily take this absence of central management and diversity into account when discussing the role of American research universities and seeking to understand essential characteristics. One should take the diversity into account when considering the establishment of new research universities as they may find that some types of institutions included in this classification offer better models for their needs and goals than do others. Nevertheless, I believe that all high quality research universities share the characteristics discussed below.

Briefly stated, these characteristics are:

High quality faculty committed to research and teaching
High quality graduate students who want to learn to perform research or function with advanced expertise
An intellectual climate that encourages scholarship
Facilities in which teaching and research can be performed effectively
Funding for operations and instruction
Research funding
Research infrastructure
High quality leadership

It is desirable, but not essential, to have a high quality undergraduate student body as well. As discussed later in this paper, however, there may be circumstances in which it would be wise to establish a graduate-only institution.

## Faculty

No single aspect of a good research university is more important than having a high quality faculty devoted to both teaching and research. To achieve that, its faculty search and selection processes must be aimed directly at that goal. Search committees should look and advertise broadly to ensure that almost all qualified candidates around the world are likely to learn of the position, whether it be junior or senior - tenured or untenured. The position should be defined sufficiently broadly so that there is an appreciable sized pool of very good candidates.

Those institutions with a tradition of hiring faculty only from among their own graduates lose out in two ways: (a) They fail to obtain the services of better people from other institutions and (b) they lose an important source of new ideas and techniques brought by outsiders.

The selection processes should identify the very best candidates in a truly just and careful manner. They must be free of nepotism, cronyism and the like.

Those appointed or promoted to tenured positions should have proven their research capabilities through publications that have significantly influenced their scholarly fields. Sheer numbers of

paper should be insufficient. Instead, the contributions must be real and important. Similarly, the candidates should have demonstrated high-qualities teaching capabilities.

The processes by which junior faculty are promoted to tenure are critical quality control mechanisms for research universities. There is no automatic or quasi-automatic promotion to tenure in first-rate research universities. Generally, well under one-half of the untenured faculty receive tenure. The remainder leave the institution, rather than occupying positions that could be held by those with greater capabilities.

The process for assessing the contributions of those being considered for promotion to tenure must also be rigorous and fair. Scholars outside the university should participate in the assessment of the research contributions. The junior faculty should have adequate time, five or six years, to prove their research capabilities.

It's important that faculty at research universities teach courses. Generally, the process of developing courses and the subsequent interactions with high quality students deepens faculty understanding of their fields and leads to better research. In addition, good teaching in graduate courses tends to attract good students to research and helps to develop the next generation of researchers. It is also important, however, that teaching loads allow adequate time for research. Good research is truly time-consuming.

Before closing this section, let me say why I have stressed research contributions in the tenure decision in spite of the importance of teaching at research universities. Tenured faculty serve their institutions for many years. It is important that they remain enthusiastic about, and current in, their scholarship and teaching throughout those years. In my experience, those most likely to do so are those who are successful – and recognized as successful – in research.

### Student Quality

High quality faculty tend to attract high-quality students. Research universities should take advantage of this and be selective in their admissions to ensure that the students, and particularly the graduate students, are of high quality. This is important because students are major participants in the research at these universities. If the research is to be successful, the students must be intellectually gifted and prepared to devote considerable energy and time to it.

In addition, students learn a great deal from each other. That mutual learning process is most effective when all of the students are bright and eager. The presence of very good students also makes it easier to hire high-quality faculty.

In many cases, however, it is only possible to continue to attract high-quality students if there is appropriate employment for them after the completion of their studies. Those developing new research universities should take this into account.

### Intellectual Climate

If research universities are to be truly successful, they must exist in an atmosphere of intellectual freedom. The university must have an intellectual climate that is truly tolerant of diverse views and open to new findings. It must ensure that neither ideology nor dogma hinder intellectual exploration and exposition. The faculty themselves must, for the most part, determine their own scholarly research directions. They must be able to publish the outcomes of their research freely. Only under such conditions will the university be able to attract and retain the very best scholar-teachers and graduate students. Only under such conditions will the university host the research that will advance the society and economy effectively.

There is, of course, an apparent inconsistency between the faculty determining their own scholarly research directions and the achievement of societal goals (usually economic). To this I respond first that most university research outcomes that have had major economic impacts were unanticipated by societal leaders or research funders. No group of central scientific administrators or scientists, no matter how wise, can anticipate the creative inventions and discoveries of a healthy scientific community. Wise strategic planning and scientific funding incorporates this concept deeply.

Societal goals can be achieved, however, by the structure of the university. Strong engineering, computer science and physical science departments will yield advances in information technology. Strong biological sciences programs are likely to advance biotechnology. Similarly, strong agricultural research is likely to advance agricultural productivity. Institutions may influence the outcome by building scholarly strength in areas where they seek to advance the economy. Once they have obtained the high-quality scholars, however, they should let the scholars choose the fruitful research areas.

### Facilities for Research and Teaching

It is vital that a research university have facilities that are consistent with the types of research and teaching to be performed. Effective education of graduate students requires libraries (increasingly digital these days), seminar rooms, classrooms and teaching laboratories of reasonably high quality. Of even more importance are the laboratories in which research is to be performed.

In almost every university of which I'm aware, space is at a premium. There should be a space allocation system that is fair and perceived to be fair. It should be allocated in a manner that allows junior faculty to develop programs that are independent of the senior faculty.

## Operations Funding

I am not aware of any major research university in the world that obtains its operations funding completely from tuition. Universities established by government usually receive significant allocations for funding operations, instruction and capital improvements. These are supplemented by tuition, gifts and, in some cases, endowment. Private universities do not generally receive the allocations from government bodies. Instead, non-research income is a mix of tuition, gifts and endowment. At Stanford University, income from tuition and endowment are roughly equally important, while expendable gifts form a significantly smaller income component. Less heavily endowed universities depend considerably more on tuition.

## Research Funding

Research is expensive and requires adequate funding. Various funding mechanisms are employed throughout the world:

- funding in a block grant to the university
- funding in block grants to departments or large subgroups
- funding to individuals or small groups

I strongly favor the process in which most research funding is provided by an outside agency, or agencies, in competitive, peer-review processes to individuals or small groups (as opposed to block grants to departments or institutions). The process of selecting those who would receive funding should be based on a fair and unbiased selection process that assesses the merits of the proposal and the proposer. While faculty often dislike writing proposals, the process serves a very important function for them. It forces them to determine what is the most important and achievable research that they might perform. Such a determination is an extremely valuable, but often overlooked, aspect of high quality research. The peer review process also tends to ensure that the agencies' money is well spent and that research of high quality and importance is performed.

It should be noted, however, that some universities construct, maintain and improve large facilities for use by many scientists. In this case, block funding is an appropriate and valuable funding mechanism.

If young people are to be attracted into the system, junior faculty should be able to compete directly for research funding. One of the great attractions of the United States to young researchers from other countries is that they have the freedom to propose and perform research independently. Too often in other countries, the research programs of the younger faculty are dictated by more senior faculty.

In many fields, a faculty member must have initial funding from the university for the establishment of a functioning laboratory in order to compete effectively for regular research funding. In the United States, that often means investments of between $500,000 and $2 million in new faculty members. This, of course, varies with the field. For example, starting costs for theoretical physicists tend to be less than those for experimental physicists.

### Infrastructure

Often overlooked is the importance of university infrastructure to support research. Indeed, it is my view that the United States government under-funds such infrastructure, placing financial strains on that country's research universities. Those establishing research universities elsewhere should not repeat that mistake. Here are some of the infrastructure offices that I find important.

The Sponsored Research Office is typically the interface between the researcher and funding agencies. It assists the faculty member in meeting the requirements of the funding agency with respect to budget formulation, proposal formats and the like. It ensures that funding agency requirements in contracts are consistent with the university's policies. For example, most research universities in the United States will not accept limitations on a faculty member's right to publish the results of research. Occasionally, funding agencies want to limit that right. It is typically the Sponsored Research Office that performs the ensuing negotiation.

It is vital that there be an accounting function so that the researcher knows how much money is available to be expended on the research. This function also insures that expenditures are appropriate and consistent with the conditions set forth in the research grant her contract, as well as university policies.

If researchers are to have the instruments and supplies that are needed for research, there should be a Procurement Office that has the expertise to purchase those items and a Receiving Office that can receive them once they've been purchased and ensure that they reach the researcher. If these functions are not performed effectively, research can be delayed considerably.

A thriving research university is likely to generate intellectual property that may be commercialized and contribute to the economy. A good Office of Technology Licensing contributes to that process by evaluating new intellectual property for its marketability and then marketing it to industry. Too often in the United States, however, university leaders view intellectual property solely as a source of income, rather than as a means of improving the economy. In my own view, that is shortsighted. Only about ten universities get significant funds from their intellectual property. Almost all universities do get significant gifts from industry - and particularly from those companies that have been aided by the presence of the university. Thus, most universities do better financially in the long run by contributing to the regional economy.

There should be an Environment, Health and Safety Office ensuring that university functions are carried out in an environmentally benign, healthy and safe manner. This role can be a very sophisticated in institutions where advanced research is performed. The staff have to deal with circumstances ranging from the disposal of toxic chemicals to radiation safety to the safety of personnel caring for large primates.

Finally, institutions in which human subjects research is performed should have an office that ensures that such research is carried out properly with due regard for the well-being of the subjects.

Various mechanisms for funding infrastructure are employed around the world. In some cases, that funding is part of the university's budget. In the United States, where research funding is provided primarily by the federal government, while the establishment and operation of the remainder of the university are funded by others, the indirect cost mechanism is employed. Here, indirect costs are costs that cannot be associated with the specific grant that funds the research. The infrastructure items discussed above are among those. This mechanism is a cause of constant strain between the universities and the government in the United States. Many of those funding the research would like to pay only the direct costs, but recognize that someone must pay for the indirect costs.

## Undergraduate Education

Most research universities also educate undergraduates. Typically, these institutions attract outstanding students who can benefit from the intellectual sophistication of the faculty. The contact of the students with faculty heavily involved in research leads some of those students to pursue research careers themselves.

There are circumstances, however, in which it may be wise to establish graduate-only research institutions. States or countries may have undergraduate institutions of sufficient capacity and quality to meet their present needs. The faculty at these institutions may have focused on undergraduate education and not developed their research capabilities. It is extremely difficult to transform such institutions into first-rate research universities. Instead, it may be best to establish a new, graduate-only research university and staff it with new faculty who have the research capabilities needed.

## Leadership

As implied above, the establishment and maintenance of a first rate research university is a major undertaking. It requires visionary leadership that is committed to the educational and research goals. It requires leadership, as well, that is capable of managing a complex organization in which the faculty provide much of the intellectual leadership and in which, consequently, power

is spread diffusely through the institution. Despite the goals of some who establish it, a new university is unlikely to yield major scholarly or economic advances in its early years. The leadership must have the political capability to withstand outside impatience and guide the institution's evolution towards great intellectual strength.

Fortunately, however, the university may soon benefit the local economy significantly by bringing outstanding researchers to a region where they can function as consultants to local industry and agriculture. In that consultant role, they themselves will learn of local needs and may have their research influenced accordingly. Similarly, they will attract outstanding students who can and will eventually contribute to the economy. These outcomes are likely, though, only if the leadership is committed to attracting and retaining first-rate the faculty and students. To attract such faculty and students the leadership must ensure that they will have the opportunity to pursue their own ideas in a free and encouraging environment.

## Edquist Charles

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## *"The role of universities in the innovation system"*

### Abstract

Organizations and institutions are often considered to be the main components of systems of innovation (SIs), although it is not always clear what is meant by these terms. Let me therefore specify what organizations and institutions mean here.

*Organizations are formal structures that are consciously created and have an explicit purpose.* They are *players or actors. Institutions are sets of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups and organizations.* They are the *rules of the game.*

One way of addressing what happens in SIs is the following. At a general level, the *main function* – or the 'overall function' – in SIs is to pursue innovation processes, i.e. to develop and diffuse innovations. What I, from now on, call *activities* in SIs are those factors that influence the development, diffusion and use of innovation.

I believe that it is important to study the activities in SIs – or causes/determinants of innovation processes in a systematic manner. The hypothetical list of activities presented below is based upon the literature and on my own knowledge about innovation processes and their determinants. The activities listed are not ranked in order of importance, but start with knowledge inputs to the innovation process (1-2), continues with the demand side factors (3-4), the provision of constituents of SIs (5-7), and ends with support services for innovating firms (8-10).

*The following activities can be expected to be important in most SIs:*

1. Provision of Research and Development (R&D) creating new knowledge, primarily in engineering, medicine and the natural sciences.

2. Competence building (provision of education and training, creation of human capital, production and reproduction of skills, individual learning) in the labour force to be used in innovation and R&D activities.

3. Formation of new product markets.

4. Articulation of quality requirements emanating from the demand side with regard to new products.

5. Creating and changing organisations needed for the development of new fields of innovation, e.g. enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms, creating new research organisations, policy agencies, etc.

6. Networking through markets and other mechanisms, including interactive learning between different organisations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.

7. Provision (creation, change, abolition) of institutions – e.g. IPR laws, tax laws, environment and safety regulations, R&D investment routines, etc - that influence innovating organisations and innovation processes by providing incentives or obstacles to innovation.

8. Incubating activities, e.g. providing access to facilities, administrative support, etc. for new innovating efforts.

9. Financing of innovation processes and other activities that can facilitate commercialisation of knowledge and its adoption.

10. Provision of consultancy services of relevance for innovation processes, e.g. technology transfer, commercial information and legal advice.

Here we are placing greater emphasis on 'activities' than much of the early work on SIs. Nonetheless, this emphasis does not mean that we can disregard or neglect the 'components' of SIs and the relations among them. *Organisations* or individuals perform the activities and *institutions* provide incentives and obstacles influencing these activities. In order to understand

and explain innovation processes we need to address the relations between activities and components, as well as among different kinds of components.

On the basis of these ten activities, I will address the role of universities in SIs. This includes discussions of the differing cultures in universities and in firms, the organisation of the "third task" of universities, the role of intellectual property rights in universities and the role of universities in regional and national economic development.

**Lan Xue**

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## *"Universities in China's national innovation system"*

### I. Introduction

The proper role of the university in a national innovation system, or more broadly, in a knowledge economy has become increasingly controversial in recent years. While there is a consensus on the role of the university in disseminating knowledge through teaching activities, there are certain disagreements regarding its role in generating knowledge[1], and even less agreement on its linkage to the industry and the commercial market.

Theoretically, the work of Nelson (1959) and Arrow (1962), Merton (1973), Dasgupta and David (1994) has laid the foundation for the division of labor between industrial research and academic research. Nelson and Arrow examined the economics of knowledge production through investment in industrial research by profit-maximizing firms. The investment decision in R&D is guided by the return to this investment. Nelson and Arrow argue that while the generation of scientific knowledge through R&D is costly, transferring this knowledge is relatively easy. Once produced, the knowledge will not diminish or degrade as the result of usage by different firms. From societal point of view, therefore, the widest possible diffusion of this knowledge is optimal. However, because the practical use of scientific knowledge is limited and the price of transfer is low, the firm that has discovered this knowledge can hardly recover its investment in R&D. As a result, the social returns to R&D investment far exceed the private return earned by the individual firm, which would lead to under investment in basic research. The identification of this important market failure has provided theoretical justification for the public support of basic research most of which is carried out in either universities or government labs, while firms are left to engage in industrial research typically carried out in their own labs.

[1] The disagreement mainly comes from the division of labor between public research institutes and universities. In the U.S. academic research is mainly carried out in universities, particularly research universities. Whereas in Europe, national laboratories, such as those operated by French National Committee for Scientific Research (CNRS), play the central role in academic research (Noll, 1998).

In a similar vein, Merton argued for the separation of industrial and academic research out of the concern for efficiency. In his view, academic research has its own motivations that are centered on the efficient creation of knowledge and on the advance of scientific frontiers. The quest to discover and publish early creates a productive competition which leads to quick dissemination of information (Merton, 1973, Florida and Cohen, 1998). Dasgupta and David (1994) presented an economic argument which also favors keeping academic and industrial research separate. They argue that industrial research focuses on profit and intellectual property while academic research is a quest for fundamental discovery. Intermingling the two would distort resource allocation and hence have negative social welfare implications.

In reality, however, the picture is more complicated. In the U.S. and Japan, the world number one and number two R&D spenders, university-industry links have "an old and honorable history." In the U.S., industrial funding for university research was close to 8% of total university funding for research through most of the 1950s, dipped to as low as 2.5% in the late 1960s, and has been on a steady rise through 1980s and 1990s, reaching 7.1% in 1997. While such support to university research takes many forms from contracted research to individual consulting, university-industry cooperative research centers are seen as an effective means to promote the linkages between industry and university, and have been strongly supported by National Science Foundation (Hane, 1999). In Japan, university-industry links after World War II became largely informal and consultative, based on networks of individuals rather than of institutions ((Kodama and Branscomb, 1999).

In this configuration of the innovation system, the scientific knowledge generated from academic research is assumed to be exploited by industrial firms at almost no cost. In recent years, however, the argument that knowledge transfer from academia to industry is a cost-free process has been challenged. In particular, studies by Rosenberg (1982), Mowery (1983), Pavitt (1987), and Cohen and Levinthal (1990) indicate that transferring and utilizing scientific knowledge is itself a costly and knowledge-intensive process. This process, which has been ignored by neoclassical economic analysis of R&D, is heavily influenced by the division of labors among different institutions in an innovation system and the networks and coordinating mechanisms in the system, as well as by the internal cooperation and coordination among R&D, marketing, and production functions in a firm.

One way to characterize the institutional relationships among university, industry, and the government is the so-called 'triple helix' model. In this model, the university is a key element of the innovation system both as human capital provider and seed-bed of new firms in the emerging knowledge economy (Etzkowitz, 1999). The three institutional domains, public, private, and academic, that formerly operated at arm's length in *laissez faire* societies, are increasingly

interwoven with a spiral pattern of linkages emerging at various stages of the innovation processes.

The key issues in this debate lie in the proper role of academia in an innovation system and to what degree this role is dependent on the specific historical and institutional environment of the innovation system. The contrast between the neat theoretical division of labor among universities and other institutions of a national innovation system and the blurred reality of interwoven relationships among these players is no more apparent than in the university-market linkages in China where universities have become major players in the market. This paper tries to provide an account of how the roles of Chinese universities in the national innovation system have evolved over the past two decades and what are the new challenges they are facing today. The next section will provide a general picture of China's education system and innovation system, which will be followed by a discussion of China's universities in the innovation system. The section following will focus on the university-industry linkage which has traditionally been the weakest. The case of university-owned enterprises will be examined closely in section four. Section five will analyze the forces that have shaped the current status of universities in China's innovation system. The last section will provide some concluding comments and policy recommendations.

## II. An overview of universities in China's national innovation system

### 2.1. The Chinese university system in transition

China's current higher education system was largely shaped by the history of the last 50 years since the founding of the People's Republic of China in 1949. During this period, two opposing forces have played an important role in the formation of the current system, the centralized Soviet education model and the informal Chinese education model. The working of these two forces generated the current two overlapping systems: the regular higher education system and adult higher education system. Both systems were administered by central ministries and provincial or municipal governments. Only in recent years have private higher education institutions begun to emerge. The regular higher education system was set up to respond to the state's need of industrialization and the adult higher education system was to meet the education need of the generation whose higher education opportunities were delayed by wars before 1949 or by the cultural revolution, and the needs of those who failed in the national higher education entrance examination (Hayhoe, 1996).

There were two major structural changes in China's higher education system in the latter half of the 20$^{th}$ century which have had and will have a long lasting impact on China's higher education system. The first major structural change took place from 1949 to 1955. Private universities, 65 in total, were either merged into public universities or transformed into public universities soon after the founding of the People's Republic of China (Wang, 2004). Also, 227 Chinese

universities were consolidated into 181 universities following the Russian model (Hayhoe, 2000). To match the centralized economic planning system, Chinese universities were recombined into new categories based on their disciplines, such as comprehensive universities, normal universities, polytechnic universities, more specialized technical institutes, medical universities, and so on. Geographic distribution was also considered to make sure that each major region in China would have different types of universities represented. The administration of these universities also followed a hierarchical model with Ministry of Education in charge of comprehensive, normal, and polytechnic universities. Other universities were administrated by the corresponding government Ministries and local governments.

The second structure change was carried out in a broad context of opening up and reform in the education sector, which started in 1985 when the Central government issued a major policy decree detailing the reform measures that the government was going to take (CCCP, 1985). This reform, along with other changes since the end of Culture Revolution, has been characterized as "3Ds" and "3Cs."

3Ds include decentralization, depoliticization, and diversities (Yue, 2004). As part of the legacy from the Russian model, the central government had a very tight control of the university system. Neither the local government nor the universities had much incentive to initiate any change. In the 1985 reform, the central government relinquished many authorities to the provincial and municipal governments so that better coordination among different local universities could be achieved. Universities were also given more autonomy in their day to day management. Depoliticization mostly took place in terms of the curriculum. During the Cultural Revolution, universities were seen as institutions for ideological indoctrination and many courses were designed to fit the political need. Soon after the end of the Cultural Revolution, the prerogative of setting up curriculum was returned to academics in the universities. Diversities came with several dimensions. First of all, it refers to the providers of higher education services. Many private universities have been set up since the reform began in 1985. By 2000, there were 1300 private universities, out of which 43 were authorized to grant degrees. Diversity also means different channels for financing higher education. The proportion of government funding in the operating budget of the universities has been in decline, so many universities have found ways to compensate the shortfalls by charging tuition fees, raising these fees for special groups of students, commercializing R&D outcomes, fundraising from private sources and so on.

Three "Cs" refer to commercialization, competition, and cooperation. The commercialization of Chinese higher education is discussed mostly in terms of charging tuition fees and interacting with the market by providing R&D services. Competition for students, for faculty members, for research funding, for donations, and so on has become increasingly heated, particularly among the top research universities. At the same time, cooperation amongst Chinese universities and local government and industry has also become very strong. Many municipal governments have

signed agreements with universities to become partners in promoting local economic and social development.

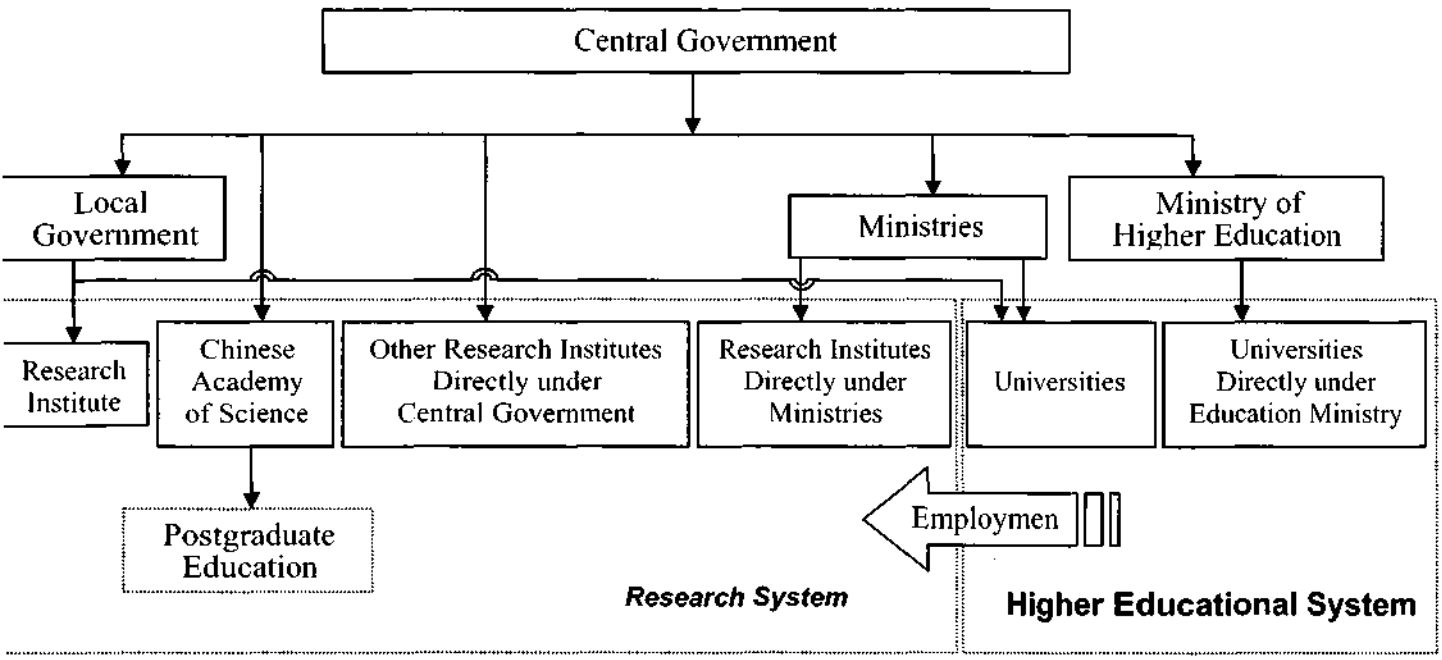
By 1998, which is right before the second major structure change, China had 1,984 higher education institutions of regular and adult forms enrolling over 6.4 million students. In addition, over 11 million self-learners outside higher education institutions registered to take the State-administered Higher Education Qualification Examination.

The second major structural change began to ferment in 1993 when the higher education system reform was put on the agenda of the government. The General Office of State Council organized many site visits and meetings around the country to explore how to change the system so that it could be more compatible with the changing economic system. A set of reform policy was proposed: "joint-support, adjustment, cooperation, and combination"(Li, 2003). The essence of the policy was to decentralize the administration and financing of universities and to merge some universities to achieve economies of scale and economies of scope (in terms of disciplines). But the change was not implemented until 1998, when the central government had a major restructuring with many industrial ministries abolished. The government took this opportunity to implement many of the proposed changes. Two major changes took place as a result. First, the administration of many universities was delegated to local governments from those ministries that were abolished. Second, there were many "merges and acquisitions" among universities which have reshaped the landscape of Chinese higher education system. By 2002, 637 universities were merged to create 270 new universities. In addition, 317 universities signed cooperative agreement to form 270 learning conglomerates. These changes as the result of the educational reform and the changing economic and social text have had major impacts on the behavior of universities, which will be discussed in the following two sections.

### 2.2. The changing role of universities in China's national innovation system

China's national innovation system began to take shape in 1950s based on the model from the Soviet Union, which emphasized centralized management and planning, with government playing a major role: 1) as the only financial supporter for research work; 2) as leader in the activities like project planning and execution, direct supervision over research institutes, unified deployment of all kinds of research resources; 3) as the pivot for the knowledge flows among different research entities; 4) as the entity to separate the function of research from teaching and production (see Figure 2-1). (Feng, 1999)

**Figure 2-1: China's National Innovation System and Universities**



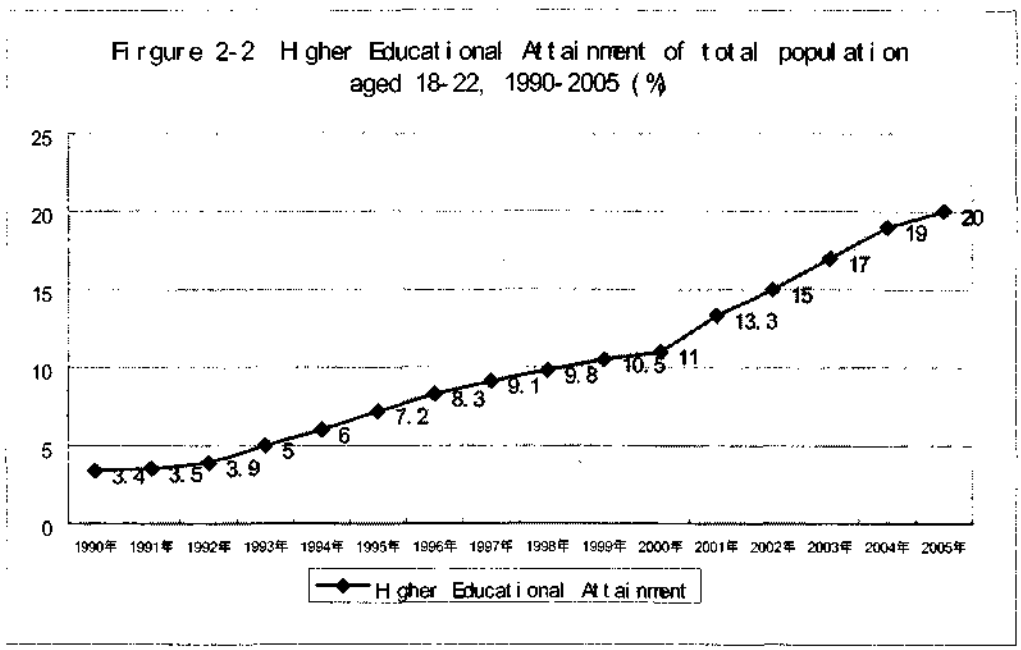

Under such a model, R&D work was undertaken by an independent research network which was composed of the Chinese Academy of Science and a number of research institutes directly under the supervision of central government, different ministries, or local governments, with projects and funds being directly deployed by the government.

As mentioned before, universities at this time were mainly set up to train S&T talents for the government. At the same time, when all kinds of research resources were organized in the above-mentioned research institutes( especially between 1950 and 1955 when the teaching function of higher educational system was strengthened), the university-based research function was further weakened.

Starting in 1978, China's National Innovation System has entered into a new era when a series of institutional reforms had been carried out, particularly for public research institutes (Xue, 1997). Meanwhile, another important step was a 1979 government document, which explicitly prescribed universities as the center for both teaching and scientific research. This marked the recognition of universities as an integral part of China's national innovation system.(Li and Zeng, 2000)

The diversification of China's national innovation system has generated much needed vitality for the system. Government-affiliated research institutes were no longer the only player in the

nation's research system; both universities and the industrial sector have become the most significant players. After more than 2 decades of reform, the position of China's universities in national innovation system has been substantially promoted to a high level. On the one hand, the teaching function of universities has been further strengthened with an increasing enrollment rate for college education, reaching 20 % in 2005 (see Figure 2-2).

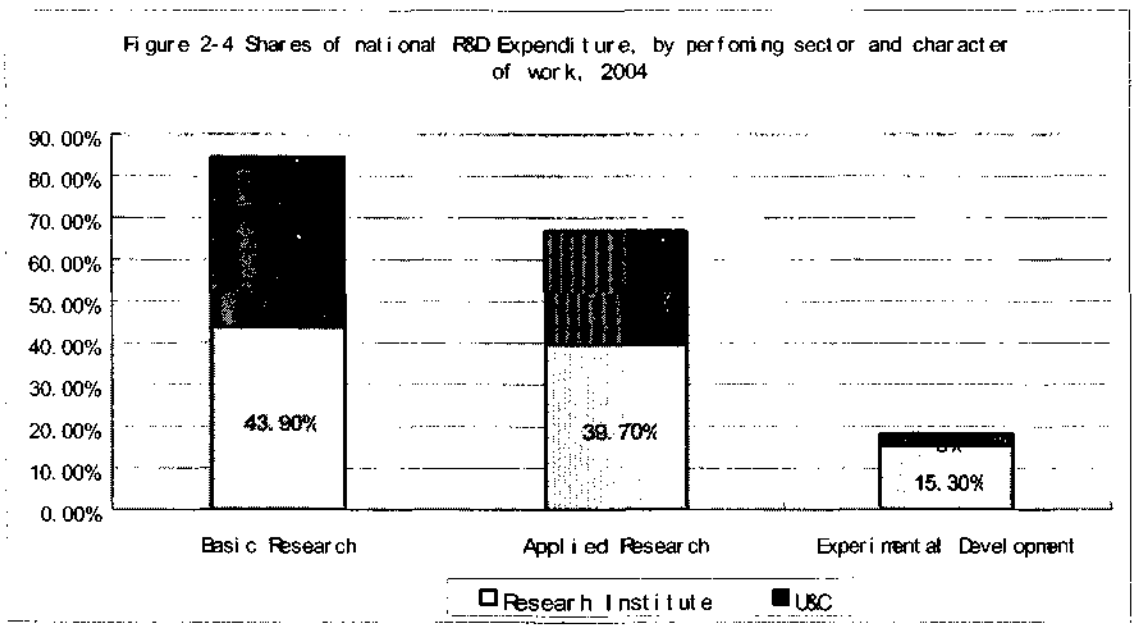



(Source: Report on the Development of National Education. www.cernet.edu.cn)

On the other hand, universities have also shown their great potential in knowledge innovation and industrialization of high-techs. Chinese universities have become a main force in China's knowledge production activities. In 2004, over 437,000 full-time equivalent research people were involved in S&T work in universities, spending 12.55% of the national R&D expenditures and publishing 64.4% of the papers being published domestically, All the facts have shown that capacities of universities in China's national innovation system have been expanded very quickly.

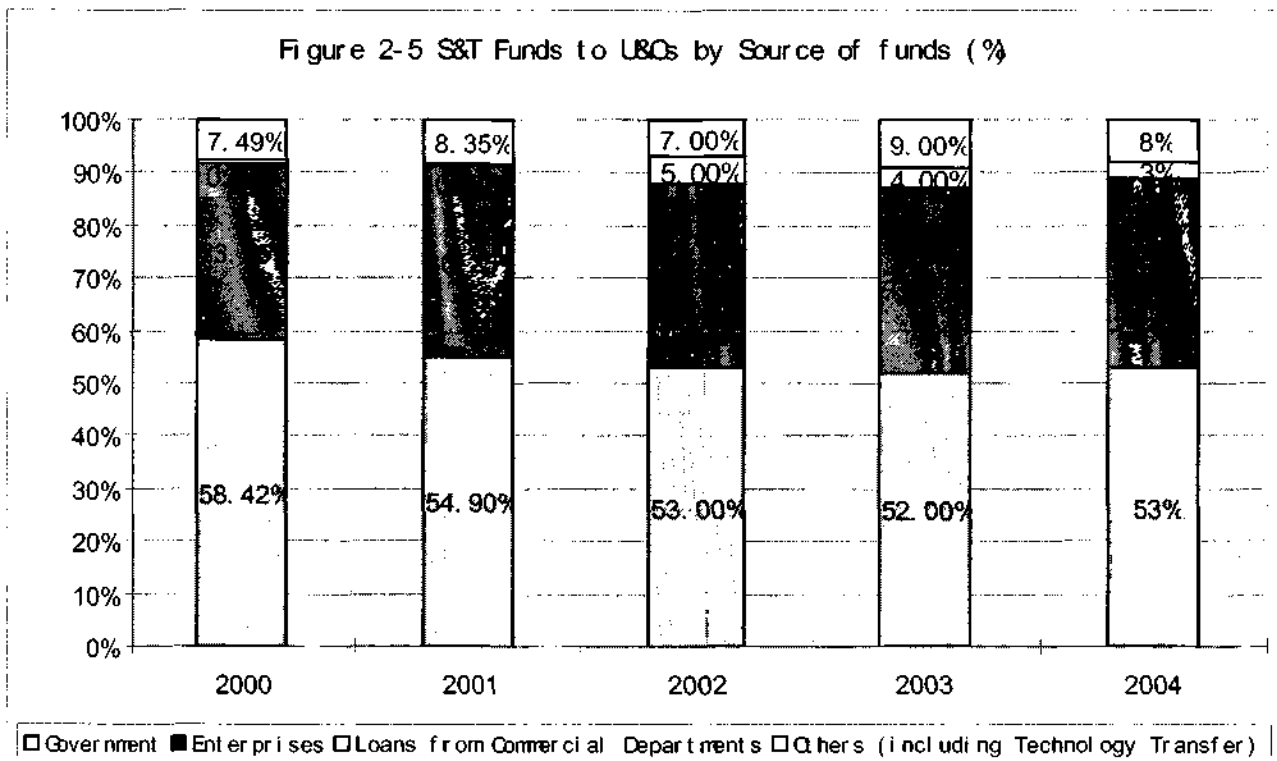
## 2.3. R&D activities in Chinese universities

In 2004, around 41% of China's basic research and 27% of applied research were performed by Chinese universities. Only 3% of development work was carried out by universities.



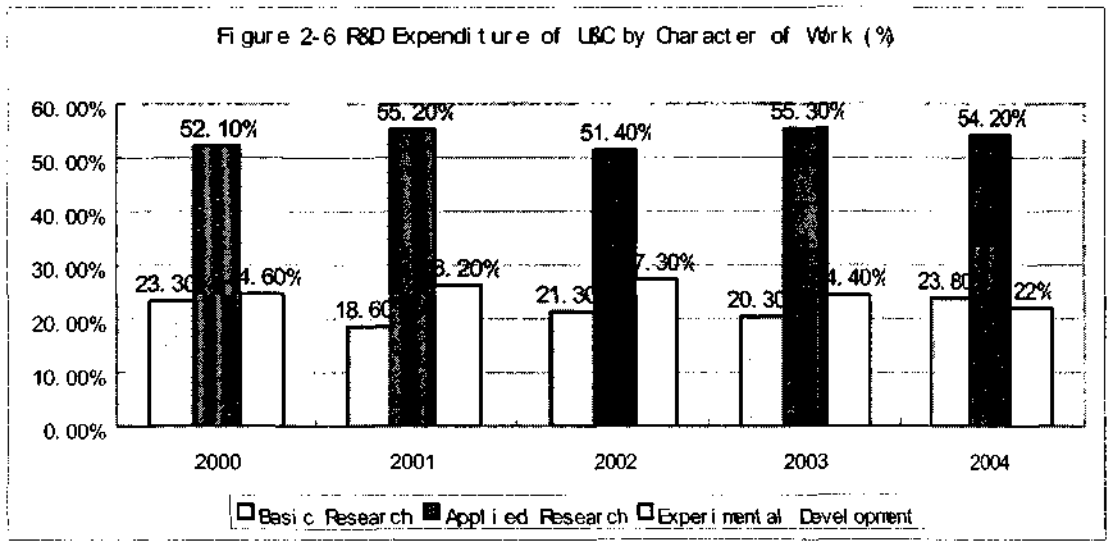

(Source: compiled by author, www.sts.org.cn, U&C: universities and colleges)

There are three main channels for universities and colleges in China to get funds for their S&T activities: 1) government; 2) industrial sector; 3) the technology market, where universities can trade their patents and other intellectual products. From 1985 to 1995, the funds from government has decreased from 75% to 43.3%, but rebounded between 1996 and 1997. Since 2000, the government source has remained above 50%. Funds from industrial sector have witnessed a big increase in the past 2 decades, and in 2004, this accounted for 36% of the total funds for S&T activities in U&Cs.




(Source: compiled by author, www.sts.org.cn )

An important fact of Chinese university research is that applied research has been the dominant R&D activity. Since 1991, the percentage of applied research expenditure of the total R&D funds in universities and colleges stayed above 55% until the year 2000, when this percentage began to drop. But it is still kept over 50% (see Figure below). Meanwhile, basic research expenditure has decreased from 34% in 1978 to 11.8% in 1992. Beginning in 1994, the government reinforced its investment in research, with funds increasing somewhat, but the percentage still hovers around 20% since 2000.




(Source: compiled by author, www.sts.org.cn)

With regard to the research output, universities and colleges in China are found to be a vital component of China's national innovation system. In 1997, among the articles of China that have been catalogued by SCI, ISTP and EI as a whole, universities produced 70.8%; and in 2004, among the articles being published domestically, universities accounted for 64.37% of the total number (see Table 2-3).

**Table 2-3 Number of articles being published in domestic periodicals by sector**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Total | 180848 | 203229 | 240117 | 274604 | 309952 |
| Universities | 115626 | 132608 | 152954 | 181902 | 199473 |
| Research Institute | 29580 | 29085 | 31936 | 30123 | 34744 |
| Enterprises | 12931 | 14452 | 19930 | 15489 | 14248 |
| Hospitals | 15816 | 19736 | 24972 | 33242 | 46890 |
| Others | 6895 | 7348 | 10325 | 13848 | 14597 |

(Source: www.sts.org.cn )

Patenting activity in China's innovation system has been relatively weak when compared with industrialized countries. For example, patents granted to domestic applicants in China in the year of 2001 were 1,653 pieces, as compared to 12,5704 in Japan, or 35,900 in Korea[2]. While enterprises are the most active participants in patenting activity, Chinese universities are nevertheless important players. In 1997, 15% of invention patents were granted to universities as compared with 23.7 % to government research institutes and 52.7 % to enterprises. Table 2-4 shows the patent sale contracts by Chinese universities in 2002. As can be expected, the largest profits were achieved mainly by top universities.

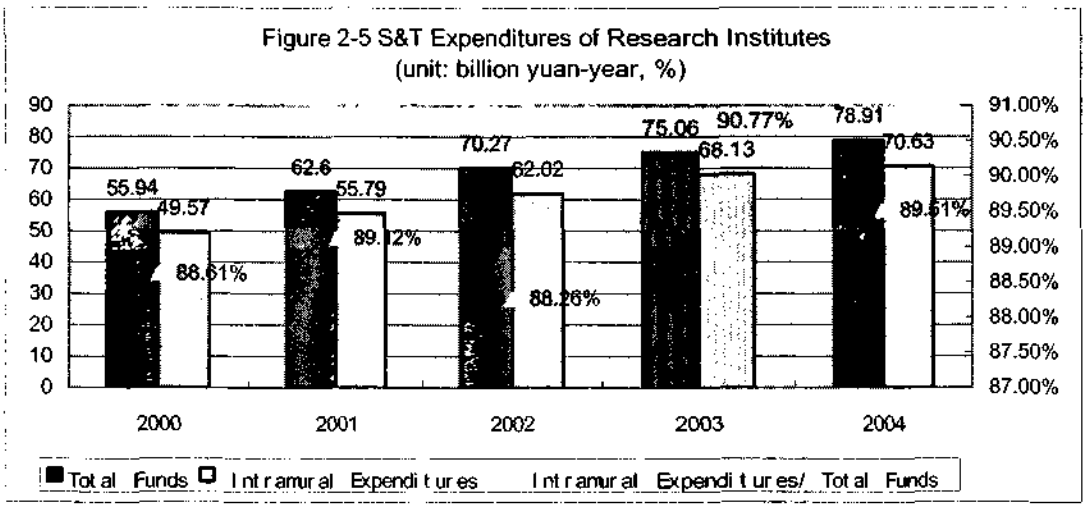
[2] The World Competitiveness Yearbook, 2001.

**Table 2-4. Patents Sales Contracts in Chinese universities (2002)**

| Universities | # of Patents Authorized | # of Sales Contracts | Real Income of This Year (in 1,000 Yuan) |
|---|---|---|---|
| **Breakdown by level of universities** | | | |
| Key Universities | 438 | 431 | 185540 |
| Regular Universities | 778 | 99 | 34359 |
| 2-3 Year Colleges | 35 | 2 | 100 |
| **Breakdown by type of universities** | | | |
| Comprehensive universities | 558 | 144 | 41856 |
| Engineering | 1323 | 327 | 161323 |
| Agriculture and Forestry | 122 | 49 | 11060 |
| Medicine and Pharmacy | 87 | 7 | 2570 |
| Teacher Training | 102 | 5 | 3109 |
| Others | 29 | | |

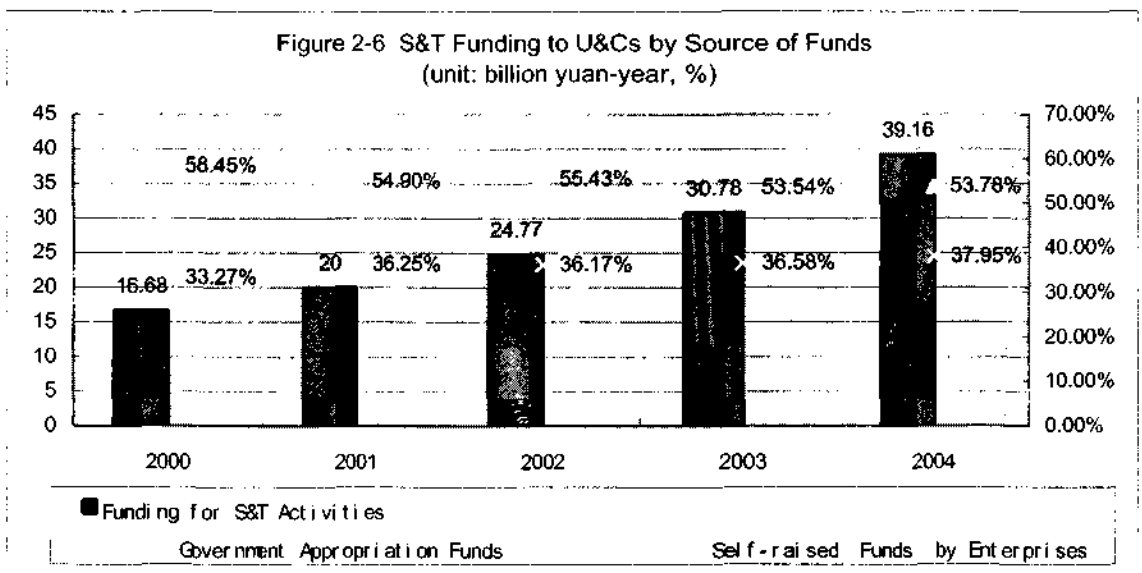
### 2.4 Interaction with other research entities

First of all, interactions between universities and research institutes in China have remained tacit due to the chronic partitions among different research entities in China, and due to the chronic shortage of research funding for universities and research institutes since the economic reform. Research institutes have spent about 90% of their S&T funds intramurally (see Figure 2-5), and seldom cooperated with universities. Interactions between research institutes and universities largely focus on the recruitment of university graduates despite some efforts by individual research institutes and universities (Liu and Zhao, 1999).




(Source: compiled by author, www.stats.gov.cn)

Unlike the relationship between universities and research institutes, the linkages between universities and industry have been very close since the economic reform started over two decades ago. The industrial sector has been the second largest source of S&T funds for universities, with the percentage getting close to 38% in 2004. (see Figure 2-6).




(Source: compiled by author. www.stats.gov.cn and www.sts.org.cn )

The close linkages between universities and industrial enterprises are largely due to the fact they need one other more than they compete with one another. At the start of the economic reform, China's enterprises had an acute shortage of research capabilities. They had to seek outside assistance to enhance their capacity for technological innovation. Universities, with limited research funding but having abundant human resources, became the natural partners. Details of university –industry linkages will be discussed in detail later.

## III. University-enterprise linkages

It should be recognized at the outset that the most important form of university industry linkage is the flow of university graduates towards industry, as well as the flow of new knowledge generated by university-based research through public channels. This is no exception for China.

However, the forms of linkage have greatly diversified over the past two decades. Since the 1985 S&T system reform, university faculty members, particularly those in the engineering school and other applied disciplines, have worked aggressively to develop closer ties with industry informally. In 1988, such relationships were formally recognized at the Third National Higher Education Working Conference by the government as an important way to serve the needs of society.

These linkages include informal consulting by university researchers to industry, technology development contracts, technology transfer and licensing, joint research centers, university-run enterprises, and university-based science parks. Table 3-1 shows the pattern of technology contracts with industry over time for a leading research university in China.

Table 3-1 Technology contracts in a leading research university

| | *1991* | *1992* | *1993* | *1994* | *1995* | *1996* | *1997* | *1998* | *1999* |
|---|---|---|---|---|---|---|---|---|---|
| chnology velopment (%) | 72.43 | 69.03 | 86.55 | 94.09 | 83.56 | 75.06 | 76.20 | 79.16 | 79.11 |
| chnology nsfer (non-:ent) (%) | 9.54 | 24.64 | 7.22 | 1.58 | 5.74 | 5.61 | 13.33 | 6.02 | 7.26 |
| tent licensing ) | 0.00 | 0.00 | 0.00 | 0.00 | 4.51 | 0.00 | 0.00 | 4.43 | 0.09 |
| chnology service ) | 16.79 | 5.83 | 5.19 | 4.10 | 5.19 | 17.97 | 9.14 | 8.05 | 11.21 |
| chnology ısultation (%) | 1.24 | 0.49 | 1.05 | 0.24 | 1.01 | 1.36 | 1.33 | 2.34 | 2.32 |
| **tal ),000 Yuan)** | 1496.95 | 5167.97 | 6621.1 | 12789 | 8866.2 | 12304.15 | 13100.1 | 17520.47 | 25286.68 |

(Source: Compiled by the author from the Contract Office, Department of S&T Development of the Research University)

Of all the forms of university-industry linkage, technology development contracts and university-run enterprises are probably the most common and flexible ones. While university licensing activities seem to have been on the rise, they are limited to universities with strong engineering disciplines which are the major players in patenting. As a newly emerged form, joint research centers are demonstrating their big role in the cooperation between universities and international companies, as well as in doing the joint research online. This has gained big support from China's government with the Law on Promoting the Transformation of Scientific and Technological Achievements being passed in 1996 to encourage different means of joint

research (CPPCC, 1996). University-based science parks have gained popularity in recent years but they have been built mostly in major cities with dynamic entrepreneurial activities. In the following sections, these forms of linkage will be analyzed in detail with the exception of university-run enterprises, which will be dealt with in the next section.

### 3.1 Technology contracts

Of all forms of linkage, technology contracts have become a major source of research funding for universities. An examination of R&D spending of Chinese universities (see Table below) reveals that a very high percentage of their spending is on applied research and development (around 80 %). Most of this spending is funded by industry through different forms of technology contracts.

Table 3-2. R&D Spending by Chinese Universities (1991-2003, 100 million yuan ,%)

| | Basic research | Applied research | Development | Total |
|---|---|---|---|---|
| 1991 | 1.9 (13.9) | 7.6 (55.5) | 4.3 (31.4) | 13.7 (100) |
| 1992 | 2.4 (12.5) | 10.1 (52.6) | 6.6 (34.4) | 19.2 (100) |
| 1993 | 3.4 (12.2) | 14.9 (53.6) | 9.5 (34.2) | 27.8 (100) |
| 1994 | 5.1 (13.2) | 21.4 (55.3) | 12.1 (31.3) | 38.7 (100) |
| 1995 | 6.5 (15.4) | 23.3 (55.1) | 12.5 (29.6) | 42.3 (100) |
| 1996 | 7.5 (15.7) | 26.7 (55.9) | 13.7 (28.7) | 47.8 (100) |
| 1997 | 9.7 (16.8) | 31.6 (54.8) | 16.4 (28.4) | 57.7 (100) |
| 1998 | 9.5 (16.6) | 31.4 (54.8) | 16.3 (28.4) | 57.3 (100) |
| 1999 | 11.4 (18.0) | 37.7 (59.4) | 14.4 (22.7) | 63.5 (100) |
| 2000 | 17.8(23.2) | 40.0(52.2) | 18.9(24.6) | 76.7(100) |
| 2001 | 19.0(18.6) | 56.6(55.3) | 26.8(26.2) | 102.4(100) |
| 2002 | 27.8(21.3) | 67.1(51.4) | 35.6(27.3) | 130.5(100) |
| 2003 | 32.9(20.3) | 89.7(55.3) | 39.7(24.5) | 162.3(100) |

(Compiled by the author from China Statistical Bureau and SSTC,1992-2003)

Technology contracts in China usually include technology development, technology transfer (non-patent technology transfer and patent licensing), technology service, and technology consultation. Table 3-2 shows the recent trends in different types of technology contracts (MOST, 2001-2004).

**Table 3-3. Technology contracts in China (2001-2004, billion yuan)**

| | | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Total amount | | 78.28 (100) | 88.42 (100) | 108.47 (100) | 133.44(100) |
| Contract Category | Technology development | 30.96 (39.6) | 36.29 (41.0) | 42.61 (39.3) | 50.90 (38.1) |
| | Technology transfer | 20.38 (26.0) | 20.24 (22.9) | 24.95 (23.0) | 29.47 (22.0) |
| | Technology consultation | 4.31 (5.5) | 5.41 (6.1) | 7.59 (7.0) | 8.38 (6.3) |
| | Technology service | 22.61 (28.9) | 26.46 (29.9) | 33.63 (31.0) | 44.69 (33.5) |
| | | | | | |
| Demand Side | Industrial Enterprise | 28.57 (36.5) | 35.86 (40.6) | 51.87 (47.8) | 75.41 (56.5) |
| | University | 8.64 (11.0) | 7.26 (8.2) | 10.85 (10.0) | 11.66 (8.7) |
| | Research institute | 18.16 (23.2) | 18.71 (21.2) | 19.52 (18.0) | 19.04 (14.3) |
| | Trade Department | 10.83 (13.8) | 13.88 (15.7) | 15.19 (14.0) | 15.00 (11.2) |
| | Private sector | 1.3 (1.7) | 7.46 (8.4) | 1.08 (1.0) | 0.81 (0.6) |
| | Others | 10.78 (13.8) | 5.25 (5.9) | 9.96 (9.1) | 11.51 (8.6) |

(Source: compiled by the author based on the data from the Ministry of Science and Technology, www.most.gov.cn.)

As shown in Table 3-3, technology contracts signed in China have witnessed a stable growth in the past. Among the contracts, the category of technology development always ranks top. The technology development normally presents itself in the form of "joint research" in which enterprises will entrust universities with technology tasks, or combine with universities to do joint research for a specific topic, or even to set up an entity with universities for long-term research in a special field. Although the proportion is quite small, other forms like technology transfer (non-patent) and patent licensing are also very important linkages.

Compared with the above-mentioned forms, technology consultation and service is perhaps the most flexible way to transfer knowledge and technology. This mainly includes technology information supply and talent training. Although such activities should normally be standardized by the means of contracts, they can be accepted by enterprises when is where basic mutual trust between the individual experts and relevant persons in the enterprise. Therefore, technology consultation and service, in most cases, is a special form of technology contract based on the personal relationship between the individuals concerned.

Patenting activity in China's universities has been relatively weak compared with other developed countries, but improvements have been made steadily. Although the absolute number is not high enough, patent licensing and sales by universities in China have great influence on patenting activities within the national innovation system. While enterprises are the most active participants in patenting activity, Chinese universities are nevertheless important players. This is specially true regarding the application of invention patents.

**Table 3-4. Income Generated by Chinese Universities through Licensing and Sales of Patents (1985-2002)**

| Year | Number of patents | Realized income (1000Yuan) | Year | Number of patents | Realized income (1000Yuan) |
|---|---|---|---|---|---|
| 1985 | 89 | 6135 | 1994 | 326 | 25345 |
| 1986 | 215 | 9024 | 1995 | 364 | 36641 |
| 1987 | 189 | 7033 | 1996 | 367 | 39584 |
| 1988 | 259 | 9117 | 1997 | 362 | 36532 |
| 1989 | 194 | 5196 | 1998 | 371 | 55369 |
| 1990 | 336 | 14410 | 1999 | 298 | 70096 |
| 1991 | 331 | 18470 | 2000 | 299 | 125396 |
| 1992 | 486 | 39045 | 2001 | 410 | 185967 |
| 1993 | 390 | 49831 | 2002 | 532* | 150097* |

(*: Number of contracts reached and the income generated)
(Source: http://www.cutech.edu.cn/)

### 3.2. Joint research centers

Joint research is an emerging phenomenon for enterprises to increase its R&D capabilities. It can help enterprises make full use of the resources needed for research both internally and externally, lower the cost for technology development, and reduce the potentially high risks brought about by the failure of innovation projects. Among all possible potential partners, universities have become one of the favorite choices for enterprises to carry out joint research activities, due to the high quality human talent and solid foundations for research.

In 1999, the Ministry of Education formally launched the *Action Scheme for Invigorating Education in the 21st Century*, in which the "Project to stimulate the industrialization of high-tech industry in universities" was a key project to be implemented. The project encouraged universities to interact with enterprises and research institutes by various means, especially through joint engineering research centers and productivity promotion centers in universities. The policy has had great success ever since. S&T research centers in Chinese universities have undergone rapid increase (MOE, 1999), with the year 2000 seeing an over 200% increase from the previous year. The importance of research centers in the universities has attracted much attention from both the government and enterprises. According to statistics from the Ministry of Science and Technology, over 1000 research centers for technology development in universities have developed close relationships with both public and private enterprises.

**Table 3-5. S&T Research Centers in universities of China (1999-2002)**

| | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|
| Total | 1456 | 4432 | 4599 | 4842 |
| Comprehensive | 243 | 1122 | 1073 | 1099 |
| Engineering | 541 | 1972 | 1958 | 2117 |
| Agriculture | 193 | 420 | 452 | 481 |
| Medicine | 381 | 635 | 604 | 579 |
| Normal Uni. | 94 | 390 | 434 | 476 |
| Others | 4 | 73 | 78 | 90 |

(Source: S&T Development Center, Ministry of Education.)

A new trend for joint research in Chinese universities is that they set up research centers with multinational companies. By 2005, multinational companies had set up about 750 R&D centers in China, which were mainly concentrated in such industries as telecommunication, biologic pharmacy, chemicals, and transportation equipment manufacturing. And, they have mainly chosen Beijing, Shanghai, Guangdong, Jiangsu and Tianjin for their R&D investment, due to the strong presence of foreign investors in these places (Xue et al, 2005). Among these R&D centers, over three fourths are autonomous and owned by the multinational companies, and only 25% chose to form joint research centers. Universities with strong R&D capabilities have become the preferred choices. (Zhou and Zhu, 2004)

### 3.3. Science parks

China's first university-based science park—Northeast University Science Park--was established in 1989. Since then, university-based science parks have become new avenues for commercializing university technologies. Now there are over 40 university-based science parks of national level throughout China, such as those in Tsinghua University, Peking University, Ha'erbin Polytechnic University, Shanghai Polytechnic University, Southeast University, Nanjing University, and Chengdu Electronic S&T University. Besides, there is also a large group of university-based science parks launched by local governments or independently organized by universities themselves.

China's university-based science parks have been inspired partlyby the legends of Stanford Science Park, Cambridge Science Park, and many others. These parks are typically created by a joint effort between local government and the university administration. Most of these parks are located on or adjacent to the university campus and administered by a commercial entity established by the university or through a joint venture between local government and the university.

University-based science parks are seeking further development by making full use of the advantages of the university in the areas of innovation capability, talent, and consolidated research foundations. Instead of a place for mass production, they are launched mainly to play the following roles: 1) to incubate spin-offs created by faculty or students from universities; 2) to provide a platform for new ideas produced elsewhere to be commercialized for the local market; 3) to provide services to the enterprises located in the science park, which means they are obliged not only to manage the real estate of the park but also to provide a sound environment for innovation ranging from fundraising to assuring legal arrangements, as well as talent hunting. (He and Zhang, 2005)

Table 3-6 helps to show the function of university-based science parks as an important incubator for university-owned spin-offs. In 2004, out of 4563 enterprises affiliated to universities, over 24% were located in science parks. Although in the minority, these enterprises performed much better than the outside sciences parks in terms of income, profit and tax paid, accounting for over 60%, 64%, and 49% of the total number generated by the all university-owned enterprises.

**Table 3-6. General statistics of University-owned enterprises in science parks (in 2004, billion yuan)**

| | Enterprises in science parks | Total Uni.-owned enterprises |
|---|---|---|
| Number | 1121 (24.57) | 4563 |
| Income | 58.26 (60.10) | 96.93 |
| Profit | 3.24 (64.95) | 4.99 |
| Tax Paid | 2.39 (49.26) | 4.87 |
| Income to Uni. | 0.49 (25.56) | 1.75 |

(Source: S&T Development Center, Ministry of Education. Figures in () indicate the ratio to these in total number for the year.)

As an important part of the national innovation system, a successful science park has become the symbol of a top-class university. They not only help the regional economy's development by fostering the growth of high-tech enterprises and boosting technology innovation, but also they provide an important platform for the university to serve society.

## IV. university-owned enterprises (UOE)- A special case

All the previous discussions on the roles played by Chinese universities are familiar stories throughout the world. The really unique and controversial story is university-owned enterprises (UOEs) in China. While there is no formal definition, university-owned enterprises refer to those enterprises that are still in one way or another controlled by the universities with which they are affiliated. Legitimacy of this control derives from the fact that many of these enterprises

were created by funds from universities and many universities are still the largest shareholders in these companies. In some other cases, enterprises willingly transfer their management control to universities so that they can generate intangible benefits for themselves.

University-owned enterprises are not new things for Chinese universities. Many Chinese universities, particularly those engineering and science-based universities, have had university-owned factories since 1950s. These are mainly used for students to get short-term internships or apprenticeships in a real production environment. Also, under the "work unit system" ( a self-sufficient organizational system for enterprises, universities, and other social institutions in China after the founding of the People's Republic of China), many Chinese universities had their own service providers such as print shops, publishers, guest-houses, and so on. For detailed discussion on the system, see Lu (1990). What was new was the new market environment, the new roles these enterprises are playing (or expected to play), and the complex relationships they have developed with their parent universities.

The development of university-owned enterprises can be divided into three stages. The first stage is from early 1980s to 1990. During this period of time, China just began to implement its reform and open door policy. In 1985, the central government issued a decree on structural reform in the educational system "The resolution of the Central Committee of the Communist Party of China on the structural reform of the education system" (CCCCP, 1985). This encouraged educational institutions to engage in the economic and social development of society in general. Faced with the commercial opportunities in the society and their internal financial need, traditional university-owned service providers began to open up to society so that many new services were created. Most of their operations were focused on technology transfer, technology development, technology consulting, and technology service (MOST, 1999).

University-owned enterprises during this stage were run under three models. The first one was university-owned factories or print shops. The second model was to bring university technologies to create joint commercial entities with enterprises outside universities. The third model was technology development companies created by universities and departments. By 1989, sales of university-owned enterprises reached 470 million yuan (Li, 2001). However, many of the university-owned enterprises in the early stage were short-term profit oriented and poorly managed. This generated some controversy as to whether it was appropriate for Chinese universities to run enterprises.

The second stage of university-owned enterprises was from 1991 to 2000. In 1991, China's State Council, based on investigations of certain cases, issued its endorsement of university-owned enterprises in a document submitted by the Commissions on Education and Science and Technology to provide guidelines for administering these entities. Meanwhile, in 1993, another document submitted by the Commission of Education was again endorsed by the State Council

to expedite the reform and development of higher education. This prescribed that university-affiliated enterprises of he high-tech type should be actively developed. Since then, particularly after Deng Xiaoping's southern tour in 1992, university-owned enterprises have been developing at an accelerated speed. In 1992, the profits of these bodies jumped to 2.9 billion yuan from 1.76 billion yuan in 1991. By 1999, this number reached 37.9 billion yuan.

The third stage started from the year 2000 when new controversies began to surface again over the appropriateness of universities getting involved in running business enterprises. There were also concerns about the potential financial risks for universities which were linked to university-owned enterprises that were traded on the stock markets. Further, increasingly more university-owned enterprises felt the need to change their governance structure so that they could operate like real commercial enterprises. Recently, the government has begun to encourage universities and their affiliated enterprises to "de-link" by clarifying intellectual property rights and respective obligations, separating management from administration, reforming shareholding arrangements to establish a modern business system, and standardizing the operating quality and investment action to ensure scientific management. Clearly, university-owned enterprises in China are now at a new crossroads.

This review of the development of UOEs allows us to now examine their current status. In 2004, there were 4,563 enterprises affiliated with regular Chinese universities. Table 4-1 presents an overall picture of the development of university-owned enterprises. It can be seen that over the past several years, especially between 1998 and 2000, university-owned enterprises have maintained their growth momentum in terms of sales, profits, and tax . However, since 2001, the growth rate has slowed down to some extent. Also, the profit and income to universities decreased in 2002 and 2003.

**Table 4-1. Growth of University-owned Enterprises (billion yuan)**

| Year | Number | Sales | Profit | Tax paid | Income to Universities |
|---|---|---|---|---|---|
| 1997 | - | 29.55 | 2.72 | 1.23 | 1.58 |
| 1998 | 5928 | 31.56(6.8) | 2.59(-5.6) | 1.35(9.7) | 1.50(-5.1) |
| 1999 | 5444 | 37.90(20.1) | 3.05(18.0) | 1.66(18.6) | 1.59(6.0) |
| 2000 | 5451 | 48.46(27.9) | 4.56(49.5) | 2.54(53.3) | 1.69(6.2) |
| 2001 | 5039 | 60.30(24.4) | 4.81(5.5) | 2.84(11.8) | 1.83(8.3) |
| 2002 | 5047 | 72.01(19.4) | 4.59(-4.6) | 3.63(27.8) | 1.72(-6.0) |
| 2003 | 4839 | 82.67(14.8) | 4.29 (-6.4) | 3.87(6.61) | 1.8(4.7) |
| 2004 | 4563 | 96.93(17.3) | 4.99(16.3) | 4.87(25.8) | 1.75(-2.8) |

(Source: S&T Development Center, Ministry of Education. Figures in () indicate growth rate.)

**Table 4-2. Growth of University-owned S&T Enterprises (billion yuan)**

| Year | Number | Sales | Profit | Tax paid | Income to Universities |
|---|---|---|---|---|---|
| 1997 | - | 18.49 | 1.82 | 0.69 | 0.68 |
| | | [62.6] | [66.9] | [45.6] | [43.0] |
| 1998 | 2355 | 21.50 (16.3) | 1.77(-2.7) | 0.83(21.0) | 0.66(-3.8) |
| | [39.7] | [68.1] | [68.3] | [61.5] | [44] |
| 1999 | 2137 | 26.73(24.3) | 2.16(21.8) | 1.10(31.9) | 1.39((111.6) |
| | [39.3] | [70.5] | [70.8] | [66.3] | [87.4] |
| 2000 | 2097 | 36.81(37.7) | 3.54(64.3) | 1.88(71.4) | 0.85(-38.8) |
| | [38.5] | [75.9] | [77.6] | [74.0] | [50.3] |
| 2001 | 1993 | 44.78(21.7) | 3.15(11.0) | 2.01(6.9) | 0.78(-8.2) |
| | [39.5] | [74.3] | [65.5] | [70.8] | [42.6] |
| 2002 | 2216 | 53.91(20.4) | 2.54(-19.4) | 2.59(28.9) | 0.76(-2.6) |
| | [43.9] | [74.9] | [55.3] | [71.3] | [44.2] |
| 2003 | 2447 | 66.81(23.9) | 2.76(8.7) | 2.94(13.5) | 0.77(1.3) |
| | [50.6] | [80.8] | [64.3] | [75.9] | [43] |
| 2004 | 2355 | 80.68(20.8) | 4.09(48.2) | 3.85(30.9) | 0.83(7.8) |
| | [51.6] | [83.2] | [81.9] | [79.1] | [47.4] |

(Source: S&T Development Center, Ministry of Education, Figures in () indicate growth rate. Figures in [] indicate the percentage of S&T enterprises in the total number of enterprises for the year.)

Both Table 4-1 and Table 4-2 show that, in each year, out of the total number of the university-owned enterprises, around 40% were classified as S&T enterprises. While the number was less than half of the total, these enterprises accounted for the majority of the total number in terms of sales, profit, and tax paid almost every year. Furthermore, in both 2003 and 2004, over 80 % of the sales were generated by these S&T enterprises. However, although the growth rate of sales, profits, tax paid for S&T enterprises have all remained higher than other enterprises, they have apparently slowed down in recent years. The growth rate of profits and income to universities from S&T enterprises have significantly decreased since 2001.

While there are many university-owned enterprises in China, only a very small proportion of these are successful. The same is true from the point of view of universities. Many Chinese universities have university-owned enterprises, but only a small number of them have really successful ones. Successful and influential university-owned enterprises are concentrated in a small number of selected universities and cities around the country. Table 4-4 presents an overall picture of the top 20 universities with the highest enterprise sales. Taken together, sales of enterprises in this group accounted for 75% of the total sales realized by Chinese university-owned enterprises. A careful examination of this group shows that universities in this group can be classified into three categories.

**Table 4-4. Top 20 Universities with highest total sales from affiliated enterprises (in 2004)**

| Sales Ranking | Name | Sales (billion yuan) | Old Classification | University Ranking | Location |
|---|---|---|---|---|---|
| 1 | Peking Uni. | 22.61 | Comprehensive | 1 | Beijing |
| 2 | Tsinghua Uni. | 17.84 | Engineering | 1 | Beijing |
| 3 | Zhejiang Uni. | 4.98 | Engineering | 5 | Hangzhou |
| 4 | Northeast Uni. | 3.59 | Engineering | 34 | Shenyang |
| 5 | Tongji Uni. | 2.94 | Engineering | 21 | Shanghai |
| 6 | Petroleum Uni. (East China) | 2.27 | Engineering | 51 | Beijing |
| 7 | Haerbin Polytechnic Uni. | 2.06 | Engineering | 13 | Haerbin |
| 8 | Fudan Uni. | 1.92 | Comprehensive | 4 | Shanghai |
| 9 | Wuhan Uni. | 1.89 | Comprehensive | 13 | Wuhan |
| 10 | Xian Jiaotong Uni. | 1.81 | Engineering | 11 | Xian |
| 11 | Shanghai Jiaotong Uni. | 1.18 | Engineering | 7 | Shanghai |
| 12 | Sun Yat-Sen Uni. | 1.10 | Comprehensive | 11 | Guangzhou |
| 13 | Huazhong Uni. Of S&T | 1.08 | Engineering | 14 | Wuhan |
| 14 | Nanjing Uni. | 1.06 | Comprehensive | 3 | Nanjing |
| 15 | Jiangxi Uni. Of Chinese Medicine | 0.85 | Medicine | 225 | Nanchang |
| 16 | Southeast Uni. | 0.81 | Comprehensive | 21 | Nanjing |
| 17 | Taiyuan Uni. Of Technology | 0.66 | Engineering | 121 | Taiyuan |
| 18 | Beijing Foreign Language Inst. | 0.65 | Language | 60 | Beijing |
| 19 | Nanjing Uni. Of Posts and Telecommunications | 0.64 | Engineering | 195 | Nanjing |
| 20 | Shandong Uni. | 0.63 | Comprehensive | 24 | Jinan |

(Source: compiled by author)

The first category is universities is classified as the "engineering type" in the old classification system of the State Commission of Education. This classification system is based on the fact that, in 1952, Chinese universities were restructured following the Russian approach including comprehensive universities and specialized colleges and institutes for engineering, medicine, language, and so on. While many of these specialized colleges and institutes have made great effort to develop a broader disciplinary base and have changed their names since the early 1980s, their current comparative advantages and weaknesses are still influenced by their history. In our top-20 group, there are 11 universities belonging to this category. This is consistent with our

previous finding that S&T enterprises are the backbone of the university-owned enterprises. It also indicates that the comparative advantages of the parent universities ( namely, strong engineering research and talented faculty and students) are an important source of strength for university-owned enterprises.

The second category is universities classified as the "comprehensive type" in the old classification system. In the 1952 restructuring, engineering disciplines in these universities were cut while basic sciences were allowed to stay. Since 1980s, these universities have also started to broaden their academic basis by developing engineering disciplines, particularly in those areas where strong basic science is needed. Seven comprehensive universities in our top-20 group are in this category. They are also among the most prestigious universities in China. While there is no official ranking of universities in China, unofficial ones have begun to appear in recent years. In the column "university ranking", I adopted one of these unofficial rankings of universities which is based on a number of academic performance indicators such as academic reputation, academic resources, academic achievements, quality of both students and faculty, and material resources. Ranking has become quite influential (Netbig, 2004). The seven comprehensive universities in our group (based on enterprise sales) also happen to be the best comprehensive universities based on academic performance. This fact indicates that academic strengths and reputation are another important contributor to the strong growth of university-owned enterprises.

The third category is universities that belong to neither the "engineering type", nor to the elite "comprehensive type ", but rather, have their unique comparative advantages. Out of the two universities in our top-20 group, one is Jiangxi University of Chinese Medicine. The lion's share of its enterprise sales comes from a nationally well-known pharmaceutical company for Chinese medicine, Jiangzhong Pharmaceutical. The other one is the best-known foreign language university in China. Its unique market niche comes from the huge population who want to learn foreign languages. This demand has been increasing dramatically since China's opening up more than 20 years ago. Their sales mainly come from language learning material and services.

A unique feature of Chinese university-owned enterprises is that some of them have been publicly traded on the stock market. This can be traced back to the year of 1993 when "Fuhua Shiye" of Fudan University in Shanghai went public on the Shanghai Stock Exchange. Like other kinds of university-affiliated enterprises, these listed companies have played a big role in translating technological achievements into productivity as well as in solving the problem of capital shortage in university operations. However, with their numbers being increased and the scale being expanded, university-affiliated enterprises have gradually met problems in areas such as unclear intellectual property rights, the degree of risk management for the university arising from the enterprise's operation, lack of adequate mechanisms for the university's initial investment and exit strategy, difficulties for capital to be managed freely, and abnormal practices

such as excessive interference by universities in the enterprises' administration. Due to these facts, business achievements in recent years have declined almost every year. To guarantee the healthy development of the business operations of these enterprises as well as the education and S&T activities of universities, it is in urgent to transform the management of these enterprises so that they are in line with standard market practices. In 2001, the State Council formally endorsed a document submitted by the Ministry of Education to change the corporate governance structure of university-affiliated enterprises by selecting both Tsinghua University and Peking University as the pilot cases. (State Council, 2001)

## V. Forces that shaped the evolving roles of universities in China's innovation system

The current roles played by Chinese universities, particularly their strong linkages developed with industry, are shaped to a large degree by various "pull and push forces". These result from the S&T system reform started in 1985, from the change in macro-economic environment, and from the slow reform in higher education system.

### 5.1. The general background—China's innovation system reform

Unlike certain other developing countries that lack indigenous R&D capability, China has managed to build a national innovation system on a significant scale over the past 50 years. However, as China's economic reform progressed, it was increasingly clear that its innovation system could not meet the demand from a more market-oriented economic system.

After 1949, China's innovation system was very influenced by the Russian model, which was a mission-oriented system with strong centralized administration. Table 5-8 provides a general profile of the structure of China's innovation system in 1987, when China had just began its reform of this area. The division of labor among the three types of R&D institutions was as follows: public research institutes (PRIs) were responsible for conducting the majority of China's R&D activities; universities were responsible for S&T training with limited involvement in R&D; and enterprise R&D units were responsible for production, prototyping, and other downstream innovation activities.

**Table 5-1. A profile of China's innovation system in 1987**

| Types of R&D Institutions | Number of R&D Institutions | R&D Personnel | R&D expenditures (in million yuan) |
|---|---|---|---|
| Public Research Institutes (PRIs) | 5222 | 385,857 (47.2%) | 10,683 (60.7%) |
| Universities | 934 | 178,292 (21.8%) | 700 (4.0%) |
| Enterprise R&D Units | 5021 | 252,781 (31.0%) | 6,214 (35.3%) |
| Total | 11,177 | 816,930 (100%) | 17,597 (100%) |

Source: (Xue, 1997)

The major deficiency of this system was the separation of R&D activities from production processes and the market. Most PRIs, including research institutes under the Chinese Academy of Sciences, were funded by an annual budget from either the central or local government, conducted research projects guided by five-year national plans or other central or local plans. Industrial managers rarely had any input into such plans. Scientific and technological knowledge was perceived as a free public good, leaving little incentive for researchers in PRIs and universities to transfer their results to commercial applications. Thus, transfer of R&D results from PRIs and universities to industry was, if not under the organization of the planning body, left mostly to serendipity.

Because of the problems discussed previously, the reform of the China's innovation system was unavoidable. Reform started soon after the economic reform began in the agricultural sector. In 1985, the Chinese Government published a landmark resolution on the Structural Reform of the Science and Technology System in China (CCCPC, 1985). The essence of this reform was to make China's research organizations directly serve the needs of national economic development (Section VI will elaborate the reform in detail). The reform focused on making important changes in the funding system, establishing technology markets, introducing new approaches to the management of research organizations and so on, in order to create regulatory conditions and incentives to make R&D organizations responsive to market needs, or as the Chinese expression goes , to push them " to jump into the sea."

After more than a decade's reform, China's innovation system has made important changes (see Table 5-9). As a result, government appropriation decreased as a source of income for PRIs by an average of 5% each year from 1986 to 1993. By 1993, only 28% of the income of PRIs came from direct government appropriation, compared to 64% in 1986. PRIs were able to generate close to 60% of their income from non-governmental sources, half of which came from the provision of technical services by PRIs to industrial enterprises (SSTC, 1994, 1995). Similar changes also happened to universities. Government funding constitutes less than half of many universities' operating budget. They, too, have to diversify their sources of financing, for example, by raising tuition fees, providing technical services to industrial enterprises, or running

their own enterprises. Table 5-10 shows the characteristics of R&D activities performed by various R&D organizations. It can be seen that both PRIs and universities have put their R&D emphasis on applied research and development work, reflecting the trend discussed above (Note: situations in universities have been improved a little bit. Table 5-10 shows that the percentage of its R&D expenditure in Basic Research has been increased to 23.9 in 2004, compared to the number of 16.7 in 1997).

**Table 5-2. A profile of China's innovation system in 1999**

| Types of R&D Institutions | Number of R&D Institutions | R&D Personnel (in 1000 person) | R&D expenditures (in billion yuan) |
|---|---|---|---|
| Public Research Institutes (PRIs) | 4728 | 234(28.5%) | 26.12 (38.5%) |
| Universities | 3124 | 176 (21.8%) | 6.35 (9.3%) |
| Enterprise R&D Units | 11237 | 351 (31.0%) | 33.67 (49.6%) |
| Other | 3134 | 61 (7.4 %) | 1.75 (2.6%) |
| Total | 22223 | 822 (100%) | 67.89 (100%) |

**Table 5-3. China's R&D expenditure by types of activity and institutions in 2004 (in 100 million yuan)**

| | Basic research | | Applied research | | Development | | Total | |
|---|---|---|---|---|---|---|---|---|
| | **Amt.** | **%** | **Amt.** | **%** | **Amt.** | **%** | **Amt.** | **%** |
| Research Institutes | 51.7 | 12.0 | 159 | 36.8 | 221 | 51.2 | 431.7 | 100 |
| Universities | 47.9 | 23.9 | 108.8 | 54.1 | 44.2 | 22.0 | 200.9 | 100 |
| Enterprises | 15.8 | 1.2 | 126.1 | 9.6 | 1172.1 | 89.2 | 1314.0 | 100 |
| Others | 1.8 | 9.1 | 6.6 | 33.5 | 11.3 | 57.4 | 19.7 | 100 |
| Total | 117.2 | 5.96 | 400.5 | 20.37 | 1448.7 | 73.68 | 1966.3 | 100 |

(Source: created by the author based on (MOST, 1998))

Despite the tremendous progress that China has made over the last 20 years, its national innovation system still suffers from a number of deficiencies that hamper the achievement of its full potentials.

### 5.2. The pull factor—Opportunities due to the lack of industrial R&D capability

One of the major problems with China's innovation system is the weak industrial R&D capability. In general, the crucial players in the innovation process are business enterprises that translate R&D results into profitable products or processes. Without a strong and effective industrial R&D capability, efforts by universities, research institutes, or other organizations often become futile. The current status of industrial R&D capability in China can be illustrated by the

results of a 1996 innovation survey of large and medium sized industrial firms in 6 provinces and cities conducted by the Ministry of Science and Technology.

The provinces and cities covered include Beijing, Shanghai, Guangdong, Jiangsu, Liaoning and Haerbin. They are either China's economic powerhouses (such as Beijing, Shanghai, Guangdong, Jiangsu) or China's traditional industrial bases (such as Liaoning and Haerbin). In addition, the average firm size ranges from 21,622 employees (for the Special Large Class in the Chinese classification system) to 796 (for Medium II). Small firms are not included. Even for this somewhat selected group, the situation is not encouraging. It was found that, while 73 % of the firms surveyed had engaged in some forms of innovative activities in which R&D accounted for a small part, they spent only 3.7 % of the total sales from these activities. Of tjis, more than half (54.7 %) was spent on purchasing equipment. Only 0.5 %of total sales were spent on R&D (MOST, 1999).

One reason for this situation is that many large and medium sized state-owned enterprises (SOEs) are undergoing governance and managerial reforms. This has become the top priority of China's economic reform. However, such a challenging task could not be expected to occur overnight. Under such circumstances, many of them simply do not have the financial resources needed for R&D investment. Therefore, without some fundamental changes in the external financial environment and internal management in these SOEs, there is little hope that they can be active in R&D activities. While in recent years non-state owned industrial enterprises are playing an increasingly more important role in China's economy, most are still relatively small compared to large and medium sized SOEs. Their R&D activities are limited at present. However, in the long run, the non-state sector will become one of the most important forces in R&D commercialization.

The lack of in-house R&D capability in most Chinese industrial enterprises means that they could not rely on themselves for solving the more complex technical problems related to their production. They are also incapable of acquiring external knowledge through informal or more structured arrangements. Thus, these enterprises need technical services from research institutes and universities. This is partly why technology contracts have become major sources of funding for university research.

The weak industrial R&D capabilities also meant that much potentially useful research work in universities, particularly that conducted in engineering schools and departments would be difficult to commercialize by firms outside universities. At the same time, the rapid technological change in many high-tech and traditional industries has also created many technical and economic opportunities for these research works. Some faculty members with entrepreneurial skills naturally see the opportunities and began to "jump into the sea". For these people, universities have provided great support such as establishing specific funds to improve

working conditions and salaries, helping working staff to cooperate with the industrial sector via technology contracts and joint research, and enabling departments to start small-sized technology development companies. However, few of these faculty were willing to give up their jobs in the universities. Most of them wanted to have a safe cushion in case their venture failed. For a long period of time, many universities indeed provided this security. To understand why universities are willing to do so, we need to examine "the push factor" in the equation.

### 5.3 Push factor—Slow reform in higher education system and government policy orientation

Since the mid-1980s, there have been a number of related factors that have helped to push universities to establish closer linkages with the market. These factors include slow reform in the higher education system and government policy orientation.

The major difficulties in China's higher education system lie in its heritage from a planned economy where central government played key roles in determining everything from faculty salaries to the number of students to be admitted to a specialty field of study in a particular university. The autonomy of Chinese universities is much less than state-owned enterprises in other domains. At the same time, the environment where universities operate has dramatically changed to one that is very market-oriented. The mismatch between the centralized system and its market-oriented environment has created many tensions and pressures that have prevented China's higher education system from adapting itself to meet the new challenges brought about by the new changes.

One constant challenge is the funding shortage. Table 5-11 shows the income structure of a nationally well-known university in selected years in the 1990s. It can be seen that government appropriation, often tied up closely with the number of undergraduate admissions, was only about one third of the total budget and was declining slowly throughout the 1990s. The largest sources of income came from research, including those from government research projects, industrial collaborations, and so on. The contribution of university-owned enterprises to universities comes in two ways. One is through contracted research and the other is payback to universities through the profits they have earned from the operation of the enterprises. The former is included in the "Research" category while the latter is included in the "Other" category. Unfortunately, detailed data on the payback of university-owned enterprises to universities are difficult to get.

The heavy reliance on research funding was mainly due to the slow reform in the higher education system. Reform proposals to grant universities more autonomy and to take a more market-oriented approach in financing the higher education system were debated but not implemented until very recentl in 1999 when the policy to expand enrollment in higher education was launched ( Xue, 1999). Dramatic changes have taken place in universities ever since. From

1998 to 2001, the number of students in universities jumped from 6,430,000 to 12,140,000, and the annual average tuition costs for each student has increased from 2,500 yuan to 5,000 yuan. While tuition and fees increased rapidly, these started from a low base and government regulations prevented them from increasing substantially. Thus, universities in China were put in a difficult position: they were not provided with enough funding to operate, nor were they given enough autonomy to take a more market-oriented approach to finance their operations. Providing S&T service then became a very attractive and legitimate way for many universities to finance their operations.

**Table 5-4. An Example of the Income Structure of a Well-known Chinese University**

| | 1990 | 1992 | 1994 | 1996 | 1998 |
|---|---|---|---|---|---|
| Total income (Million yuan) | 152.1 | 222.6 | 342.3 | 532.7 | 741.9 |
| Gov't appropriation (%) | 36 | 30 | 32 | 32 | 29 |
| Tuition and fees (%) | 2 | 4 | 8 | 10 | 11 |
| Research (%) | 48 | 53 | 49 | 45 | 41 |
| Donations (%) | 0.2 | 0.0 | 0.0 | 2.5 | 4.2 |
| Others (%) | 13 | 12 | 12 | 11 | 15 |

(Source: collected by the author)

A further analysis of sources of research funding for universities in China from the mid-1980s to the late 1990s shows an interesting pattern. In 1985, when the S&T reform and educational reform started, funding from government for university S&T activities accounted for about 75% of the total. The rest mainly came from industry. Since then, the government proportion had been declining steadily while the industry proportion had been rising also steadily. By the mid-1990s, industry surpassed government slightly to become the largest source of funding for university S&T activities. While there have been fluctuations since, this industrial source still provides close to half of the funding of university S&T activities. To a certain degree, universities, particularly those with an engineering background, have begun to depend on industrial research income to support their daily operations.

Government policy orientation has also played an important role. (Shao, 2002; Chen, 2004) Since the Central Government issued the policy documents on S&T system reform and education system reform in 1985, government policy orientation has been consistently focused on pushing universities to offer their research services on the market, to help national and local economic and social development. University high- tech industrial development has become one of the top priorities for university administrations. Both Central and local governments at various levels have seen universities as engines of economic development and tried to provide various incentives and supportive policies to encourage these institutions to forge closer ties with local industry.

To summarize, government appropriation for Chinese universities has been far from adequate over a long period of time. Research funding from industry has thus become a major source of income for universities. Given that research funding from industry accounts for almost half of the total research income, universities naturally encourage its faculty to develop closer ties with industry, or even to become entrepreneurs themselves. In addition, the endorsement of the Central government and the fact that university-owned enterprises have become a priority for university administrations have also been important factors. These may help to explain why Chinese universities have become so close to industry in China's national innovation system.

## VI. Conclusion

The previous discussions have outlined the changing roles of universities in China's national innovation system from one mainly responsible for training S&T talents to one that is also engaged in the commercialization of R&D results from universities by forging closer links with industry and even by starting their own companies. Such transformations have yielded many economic benefits for society. While there may still be other useful benefits, there are also some serious problems that need to be sorted out.

The first issue is related to the division of labor between different social institutions. Are there comparative advantages that are inherent to universities in carrying out their basic mission of education and research? What are the explicit and implicit social contracts in such social division of labor? Is there a change in the comparative advantages of universities in the new social and technical environment? Currently, these issues are not well thought out in China. Policy orientation and institutional design are also somewhat confusing. For example, while universities are supposed to be the only social institutions responsible for higher learning, but the government does not provide enough funding to them for this purpose. Nor are universities allowed to raise their tuition fees to become self-sufficient. It is these distortions in policy that force many universities or faculty members to engage in activities that may - or may not be - in their best interests in the long run.

Another problem is related to the university's close linkage with industry. Some people are concerned about the possible negative impacts of such activities on the academic environment. Others are concerned that close linkages with industry may distort the university's long-term research directions. In our interviews on these issues, some complained that too much commercial activity on campus has changed the academic environment and this, in turn, hurts basic research. Others consider this as an inefficient way of allocating R&D resources which has distorted he directions of university research. Moreover, many faculty members and graduate students are no longer engaged in academic research. Rather, they are doing applied research work the commercial value of which is far greater than its academic value. In addition,

university administrations also have to devote considerable time and energy to running university-affiliated enterprises.

A related question is to what degree one could attribute the slow improvement in university teaching quality in China to the close linkage with industry. This is a complicated question to answer and there is little systematic data to support the argument one way or another. In the years prior to the reform, one of the missions of many university-affiliated enterprises was to improve teaching by providing students with better "hands on" opportunities. This mission seems to have become less important in latter years. Many people who are involved in university-affiliated enterprises have become full-time employees in the enterprises rather than professors in their original academic departments. On the other hand, there is a general agreement that, along with the reform in S&T system since 1985, Chinese academic institutions, including public research institutes and universities, have become more commercially and application oriented. Government policies in general have supported this trend. Therefore, while it is somewhat unfair to blame university-industry linkages for the slow improvement in teaching quality, it is reasonable to say that linkages with the industry have contributed to the overall trend of over-commercialization within academia.

In conclusion, there are historical and institutional rationales that fostered the emergence of universities as a major player in China's innovation system. They have made a significant contribution to the reform of China's national innovation system and the growth of China's high-tech industry. At the same time, one should not overlook the potential long-term negative impacts of being too close to the market. The challenge for the universities is how to maintain this delicate balance in a fast changing environment.

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## *"Science and technology human resource capacity building in Africa. The role of regional cooperation"*

**Abstract**

There are many regional cooperation efforts in use as strategies for capacity building in Science and Technology. These include regional centres jointly owned by a group of countries, institutional networks and networks of regional centres of excellence. Each type has its objectives and achieves results at a different rate, to a different extent and at a different cost. In order to understand which model to use it is therefore necessary to know the state of the problem, the rate at which one wants the solution to evolve and the resources available for cooperation.

In this paper we have presented results of a survey of the state of science and technology human resource capacity in Higher Education Institutions in the region. Through the analysis we have established that human resource capacity for scientific and technological research in higher education institutions is minimal. Thus, there is need for a model of regional cooperation that will rapidly increase human resource potential in all areas of science and technology.

The paper has also presented the challenges and opportunities of regional cooperation and analysed the performance of different models in the region with a view of identifying the most suitable one for rapid generation of large number of scientists in the region. Two cases are presented: The UNESCO project – the African Network of Scientific and Technological Institutions (ANSTI) - as an example of institutional network and the Consultative Group of International Agricultural Research CGIAR as an example of Networks of Centres of Excellence (where the centres are jointly owned).

The paper concludes that Network of centres of excellence model is excellent for providing high quality research work that contribute to national/regional development. It may not be useful in generating large numbers of researchers to build the human resource capacity of countries in the region. Institutional Networks (including nodes that are both strong and weak and where there is no joint ownership of institutions in the network) offer the best opportunity for rapid, low cost, large-scale human resource capacity building. It is argued that Africa needs the two models: One dedicated to the production of high quality and relevant research to address the regions' problem and the other for human resource capacity building in higher educations institutions.

## 1. Introduction

One way of carrying out a comparative analysis of research systems in higher education is by examining their capacities, their productivities and the relevance of their products. Each of these characteristics can influence the contribution that a system makes to the creation of knowledge and socio-economic development. Thus in considering the research system of higher education institutions, it is important that we analyse these attributes. In this paper we are focusing on one particular characteristic: i.e. Capacity of higher education institutions to do research. In particular we want to examine the human resource capacity in Science and Technology and describe a strategy that could help the process of reinforcing the same.

Human Resource is an important component of research capacity of any institution. It directly affects the ability to do research and indirectly influences the relevance of the research through the capacity to determine the research agenda. Without it, even with the best equipment and financial resources, the quality of the research output will be very poor.

The generation of human resource is the responsibility of Universities. They produce graduates with research degrees such as PhDs and, through post-doctoral assignments, they provide opportunities for the initial research training and experience. In Africa, the neglect of higher education over the years led to the collapse of all aspects of this important level of education and made it difficult for universities to provide the human resource capacity required for research. Although the situation has changed dramatically over the last few years, the effect on the availability of high level human resource for research is still apparent and will likely stay so for some time for reasons which are highlighted in this paper.

The paper addresses two categories of issues related to human resource capacity for research in higher education institutions. In the first category are those issues affecting *training* of research personnel. In the second category are factors that affect the *retention* of the trained personnel. Both the training and retention issues affect the level and quality of human resource capacity for research in all disciplines. The situation in higher education institutions in Africa with respect to the training of research personnel is presented and from the analysis we have identified five (5)

challenges facing the human resource capacity building process. The paper proposes regional cooperation as one of the strategies for overcoming the identified challenges. It highlights the potential role of regional collaboration, the opportunities that exist for regional cooperation and the mechanisms for such cooperation. The paper has tried to clarify some issues by presenting experiences with different types of regional cooperation for human resource capacity building.

## 2. Context: Human resource capacity issues in Science and Technology in Africa

### 2.1 The background

The generation of S&T human resource capacity requires training institutions, which have the ability to provide quality training and education in all the relevant disciplines of science and technology.

These institutions must have important resources including staff, laboratory facilities, a good library and a collection of learning materials. Because of the dynamic nature of science, it is essential that these resources are regularly improved so as to be able to maintain the quality and relevance of the training they offer. Such frequent updates of resources require continuous financial investment in higher education institutions that offer scientific and technological training. Unfortunately this has not been the case in most sub-Saharan African countries. Since the mid 80s there has been serious under-funding of Higher Education Institutions (HEI). This was partly due to the widespread belief in donor organizations and development banks that the rate of return on investment in higher education in Africa was less than that for basic education, and that public subsidies for higher education tended to favor higher-income families from which majority of the university students came. In fact The World Bank recently acknowledged that expenditure on higher education declined from 17 % of the total education expenditure in 1985-89 to 7% during the period 1995-99.

Furthermore, African governments under pressure from their development partners and the competing pressures of other demands for public resources also cut down on their support for higher education in favor of primary and secondary education. The situation was further complicated by the poor governance and economic performance which reduced the flow of funds to all service sectors

### 2.2 The issues

This neglect of higher education manifested itself in many ways including poor remuneration for staff. Research staff salaries declined substantially and many institutions found it difficult to retain staff. In some African universities, staff salary is usually about 20% of what it used to be ten years ago. And in other countries, the rapid devaluation of national currency without a matching rate of increase in salaries, have left staff with a salary which, in hard-currency

equivalence, is only 10% of what it was 5 years ago. As some staff leave for better-paying jobs, inadequacy in staffing becomes a major problem.

The above scenario has led to two problems with regard to human resource capacity for research in higher education institutions. These are: the shortage of staff as exemplified by the high level of vacant posts in many institutions and the inadequate numbers of researchers with doctorate degrees (i.e. highly trained staff). A recent survey of some faculties of science and engineering by the African Network of Scientific and Technological Institutions (ANSTI; 2005), revealed weaknesses in both the quality and quantity of staff. The survey, conducted among 20 institutions spread over the all geo-political regions of sub-Saharan Africa (excluding South Africa), revealed that on average, across the region and across disciplines only 70% of the required staff are at post. In some universities there are science and engineering departments with only 30-40% of the total staff requirement.

The situation gets even worse when one considers that most of the staff at post are young and inexperienced. The ANSTI survey, referred to earlier, established that on average the percentage of staff with PhD in science and engineering faculties in the institutions surveyed was just above 50%. This suggests that majority of staff in universities in the region are at the level of lecturer, assistant lecturer or research assistant because staff without PhD in most universities cannot proceed beyond these levels. This indicates an overall weakness of staff to undertake research since most of them do not have long experience of unsupervised research.

The small size of the staff and the weakness of their background confirm that staff in the universities in the region spend more time teaching and less time on research. *In effect the human resource capacity for research in science and Technology in higher education institutions is minimal.*

The reasons for this poor state of affairs are many. The first is the poor remuneration which has led to flight of scientists from the region (the so-called *brain drain*). Staff members with PhD are more likely to be the first to leave which leads to a drop in the quality of the staff. Furthermore since Brain drain tends to affect mainly younger PhD holders, one can conclude that most of the good staff now in higher education institutions in the region are already nearing retirement. Another reason for the poor human resource capacity is the weak state of the universities which has made it difficult for them to carryout postgraduate training and regenerate the capacity that they lose through brain-drain. Because the institutions cannot train locally they are forced to send some of their best staff abroad who never return. Institutions find themselves in a predicament. *They cannot have staff because they do not have staff* to run training courses. There is need for assistance to break out of the cycle.

## 2.3 The challenges and opportunities for human resource capacity building process in science and technology

The preceding situation analysis has highlighted several problems and weaknesses in the human resource research capacity in the region. As we consider re-building that capacity to enable higher education research systems to contribute to national development it is important to recognise some of the challenges that confront such efforts. This is to enable the development of adequate strategy. The problems in the research system pose five (5) main challenges to the process of capacity building in science and technology.

- The first challenge is the *size of the problem*. It has been established that the human resource capacity for research is minimal and non-existent in most universities. Therefore it will require the training of twice the number of the current staff to PhD levels for the research capacity to begin to function

- The second challenge arises from the first. The *weak human resources* base means that higher education institutions are not in a position to quickly develop post-graduate training programmes to begin to build the research capacity.

- The third challenge is the *threat of brain drain* to more developed countries. If this problem is not addressed all the efforts in training new staff will be in vain. The fear of brain drain is forcing institutions to undertake training locally but this is proving difficult because of the weak state of higher education institutions.

- The fourth challenge is the general *weak institutional capacity* to build human resources. In particular the physical facilities required for training scientists are very weak. About 55% of laboratory equipment in some departments are not in a state in which they can be used to carry out experiments. There is poor maintenance. Some equipment are no longer in production and hence spare parts are not readily available. The average age of the available equipment is very high. There are also problems with the availability of good reliable ICT infrastructure and library facilities for research. All of these problems will pose a major challenge for human resource capacity building in the region.

- The final challenge is the *isolation* suffered by the scientists that are recruited in higher education Institutions. Scientific knowledge advances through dialogue and exchange of views. Such will not happen if the local scientific community is not large. From the preceding staff analysis it is obvious that there are several disciplines of science where there may be only one specialist. This means that the scientist will not be able to subject his ideas, hypothesis or research results to informal peer review through regular contacts with his/ her colleagues. The result is the capacity of the individual to do research withers away and over time it is either completely lost through decade (*brain-in-the-*

*drain*) or externally (*brain drain*). In fact the escape from isolation is one of the contributory factors to brain drain. Thus, isolation will initially be a challenge to human resource capacity building in the region.

Although there are many challenges facing the human resource capacity building process, over the last few years several opportunities have emerged which can be harnessed to overcome some of the constraints.

- The first is the change in the policy of development partners. There is now a realization that higher education and Science and Technology training and research in particular, is vital for economic development and the attainment of the millennium development goals (MDGs). This has led to change in policy of national governments which are now willing to support higher education.

- The second opportunity is the improved economic performance of most African countries which is enabling governments to make modest increases in their contribution to higher education.

## 3. The role of Regional cooperation

Actions are required at all levels (institutional, National and regional) to address the challenges facing the process of human resource capacity building in the region. However it is quite clear form the nature of the challenges confronting the training institutions that most countries will not be able to act alone to successfully build their capacity. The training resources are weak. The scientists are isolated and the threat of brain drain prevents the search for training outside the region. Under such circumstances, regional cooperation offers a good alternative.

### 3.1 Rationale

Regional cooperation will enable institutions to overcome some of the problems highlighted above. Such cooperation can have three benefits: *information sharing, resource sharing* and *resource mobilization.*

Information sharing is one of the most important objectives of any regional cooperation effort. Several universities in the region have adopted innovative actions to overcome some of the problems mentioned above. It will be useful if their experiences are shared with others. This will obviously prevent attempts to re-invent the same solutions or to repeat the same mistakes. Using various media (Electronic, printed materials, meetings, conferences) information is disseminated on good practices and strategic issues in training. The challenge associated with isolation of scientists will be overcome through regional cooperation

Another role of regional cooperation will be in the area of resource utilization and sharing. Institutions in the region may be weak individually, but collectively they could be strong because they will tend to mutually reinforce each other. Strengths of some institutions in certain subject disciplines will even out the weaknesses of the others. There may be an institution with a strong human resource but weak laboratory facilities. There may be another for which the reverse is true. Such institutions could collaborate to minimize the effect of their weaknesses. Thus through cooperation it will be possible to undertake high-level training within the region and thereby minimize the threat of brain drain (one of the challenges facing human resources capacity building).

Finally resource mobilization can be carried out collectively in order to undertake regional activities such as the establishment of regional centres of excellence.

**3.2 The opportunities for regional cooperation**

The developments in technology and regional policies have presented opportunities for regional cooperation. In the first instance the development of ICT infrastructure in most institutions has made it possible to share information and engage in collaborative research. Rapid exchange of information is not only possible but also faster. In some cases the Information and communication technology is being used for distance training. The network of air transport links among countries in the region has increased considerably thereby making it possible for low-cost exchange visits of researchers.

The renewed interest in regionalism has also presented an opportunity for cooperation in science and technology. Indeed regional groups, such as ECOWAS, COMESA, SADC, etc can provide strong platforms for regional cooperation in human resource capacity building in science and technology. Through policies, institutional arrangements and financial support, the Regional Economic Communities (RECs) can create a platform that will facilitate cooperation among institutions of higher education with a view of training high-level scientists. In fact a common feature of most of the RECs is the recognition of the role that science and technology could play in economic development and regional integration. Several of the economic, political and trade treaties make reference to the need to strengthen cooperation in the field of science and technology. Mugabe (2006) has actually identified articles in the founding charters of several Regional Economic Communities which make commitment to the use of science and technology for economic integration.

Unfortunately, in the past, such statements and agreements have not been translated into actions. Now this is changing. The African Union's NEPAD programme has developed an Action Plan for Science and Technology which is receiving support from various sub-regions. It is becoming the guide for all actions that the RECs may undertake. This is evident from the endorsement it

has received from sub-regional groupings of ministers such as the one recently held in Yaoundé Cameroon for the ministers of Central Africa. (26-28 September 2006). Thus, it is hoped that renewed interest in regional integration will this time lead to active collaboration in development and implementation of science and technology activities.

**3.3 The guiding principles**

Regional cooperation for human resource capacity building should be grounded on three concrete principles. The first principle is the recognition of the disparity in resource endowments in the various institutions and countries. Regional collaboration should bring together the strong as well as the weak so as to promote good scientific work. The cooperation must use the strong institutions to enable the weaker ones grow. The ANSTI survey of institutions in the region showed that several institutions especially in southern Africa are endowed with the physical resources which could be used for training activities. In this regard regional cooperation effort should identify and include centres of excellence to ensure that it is anchored in good science.

The second principle is the emphasis on training within the region. In order to prevent brain drain, it is necessary that high-level training courses are carried out within the region. Such training and research will also contribute to the growth of scientific work in the region. The selected centres of excellence should be used to do such training. Furthermore the centres will undertake high-level training in specialized areas so that the trainees will return to their home institutions where they will transfer the knowledge to others. On the basis of this principle the regional efforts are now promoting the concept of networks of centers of excellence

The other principle is the establishment of links with counterparts in other regions. Africa cannot isolate itself in an era of globalization. In the fast-moving world of science it is essential to stay a breast with developments from all regions. The regional cooperation arrangements should conduct research and training in partnership with others in the global scientific community

**3.4 Types of regional cooperation used in the region**

For human resource capacity building Massaquoi and Savage (2002) identified and described two types of regional cooperation mechanism that has always been in use in the region: regional centers of excellence for training and research and regional institutional networks. The former is an example of how financial resources can be pooled to establish regional institutions for research and training in highly specialized training such as those worked on at the Consultative Group of International Agricultural Research (CGIAR) centres. The latter brings together physical and human resources available in institutions for the purpose of training and training. This is the model used by the African Network of Scientific and Technological Institutions

(ANSTI). The latter is a project of UNESCO Regional Office for Science and Technology in Africa.

Each of the networking types has its advantage and disadvantage. The major advantages of regional centers include the fact that high-quality facilities and opportunities are offered to a selected few, and that major scientific break-through made at the regional centers (in contrast to resource-sharing networks) have an immediate and significant impact on national economies and the quality of life of a number of Africans. Such centre will engage in training in specialized areas where it may not be cost-effective for each country to have its own training programme. The problem with Regional centers of excellence is the issue of control and ownership. Non-host countries tend to feel marginalized and may withhold contribution. This is particularly true for countries whose medium of education is a language different for that used in the regional training centre. Another disadvantage is that regional centres only provide the training in highly specialized areas such as biotechnology, agriculture, theoretical physic etc. and are not effective in the development of human resources across all fields of basic and applied sciences. Finally, the regional centre approach is expensive requiring construction of new institutions and facilities.

There are two types of regional centres of excellence models: The single (stand-alone) regional centres jointly owned by member countries; and the CGIAR model which is a network of regional centres.

The greatest advantage of institutional networking (involving all institutions, weak and strong) is its low cost. It does not require new building or facilities. Rather it puts those that already exist in individual countries at the disposal of the entire region

Through networking, postgraduate students requiring specialist training are moved from institutions with low resource endowment to others with better facilities. Because of the low investment required in establishing networks, the financial contribution by members involved in the cooperation is lower. Furthermore, training can be provided in many scientific disciplines. Among the many universities in the region, it will always be possible to find one with the required resources, and because of the range of institutions students will be able to receive training in the language with which they are familiar. Networks also enable members to share experiences on policy implementation and the outcomes of various strategies in training and development of science and technology capacity.

A major disadvantage associated with networking is quality control that arises because training takes place in different institutions with different rules and regulations. Sometimes even the system of education and duration of programmes may differ. Under such circumstances it is a challenge to assure quality of the training.

## 4. Some experiences with cooperation for Science and technology human resource capacity building

Africa has had experience with three types of regional cooperation models for capacity building. The African Network of Scientific and Technological Institutions (ANSTI) is model of institutional networking (involving a range of institutions) and the Consultative Group of International Agricultural Research (CGIAR) is a model of Networks of centres of excellence. The CGIAR established regional centres of excellence and pooled their resources together in a network. This network of centres of excellence is different from that proposed in the NEPAD consolidated Plan of Action for science and Technology (2005) where the network of centres of excellence is selected from among existing institutions. No regional institutions will be constructed and there will be no joint ownership of institutions. According to the AU/NEPAD model existing institutions are identified and designated as regional centres of excellence and then made to collaborate in a networking arrangement. The latter model does not require new institutions and in this respect it is very much like the ANSTI model and carries all the advantages of institutional networking.

### 4.1 ANSTI Network

The African Network of Scientific and Technological Institutions (ANSTI) is one of the oldest institutional networks dedicated to human resource capacity building in science and technology in Africa. Indeed, the network is the only regional cooperative activity with a mandate for high level manpower development in all fields of basic and engineering sciences in Africa. Established by UNESCO in 1980, at the request of African Ministers responsible for Science and Technology the network brings together 105 institutions in 33 countries in sub-Saharan Africa. It pools together the resources of its member institutions for training and research. It recognises that regional cooperation for human resource capacity building cannot take place without fellowships, grants that facilitate staff and student mobility. Therefore its programme activities include fellowships for staff exchange, post/graduate training, conference/ travel grants and the organisation of conferences/ seminars and forums for exchange of experiences.

Since its establishment the Network has achieved a lot and has become a vehicle for delivery of human resource capacity building programmes on behalf of several organisations working in the region. Each year these achievements are chronicled in the annual report ( see for instance ANSTI annual report 2005)

ANSTI has strengthened individual scientists in member institutions and also facilitated travel of hundreds of senior African academics to visit other institutions where they have carried out

research which had enriched their experience. It has also enhanced the postgraduate training and research capacity of its member institutions.

Through ANSTI, some faculties/schools of science and engineering in African universities have established contacts where there was none before. These contacts have yielded savings in the cost of student training, staff recruitment and assessment by external examiners.

One of the important activities of any capacity building programme is the identification and discussion of strategic issues involved in the relevant fields of education. ANSTI, through the meetings of deans and other expert groups has in the past identified several issues that affect science and technology education in Africa. The Network has established a biennial forum - Conference of Vice-Chancellors, Deans of Science, Engineering and Technology (COVIDSET) - which brings together university leaders responsible for science and technology to deliberate on strategy issues in higher education relevant to their disciplines. The findings of these consultations are published and circulated. (*see for instance: Revitalization of science and Technology training Institutions –ANSTI 2005).* Considering the small amount of funds used to establish the network and the limited resources at the disposal of the small network secretariat, it can be concluded that institutional networks are more effective for rapid human resource development on a large scale.

**4.2 CGAIR Model**

The consultative Group of International Agricultural Research (CGIAR) is another example of Networking. It is an example of network of centres of excellence. Established in 1971 the CGIAR sponsors a network of 16 international research centres four of which are located in Africa. The Africa-based centres are: The West African Rice Development association (WARDA) based in Benin; the International Institute of Tropical Agriculture (IITA) based in Nigeria, the International Livestock Research institute (ILRI) in Kenya and the International Centre for Research in Agroforestory (ICRAF) also headquartered in Kenya. These regional centers which are fully equipped with the most-up-to date equipment and facilities form the nodes of the Network. Unlike ANSTI which brings together institutions from various countries, the CGIAR brings together regional centres. None of the CGIAR centers belong to a single country. For instance WARDA's 17 members include Benin, Burkina Faso, Cameroon, Chad, Cote D'Ivoire, Liberia, Mali, Mauritania, Niger, Nigeria Senegal, Sierra Leone and Togo.

The CGAIR network of centers of excellence provides a very important model for pooling together Africa's scarce research resources to engage in cutting-edge research that can contribute to the food security of the region. It limits brain drain of African scientists and technologists from the continent through provision of good terms of service, high quality research facilities and links with the global scientific community. It is the ideal form of networking for

strengthening research productivity and ensuring the use of science and technology for development. It is however not useful in human resource capacity building on the scale that is now required in the region as shown earlier in this paper.

### 4.3 The Single (Stand alone) regional centers of excellence

There is also another regional cooperation leading to the establishment of single regional centres which are not in a network as in the CGIAR model. There are a few such cases in Africa which are used for capacity building. An example is the Africa Regional Centre for Engineering Design and Manufacturing (ARCEDEM) which is based in Ibadan Nigeria. Established in 1979 to facilitate skills and technology transfer, the centre has 24 member states. However, over the last five years it has fallen victim of one the problems of regional centers that was highlighted earlier in this paper (i.e. ownership, sovereignty and refusal of member states to pay their contributions). In a reply to a letter from ARCEDEM management seeking payment of dues, one of its members refused to pay because it "has not enjoyed any service from ARCEDEM since 2000" (Nigerian Tribune 2006. In fact the ARCEDEM case illustrates all the weaknesses of jointly-owned regional centres of excellence.

### 4.4 The proposed AU/NEPAD model

The Consolidated Plan of Action prepared by AU/NEPAD and adopted by the last Conference of African Ministers responsible for Science and Technology in Dakar 2005 proposed an institutional arrangement for implementation of the plan through networks of centres of excellence. These networks will be organized as consortia of institutions that bring their best intellectual, administrative and physical facilities as well as financial resources together. The institutions will be identified from among existing institutions in the region. In this regard it is very much like the CGIAR Network but defer in two ways: No *regional institutions* will be built; and there will be no joint ownership of member institutions of the Network. It is similar to ANSTI model since it networks existing institutions from various countries. However it defers from the ANSTI model because it will be restrictive (linking only centers of excellence) while the ANSTI network is open to all institutions in the region.

## 5. Conclusion and Recommendations

The paper has described the situation with respect to the human resource capacity available for scientific and technical research in higher education institutions in Africa. It has presented analysis of results of survey of institutions which show that the human resource for research is minimal in most institutions in the region. It has identified the challenges that confront the process of human resource capacity building in science and technology in the region. These include the scale of the task, the weakness of the available human and material resources for the

task, brain drain, and isolation of the trained scientists. The paper suggests that regional cooperation is the only way to enable the region to confront these challenges. It goes on to present the opportunities for regional cooperation and the various models that have been tried on the continent.

The existing regional cooperation models for capacity building in science and technology in the region include:

- The single (stand alone) regional centre of excellence which is collectively financed by many countries. An example of which is the African Regional Centre for design and manufacturing (ARCEDEM) based in Ibadan Nigeria.
- The Network of regional centres of excellence which puts at the disposal of its members the resources of several regional centres (collectively owned) as in the case of the CGAIR .
- Network of National Institutions (weak and strong) as illustrated by the UNESCO project of the African network of Scientific and technological institutions (ANSTI)
- The network of Institutions (national institutions identified and designated as regional centres of Excellence). This is proposed by the Africa Union's NEPAD Science and Technlogy Consolidated Plan of Action.

From the analysis of the experiences with the various models, it is concluded that CGAIR model is good for participating in cutting-edge research to produce research results that will have an impact on the socio-economic problems of the region. It is the best model for enhancing the productivity of the regions research system. However it is not very useful for large-scale development of human resource capacity. For the latter then ANSTI model will produce better results considering the limited resources and the size of the problem facing human resource capacity building in the region. The paper has concluded that the NEPAD/AU model combines the good qualities of both the CGIAR and the ANSTI models

Based on the analysis and experiences with regional cooperation the following actions should be taken in order to enhance regional cooperation.

- Strengthen ICT facilities in higher education institutions in order to improve communication and the sharing of information and experiences
- Develop data base on the available human resources in science and technology training and research institutions in the region with a view to facilitating the optimal use of all the available manpower in the region.
- Develop data on the mobility of human resources in order to determine the nature and direction of loss through brain drain
- Establish a forum which will facilitate the regular (once every two years) exchange of experiences.

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## *"Commitment to society: contemporary challenges for public research universities"*

Globalization has substantially modified the nature of contemporary Nation-States as the principal organizers of capital accumulation and as bearers and creators of national identities (Castells, 1996; Evans, Rueschemeyer, & Skocpol, 1985). The Nation-State's progressive withdrawal from higher education, expressed notably in the reduction of public resources (Altbach & Johnstone, 1993; D. B. Johnstone, 1998), has implied an increasing competition for individual and/or institutional resources from the State and vis-à-vis the market (Marginson, 1997; Marginson & Considine, 2000; Pusser, 2005). Consequently, traditional autonomy of academic institutions (universities and other postsecondary organizations) and its professionals from both Nation-States and markets, has been notably reduced (Rhoades, 1998; Slaughter & Leslie, 1997).

### Globalization and higher education: the economization of the university

The provision of public resources, one of the essential spheres of interaction between the modern university and society through many decades, and institutional autonomy, granted by society to higher education through the State, were the most essential material conditions for the emergence and survival of HE institutions with a relative but significant independence from the State and a qualified isolation from the market. Both the granting of public resources, without previously established requisites for the provision of public goods or services and with few demands for accountability or intense scrutiny; as well as legal, organizational and administrative autonomy for universities; were based on an implicit relationship of trust by society towards higher education institutions (Trow, 1996).

Due to globalization and internationalization processes as well as changes in the nature of Nation-States, initiatives for accountability have been promoted in almost every area of societal life. The public sphere has been put into question and the weight of market relations in every type of social interaction has increased. Globalization has been a product and has in turn promoted a growing economization of society and an erosion of all that is considered "public" (Wolin, 1981); changes in the nature and capacity of Nation-States (Evans et al., 1985); and continuous expansion of markets, particularly within the realm of education and the production of knowledge (Marginson, 1997; Marginson & Considine, 2000; Slaughter & Leslie, 1997); all of these contribute to explain the "reduction of trust" from societies towards universities, institutions that rely heavily on public resources.

This crisis of "publicness" and eroded societal trust in the realm of education has been expressed in permanent challenges to the efficiency, productivity, lack of equity, and low quality of large educational systems (Díaz Barriga, 1998). Critiques about the state of education and demands for accountability have put assessment, evaluation and certification policies at the core of public educational guidelines all over the world. Diversification and dissemination of academic and institutional assessment and evaluation is a consequence both of international dynamics generated by international organizations –such as OCDE or the World Bank among other —as much as a response to the adoption of the discourse and practice of evaluation and accountability by Nation-States and educational administrators at the local level (Bensimon & Ordorika, 2005; Coraggio & Torres, 1997; Díaz Barriga, 1998; Ordorika, 2004).

Colleges and universities all over the world have been subject to profound transformations during the last two decades of the twentieth century. Higher education institutions, and the nature of academic work that is performed within them, have suffered changes that have no precedent in the history of postsecondary instruction. (Slaughter & Leslie, 1997). Until the 1970's higher education expanded continuously in student enrollments, number of faculty and availability of financial resources. Since the 1980's, however, public resources for higher education has been reduced significantly in almost every country (Altbach & Johnstone, 1993; B. Johnstone, 1998; World Bank, 1994, 2000).

The fiscal crisis of universities has been accompanied, both as a cause and as a consequence, by a redefinition of meanings, goal, and practices of higher education. Ideas of universities as broad cultural societal projects or as institutions that focused on the production of public goods have moved into a marginal or solely discursive realm (Marginson, 1997; Readings, 1996). These notions have been substituted by a renewed emphasis on the links between higher education and markets (Marginson, 1997; Marginson & Considine, 2000; Slaughter & Leslie, 1997), by a scheme of "entrepreneurial universities" (Clark, 1998), by notions of excellence (Readings, 1996), by the centrality of managerial concepts and goals --such as "productivity" or "efficiency"--, and by the increasing privatization of educational supply and financing (Slaughter & Leslie, 1997).

As noted before the impact of globalization upon higher education is very evident through the reduction of public resources and privatization processes. These topics have been exhaustively analyzed by many authors. On other hand, it is very relevant to emphasize the fact that globalization also becomes materialized, in a significant manner, through the emergence of new markets and market relations for higher education institutions and their "products." The adoption of market practices or of those routines that try to imitate these practices (markets, pseudo-market, or fictitious markets) have become some of the most relevant characteristics of contemporary higher education (Ordorika, 2002, 2004; Slaughter & Leslie, 1997).

This economization of the university has brought fundamental concepts and concerns of the realm of business, industry and production in general into higher education campuses. Central among these is the concept of productivity, a notion that attempts to simplify the relations of production into a measurable indicator, established through the relation between inputs and outputs.[3] By putting the simplifying notion of productivity as a core concept of individual academic or institutional assessment in colleges and universities, the complexity of university life --of knowledge creation, of the teaching and learning interactions, of knowledge dissemination, extension and service-- the whole value of higher education is reduced to crude and problematic measurements of faculty and student practices and performances as reduced to standardized measurable "products."[4]

## Productivity and the hierarchical field of HE

From a different angle it is possible to think of higher education at the global level as an existing world-wide field of power. Within this worldwide field of power elite research universities exist simultaneously in three interactive dimensions: (1) they relate directly to each other within common global networks, including disciplinary networks; (2) they take peak roles within national higher education systems and in most nations are closely implicated in government policy; (3) they also have more localized constituencies (Marginson & Ordorika, 2007).

It is argued here, that what we have come to know as research productivity is fundamental in establishing a university as a prominent institution, at the international and local level. Consequently these institutions' networking and global interacting potentials are strengthened -- or diminished-- by their adherence to a dominant productivity model, which they constantly therefore reproduce, purposefully or not. Their national peak rolls and public policy influence also become increasingly dependant on their research productivity and many times hamper the institution's ability and commitment to local problems and constituencies.

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[3] In economics, productivity is usually framed as the amount of output generated (goods produced or services provided) for each unit input. Labor productivity, for example, is usually measured as output per worker or output per hour of labor.

[4] Almost every study in the field of economics of higher education speaks to the extreme complexity of measurement of knowledge related activities, to the difficult grasp of inputs and outputs, and to the imperfectness of measurement proxies of teaching and or research productivity (i.e. Hughes & Tight, 1995; Johnes & Johnes, 1993; Pla Vall, 2001).

Following Bourdieu, the field of higher education is understood as uneven, hierarchical, shifting and contested. Within the field institutions and nations are on one hand positioned within global, national or local settings, and on the other hand engage in position-taking strategies (Bourdieu & Johnson, 1993, p. 35). Research universities can change their position to some degree by their own efforts; the same resource base or national history might be associated with many possible strategies. To a great degree international positioning is based on adherence to international standards of research productivity (Marginson & Ordorika, 2007).

Potential for university self-determination (i.e. the strategic freedom of each university) varies by time and place. It is shaped by historical circumstances, university traditions and local settings. According to Naidoo (2004, p. 459) these position-takings are inseparable from the objective positions occupied by the agent or the institution as a result of their possession of a determinate quantity of specific capital. This includes not just financial capital but cultural capital, and derives from not just the position of the particular research university but the position of the nation within the global field of power.

Globalization has added a new element to competition and stratification in higher education. Research universities have always competed with each other for social and academic prestige, and also have long engaged in cross-border activity at their margin. Now for the first time we can identify a single system of world-wide higher education: a network of web-sites joined by instant messaging and data transfer, in which global connections run through the centre of institutions and governments and are integral to day-to-day practices. At the same time global people mobility in higher education has substantially increased. In turn global communications and mobility have created conditions for the emergence of a global market in higher education, i.e. competition among elite universities is now worldwide and is moving closer to capitalist economic forms.

The global higher education market is structured in two tiers: a super-league' of global research universities, which are driven more by prestige and power than by economic revenues as such; and a larger group of institutions of lesser status involved in the commercial export of higher education, where the mode of development is that of an expansionary capitalism. This global market is mediated by comparative 'league tables' of research performance or university status (e.g. the annual comparisons issued by Shanghai Jiao Tong University, and the UK Times Higher Education Supplement). These league tables have captured worldwide attention, a sign of the new global market; while at the same time the comparisons themselves generating material-ideological effects in structuring the market as a system of power. For example, the leading national research universities outside the Anglo-American world, that long were unchallenged leaders within their own countries, are now increasingly overshadowed by universities like Harvard, Stanford and Oxford. In a more mobile world in which students from everywhere now imagine entering the 'super-league' institutions, this affects not just the global standing of those national research universities, but the position of those universities at home as well.

In this context, the perception of institutional and individual competition within an international market for higher education reinforces the presence of business like practices and concerns. The focus on research productivity and in a significantly minor proportion teaching productivity also, becomes central to the notion of institutional self-positioning in the world-wide field of higher education. The concerns of public official and university administrators is how to reach higher levels of research performance, a complex notion whose discussion goes well beyond the scope of this text, with the most efficient levels of investment in material and human resources. That is, how to increase academic productivity.

## Hegemony and the narrowed role of the university

The global field of power in higher education is most usefully understood in terms of Gramsci's (1971) notion of hegemony, in which domination is exercised through a 'thick' overlapping complex of economic transactions, traditional authority, state regulation, ideologies and cultural production. The measures of research performance, and consequently productivity, describe a highly unequal distribution of resources and status. Leading research universities are mostly located in the United States with a handful in the United Kingdom. The Jiao Tong world ranking top 100 (2005) includes 52 US universities and 17 from other English-speaking countries, with the remainder from Western Europe and Japan. The measures themselves reproduce and strengthen this pattern of domination, because they advantage wealthy nations able to invest in science-based research infrastructure; advantage the English-speaking nations because English is now the only global language of research; and neglect criteria that are important in non Anglo-American systems, such as the contribution of leading research universities to national culture, democracy and national government, to the solution of important social needs and problems, and to sustaining mass participation in higher education (Marginson & Ordorika, 2007).

Nation and State building commitments of national and local universities lay far from international performance and productivity higher education standards. Orientation towards local constituencies, as well as impact on local, regional and national development, is difficult to measure and outside traditional criteria of academic performance and research productivity. International trends drive universities away from indigenous commitments and diminish their role as State Building institutions (Ordorika & Pusser, forthcoming).

The outcome of this pattern of hegemony is that higher education is subject to a greater degree of US domination than is foreign trade, or technological innovation. This hegemony is expressed ideologically in the normative character of an idealized model of the American research university and the stratified and competitive American public/private higher education system, which combines a high level of participation overall with an extreme concentration of wealth, academic authority, academic resources and social status in the leading universities. This model is very different to that which has developed in most nations, especially those in Latin America which historically emphasized the contribution of the university to national democracy and

placed the research university at the centre of national politics and culture; as well as the more homogeneous systems of Western Europe, sustained by State investment, in which all research universities have enjoyed similar status and access resources.

This norm of the idealized American research university is propagated by international organizations --like OCDE, UNESCO and the World Bank-- in its advice to policy-makers in peripheral countries, and the conditions attached to World Bank loans. These narrow performance and productivity oriented higher education guidelines and policies have become essential components in dominant neo-liberal policy ideologies in most other nations. They constitute the foundation for mainstream research literature in higher education studies; and appear as unique and common sense alternatives in mainstream public debate. In this way the idealized model of research performance and productivity has been translated into simplistic recipes that are reproduced without sufficient analysis or critique in many countries and universities (Ordorika & Pusser, forthcoming).

According to *The Economist* ("How Europe fails its young," 2005) the lessons of American success are to diversify income sources in quasi-corporate universities, reduce direct government intervention, and foster diversity and competition to produce an institutional hierarchy. It seems that every national government imagines that with the right policy settings and university cultures it can increase research productivity and have its "own Harvard." Yet none can replicate the domestic and imperial conditions that make US higher education powerful on the world scale; and if all nations follow the American ideal university system templates this will strengthen the global hegemony of narrow economic instrumental goals and productivity oriented models in higher education. The norm of the idealized American research university is an unrealizable ideal even within most of the universities in the USA.[5] American higher education is much more affected by political factors than the norm of the idealized American research university implies (Marginson & Ordorika, 2007).

**Diversity and difference in higher education**

In spite of great similarities between systems and institutions in the world there has been no single idea of the university (Bonvecchio, 1991; Wittrock, 1993). On the contrary, diverse and distinct major university traditions operate at the national, meta-national or regional levels.

[5] It corresponds more to the US Ivy League private university than to the US state universities whose roles and missions are more complex and contradictory (and on the whole more democratic) than the norm suggests. American higher education is highly unequal, but it scarcely corresponds with the forms of a competitive economic market. Approximately 60 per cent of tuition is subsidized from state or private sources, and regulation by federal and state governments, and accrediting agencies, has played a key role in shaping the system and securing the dominant position of the leading universities.

Some models or traditions[6] are defined by national borders, or in some cases by post-colonial traditions, others are tied to cultural or geographical proximities. Even though some of these models have had more international influence than others, they have all represented robust university traditions in their own domains.

In this global era in which models, ideas and policies are freely communicated across national boundaries, it would be expected that these different traditions contribute collectively to de the development of international higher education. We have noted here, however, that this is not so and that the hegemony and domination by the North American model and its "idea of a university" exercises a powerful, and many times disruptive influence at a world scale. Trends towards global standardization partly reflect the emergence of common guidelines and systems in higher education but they also evidence cultural and material differences and inequities.

Moreover, a narrowly defined idealization of the elite research North American model of higher education --which corresponds to a virtually unique relationship between university and industry, existing in the United States-- becomes harmful and dangerous when it is romanticized and transported to the rest of the world. Business inclinations as well as market orientations and market-like behaviors are characteristic of the top tier of US higher education institutions which have increasingly narrowed their role to knowledge production with significant capital accumulation purposes. Adherence to this paradigm in other central countries with distinct accumulation processes might become prejudicial. Harnessing public research universities in peripheral countries, historically more diverse in the range and nature of their tasks and social responsibilities, to research productivity and performance goals, as set through international standards by dominating systems and institutions, can easily erode public universities' commitment to the broader society.

## Diversity and commitment to society: universities in the periphery

Globalization, understood as the contemporary stage of capitalist development and as a hegemonic model of capital, establishes a set of different relations within and between State institutions. Higher education is a State institution that has suffered profound transformations in the context of globalization. The new economy and the hegemonic discourse of globalization, has implied a reduction of public resources and the privatization of higher education supply and financing. In a process that we can label *marketization* or *comodification*, higher education has been aligned to the requirements and practices of diverse markets both at national and international levels. In this global context, research universities have been, willfully or not, integrated into a global market with a centrally established system of valorization through

[6] We are referring here to models such as the US *elite research university* (Geiger, 2004; Kerr, 2001), the *state building university* in Latin America and other peripheral countries (Ordorika & Pusser, forthcoming), or the *napoleonic* and *humboldtian* traditions in continental Europe (Flexner, 1994; Wittrock, 1993).

international rankings. These international rankings promote, reproduce and reify research performance and productivity indicators as unique sources of value and societal appreciation for higher education institutions and academic work.

Standardized measures of academic output become an international homogenizing force that throws universities of diverse origins, traditions and roles, into a common process of competition in uneven conditions and with unequal possibilities for success. In this way, the global higher education market works as a powerful mechanism that reproduces inequities between different types of universities, from diverse regions or countries y with extremely differentiated access to intellectual and material resources.

The reproduction of the global market of higher education is based in two distinct but deeply interconnected processes: alignment and hierarchical stratification. Alignment, based on the normative character of the productivity oriented model that we have discussed above, and its homogenizing effect on diversity of projects and university traditions. Hierarchical stratification, through the establishment of a pecking order of institutions based on international status and power as compared with international productivity standards fashioned by those institutions that shape the hegemonic model.

Many universities in the periphery of the hegemonic model, certainly those in peripheral countries like Latin America, have maintained differentiated traditions and have played central roles in the development of Nation-States. Most of these have entered, willingly or forcefully, a conflictive process of conformity and homogenization towards the global hegemonic model. This constitutes an enormously risky transition for peripheral universities, and the countries in which these are based, by entering a process of subordination and unequal competition with the extraneous North American model of research universities and its top institutions. Legitimacy and rooting of national institutions becomes eroded by unfair and unjustified comparisons with the bearers of the productivity models. The distinctive character of national systems and universities is lost giving way to uprooted institutions that qualify lowly in international rankings, and with diminished impact on national and local realities to which they should respond.

The emergence of a higher education market posses a significant challenge for national research universities: the need to participate in the global realm of colleges and universities on the basis of their own nature and distinctive character, without diluting these in the face of hegemonic models and dominant international guidelines. For this purpose it is increasingly important to understand the loaded nature of concepts and notions of research performance and productivity that are so deeply linked to market oriented institutions of higher education. We need to be aware homogenizing effects of productivity driven policies, their impact on the narrowing of university goals and the detrimental consequences on the social responsibilities of the university. In the face of this hegemonic understanding of what constitutes a successful university in

contemporary society, the challenge for peripheral universities is the preservation of diversity of traditions and responsibilities trough a broad commitment to society.

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## *"Relevance and utility issues for research in developing countries"*

Research relevance and utility of research has been a topic for serious consideration for several years, even in developed countries. The issue appears to be more acute for developing countries where wider competing demands meet with more serious limitations. There are multiple and divergent users and beneficiaries of the knowledge generated from research, for instance policy makers, action implementers, service providers, and wider communities. National competitiveness is also linked with research and innovation. The benefit of research may derive from the process rather than the products. Assessment of the relevance and utility of research thus becomes complex.

After a study of health research situations in developing countries worldwide, the independent Commission on Health Research for Development identified in 1990 the shortcomings of health research in developing countries as limited resources, imbalance, fragmentation and the wasteful use of resources. The OECD, the International Institute for Management Development (IMD) and the World Economic Forum (WEF), among others, have addressed the role of and the investment in research and development with emphasis on developing countries.

While developing countries have significantly lower national wealth in the form of their gross domestic product than developed countries, the portion devoted to their investment in research is proportionately much smaller. For instance, while the United States, United Kingdom and Japan had GDP per capita above US$25,000, they spent more than 2% of GDP on research and development, Thailand, Malaysia and Indonesia, where the per capita level was below US$5000, spent less than 0.5 % of the GDP on research and development. China and India had lower GDP but spent around 1% on R & D. The actual funds available thus vary greatly. For decades, this

situation in developing countries has resulted in a shortage of all kinds of resources for research: human capacity, finance, facilities and infrastructures. The research system and its management, including rules, regulations and traditions, are also inadequate. Moreover, the higher education system in the past several decades has concentrated on producing practitioners for the application of imported knowledge. Research is a relatively new function.

Old scenarios persist. The research undertaken in many developing countries depends on the interest of academics who are generally trained in the developed countries and continue their interests after returning home. In many countries, imbalance in the areas of research or in relation to certain problems has become evident. Research is concentrated in some areas, while other much needed fields are neglected. Basic research resulting from academics' interest but which has no immediate use is deemed as wasteful. Research is thus seen as a luxury with no utility and not relevant to the country's needs. In turn, decision-makers do not depend on evidence from research. Some even seek those research findings which will support their decisions which are already made. At the same time, the public does not know enough to question this situation. Fragmentation also prevails and the research results from small disconnected projects are not usable. The limited resources are therefore wasted.

However, the situation described above has changed somewhat in many countries and there are cases or practices that can serve as lessons learned. The relevance and utility of research in developing countries is therefore a challenging issue. The appropriate criteria for research relevance and utility are therefore different from those applicable in developed countries.

## 1. Essential National Research

The Commission on Health Research for Development devised the term "Essential National Health Research or ENHR" to specify the range of research that a developing country needs to do, or cannot do without. Even the poorest country must undertake some research in order to adequately serve its people's needs. The extent must be determined by the country itself.

The notion can be said to be true for all sectors, and thus can be termed as ***essential national research.***

### 1.1 Research towards the local application of the global knowledge pool.

Large amounts of knowledge exist in the world and have been used by developed countries for their progress. Developing countries remain far behind in their development partly because they cannot take advantage of the existing and emerging knowledge. The reasons for non-application range from inadequate accessibility and affordability to acceptability and feasibility. Poverty and inequality thus prevail due to persistent problems and low productivity. Financial, educational

and infrastructural limitations, as well as geographical and socio-cultural uniqueness, are among the barriers to the effective application of knowledge and technologies. Research to produce location-specific and time-specific knowledge is needed.

In the application of imported knowledge, intelligent choice, critical appraisal and appropriate adaptation are generally necessary. The manifestation of a problem may be quite different in different countries, and a diversity of responses is needed. The detailed analysis of problems, including their nature and extent in specific localities, and in relation to demographic and other underlying factors, may be different. The societal wealth and necessary infrastructures, such as personnel, facilities, management and infrastructure, affect the feasibility of using knowledge, while cultural attitudes and beliefs can influence its societal acceptability.

To illustrate this point, people in developed countries have the advantage of technology for the screening and early treatment of cancer when it is controllable or curable. Those in developing countries still suffer from advanced cancer with high mortality rates. Technology assessment is required. Screening methods must be selected and adapted to suit local conditions where infrastructures must be put in place. This situation requires research to identify these conditions and to find solutions specific to each location.

Indigenous and traditional knowledge can prove to be useful. However, assessment of its trustworthiness would enhance its integration into current practice.

In the present knowledge-based economy and knowledge society, the explosion of the knowledge base and the possibility of access via information and communication technology have drastically changed the research which is needed in developing countries. Access requires infrastructures as well as competencies, while sorting needs critical appraisal and knowledge of research methodology. For instance, the formulation of a National Drug List as a tool for benefits and reimbursement in the Thai universal coverage health care programme requires extensive review of up-to-date worldwide knowledge about drugs, as well as critical appraisal and judgment regarding their affordability. Competencies to ensure the clinical trialling of drugs are essential in this process.

### 1.2 Research for understanding one's own situation and problems

Development efforts and solving local problems through local means must be holistically considered. Technological knowledge alone is not sufficient. Understanding the people and the environment, especially their peculiarities, strengths and weaknesses, is essential. The identification and prioritization of problems in a locality requires adequate understanding of the relevant factors in that specific locality. This can come from essential research. Situation-specific knowledge and site-specific data are also crucial.

One of the great mistakes in the past was the adoption of ways to solve local problems by solutions imported from elsewhere. Local peculiarity must be taken into account. For example, soil and water management is important for introducing new crops. Social and cultural beliefs as well as genetic and environmental conditions are important for sustainable success and compliance with new health measures. Effectiveness, cost-benefit, safety, feasibility and acceptability must be determined along with how to adapt to local economic, socio-cultural and political conditions.

Social science is an importance area of research in any attempt to use known and explicit knowledge in a new population. Research policies or action with a social science component will be more socio-culturally relevant.

### 1.3 Problem-oriented Research

Research which addresses practical problems would be immediately relevant and usable. Solutions applied to the targeted problems are the main aim, but wider utility can also result. Research to find new and more affordable technology may contribute to the answer. For instance, oral rehydration salt powder which was developed in Bangladesh has saved the lives of many children with diarrhea throughout the world.

The national family planning programme in Thailand during the 1960s can also serve to illustrate this point. One of the most difficult target groups was those people who lived in remote areas with difficult terrain, where communication and transportation would be cut off for several months during the rainy season. Longer-term contraceptive methods were believed to be a good alternative. Research on injectable DMPA was undertaken in spite of the known objections since, at that time, amenorrhoea and side effects were the basis for advice against its use in Western countries. It was found that these people in Thailand were already suffering from amenorrhoea through successive pregnancies and so this was not seen as a contrandication. Other side effects were also found to be less prevalent in the local population. From the results of such studies, injectable contraceptives were among the methods leading towards the success of family planning programmes in Thailand.

In the present energy crisis, alternative energy sources can be he subject of specific research for use in a specific locality which has potential for a wider market. For instance, wind power, wind farm systems and new engineering-inspired models (such as small turbines or grid connections) can be used in many villages. From this type of basis, research and the further development of solar energy and biomass are carried out on a wider scale to generate more abundant resources in tropical regions.

### 1.3 Policy research, system research and operational research

Public policies, as well as guidelines for practice or action, must now be accountable based on evidence and sound reasoning. They must take into account not only scientific evidence but also socio-economic and cultural evidence of local conditions. The answers developed elsewhere may be even harmful if they are applied uncritically in developing countries. Policy and system research are essential for national research and so must be conducted both professionally and holistically. The situation-specific and time-specific information is amalgamated with theoretical or generic knowledge to come up with alternatives or choices, as well as with the information necessary for sound decision-making.

One type of essential research is that which supports policy formulation, implementation and evaluation. Effective and sustainable policies require comprehensive and inclusive information, for which research must be rationally planned. Impact assessment is a requirement for any major public policy and its implementation because there must be a safeguard against long-term undesirable consequences for the environment, biodiversity and social cohesion.

Knowledge from appropriate research is an essential element for all aspects of national development including economic, social, cultural and political policies and programmes. Back in the 1970s, population growth was alarming and food shortage was of great concern, both globally as well as for developing countries. Under the so-called "Green Revolution", research into high-yielding varieties of crops and improved agricultural practices in several developing countries led to self-reliance in food production in countries like India. Many countries were able to increase their export of agricultural products, which then contributed to their national growth and wealth.

In the present era of the knowledge-driven economy and the knowledge-based society, knowledge policy - including policy regarding science and technology as well as knowledge management and tacit knowledge - is crucial. Developing countries must find appropriate positions and strategies to cope with change and to take advantage of this. Research on the research system itself, which must include knowledge production, innovation and knowledge utilization, offer this type of opportunity.

System research examines both the whole system as well as its parts: input, processes and outputs. Services research also takes into consideration the client- related aspects, as well as the impact on society at large. Marketing of the services as well as satisfaction of the service providers and receivers are topics for essential research. Lastly, evaluation is an essential part in the process which spans planning, action, review and readjustment.

Programmes and projects which are knowledge-based require a research-oriented approach throughout all their phases from planning, execution to evaluation and fine-tuning. Utility and practical applications are the main aims of such research. The research methodology must strike a balance between scientific rigor and timely output within practical limitations. Quantitative and statistically proven results should be complemented by qualitative and descriptive case studies. Quality, validity, reliability and acceptability of the methods and results must not be too greatly compromised. The ethical aspects of research, while they may occur in varied environments, must observe accepted norms. Some may not consider this type of enquiry or mundane science to qualify as real research. Nevertheless, this is very much needed. Publication as an indicator of research output may not be as important as the application of research results in practice. Action and other participatory types of research serve to bring relevant stakeholders together in a reflective and flexible process in order to maximize the possibility of success.

The extent of and need for operational research is obvious, so no further elaboration will be given here.

### 1.5 Poverty reduction research

A key target of the Millenium Development Goals is poverty reduction in developing countries. If the global programme is to be successful, the country level needs to be tackled first. The issue of poverty and its solution is complex and varies in different settings. Thus research on poverty reduction which is country-specific is essential. Equity and pro-poor policies require strong political will and aspiration, while much needed changes in all aspects of society in general must be based on knowledge and wisdom. These can result from proper research. There are numerous research programmes aiming at poverty reduction in developing countries, which are undertaken with the assistance of international agencies. Research can also serve as an educational tool for human resource development, as well as for the empowerment of the community.

## 2. Orphan problems

The Global Forum for Health Research was established in 1996 with the aim of addressing the 10/90 imbalance in health research. It was based on the finding that 90 % of the efforts and investment in health research was for the health problems which affect only 10 % of the world population, while 90 % of the people (mainly in developing countries) were left with neglected health problems. Drugs required to prevent or combat tropical diseases fall into the category of "orphan drugs" for which commercial enterprises do not have any interest or incentive to undertake research and development. Tuberculosis, malaria, oncocercariasis, filariasis and snake bite are such examples.

Tuberculosis, which has mostly disappeared from the developed world, still persists and has become a very serious threat in developing countries. This disease which is resistant to currently available drugs, is the cause of a rapidly increasing number of deaths. The drugs currently

available are more than 40 years old and no new ones are in sight in the near future. Moreover, the multi-drug resistant TB (MDR-TB) has now evolved into a more dangerous extensive drug resistant TB (XDR-TB). So, it is certainly relevant to invest in research on new drugs to treat resistant tuberculosis.

The epidemics of SARS and bird flu are urther pertinent examples. Even though emerging viral diseases originated from wild animals, they are recognized as new threats with the potential to spread worldwide. The research capacity required for the identification of these diseases and for the management of their treatment during such outbreaks is lacking in developing countries. When SARS started to spread, the countries initially infected were unable to identify the virus. When many chickens and other types of poultry died in farms in Thailand, Vietnam and Indonesia, it was necessary to send specimens to laboratories in other countries to definitely confirm the seriousness of the outbreak and its risk for human infection. This delay was probably responsible for the disease 's rapid spread before appropriate control measures were instituted. In the aftermath, the countries involved had to bear the burden of human casualties, as well as the economic loss from culling several million chickens. Fortunately, in Thailand, the research laboratories at universities working on genomes, genetic mapping and viral infections were able to decode the virus and confirm that it was indeed the H5N1 influenza virus. It is therefore vital for developing countries to invest in research capacity which enables them to cope with local problems. At present, there is only one drug efficacious for bird flu, namely Oseltamivir or Tamiflu. This is still under patent and only one pharmaceutical company is producing it. Furthermore, the price and availability of this drug became a problem when many countries started to stockpile it. It must be recognized that the best response to such occurrences is effective action at the earliest stage of the epidemic in the country where it starts. For this, local capacity is critical.

Research relevance can therefore be assessed from the negative angle, i.e. the extent of the undesirable consequences when this is lacking. Problems facing developing countries in many regions require reorientation of the way one looks at research relevancy and utility. For instance, there is no satisfactory progress concerning research on ways to overcome problems regarding communication and information distribution over vast areas in the developing world. It is a fact that many recurring natural disasters such as flood, draught, plague and deteriorating farm productivity can improve with proper research.

Research capacities to cope with such situations may be in the form of regional or global networks, but the ability to meet the need in the most peripheral areas must be an important criteria. Developing countries can no longer wait for the mercy of the developed world to solve their problems through research. They must develop their own capacity for this purpose.

## 3. Research Divide

In the market system, knowledge and technology have become salable commodities. Investment in research and development, as well as in production, is made with the expectation of high return. Intellectual property management and its protection by law guarantees ownership with monopoly for a certain length of time. Profit maximization leads to price setting based upon the level of need for the product and the ability to pay by those persons who need to use it. International protocols and free trade agreements are extending the commerical basis of knowledge across the countries of the world.

With escalating costs for commodities such as drugs, supplies and services, the gap between those who own and sell intellectual property and those who buy this is rapidly widening. The divide between technology-exporting countries and those which import this commodity has led to the disadvantaged position of developing nations. Inadequate resources and limited funds for investment put developing countries in a seriously dependent position which is progressively worsening. They have little chance to compete on an equal basis.

Cross-country differences in research capacity and productivity are great, especially between developed and developing countries. Many developing countries are therefore trying to create a dynamic to permit them to cross over this divide - if and when they see the possibility to do so. Research and development policy thus reflects this aspiration. In spite of the obstacles, strategies are aimed at new-to-the-world knowledge and technologies. The stock of domestic knowledge and sound human resources provide certain opportunities to gain a competitive edge. In the present international situation, R & D efforts by developing countries, notwithstanding the numerous difficulties, must be seen as relevant for them. Their utility can help stimulate greater economic growth, export orientation and competitiveness.

In certain developing countries, there are also examples of opportunities to jump-start or leapfrog in order to progress. Research utility is not limited to local users. One can ambitiously aim for a wider or even a global market. The development of information and software computer technologies in Bangalore, which has transformed India from an importing to an exporting country, clearly illustrates this possibility. Thus, frontier technologies can be relevant to even poor developing countries.

Appropriate strategic research can hopefully lessen the consequences of dependence and monopoly. Wider research attempts, especially in developing countries with lower production costs, can help to reduce the cost of necessary products. For example, the development of Hepatitis B vaccines in many locations has resulted in more than 300 products on the world market and has led to the reduction of prices.

Nanotechnology is another frontier area with potential utility to help developing countries through improved drug delivery devices, textile modification, energy storage, water purification, sustainable environments and enhanced agricultural productivity. It should be considered relevant for developing countries to invest and pursue these research avenues, if they have the capacity. Besides, the jump-start approach can make them more competitive. While the United States, Germany and Japan are taking the lead in the number of patents for nano-scale science and engineering, it is not surprising to see China, India and the Republic of Korea establishing national activities in nanotechnology with strong government support. Similar attempts, although less obvious, are also occurring in many other countries such as Argentina, Brazil, Chile, Malaysia, Mexico, Philippines, South Africa and Thailand.

## 4. Research as an educational and empowerment tool

The benefit of research may derive from the process itself rather than from the utility of its results. It is indeed relevant for developing countries to invest in research with this objective in view.

In developing countries, education is one of the most crucial elements for the development of human resources. Research can serve as a tool to cultivate scientific and critical thinking in the next generation as well as amongst the general public. Research, simply as a process, can be applied in education at all levels, and particularly in higher education. With the increasingly crucial role of knowledge, university graduates are required to gain knowledge and skills acquired through the research process. Employment in technology-intensive jobs will demand the ability to access knowledge and technology and the critical appraisal to apply this new technology as well as to prepare its future advancement. Some graduates may serve as knowledge workers who focus mainly on amalgamating knowledge and technology for their application. Knowledge and skills for exploring the frontiers of knowledge will also be needed. Graduates with broad and interdisciplinary experience acquired through broad-based research may prove to be well prepared for the global marketplace.

On a very different level, research projects undertaken by villagers in their communities have been observed to empower them, so that they are cognizant of their own problems and of ways to solve them. In the process, they are more self-dependent and emancipated.

## Conclusion

Relevance and utility issues for research in developing countries clearly vary according to the situation in the country, both regarding its state of socio-economic development in general and the functioning of its research activity in particular. Some research undertaken in these countries can be tackling pressing needs, while other research may not be doing so. Thus, the quality of relevance varies as well. Research considered to fall within the scope of essential national

research should be determined by the country itself. Although most countries depend on the global knowledge pool, research to better understand their own situation and problems as well as for better local applications of imported knowledge and technologies is also needed. Some problems with no available solution may require local research since this may prove to be the most appropriate. Policy, system and operational research depend on whether evidence is properly used in the research process itself. Poverty still prevails in most developing countries and solutions cannot be simply transplanted from other contexts. Some countries with larger research capacity may opt to study the so-called "orphan problems" which are neglected by the global efforts, perhaps using international input to do this. In order to be competitive in the global scene and to narrow the knowledge divide, some countries may try to frog-leap and tackle new frontiers. At the same time, the research process should be recognized as a vital educational tool in the efforts to strengthen human resource development and as an empowerment tool for local communities. Thus, the relevance and utility of research in developing countries must be viewed both from the positive side which demonstrates its contributions to human development, and from the negative side, which shows the dire consequences when this aspect is lacking.

**Yutronic Jorge**

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## *"University based applied R&D: promising results and new challenges. A regional perspective"*


### Abstract

This presentation is based mainly in the recent Chilean experience on joint R&D projects between universities and companies. After more than 10 years of sustained investment, very interesting results arose: new products and processes related to main economic and social sectors, technology based businesses, increasing amount of patents, momentum of cultural change at academia.

This analysis is complemented with some considerations of other Latin American experiences in the subject, concluding with a proposal for a regional framework for applied R&D


### 1. Introduction

The world is under transformation. Almost all human activity is facing new ways of doing Things. Globalization, knowledge creation and diffusion and more educated people are the main driving forces that are shaping new societies, very likely a global society.

Among all those activities, research and development based on universities in developing countries face a relevant challenge: how to participate in the wealth creation process that those societies urgently need.

The main universities in Latin countries usually have some amount of R&D activity that is strongly linked to objectives and patterns coming from the main universities and other entities in

developed countries (mainly European Union and USA). But, rarely those R&D work is connected to the local needs for wealth creation (although it is common that researchers say they do that).

Nevertheless, in the last decade interesting seeds of change have arose. Now, it is easier to find some of those experiences in Chile, Argentina, Brasil, Mexico and other American countries.

This paper provides evidence of this emerging process. The case of Chile is presented to deepen the analysis.

## 2. Global perspective

Developed countries that are entering the knowledge-based society around the world have similar characteristics and national/regional strategies. One, they heavily invest in education at all levels in order to build the human capital necessary to develop an educated and skilled population that is needed to create, share and use knowledge. Two, they create an appropriate set of economic incentives and institutional regimes to create an enabling environment, including a regulatory and economic environment that enables the free flow of knowledge, supports investment in information and communications infrastructure and alfabetization, and encourages entrepreneurship central to a knowledge economy. And three, they create a strong and effective national innovation system, promoting research and development to bring innovations to market, thus rationalizing government funding for R&D, improving support for innovation and networking, and encouraging greater cooperation and interaction of the various stakeholders: industry, university, government and private research organizations, as well as foreign entities.

In this perspective, developing countries need to accelerate the creation of policy frameworks, economic incentives, human capital, infrastructure and innovation capabilities that will make possible for them to participate regionally and globally and thus create sustainable economic growth that benefits all sectors of their society.

In the pursuit of a more prosperous, secure and sustainable world, developing countries are seeking to enhance their human, institutional and infrastructure capacity. International organizations like UNESCO, World Bank (WB) and InterAmerican Developing Bank (IDB) are mounting major efforts at technical capacity building in developing countries. Their aim is to develop a solid base of technologically prepared people that can compete internationally and will effectively improve their economies and quality of life. Such a base will facilitate the infusion of foreign capital through attraction of multinational companies to invest in the developing country, assist in making the most of foreign aid funds, and provide a basis for business development by local entrepreneurs.

### 3. The case of Chile: general framework

Chile is a country under a relevant transformation process. In less then 15 years, it has rebuilt the nation democratic system and more than doubled both its GDP and the number of students in universities. Huge efforts and investments have been deployed to reach those results. The country is in the transition process to be a developed country in a new context, the global economy. Creating wealth is the main challenge now, not only for government but also for industry, institutions and people as well. Improve the quality and productivity of work, improve education to prepare people to be able to create value, fight against poverty and foster social mobility and protection, are some aims of this challenge.

Chilean economy is mainly based in natural resources (mining, agribusiness, forestry, fishing, aquaculture) and services (telecommunications, energy, financial resources, transportation). In the last decade, the main Chilean companies have multiplied for more than three times their exportations to more than 160 countries, amounting about 30% of GDP, competing with world class operators. Those kinds of activities are a good opportunity for R&D and innovation in order to increase its competitiveness in the global economy. This is possible not only because the well known international specialization of Chile in quality natural resources processing, but also for the local conditions that are appropriate for that purpose.

Companies that compete in international markets require better technologies continuously. More and more, Chilean bigger companies are demanding improvements in technologies (equipment, processes, and services) from other companies, usually smaller and technology based ones.

These technology based companies, more oriented to innovation, are the seeds in the market for the transition to a knowledge economy. These enterprises work as components of clusters linked to leader companies in each economic sector, developing competitive value chains. That entrepreneurship constitutes interesting partners for foreign companies looking for market and investment opportunities. Investment is one of the main drivers in the capacity building process.

Chilean universities and technological institutes have been the base for research and development in the country. Chile invests 0,7% GDP in R+D, about 65% of that financed with public resources and mainly executed in these institutions. About 30% of total is financed by industry and other is 5% is financed by international institutions. Hence, the challenge in the Chilean knowledge creation process is to increase the investment in R&D and innovation, particularly by the private sector.

The Chilean government, conscientiously, created some mechanisms to increase the R&D investments and to foster the links between universities and companies and to attract investment from industry. First, in the nineties, was FONDEF (Chilean fund for fostering science and technology development) and other instruments in CORFO (now ChileINNOVA), all of them

supported by IDB. Then, at the beginning of this century, was the establishment of the Bicentennial Science and Technology Program for the Knowledge Society (supported by WB). And recently, one year ago, started to operate the new Fund for Innovation and Competitiveness (financed by a new tax: royalty to mining).

These mechanisms also promote the participation of institutions and companies from other countries, creating an effective opportunity for international cooperation and developing alliances to participate in competitive markets. One of the mechanisms established in these programs are the competition for technology based consortia formation among companies and universities and technological institutions, from Chile and abroad.

The main science and technology fields in which Chile is investing (both public and private) are information and communication technologies (ICT) and biotechnology (BT). ICT has been playing a relevant role in government modernization (e-government), education (ICT tools), company management systems, automation and networking. BT has been playing a relevant role in the natural resources processing in several fields in the Chilean economy: forestry, food production, agribusiness, etc. Both ICT and BT provide a realm of opportunities for advancement of country economic competitiveness and people quality of life. From that perspective, ICT and BT are the right base for value creation in a country that transits to the knowledge society.

Those seeds will grow in a new scheme under development, based on: policy framework and economic incentives to knowledge creation and transfer; human capital development mainly through education; strengthening and evolution of the Chilean innovation system; development of the information and communication infrastructure.

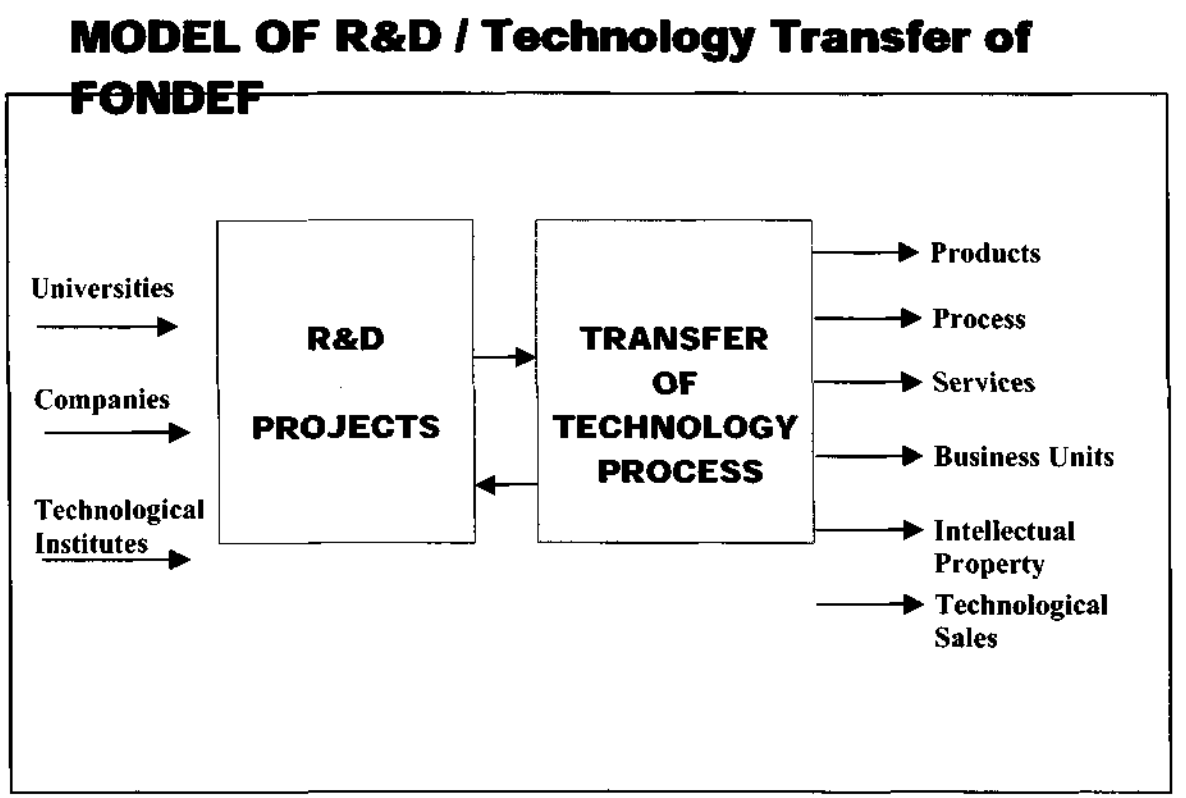
## 5. The case of Chile: FONDEF R&D experiences and results

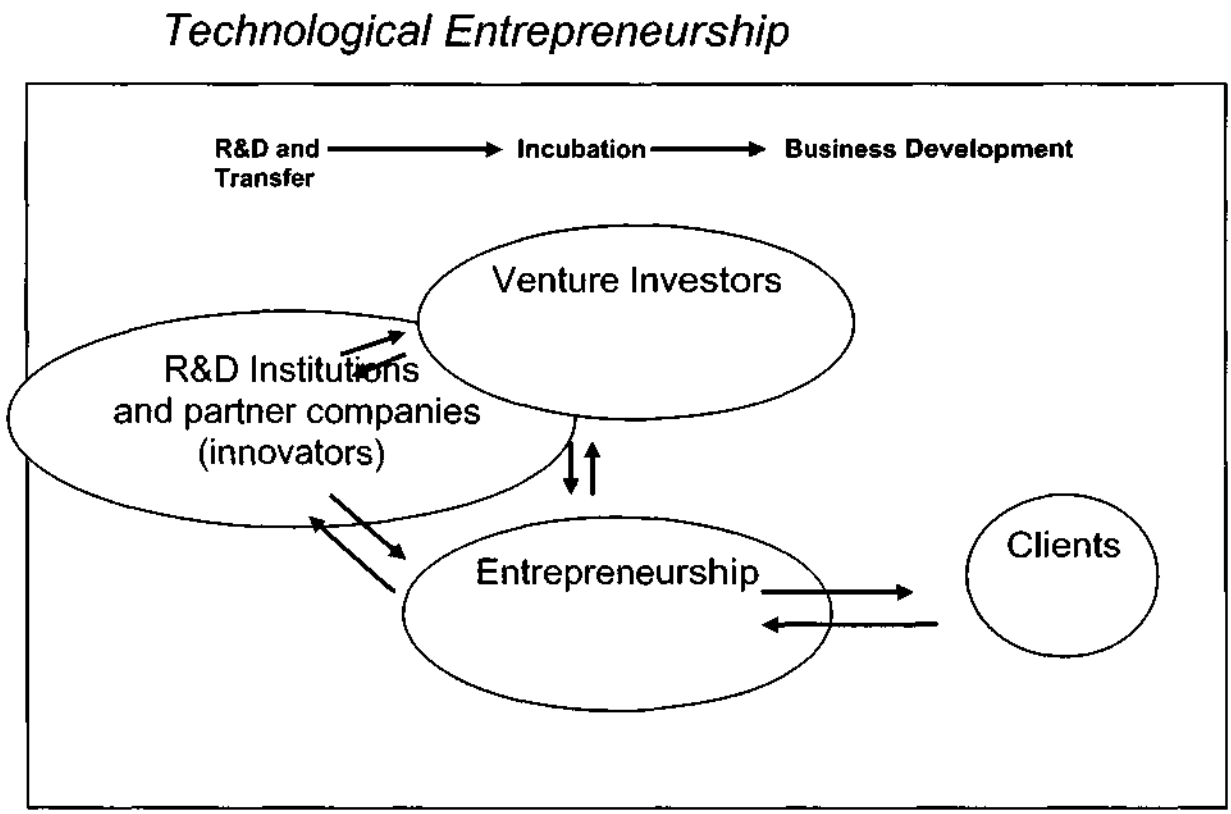
To illustrate the transformation that is occurring in university based R&D, it is shown the experience of FONDEF. This governmental instrument invests in R&D projects among universities, companies and technological institutes. It assigns resources on a competitive base in several fields: agribusiness, mining, forestry, fishery, aquaculture, industry, information and communication technologies, building, water and energy, health and education.

To participate in the contests, institutions and companies need to constitute competitive teams, usually with the participation of universities and companies from other countries that are specialized on the subject. FONDEF finance less than 60% of total project budget and companies are required to invest at least 25% of that. The projects need to be pre-competitive in order cooperation is feasible.

The main features of FONDEF process are: the combination of international technology transfer and local adaptation / improvement as the base to identify technology innovation and R&D opportunities; understanding of country challenges that demand science and technology contributions; building long lasting relationships among companies, universities and technological institutes; a specific environment: linkages among relevant actors; a specific task oriented to foster science and technology in order to increase the competitiveness of the economy and improve the quality of life of people; fund design to achieve linkages and impact; grants to institutions that can share de property of R&D results with researchers and others; promoting competition and open participation; focus in management efficiency and transparency; project evaluation and selection based on: science and technology peer review evaluation and socio-economic evaluation; contracts with institutions in the linkage chain (then, contracts between university, companies and other institutions, from Chile and abroad); combination of quality, relevance and pertinence; promoting leverage and co-financing; promoting good teams, best practices in R&D, particularly in project management and project follow-up and control ; implanting appropriate metrics for results and outcome

The general model of the instrument is presented in the following figures.






After less than ten years of continuous improvement of the instrument and its application to a growing base of universities and institutions (more than 40 by 2005) and companies (more than 500 by 2005), relevant results started to arose:

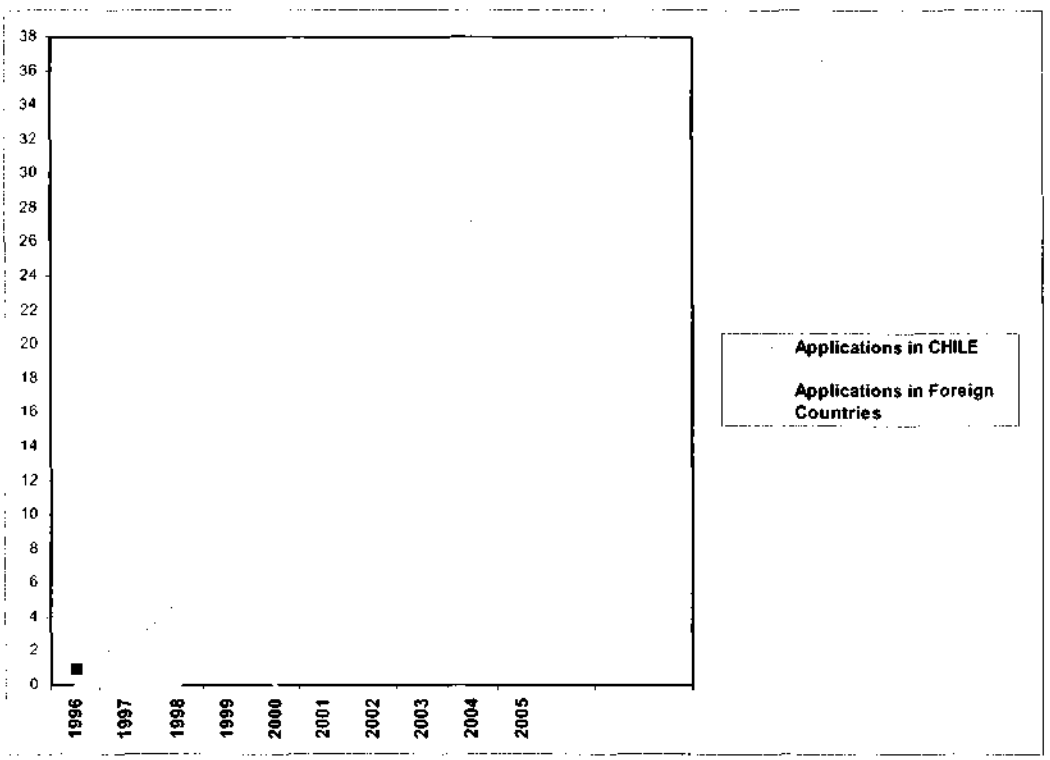
- Science and technology impact
  - Cultural change: almost 50% of the Chilean researchers have experienced this kind of R&D activity, building new ways for doing applied research and finding new goals for their projects, and trespassing these experiences to new researchers and students.
  - Building of new science and technology world class capacities, attracting and forming people and developing infrastructure.
  - Building trust and knowledge in companies to work with universities in R&D projects with mid and log term objectives
  - Increasing the science and technology assets.
- Socio - Economic impact
  - Value creation process: by 2003 more than 273 new products and processes were developed from 159 projects (about 150 million dollars of R&D busget) with a projected value of 5,1 times the amount invested; almost 60% of those results are new in the international market, the 40% other are improvements; 56 spin off business units and new enterprises were created. These results are improving yearly. For instance, the patenting rates are improving a lot, as

shown in the following figure (for the first time, the Chilean universities are patenting in USA, Europe and other countries as a regular protection of their intellectual property rights).

- "Virtuous" process development among universities, companies, technologies and other institutions and attraction of investments to the resulting transfer of technology to market and society.
- Capabilities to afford relevant country problems and opportunities: increasing the efficiency of mining and industrial processes; value added: improvement and new products and processes; development of "clean technologies"; development of "integrated production technologies"; development of new regulations for industrial production; introduction of new vegetable and animal species; genetic improvement of plants; decontamination of industrial processes; new treatments for animal and plant diseases; biological control for agricultural production; development of "organic" production in agriculture; mechanization and automation of industrial and mining processes; development of agriculture in desertic and semi-desertic zones; development of computer based networks for different applications; valuation and sustainable management of native forest; information technology solutions applied to natural resources industries; development of pedagogical instruments; new educational methodologies and instruments for science, technology, language and mathematics; preventive and clinical treatments for human health; new organization and management technologies for human health services; new mechanisms for school evaluation, certification and management; methods for teaching in specific fields: non violence education, environmental protection and others; new water resources processing and management; detection and evaluation of basic natural resources: water, minerals and energy sources; improving energy efficiency in process and products; new technologies for wood and timber industry; new technologies and designs for antiseismic devices; new catastrophe and emergence management systems; exploration and evaluation of new energy sources; active principles and new molecules for pharmaceutical industry.
- New technologies and innovations that are transforming a complete economy sector (for instance, aquaculture).

- Institutional impact: contribution to the renovation of university mission and strengthening the institutional capabilities; international cooperation and participation; increasing the employability of scientists and technologists in productive sectors.

# Patenting of R&D results




As a consequence of this evolution, new programmes have been created to deepen the R&D and innovation activities. In all of them, universities are playing a relevant role:

- Fostering intellectual property (IPR), particularly patents
- Birth of thematic programmes: Genome Chile applied to vegetables and mining; information and communication technologies applied to education; red tide; word class aquaculture; science, technology and innovation information systems; ICT international center in high performance computing; R&D in health public policies.
- Technology based consortia among universities companies, from Chile and abroad, in several fields: biotechnology applied to forestry, fruitculture and agribusiness; drugs development for catastrophic deceases; unmanned airplanes.

## 6. Challenges to universities.

The Chilean case shows that is possible to have university based R&D activity simultaneously related to wealth creation (and linked to industry) and complying with quality standards according to international mainstream science and technology trends.

For instance, in biotechnology applied to mining (genomics applied to bioleaching bacteria to process copper mineral ores) is at the same time a R&D with relevant economic impact (it is expected to decrease the production cost to one half and increase by four the amount of exploitable mineral resources) and a science and a technology breakthrough.

As a consequence of the evolution explained, universities in Chile are facing a huge challenge at the crossroad.

For one side, R&D activity is growing and there are more opportunities for better contributions to wealth creation. But their researchers are few and it is required to increase the amount of them. Time to form them is not always available, then the attraction from other countries need to be considered. More world class researchers in universities will lead to major renovation of research universities and also to transform some of the others. In every case, academic staff needs to be renewed.

For the other side, big Chilean companies that are competing in international markets are looking for university partnerships not only in Chile but also in developed countries. Some of those relations are already in place and results are becoming in the next years Chilean universities need to strengthen the fields they want to be leaders and compete with universities from abroad (forming world class R&D teams with enough critical mass). In the other fields, they need to cooperate with universities and technological institutes from other countries to form research associations and networks.

That will lead to open innovation system, more extensive than the national ones. In this model, universities and companies and technological institutes from different countries cooperate and define the specific participation of every player.

This is the challenge for the universities in Chile and also in developing countries, like American ones.

The lasts decades have seen universities playing a more relevant role in Latin America. Both private and public universities have being paving the way for the gradual expansion of cultural elites and established the foundations for national research and development and innovation systems.

Furthermore, these universities have facilitated social mobility, served as political socialization channels and, in general, fostered the development of national cultures and common markets.

University research is not a frequent practice in Latin America. According to the criteria of the Carnegie Foundation for the Advancement of Teaching, in 2003 Brazil, which is the country more populated in the region, had only 16 "extensive research universities". Other countries like Argentina, Mexico, Colombia, Chile and others have fewer research universities that that figure.

Local governments finance most of the research carried on Latin American Universities, producing results mostly on basic research. Although these results are solid, they do not lead automatically to wealth creation, unless they become part of a larger ecosystem of knowledge creation involving the productive sector.

For that reason, the situation presented in the Chilean experience is so interesting. Of course, is not unique in the region. Every major country has its successful experience. For instance, some Brazilian universities from Rio de Janeiro are working with the Brazilian petroleum company, in developing high-level applied research. In the State of São Paulo, well-established lines of research and development are already the results of interaction of the universities and the local industries. Other well known example is Monterrey in Mexico where research and technological development are pivotal activities. Through its research centers and national and international network of researchers in disciplines that have been defined as a priority, Monterrey Tech generates knowledge by means of patents, innovations, technological development, and social development in the different areas of the economy.

These are a few examples and not the rule in Latin America. But the new seeds of change are starting to grow. Clearly, different countries will have different experiences and results. But, capabilities will be higher and the possibility to succeed in more ambitious projects will also increase. Hence, the interconnection of those capabilities will create a new way of doing R&D in America.

Universities need to assume the challenge in a more aggressive way and the same is for technology-based companies both from local countries and abroad. The opportunity is now.

## Zakri A.H.

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### *"Research Universities in the 21st Century: Global Challenges and Local Implications"*

Excellencies, Ladies and Gentlemen

I take note that "the central premise of this august conference is that research is a key ingredient in the institutional identity of universities and an indispensable prerequisite for a successful program of teaching and public service. Universities that are weak in research risk the intellectual erosion of their programs of study, lose their critical ability to assess claims to knowledge, and become dependent on the outside supply of knowledge."

I am also aware that the main bulk of this meeting will be addressing issues that relate to research capacity, research productivity, and research utility, three elements which are crucial and important in the generation and exchange of knowledge by universities.

In this context, my task this morning is to draw your attention on the prospects and problems that universities may want to avail themselves to, or that they are compelled to take on. These are the global challenges facing humanity today and in the future and which entail research efforts for their conceptualization and for testing and operationalizing possible solutions to such challenges.

One of the key features of our society today is the recognition of *knowledge* as a key factor in human development. This is why we often hear phrases like 'knowledge-based society' and 'knowledge-based economy'.

I am drawn to the data presented by Carlos Tunnermann and Marilena de Souza in a paper presented to the UNESCO Forum Regional Scientific Committee for Latin America and the Caribbean where they estimate that every four years the amount of information available in the

world doubles but we are only able to give attention to between 5 and 10% of that information. According to James Appleberry [7],
discipline based knowledge is doubling once every five years and it is projected that by 2020 knowledge will double every 73 days!

What do these figures mean for us today? Information and knowledge are the driving forces in changing societies. However, having information does not mean much. Unless information is turned to knowledge we will be struggling with loads of information but no knowledge.

Global leaders understood these issues and articulated some of these through global declarations, including the World Declaration on Higher Education (Paris, 1998). It calls for education systems to enhance their capacities to live with uncertainties and wanted the systems to change and bring change.

There cannot be a more emphatic statement on this need for change than the words of Prof. Federico Mayo who professed that (academic) communities "must have the courage to tell young people that privilege and certainty are now no longer a part of life; it is in uncertainty that hope is found".

Reflections of these can be seen in the Millennium Declaration and the associate goals, the Millennium Development Goals (MDGs) through a well articulated campaign launched by world leaders in 2000. This is an ambitious vision of development: a vision that has human development at its core to sustain social and economic progress. Eight goals, eighteen targets, and forty-eight indicators have been accepted as a framework for measuring development progress. They aim to cut extreme poverty by half, ensure every child has the chance to go to school and live a long and healthy life, and bring discrimination against women to an end. The risks of dying as a result of childbirth are to be dramatically reduced, deadly diseases brought under control, the environment better managed, and the benefits of progress more equally shared by all the nations of the world. Together, the aspirations of the MDGs and their associated targets and indicators represent a powerful framework for action. The goals are to be achieved not later than 2015.

In January 2005, the UN Secretary-General launched the UN Millennium Project's report entitled "Investing in Development: A Practical Plan to Achieve the Millennium Development

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[7] This is cited in: Carlos Tünnermann Bernheim and Marilena de Souza Chaui (2003), *Challenges of the university in the knowledge society, five years after the World Conference on Higher Education*, UNESCO Forum Occasional Paper Series, Paper No. 4, Paris.

Goals." [8] The report is an ambitious effort to outline practical measures for implementing the MDGs. It represents the most comprehensive effort to address poverty and economic growth in the developing world ever mounted by the international community.

The report focuses on the unprecedented opportunity to improve the lives of billions of people around the world by adopting practical approaches to meeting the MDGs. It identifies practical strategies to eradicate poverty by scaling up investments in infrastructure and human capital while promoting gender equality and environmental sustainability. It is a landmark report that will redefine development thought and practice for a long time to come. It emphasizes that the MDGs are within reach, even for the poorest of countries. But to do so will demand aggressive local, national, regional and international strategies.

International organizations, governments, and private sector groups have all coordinated their development work around the MDGs. The resulting increased cooperation is expected to produce significant development gains. In this context, research universities constitute a natural fourth pillar of such MDGs 'alliance'.

All nations, whether industrialized or developing, face a broad array of challenges that will require the application of up-to-date scientific knowledge and technology. Such challenges include stimulating economic growth, mitigating environmental problems, safely adopting new technologies, and quickly responding to sudden outbreaks of new diseases. No nation can now afford to be without access to a credible, independent science and technology research capacity that would help it to develop informed policies and take effective actions in these and other areas.[9]

The conveners of this forum appropriately note that in the globalized society of the 21st century, equitable access to knowledge is an acknowledged factor for sustainable development, and thus for eradication of poverty for nations of the developing world. The challenge then is to assess how universities could contribute through their research the fulfillment of the MDGs. Put it in another way, how could knowledge be mobilized to achieve the MDGs.

In addition to access to knowledge and its applications, in the current context of globalization, the very issue of knowledge generation is at stake. In many countries around the world, economic sectors are being developed by practical needs and little by research. In the long run, generation of new knowledge through research in basic sciences and frontier technologies such

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[8] UN Millennium Project (2005) Investing in Development: A Practical Plan to Achieve the Millennium Development Goals.

[9] InterAcademy Council (2004). Inventing a Better Future: A Strategy for Building Worldwide Capacities in Science and Technology, Amsterdam

as biotechnology are required on a continuous basis if one is to ensure sustainable development. This is precisely the task of universities, that is to say, to continue putting research at the heart of their efforts and to ensure that new knowledge is generated so as to ensure long-term sustainability.

As spelled out in the programme of this conference, generating and applying knowledge requires research capacity, research utility, and research productivity.

## Research capacity

This would constitute a challenge for universities in the years to come, while the nature of the challenge may differ among developed and less developed countries, strengthening universities research capacity would be a continuous necessity. Research capacity would include not only research facilities, but also availability of trained human resources capable of doing research.

Stark differences exist in the national spending on R&D. Wealthy industrialized nations spend up to 3.8 percent of their gross domestic product on research and development. While India allocates 1.2 percent; Brazil, 0.91 percent; China, 0.69 percent, most developing nations devote less than 0.5 percent of GDP to research and development, whereas a minimum of 1% has been suggested in order to support MDGs.[10] Similarly, in high-income nations, the number of scientists and engineers averages 3,281 per million population. In middle-income nations, there is an average of 788 scientists and engineers per million. But in most developing nations, the number is too small to be reliably calculated.

These types of deficits, in the case of rapidly emerging fields such as biotechnology, can leave entire developing economies behind creating sets of 'technological apartheid'. And when nations need to respond to diseases such as HIV or SARS, or make decisions about issues such as stem-cell research or genetically modified foods, this lack of S&T capacity can breed unfounded fear and social discord, and lead to inappropriate regulatory response where warranted.

A recent UNU-IAS assessment of ongoing efforts to build capacity for biosafety and biotechnology demonstrated, in a vast number of developing countries, and even subsequent to significant efforts on the part of the international donor community to build capacity, they remain without the basic infrastructure and human resources capacity to address biosafety concerns, or to undertake research and development in biotechnology. Such capacity deficit are apparent across many technological areas, and are particularly, though not only, apparent when it comes to emerging technologies.

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[10] United Nations (2005), *Science and Technology Promotion, Advice and Application for the Achievement of the Millennium Development Goals*, Commission on Science and Technology for Development, Eighth session, Geneva, 23–27 May.

All nations, particularly developing ones, require an increased level of S&T capacity and discipline-based knowledge to enhance their ability to adopt new technologies – as in those related to the new life sciences – and adapt them to local needs. Enhancing S&T capacity in developing countries is truly a necessity and not a luxury. But this should be based on current needs and future necessities.

Capacity development is a huge task that requires more joined up thinking and greater cooperation and harmonization of aid efforts among donor countries.[11] Both developed and developing countries should join forces in future efforts and new initiatives to invest in research capacity building. In this regard, Ladies and Gentlemen, I would like your indulgence to focus on not just building and developing capacities but also retaining capacities.

## Research utility

Research utility calls for research to be **relevant**, namely to the development agenda. Despite the fact that the notion of sustainable development has been mainstreamed successfully already by a large number of governments and international key players such as the global funding institutions (the World Bank, the Global Environment Facility, the World Food Programme, the United Nations International Children's Fund, etc.), much remains in order to **operationalize** this notion. In fact, universities are crucial in designing and implementing the research that is needed to fill the gap between conceptual aspects of sustainable development and the needs of the end user. Development needs are spread over a large domain of knowledge and disciplines, which in turn would offer a large landscape for research. For the research to be useful, universities need to remain focused, and careful in choosing their research agenda. On the other hand, most of today's problems, as exemplified by the MDGs, are multisectoral in nature and therefore necessitate a multidisciplinary approach. On top of this, a challenge for research universities is to develop approaches on how to bring policy needs into the sustainable development research equation.

According to the Netherlands Development Assistance Research Council, there is a gap between the production and the use of knowledge in policy and practice. There are gaps in linking research with development priorities. Universities in developing countries are not fully geared toward solving development related problems.[10] There are weak linkages between knowledge producers and knowledge users, and between knowledge production and innovation.[11] There are many measures that could help bridge this gap such as creating intermediate institutions or incentive mechanisms, but perhaps the most important measure would be for universities to improve the quality of their education system such that the learning offered to the students

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[11] Netherlands Development Research Council (RAWOO) (2005), Mobilizing Knowledge to achieve the Millennium Development Goals, The Hague.

empowers them and make them more competitive in the society. Many university graduates, particularly those from developing countries, have little entrepreneurship capacity, and little ability to compete in job market. Improving the quality of education is important if the research at universities is to be directed towards solving development related problems.

For a large part of the developing world, eradicating poverty is of the highest priority, but it can't be delinked from the natural environment in which human beings live. In other words you cannot address the MDGs without also thinking about environmental implications and conditionality. Simply put, environmental issues cannot just be tucked away in a neat corner as well-organized, separable closet as the MDGs have done. Environment underpins all the MDGs. It must be mainstreamed into any policies that will ever have a chance of eradicating extreme poverty or disease.

The Millennium Ecosystem Assessment has now demonstrated that the link can be made. It has been shown at the global level which of the crucial services such as fresh water, storm control, protection from disease, recreation and spiritualism that human rely on everyday are in decline. Just like economic assessments are done to determine the state of the economy, this kind of ecosystem analysis must be done at the national level within countries to understand which ecosystem services are declining the fastest and then integrate this into the financial well-being so countries can truly understand their overall state of human wellbeing. Not just their narrow financial well-being. Only then can the most effective policy (e.g. Poverty Reduction Strategies) be properly chosen to reduce poverty and address the situation that poorest nations live in.

Cultivating the know-how to conduct assessments based on the MA approach is important and research universities could play a major role in this including leading assessments and creating knowledge base for better understanding.

To help research and human capacity development targeted at local problems, the UNU-IAS along with the International Foundation for Science (IFS) in Sweden undertook a joint initiative in Sub Sahara Africa. Fellowships were offered to those African scholars who were able to identify a local problem related to poverty alleviation, and through one year policy research in their home country, and under technical supervision of researchers from UNU-IAS and Japanese universities, identify a solution to that problem. The research was mainly focused in the field of agriculture.

Such initiatives demonstrate that it is possible to channel research and resources towards solving local problems and also bring in knowledge from other parts of the world and tailor it to the needs of people living in poverty.

## Research productivity

Improving research productivity is the third major challenge for universities for the future. It refers to the ability of universities in providing a better and competitive service to the society through their research. Shortages in research funds, facilities and trained human resources would all mean that universities should become more competitive by continuously improving their research productivity. This is particularly of relevance to situations where scare resources are spread thin among many universities. Improving the competence of universities in carrying out research relevant to local problems would gradually lead to better optimization of national resources allocated to science and technology. There are many strategies for arriving at this and the experiences of other countries could be a point of reference for others to use.

## The way forward

Excellencies, Ladies and Gentlemen

The issues that I raised above are familiar to those of us who have developed our career as a university researcher and have served in developing countries, and solving them are a deep desire and aspiration for all of us. But the reality is we can solve them only if we create appropriate, effective and sustainable institutions that lead the way for the creation of a competitive university system.

I would like to mention some of the key areas that we have to focus on if we are to make research meaningful in universities and eventually turn universities as a key contributor to achieving the MDGs. These key areas have been identified through experience and through many previous case studies carried out by various organizations both within and outside the United Nations System.

***1) Improve universities competence and effectiveness through networking***

Collaboration should be promoted among knowledge institutions, the government, civil society and the private sector to promote the knowledge and MDG agenda. A recent example of a strategic knowledge alliance aimed at moving forward the MDG-agenda is the Millennium Ecosystem Assessment (MA). It was carried out between 2001 and 2005 to assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being. The assessment involved 1,360 experts from 95 countries.

The MA, recognized as the most comprehensive scientific review of the health of the world's ecosystems ever undertaken, confirms that our planet's capacity to sustain human society is eroding. The Assessment shows the urgent threats from globally declining fisheries, degraded soils, water shortages, widespread biodiversity loss and climate change. It concluded that the

current state of affairs is likely to be a roadblock to the MDGs. "Any progress achieved in addressing the goals of poverty and hunger eradication, improved health, and environmental protection is unlikely to be sustained if most of the ecosystem services on which humanity relies continue to be degraded," the report states.

***2) Make foreign aid more effective by strengthening developing countries' own capacity for MDG-related knowledge production.***

Many donor countries are concerned by the ineffective use of development aid they provide to recipient countries. It is an important matter that aid money is channeled in such a way that it assists developing countries harness knowledge and strengthens science, technology and research capacities for achieving the MDGs.[11] To this end, strengthening and supporting universities in developing countries is critical. It is primarily for the donor countries to take effective action in this regard, but it is also important that the recipient developing countries be consulted as to how the aid money should be spent.

***3) Make policies and practices more relevant to existing knowledge.***

It is important to avoid reinventing the wheel or have the so called trial and error approach in public policy making. To use the existing knowledge and experience in policy making, universities could play a central role. They can make a significant contribution in channeling lessons learned elsewhere to policy makers. Through their advocacy role, they can make MDGs the central focus of public policy making.

***4) Tap into the global knowledge pool through greater involvement in knowledge networks.***

Devising and shaping knowledge networks that focus on problems related to underdevelopment and MDGs would be a cost effective collective method to make universities more competent in providing technologies needed in underdeveloped parts of the world and for meeting the MDGs.

A promising initiative is the one recently drafted by the High-Level African Panel on Modern Biotechnology of the African Union [12] to develop a common position on biotechnology. It addresses the role of modern biotechnology in the transformation of African economies. It examines how a wide range of opportunities presented by biotechnology can be tapped by African countries. It focuses on how best to build the capacity needed to harness and apply the technology to improve agricultural productivity, public health, increase industrial development and economic competitiveness and promote environmental sustainability in Africa. It also takes into account the importance of promoting the conservation and sustainable utilization of Africa's biodiversity.

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[12] African Union(AU)/New Partnership for Africa's Development(NEPAD)(2006), Freedom to Innovate Biotechnology in Africa's Development

As advocated at the Johannesburg World Summit for Sustainable Development in 2002, partnerships involving different levels and sectors of society or "type-II" partnerships should be encouraged. Networks are important modalities that lead to the establishment of partnership. These partnerships are helpful in reaching a balance between research and development.

**What the universities in developing countries should do?**
Bringing universities on the central stage of the fight against underdevelopment is an awesome task. Universities need to avail themselves for the task by enabling themselves to deliver what is most expected from them, and that is creativity, innovation, relevance and excellence. This cannot be made unless the same values are recognized and rewarded within universities. It is essential that universities develop strong internal rewarding system that is based on excellence.

By focusing on the practical needs of society, universities can make themselves an indispensable tool for socio-economic development. Without a proactive involvement of universities, achieving the MDGs would be a difficult task. Therefore it is essential that governments recognize the important role of universities in contributing to the success of achieving the MDGs and support them in this endeavor.

However it should also be remembered that the goals of MDGs are interdisciplinary in nature, whereas universities are traditionally structured around scientific disciplines, therefore it is important that due attention be paid to strengthening interdisciplinary research in universities.

## Conclusion

Excellencies, ladies and gentlemen

The Millennium Declaration, adopted in 2000, sets out a bold vision for "larger freedom" in the foreseeable future. That vision holds out the promise of a new pattern of global integration built on the foundations of a greater equity, social justice, and respect for human rights. It is the responsibility of today's universities to make every effort to contribute the maximum to the successful creation of this new pattern of global integration. Today's universities do not have the option to walk away from the challenges that I have just outlined above. To paraphrase the message expressed by the conveners of this conference, "universities that are deprived from, or deprive themselves of taking on those challenges, run the risk of making themselves irrelevant to the aspirations and survival of the human race in the 21$^{st}$ century".

**30 NOVEMBER 2006**

## ABSTRACTS OF PRESENTATIONS IN PARALLEL SESSIONS

### Affa'a Félix-Marie

### *« De la production à l'utilisation des connaissances : Une analyse des recherches dédiées aux paysans au Cameroun »*

De nombreuses évaluations et analyses (UNESCO, 1985; Sanyal *et al.*, 1999; Éla, 1971, 1994, 1998; Santerre et Mercier-Tremblay, 1982; Affa'a et Des Lierres, 2002) démontrent que les diverses tentatives de réforme de l'enseignement et de la recherche camerounais qui ont eu cours depuis la fin des années 1960 n'ont pas réussi à intégrer et à adapter à la société les systèmes scolaire, universitaire et de recherche. Les programmes de formation et de recherche universitaires en particulier demeurent inadaptés, inadéquats, extravertis. Y intégrer des connaissances produites localement et, encore plus, les savoirs et les savoir-faire traditionnels, demeure peu concevable. En cette ère de l'avènement de l'économie et de la société de savoir, sur quels facteurs pourrait-on s'appuyer pour mettre les résultats de la recherche au service de la réduction de la pauvreté et de la marginalisation des paysans?

Pour répondre à cette question, nous avons analysé des documents des recherches dédiées aux paysans en complément aux analyses curriculaires publiées il y a quelques années (Affa'a et Des Lierres, 2002). Il s'agit d'un échantillon hétérogène de 1413 études réalisées dans diverses disciplines et publiées entre 1993 et 2005. Ces études ont en commun d'être dédiées aux paysans - agriculteurs, éleveurs ou pêcheurs traditionnels - à leurs pratiques, à leurs conditions d'existence ou à leur milieu de vie. Dans l'analyse de ces documents, nous tentons de suivre la circulation des connaissances de leur production à leur utilisation. En plus des documents de recherche, les données analysées proviennent des textes officiels des institutions, des plans stratégiques de développement de l'enseignement supérieur et de la recherche du Cameroun, du Document de la stratégie nationale de réduction de la pauvreté du Cameroun, des documents des politiques et des attentes des bailleurs de fonds.

Les résultats obtenus démontrent que 1) des connaissances utiles sont créées dans le domaine étudié; 2) des technologies simplifiées sont développées à l'intention des paysans, en général illettrés; 3) mais les connaissances et les technologies produites parviennent difficilement aux utilisateurs potentiels; 4) peu de connaissances et de technologies sont développées pour les utilisateurs intermédiaires et pour l'industrie de production des biens et des services.

L'ensemble suggère trois utilisations possibles des résultats obtenus. Ces utilisations s'appuieraient sur les modèles développés dans l'exploitation des résultats de cette recherche : 1) le développement d'un curriculum de formation à l'utilisation des connaissances en partant des

structures en réseaux des recherches dédiées aux paysans; 2) l'extension de ce type de curriculum à d'autres disciplines en cas de réussite; 3) le développement d'un réseau de systèmes sociaux orientés vers la société et l'économie du savoir. Nous travaillons à présent à la mise en œuvre de ce curriculum d'un type nouveau.

**Aponte-Hernández Eduardo & Molina-Iturrondo Ángeles**

## *"Research and knowledge creation in the Caribbean for endogenous development and building autonomous knowledge societies: the university of Puerto Rico and beyond"*

### 1. Overview of the Issue and its national/regional/international context

- This analytical paper examines the new context for developing research capacity and knowledge creation in the Caribbean region as a new higher education 'network collaboration paradigm' emerges oriented towards endogenous development and for building knowledge societies in the region.
- In the current context of 'dependence and underdevelopment', the feasibility of endogenous development in the Caribbean is analyzed.
- Policy measures for increasing research capacity through network knowledge creation are discussed.
- Recommendations are made to strengthen the undergoing research capacity building and knowledge creation initiatives.

### 2. Current or proposed policy framework

- Knowledge Economy Paradigm: Knowledge creation and learning in emerging knowledge societies is linked to investment in information and communication technologies in a new international division of labor and a knowledge distribution system and higher education networks.
- In developing countries, there is limited access of researchers and students to the developed countries' higher education knowledge production-distribution systems.
- There is a world wide trend toward the commercialization of higher education as a result of neo liberal policies (state fiscal crisis, privatization, trade liberalization-integration agreements, market oriented provision of education; and knowledge production of economic-value) in and outside ( government-industry-university alliances) higher education institutions, (Aponte, 2003).
- Research and knowledge creation plays a central role both in creating the conditions for (1) economic growth (2) attracting global capital investment and fostering local capital accumulation (3) managing and compensating the impact of economic restructuring and globalization, locally.
- There is an underdevelopment of research capacity and technological infrastructure in the developing countries, which is the key to new forms of integration, network interaction and local development strategies.

### 3. Research results in support of this framework

- Since knowledge continues to be produced and distributed unequally, its utility and value plays a determinant role in creating the conditions and dynamics for local economic growth, and for compensating locally the un-equalizing, social effects of the new global economy (Castells, 1998; Aponte, 2001)

- If Caribbean developing countries are to enter the competitive global economy, development policies will have transform and develop higher education institutions to overcome the prevailing conditions such as self-sufficiency of higher education institutions in the Caribbean to meet demands and needs of the region's economy and Caribbean societies, pool resources in a sub-regional basis, allocation of resources for L-R&D in the Caribbean region, threats to Caribbean higher education institutions of transnational education commercial providers, and limited technological transfer (Howe, 2000; Aponte, and Molina Iturrondo, 2002; IESALC/UNESCO, 2006).
- Local ability to respond and conduct their own development and mobilized the economic potential, is an attribute of the endogenous development action approach (Vazquez-Barquero, 2002).
- Learning, knowledge creation and dissemination have become more important than ever, as it allows individuals, institutions and countries to generate rapid changes in knowledge, and how to cope with these changes in the emerging 'knowledge societies' (Jarvis, 2001).

## 4. Recommendations for policy makers

In the Caribbean, the trend is toward the 'developmental innovation university" (Didriksson, 2000; Aponte, 2003) with the aim to:

- Strengthen the level of research and student learning in order to achieve a greater number of researchers and well trained professionals.
- Create books, texts, physical facilities train technicians, teachers and professionals; develop and incorporate learning technologies.
- Create more job opportunities for young professionals and research opportunities for researchers in order to avoid under-employment and "brain-drain'.
- Include local needs in the research agenda of the academy, industry and government; priority should be given to increase the country's competitive capacity.
- Encourage and incentive (resource allocations, tax incentives, financial sources, loans) research on local development needs.
- Promote research into problems of local relevance, while at the same time, internationalize universities in order for local researchers to create, enter and interact with world wide research networks.
- Develop assessment processes and accountability procedures to enhance continuous improvement, relevance, quality, and to increase learning- research funding sources.
- Develop a multi sector financial strategy to increase research capacity and sustain the L-R&D policies programs.
- Provide support to researchers and students who identify, and are committed to R&D, solving social problems and community development.

**Belal Ahmed & Irina Springuel**

## *"Research in Egyptian universities: the role of research in higher education"*

The present paper deals with Higher Education (HE) in Egyptian Universities where together with teaching of students, the research is an essential component in education system.

Until the 1950s, Egyptian Universities were at an international standard in science and research. From the 1960s fundamental changes in the higher education system caused a decline in Egyptian education and research. Among the main reasons are the rise of a large number of new universities; scarce number of qualified staff to teach students especially in remote universities and a decline in qualified teaching staff . The University budget which depends solely on the government is not sufficient to support the vast number of students. An indication of knowledge decline is that not one university in Egypt or in any other Arab country was included in the list of the first 500 worldwide academic universities for the years 2003 to 2005.

- Number of universities in Egypt increased from four state universities in 1950s to 18 government universities at present. Within the universities, in addition to faculties, these are numerous specialised institutions, centres and units which carry out and support research and training. In 1992 a new law on higher education was issued which opened the door to new private universities. At present there are 16 private universities and another two under construction.

- The number of university students in higher education is more than one million that is about one percent of the Egyptian population. The number of undergraduate students increased by 2.6 times during ten years from 1993 to 2003. Egypt spends less money on student education than most Arab countries. The pressure of numbers, and those seeking entry to higher education in particular, was, and continues to be, relentless. The cost of one student in Egypt is $US 1191, that is one-tenth of that cost in some oil-rich Arab countries.

- For the academic staff and researchers in Egyptian universities, the students to PhD-holding staff ratio considerably increased in 1996 (35:1) compared with 1991, when it was 26:1. There was a sharp rise in the students:staff ratio in ten years from 1993 to 2003 of 20:1 students:staff to 37:1 relatively, as a result of opening new universities and disproportionately increasing the number of students to the rise of teaching staff.

- The research expenditure in Egypt is very low. The Government is the major funding source of research activities in Egypt. The share of the government budget of total R&D funding in 1996 was 86%, foreign support was 10.8% and private only 3.4%. Egyptian researchers are among the worst paid researchers in Arab countries. The research in hard sciences in Egypt suffers from a deficiency in state-of-the-art equipment; this makes advanced technology research difficult to pursue. The university budget allocated to the individual researcher for supporting research reaches the sum of US $ 50 in good years.

With such a small research budget for the universities, not much can be expected regarding the quality of research produced. At the same time the funds allocated to attending the conferences, travel, research equipment, books and scientific journal are continuously decreasing with the increase in the number of researchers.

- Foreign funding, which is only 10% of the total research expenditure, plays a significant role in supporting the research activity in universities and particularly in the research centres affiliated to the universities.

- A few reasons for the decline in research in Egypt are: the lack of resources along with the abuse of those available, the lack of a motivation for research, the lack of a strategic plan for research and the poor economic condition of university staff.

- One of the most serious higher education problems is the system of promotion, which essentially is based on research and the publication of results in scientific papers. Promotion at all levels is close to automatic. The progression moves from assistant to lecturer, once the PhD is complete. Promotion depends on tailoring research to state-imposed standards rather than increasing knowledge in the field. Once a scientist has become professor, no other academic promotion opportunities exist and there are no mechanisms for monitoring both research and teaching.

- A very sensitive issue which affects the productivity of research is the ethics of research. The lack of procedures for monitoring research leads to plagiarism, which is rampant in Egypt. It is an internationally acknowledged academic problem, the difference being that, when the plagiarism is proved, the perpetrator is penalised in most institutions worldwide but not always it is happen in Egypt. However, the reluctance of some scientists, even the authors of plagiarised work in both developed and developing countries, to verify that they have been plagiarised exacerbates the problem. This devalues scientific research and opens the door to the falsification of results.

- The poor training of the research personnel is one of the key factors – if not the most important one – responsible for the deteriorating research quality in Egypt. This is attributed to Egypt's education system, which is far from satisfactory. Education gaps exist at all under- and post-graduate levels for teaching how to perform research and write results.

- An encouraging trend is that Egyptian higher authorities have recognized the HE problems and made steps forward to improve situation. The new HE legislations should establish the mechanisms and procedures to improve higher education and research and set higher standards for research and development.

In conclusion, it can be stated that the pressure of student numbers through government policy emphasizing the quantity of students together with the deficiency of highly qualified academic staff are among the main reasons which have led to the qualitative decline education in Egyptian universities. At the same time, the deprived research environment and lack of a strategic plan for research within university causing the deterioration in research calls for urgent actions to

improve the quality of Higher Education and research in Egyptian universities. It is not a novel proposition that improving quality involves a financial investment that includes increasing salaries, improving research facilities, and enhancing "teaching and research capacities."

**Bellakhdar Abdelhak**

## *« Défaillances académiques et production du savoir dans l'Université marocaine »*

D'encourageantes mutations en cours changent profondément l'architecture de l'Université marocaine. Corrélativement aux grandes (re)structurations que connaît le pays, principalement dans les domaines de la gouvernance, de l'économie et du développement humain, les pouvoirs publics semblent décidés à sortir l'Université marocaine de sa torpeur, et ce en la dotant d'un important dispositif juridique et structurel pour promouvoir la qualité de la formation et, parallèlement, et pour renforcer la capacité à la Recherche.

Néanmoins, ces *attentions* louables risquent d'être freinées. Car, si la capacité à la recherche au Maroc repose, comme partout dans le monde, sur un financement suffisant, des structures adéquates et une articulation pertinente au socioéconomique, les aménagements antérieurs (plus que la politique) de l'Université ont laissé s'installer ou ont préféré ignorer :

I- **des disjonctions fonctionnelles et organiques** entre les différents secteurs de la Recherche :

1) D un côté, l'ingénierie et la technique sont avantagées eu égard à leur opportunité financière et stratégique,

2) et, de l'autre les sciences humaines ont été regrettablement laissées pour compte. Bien qu'elles soient le lieu d'un paradoxe

• Elles constituent un important affluent à la formation des cadres moyens et des futurs enseignants et chercheurs dans le domaine).

• Elles sont le lieu de la construction du discours nouveau (politique et ''philosophique'') qui, de manière fluctuante, donne le change ou perpétue la Tradition.

3) Dans une troisième zone contingente se situent les facultés (traditionnelle ou FST) des sciences exactes. Elles sont tantôt associées à l'ingénierie et à la recherche (fondamentale) et tantôt atteintes des mêmes insuffisances que les précédentes.

II- **des hiatus historiques**, traduits en une politique favorisant les disjonctions qui ont fragilisé la réactivité de l'Université marocaine, sans pour autant doter les centres de recherche ni de la philosophie ni de la vision globale nécessaires.

III- **et une gémellité discursive** due au cumul binaire des sciences (archaïque et moderne). Cette gémellité ambiguë, à son tour,

1) a légitimé une forme de dispense de ''l'académique'' (ce mot est pris dans son sens noble de validation méthodique et épistémologique des connaissances

2) a produit, au sein du discours académique la logique du cumul. Les discours pédagogique, scientifique ou philosophique modernes coexistent avec celui ''traditionnel'' en une sorte de palimpseste de savoirs qui neutralise la primauté à la rationalité et aux méthodes d'analyse moderne.

3) a contraint en conséquence l'Université à reposer sur une pédagogie de la consommation des savoirs, qu'elle ne cesse d'ailleurs de reproduire.

Cette situation a eu pour conséquences de

1) **conforter** la scission générique profitant à certains points consacrés à la Recherche (utilitaire), qui font la fierté de l'Université marocaine, même s'ils n'y sont affiliés que nominativement et depuis peu, et même s'ils sont en réalité plus solidaires de l'Entreprise.

2) **risquer d'hypothéquer l'avenir** en privant le Maroc du recul stratégique en viviers futurs de formés et d'éventuels chercheurs, les Universités accusant des défaillances académiques qui entachent la formation (circonscrite dans l'enseignement).

Le travail tente, bien que hâtivement pour des raisons matérielles, d'associer dans le même examen trois point de fuite séparés jusqu'à présent dans la majorité du discours didactique au Maroc : l'épistémologique, l'historique et l'académique. Examiné à la lumière de la capacité à la recherche, ils révèlent de curieuses combinaisons.

**Bernatchez Jean**

## *« L'innovation sociale et l'université au Québec : le défi de rendre opératoire un concept polysémique »*

Le Québec, province francophone du Canada, a juridiction exclusive sur l'enseignement supérieur mais partage avec l'État fédéral la juridiction sur la science et la technologie. Le gouvernement québécois dispose d'une *Politique de la science et de l'innovation* (2001) complémentaire de la *Stratégie canadienne d'innovation* (2002) qui repose globalement sur le même *référentiel* [Muller et Surel, 1998] à cette exception près que la politique québécoise considère, outre l'innovation technologique, la dimension de l'innovation sociale.

Un lobby de quelques acteurs importants de la recherche universitaire a fait en sorte que cette dimension soit ajoutée à l'*Énoncé de politique* (1999) préalablement soumis à la consultation. La tradition parlementaire mais aussi une logique de recherche de consensus dans la dynamique de prise de décision, caractéristique importante du « modèle québécois » [Trottier et Bernatchez, 2005], expliquent ce changement *incrémental* [Lindblom, 1980] à l'étape de l'*élaboration* [Jones, 1970] de la politique. Suivant la logique de cette politique, la recherche universitaire québécoise doit viser l'innovation technologique et l'innovation sociale.

Il y a très peu d'incitatifs tangibles au fait de promouvoir l'innovation sociale, sauf que les universités y voient un intérêt stratégique afin d'atténuer le clivage des professeurs entre eux, eu égard à la pertinence ou non d'inscrire leurs activités dans la logique de commercialisation de la recherche et de l'expertise universitaires. Les professeurs opposés à la logique marchande sous-jacente à l'innovation technologique pourraient voir dans son pendant social une finalité convergente avec une conception plus traditionnelle de l'idée d'université.

La difficulté tient par ailleurs au fait du caractère équivoque et polysémique du concept d'innovation sociale. Taylor [1970] et Gabor [1970] ont été les premiers à utiliser le terme. Pour Taylor, il désigne de *nouvelles façons de faire les choses* dans le but de *répondre à des besoins sociaux* comme la pauvreté, par exemple. Gabor envisage pour sa part les innovations sociales comme des *instruments de lutte* visant un *nouvel arrangement social* : ainsi, elles peuvent prendre la forme, par exemple, d'une loi ou encore d'une technologie, cela en raison des conséquences sociales positives qu'elles entraîneront.

Fontan [1998] et Potter [1998] s'entendent par ailleurs pour définir l'innovation sociale non seulement par les objectifs et le caractère novateur des solutions proposées mais aussi par son processus. L'innovation sociale serait ainsi la résultante de la coopération entre une diversité d'acteurs au nombre desquels figurent en bonne place ceux et celles vivant des situations problématiques qui commandent des *actions* et un *changement durable*.

Bref, plus les acteurs s'y intéressent, plus le concept d'innovation sociale se complexifie et se traduit (théoriquement et concrètement) de multiples manières. Les universités québécoises cherchent à associer certaines de leurs pratiques actuelles à cette visée de la *Politique québécoise de la science et de l'innovation*. Quelques-unes d'entre elles posent par ailleurs un jalon de plus et tentent de formaliser de nouvelles pratiques visant l'innovation sociale.
Une analyse de la situation actuelle liée à l'innovation sociale dans les universités québécoises, du point de vue de la formalisation et de l'institutionnalisation de leurs pratiques, suggère par ailleurs de considérer, à un premier stade de simplification, deux grands référentiels qui inspirent les acteurs : le référentiel marchand et le référentiel citoyen. [Bernatchez, 2005]

Il est évident par ailleurs que la réalité des universités québécoises, au chapitre de l'innovation sociale, s'actualise avec beaucoup plus de subtilité. Il faut aller au-delà de cette simplification pour appréhender la complexité du réel [Morin, 1977 à 2004]. Ces catégories, en conséquence, doivent être considérées comme des constructions intellectuelles permettant de questionner les pratiques particulières liées à l'innovation sociale dans les universités québécoises, afin de les mieux comprendre.

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**Chen Yang, Richard Sanders & Jinmin Wang**

## *"The commercialisation of Chinese universities and its effects on research capacity"*

This paper analyses the commercialisation of leading Chinese universities and its lasting effects on research capacity and research productivity of these universities in the context of China-in-transition over the past two decades.

In the first part, a brief historical review identifies the characteristics of the commercialisation of Chinese universities and its significant impacts on research capacity of the universities. In China, like most post-socialist transitional economies (Freeman, 1982), the R&D institutes to promote industrial technology were separated from the relevant industries; as a result, the productive 'link' between R&D institutes and production enterprises was simply deficient. This caused problems of inefficient transfer of R&D output to industrial users. In order to tackle these problems, a systematic reform of R&D mechanisms was required. As a response to the market-oriented reforms starting in the early 1980s, China's centrally-planned science & technology (S&T) system began to adopt market-oriented mechanisms. Universities were encouraged to raise funds through commercialisation and industrialisation of research outcome.

In order to narrow the gap between China and high-technology frontiers, in 1986, the Ministry of Science and Technology (MOST) launched The National High Technology Research and Development Programme of China, referred to as the 863 Programme. In August 1988, MOST launched the Torch Programme. The main mission of the programmes was to focus on the application of completed R&D and on the commercialisation of market-oriented technologies that would benefit business quickly. Both 863 and Torch programme were (and are) state-led, collectively conducted through cross-ministry co-operation. Under state direction, the universities, colleges and research institutes were the key forces employed to conduct projects nation-wide.

The empirical research findings indicate that the construction and development of institutions, mechanisms for the promotion of scientific research and advanced technology development in high-tech sector was a 'reconstitutive downward' process in transitional China. Under state direction, the universities, colleges and research institutes were the key forces not only employed to conduct R&D projects but also engaged in the technology diffusion, commercialisation and industrialisation of research outcomes.

The commercialisation of research with Chinese universities, unlike that occurred in most developed countries, has not gone side by side with privatisation. In the second part, the paper

explores the embedded problem of fuzzy property rights that gradually formed (created) in process of commercialisation and its impact on the change of the distribution of sources of financial support for research with universities. The empirical research is based on an in-depth study of leading universities in China. Research findings indicate the propensity related to the problem of fussy property rights that significant increase of research capacity of universities mainly funded by public resources has benefited fast growing non-public business sectors.

As knowledge transfer and technology diffusion have become the most essential criteria in the codes of academic recognition, empirical findings indicate that research resources including academic capital, economic capital and political capital are more likely to be allocated towards the lower end of science and technological projects which can be commercialised quickly. Moreover, as government funds remained the principal source of finance for research, it benefits researchers holding higher administrative rank rather than those with stronger research potentials. As a result, the research productivity for the development of frontier technology would be weakened which may lead towards the incompetence in research utility of universities and technology diffusion of core technologies in high-tech industries.

## Correa Henao Magdalena

### *«Réalité sociale et droit constitutionnel : une recherche scientifique possible?»*

L´Universidad Externado de Colombia et, notamment, le Département de Droit Constitutionnel sont à la tête, depuis longtemps, d'un programme sérieux de recherche[13].

Donc, l'Univérsité Externado et le département de Droit constitutionnel ne font pas partie des statistiques, qui montrent la faible production scientifique en Colombie.

Nonobstant, l´Université et les professeurs de Droit constitutionnel se demandent, encore aujourd'hui[14], si la rigueur scientifique de leurs études et surtout des recherches qu´ils suivent actuellement, produit des études «*pertinentes par rapport aux besoins du développement ...* >> national.

Comment pourrait le Droit offrir des réponses et des voies aux systèmes sociaux, pour qu'ils puissent régler les relations d´une façon assez efficace et juste et pour qu´ils résous les conflits et les besoins des individus, des groupes et de la société en générale? Il s´agit d' éviter que le Droit, représenté dans ce cas par la Norme suprême, soit trop éloigné du droit materiel, trop loin des vraies régles qui gèrent les relations sociales.

Envisageant de devenir une science, au mois une discipline, la recherche juridique est menacée par l´autisme. Sauf si l´approche est celle de la Sociologie juridique[15] - la recherche en Droit se produit en tant que systéme qui subit de <<l'*autopoiesis*>>[16].

La connaissance du Droit en Colombie a héritié[17] d'une logique, plus ou mois complète et fermée, où les sources d´information et les objets d´analyse sont les *normes* formelles. A cause

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[13] Parmi les travaux réalisés, il faudrait mette l'accent sur les compilations et études du professeur Carlos Restrepo Piedrahita sur l'histoire constitutionnelle de la Colombie. Plus récemment (depuis 10 ans), toutes les publications des recherches des docteurs ainsi que les articles, qui produisent les professeurs du département pendant toute l´année.

[14] En effet, en 1997, le Département de Droit constitutionnel publiait un article sur la même question et proposait quelques lignes théoriques et méthodologiques pour rapprocher la recherche en Droit et la réalité sociale, qu'à vraie dire, on n´a pas suivi. *Vide* Departamento de Derecho Público. « Lineamientos teóricos y metodológicos para la investigación jurídica". *Revista Derecho del Estado, no. 1, enero 1997.* Bogotá, Universidad Externado de Colombia, p. 161 y ss.

[15] Qui constituent, encore, une couple qu'habite ensemble mais, qui ne se mélange pas ; ou bien, une sorte de bizarrie (ou d'excentricité) du monde juridique.

[16] Ce n´est pas par hazard qu'on prends une notion proposée par Luhmann. *Vide* LUHMANN, Niklas. *Sociedad y sistema : la ambición de la teoría.* Barcelona: Paidós, 1991.

[17] Suivant la tradition française acceuillit à la naissance de la République.

de la brièveté, il faudrait accepter que la «norme formelle>> représente la Constitution, la voix de la Loi, les décisions des autorités, les arrêts, les contrats et les accords en générale. La doctrine (c'est à dire les opinions des rechercheurs) ainsi que la coutume (manifestation commune de l'autonomie de la volonté de beaucoup de personnes), deviennent des sources non formelles et toujours accesoires. La réalité sociale est l'objectif du Droit ; mais, elle n'est pas une source pour mieux le comprendre.

Le Droit prétend s'expliquer par soi même; tandis que la société n'est reconnue que comme une idée abstraite, avec une volonté presque nulle par rapport aux individus et aux groupes, véritables sujets des droits et libertés. Les uns et les autres representent le grand but du Droit ; mais, jamais un agent principal déterminant le contenu des normes formelles[18]. Ils sont des objets qui reçoivent les effets juridiques mais, qui ne sont pas introduits dans les procès institutionnels de création du Droit.

On veut offrir une réflexion sur la base de l'experience et de l'analyse, avec des hypothèses plutôt que des réponses sur les raisons d'une telle séparation : l'idée existente après laquelle le Droit est un système qui ne décrit pas la société mais qui détermine son devenir. La démocratie directe, en tant que système de création de normes, ne garantie absolument pas une société plus libre, plus égalitaire, plus solidaire ni plus juste[19].

Et d'un autre côté, comment trouver, en fin, le point d'equilibre entre les régles de la société, des communautés, des familles, des quartiers et des marchés et les régles édifiées par l'esprit de la raison, l'Illustration, la pluralité de l'Etat constitutionnel ? Comment rapprocher l'étude du Droit aux envies de la société, à sa réalité, à ses problèmes, en tant que sources propres ? Comment fixer de limites, à fin de garantir l'existence du systeme de valeurs essentiels et inéluctables.

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[18] La <<volonté générale>> en tant que celle du <<peuple souverain>>, la participation du peuple dans tous les affaires qui lui concerne, ne sont que des grosses paroles du Constitutionnalisme au même temps que de promesses manquées de la Révolution française et de la Révolution technologique. <<L'intêret générale>> et le <<bien commun>> sont des concepts juridiques indéterminés, dont le lien avec la société est fort mais entièrement institutionnel. En Droit international humanitaire, la <<société civile>> est un sujet qui mérit un traitment spécial. En Droit privé on retrouve les tiers, les voisins, la communauté.

19 Un point de vue élitiste qui, malgré le vif discours de la participation et du pluralisme, est encore prédominant.

**da Conceição Rego Maria**

## *« Les universités dans les pays de la périphérie : faire de la recherche « dans les régions » ou « pour les régions » ? Quelques réponses tirées de l'exemple de l'Université d'Évora" »*

Universities are a source of significant multiplier effects upon local and regional economic activity. In the case of economically depressed regions, the importance of universities is enhanced. This is the case with the University of Évora, located in the Alentejo (Portugal), one of the poorest EU regions, where it has been a key element in the dynamics of local economic activity.

Regional development is, basically, the construction of a propitious way to innovation, and the sharing of it with local agents. The effect of the research done in the Higher Education Institutions (HEI) is particularly important for SME's- the predominant companies in the Alentejo, as well as in the majority of the regions of the interior of Portugal – insofar as the companies are those which most need to look to the exterior for technological developments capable of promoting improvements in the efficiency of their productive processes.

The Alentejo, occupying one third of the country, is the least densely populated Portuguese region and its population is increasingly aged. In terms of the income of the region and its residents, the available data for GDP per capita discloses that the Alentejo is one of the 25 poorest regions of the EU. Also, disposable family income presents values lower than the average of the country (Portugal). The industry of the Alentejo constitutes only a small part (3,4%) of the Portuguese total. These companies are small to medium size, in terms of employees (6,2 people) and in terms of sales (about €450,000).

Apart from having a direct impact upon the economic activity of the Alentejo, the University of Évora has also been responsible for demographic effects as well as for transference of innovative knowledge and technology processes.

The University of Évora, with about seven thousand students and more than five hundreds teachers and researchers, is the main higher education institution, and the only public university in the region: in the first years of this decade, it had 40% of the students in public higher education in the Alentejo, and more than 50% of the teachers.

Being the main institution of research and development located in the Alentejo, with more human resources and having the best levels of qualification, the U.E. has increased responsibilities in the areas of the research and community service. Obviously, Alentejo has a small participation in the Portuguese R&D activities (in 2001, the region represents only 2,4% in

terms of expenditures and 3% in terms of researchers). In this region, the core of R&D activities is in the area of Évora (more than 80% of the expenditures) and in the HEI (more than 50% of the expenditures). The U.E. is the main R&D institution with more than 80% of the researchers working in Alentejo.

The analysis of the effect of the U.E. in the transference of innovative knowledge and technology to other regional economic agents was made using 2 instruments of information gathering: questionnaires and the analysis of the content of protocols. The questionnaires were applied to many public targets: local and regional companies, other institutions, graduates and teachers of the U.E. These questionnaires allowed us to evaluate the relationship with a diversified set of regional and local agents.

In this paper we can conclude that the research developed, in U.E., is applied to nationwide and international questions, reflecting the concerns and the interests of the investigators, such as of the possibility to get financing. On the other hand, the community services responded to the needs presented by regional partners, and has become a team based on members of the same R&D unity.

**Keywords**: Transference of innovative knowledge and technology, Regional Development, Universities

**Didou Aupetit Silvie**

## *«Contrôle de la productivité académique et réforme des systèmes de recherche en Amérique latine»*

Les pays d'Amérique Latine, depuis deux décennies, ont mis en place des politiques publiques destinées à renforcer la recherche.: De manière convergente, malgré des clivages temporels, ils ont créé des centres spécialisés, avec ou sans liens avec les universités publiques, installé des dispositifs d'évaluation des personnels de recherche et de leur productivité et consolidé les mécanismes de formation des ressources humaines hautement qualifiées, privilégiant au plan national des établissements ou des cursus certifiés comme de qualité et au plan international des institutions de prestige . Ils se sont également efforcés de mettre en place des programmes de co financement de la recherche, en liaison avec les entreprises, les organismes internationaux et les réseaux disciplinaires.

Ces politiques et les réactions qu'elles ont suscitées ont modifié le statut institutionnel de la recherche et les modèles d'assignation des enveloppes destinées à l' appuyer ainsi que les critères de prestige et les trajectoires professionnelles des individus. Elles ont poussé chercheurs et directeurs de laboratoire à modifier leurs stratégies internes d'organisation et de négociation, leurs schémas de fonctionnement ainsi que leurs choix de publication et de diffusion. Elles les ont amenés à renforcer leurs partenariats externes, quel que soit l'usage réservé aux résultats produits, à des fins privées ou d'intérêt public. Elles les ont conduits à assumer de nouvelles « façons de penser et faire » de la recherche universitaire, selon lesquelles ses enjeux principaux consistent tant à assurer sa qualité intrinsèque et sa contribution au développement endogène local, régional et national qu'à garantir son financement, la protection des droits de propriété intellectuelle et la mutualisation des ressources humaines et matérielles.

Les changements ci-dessus énumérés ne sont guère originaux. Ils ont été bien documentés au niveau global, principalement dans les pays développés. En Amérique Latine, ils ont fonctionné comme les leviers d'une transformation profonde de la recherche –quoique incomplète et non consensuelle-, produisant des phénomènes d'adaptation, de simulation et de détournement, à l'échelle des individus et des institutions.

Leurs réactions d'adhésion et de rejet se sont produites en réponse à une restructuration de la profession qui a entraîné un renouvellement (encore en cours) des élites scientifiques. L'adoption de critères de recrutement et d'appartenance, tels que le doctorat, les articles acceptés dans des revues de prestige, l'habileté à faire rentrer de l'argent de l'extérieur, l'inscription dans des réseaux disciplinaires, de préférence internationaux, s'est généralisée. Elle a creusé des clivages

entre chercheurs et collectifs, contraints de s'insérer dans un cadre de légitimation, considéré alternativement comme engendrant stress ou opportunités.

En ce qui concerne les institutions une érosion du monopole exercé par l'université publique dans le champ de la recherche est discernable et alimente des pertes de crédibilité. A l'intérieur même des universités, une hiérarchisation et une redéfinition des caractéristiques des équipes considérées comme les plus performantes, une désinstitutionnalisation de leurs comportements et une déterritorialistion de leurs dynamiques de travail sont visibles. Elles produisent des crises de fonctionnement, qui se traduisent, à l'intérieur des établissements, par l'émergence de tensions autour de la régulation et de l'usage des appuis financiers non budgétisés.

En conséquence, nous nous proposons de centrer cette intervention d'abord sur l'agenda régional concernant la recherche. Nous examinerons ensuite les réponses des établissements universitaires touchant aux stratégies de consolidation et d'administration des capacités installées. Finalement, nous analyserons les modes de fonctionnement des équipes de pointe. Nous identifierons ainsi les axes autour desquels se joue la réorganisation actuelle de la recherche en Amérique Latine.

**Didriksson Axel**

## *"The academic research at the Latin American and Caribbean Macro-universities: initiatives and networks"*

This paper works and discusses the current debate about scientific and social research, since the on going activities of the Latin American and Caribbean Public Macro-universities, and from its new regional network, and its related programs and initiatives.

The concept of Macro-universities is introduced to expose the historical and present model of the most important public and largest universities of the region. These Macro-universities are the national ones, most of which descend from the Spanish colonial period, or from the war of Independence, but, basically, they are the most representative universities of this region of the world.

Its features are, in terms of the main topic of this paper, that they concentrate, at a regional level, around 80% of the students in the postgraduate level (mainly at doctoral level); they have a very important number of researchers, and concentrate, in many countries, more than the 50% of the areas of scientific activity at national level, disciplines and frontiers of knowledge, and they are the most dynamic and strategic institutions, that are being organized very active networks and associations to impulse creative and original experiences, working on the endogenous capacity in the frontiers of academic research.

Particular references in this paper will provide the concepts and political declarations of these Network, which wants to demonstrate that these efforts are now part of the current international debate for the promotion of a new kind of international cooperative international division of knowledge.

The main topics of the paper will cover the characterization of the original concept of Macro-universities, its historical development, and its differences with other world university models, as well as its historical and actual contribution in the research activities, its current indicators and variables of development, and its perspectives.
At the same time, this paper discusses the creation and development of the Public Macro Universities Network in the region, its principal programs, mainly in reference to its important contribution to the scientific and technological research organized by the ***Consejo Latinoamericano de Investigación Científica*** (***CLIC***: Latin American Scientific Research Council), in ten (interdisciplinary) scientific areas:

- Nanotechnology
- Multicultural Studies
- Energy

- Genomic Sciences and Food
- Public Health
- Knowledge Society, Education and Culture
- Disastrous and Sustainable Development
- Civil Society, Democracy and Governability
- Neurosciences
- Economic, Social and Technological Development and Innovation

Finally, the discussion settles around some scenario elements to demonstrate that making joint efforts and pushing for new kind of horizontal cooperation among the Macro-universities, can be possible built pertinent and quality research in strong relation with a regional solutions of poverty, inequality and equity.

**Donwa Patience**

## *"Funding of academic research in Nigerian universities"*

The level of significance of academic research in Nigerian universities has its origin in the main objectives of establishing these institutions. The first of these institutions, the University of Ibadan, which was established in 1948, had the main objective of producing manpower that would eventually take over administrative responsibilities from colonial masters. The other universities which were later established have the same focus of awarding degrees for the purpose of increasing manpower. Research was not accorded its place as a policy in the establishment of universities in Nigeria.

From a study carried out by the University of Sussex on funding of university research in different nations, evidence shows that in many countries, over 50% of research funding comes from industry. Belgium, Germany, Ireland, Sweden, Switzerland and the U.S.A. recorded industry funding of over 60%. Korea and Japan showed funding by industry of over 70%. For Nigeria, industry involvement in universities include endowment of professional chairs in certain disciplines, construction of office and hostel blocks and some donations of laboratory equipment. Often times experts have been invited from universities by organizations (notably oil industry) to carry out some feasibility studies and surveys, and sometimes to conduct training workshop for employees. There is no industry involvement in funding academic research.

The problem identified for this study is that universities, which should thrive as centers of knowledge dissemination, research and knowledge creation have not maintained their full savour in developing countries. In most of these regions, universities can at best be described as 'teaching centres' due to their focus on knowledge dissemination and insignificant contribution to knowledge creation through academic research. Thus, much of the knowledge disseminated is copied work as no flavour of originality can be credited to them. A number of factors are responsible for this condition, notable among them is inadequate funding of universities generally.

The objectives of the study are to evaluate:

- the extent of funding of academic research in universities,
- the pattern of funding,
- the factors that motivate these funding,
- the sources and reliability of these sources of funding,
- the demand for academic research as well as the frequency of demand.

The scope embraces the capacity for research as it exists in the universities, specifically funding. The conditions, dependability and sources of financial support for academic research in Nigerian universities were the foci.

The methodology involved the use of self-administered questionnaire to academic planning units of 8 universities that made a fair representative of all regions (north, south, east and west) of the country. The analytical approaches used were descriptive and simple percentages that related research funding to GDP.

The study revealed that:

- Government support accounts for over 98% of research funding in Nigerian universities, no industry support and the rest of the funding which is less than 20% comes from foreign agencies.
- Research funding is inadequate and not regular.
- Whereas investments in R&D in many countries are as high as 6 t0 10% GDP, that of Nigeria is less than 1%.
- In no year did research funding exceed 0.03%.

Some suggestions that would help improve research funding for the universities are as follows:

- Government should emphasize research in policy
- Investment in research should be seen as a development strategy
- Collaborative links between universities and industries is inevitable
- Industry involvement in funding should be seen as corporate social responsibility.
- Government should channel all researches to universities, and encourage industries to do the same.

**Dzulkifli Abdul Razak & Ramli Mohamed**

## *"Dis-endangering research and knowledge creation inertia admist constraints in a teaching university: the experience of university Sains Malaysia"*

The general thrust of Third world universities in general and in Malaysia in particular, are often geared toward producing human capital to support and sustain national development goals. This is especially true in countries where, ever since their independence, the required skills are still inadequate particularly in science and technology, medicine and, to a lesser extent, social sciences. Hence the general focus would be to emphasise on teaching of the undergraduate programmes, at the expense of postgraduate supervision and scholarly research. This anomaly is not necessarily due to financial constraints (as in the case of Malaysia, the income from tuition fees do not often exceed 10 percent of total revenue of the universities) but on the need to expand human capacity for national development.

Given this trend and difficulties, it is, however, still possible to promote and inculcate research culture within the university and it is still possible to avoid this "endangered species" syndrome. Based on the experience of Universiti Sains Malaysia (USM), research can be given equal impetus and weightage as teaching, and research culture can be assimilated in many dimensions of academic endeavour, including key performance indicators, institutional goals, external relations and promotion exercises.

Since 2000, USM was able to escalate and forge R&D culture into its day-to-day activities through:

- an extensive audit of R&D activities and promotion of new modes of operations and out-of-the-box thinking;
- the realignment of R&D governance, management and organisational structure;
- the creation of parallel units and approaches to ensure the equal standing of research and teaching as well as promoting greater synergy between research and teaching;
- the creation of a holistic platform which can take research through the stages of development, commercialisation, entrepreneurship and research park vis-à-vis the creation of the one-stop research management centre and an innovation system;
- the establishment of a commercialisation arm to handle marketing and sales of R&D products and processes;
- the development of a research agenda which promotes a borderless interdisciplinary ideas powerhouse and knowledge enterprise through (i) creation of new collaborative research frontiers, (ii) de-compartmentalising research disciplines, (iii) 'co-collaboratories" (sharing of research facilities), (iv) optimising the usage of financial resources through

research endowment, (v) developing dynamic research programmes through clustering, and (vi) 'brand name' research training programmes.

The paper discusses USM's attempt at promoting research as a way of life, as an institutional norm and behaviour amongst its academic staff thereby enhancing its global competitiveness and move up the value chain of tertiary education. The paper will also share the positive outcomes and accomplishments recorded and accrued since the past six years, including:

- the establishment of new research areas and the consolidation and strengthening of the existing niche areas;
- the increase in the number of contract research and external grants, the increase in the number of publications in citation-indexed journals including high impact factor journals (ISI Serials);
- the proliferation of recognition/awards/stewardship conferred by national and international learned and professional bodies;
- the qualitative and quantitative increase in the in-take of postgraduate candidates through the provision of opportunities and choice for research in a high quality training environment; and
- the continuous improvement of research capacity of the university as a whole, including human capital, infrastructure and resources.

**Gahama Joseph**

## *« Pour une recherche concertée et partagée dans les universités de la région des Grands lac est- africains »*

### 1 . Une vue d'ensemble du problème

- L'objectif de cette communication est de démontrer que les universités en tant que centres de recherche et de création des connaissances ne sont pas une espèce menacée, contrairement aux idées reçues
- Notre argumentation s'appuiera sur les universités de l'Afrique des Grands Lacs
- Une redynamisation de l'enseignement supérieur qui se caractérise par la multiplication des établissements publics et privés et la création de nouveaux centres de recherche
- Il existe aujourd'hui une nouvelle génération d'intellectuels universitaires formée sur place ou dans le système dit *sandwich* et contribuant fortement dans la reconstruction et la réconciliation de leurs pays en sortie de crise
- Cette génération s'oriente vers de nouvelles voies et est appelée à s'impliquer dans des débats nationaux, régionaux et internationaux sur la bonne gouvernance, elle est sollicitée fortement par des expertises de tous genres, elle est consciente de la nécessité de la coopération interuniversitaire.
- Elle a besoin de travailler ensemble autour de grands projets et programmes de recherche qui mobiliseront toutes les universités de la sous- région.

### 2. Contexte politique actuel et envisagé

- Les universités dont il est question ici se trouvent dans une région qui sort de crises (Ouganda, Rwanda, Burundi, République démocratique du Congo). Dans le contexte actuel de demande d'une forte décentralisation, on s'attend à ce que la massification des universités se poursuive, parce que toutes les grandes unités administratives voudront chacune se doter d'un établissement d'enseignement supérieur et d'au moins un centre de recherche.
- Par ailleurs, on est conscient que ces universités et ces centres de recherche ont fortement besoin de se constituer des réseaux sur des thèmes de recherche ou des enseignements à entreprendre en commun ou en partenariat, comme la bonne gouvernance, la biodiversité, les nouvelles technologies de l'information et de la communication, etc.

## 3 . Les résultats de la recherche

- Ils contribueront à montrer que l'afro- pessimisme qui a gagné une grande partie du monde occidental à propos de la faillite des universités africaines a besoin d'être sérieusement nuancé
- Ils inviteront les bailleurs de fonds réticents à investir dans la recherche en accordant à ces établissements de l'enseignement supérieur des moyens financiers dont ils manquent cruellement.
- Ils apporteront des améliorations sensibles dans les systèmes politiques des pays de la région des Grands lacs qui seront beaucoup plus sensibles à la démocratie, la bonne gouvernance et la réduction de la pauvreté.

## 4. Recommandations

- Aux décideurs politiques, il est recommandé de faciliter la mise sur pied d'un Centre de recherche régional ou à défaut la constitution d'un réseau des centres d'excellences relevant des universités des pays des Grands lacs,
- Aux bailleurs de fonds, il est demandé d'accorder plus de crédits aux recherches en cours et de financer celles qui sont envisagées,
- Aux intellectuels chercheurs des universités et établissements de l'enseignement supérieur des pays de l'Afrique des Grands lacs, il est recommandé de se constituer par domaines de recherches des réseaux de chercheurs qui travailleront sur des projets et des programmes communs.

**Hanafi Sari**

## *"The social sciences research in Palestinian territories, the dilemma of the research centers outside of the university"*

From a previous study I did on the population studies written in the Palestinian Territories (1996), I realized that a major part of the studies were in the form of unpublished report. The study also shows that the research is produced in NGOs research centers or developmental NGOs which tend to make policy studies done by either contractual researchers or practitioners. The Palestinian Universities play a very marginal role in the research field. Why does the research situation look like that in Palestinian? Why are empirical and theoretical studies unpublished? Who are the authors? In which structures and institutions are they produced?

The proposal at hand is a follow-up of the previous study. I will start by mapping the Palestinian research structure. While there are many research centers based outside of the university, one identifies only two active research centers connected to the university: the Public Health institute of Birzeit and the Law center. I will also inquire into the ways in which external actors influence research production in the Palestinian Territories. These actors are donor agencies (such as the French cooperation, German Stuftungs, Population Council, UN agencies) and international organizations (like the Ford Foundation of the Canadian agency IDRC). I will study the interaction, cooperation and negotiation between these actors and the research centers, whether inside of the Arab University or in a research center with NGOs status.

Fieldwork results seem to indicate that the donor community encourages the creation and the development of such centers. According to the **new policy agenda**, there was simultaneously empowerment of the civil society institutions and disempowerment of the state. University was seen and treated as a public institution as if it were part of the State. In this process the **university becomes a very marginal actor in term of research**.

Moreover, the NGO research centers preferred to avoid affiliation with the universities for fear that universities will have a claim to funding or for other individual reasons. Thus the Palestinian universities have become unable to make research and consequently have become poor institutions. At the same time there is little effort from the research centers to cooperate with universities.

Fieldwork results also show that the discourse of institution-building, capacity building of both donors and local NGOs concerns more the equipment than human resources. Almost all of these research centers has only administrative staff and don't have permanent researchers or long-term researchers. They contract for the period of research projects, which never extends beyond 18 months. It is worthy to note that a large number of researchers used to shift from center to another. This mobility is somehow problematic, going against the accumulation of experiences for these researchers. This situation compels a lot of good graduates to avoid the research realm

in favor of a more stable carrier in international NGOs or in the development field, or even as employee in the administrations of the Palestinian National Authority. A substantial shrinking of the research field was witnessed. Consequently, the actual research contracts are shared by very few people.

**Janine Ribeiro Renato**

## *"Universities: a description of Brazilian problems and a proposal for the world higher education"*

Brazilian 1988 Constitution says universities should integrate research and teaching. However this is not true in practice. Among the 254,000 faculty members we have in higher education institutions (HEIs), only 54,000 are PhDs and no more than 100,000 have a masters degree. If we consider research as such would be the realm of PhDs that work in stable teams, we can further reduce the numbers of our researchers to the 34,000 that teach in graduate studies or even to the 8,500 that are recognized by CNPq, a Federal funding agency, as the best researchers in Brazil. CNPq data are not a good example, however, because budgetary problems have kept many good researchers from being funded by it; anyway, the best measure we can give is the one we owe to Capes, another Federal agency that not only funds research but also evaluates graduate studies programs.

Capes most recent data show that in the 2001-2003 period, among the 34,000 doctors that work in graduate studies programs (only PhD holders are allowed to do that), circa 23,000 have been evaluated as having a scientific production constant and recognized as such. This implies that no more than 9% of our HEIs teachers may be considered good researchers. So, in the practical realm research and teaching are far from being linked as our Constitution and as our educational militants would like them to be. We could certainly prove the same point considering other data, as the numbers of students per HEIs and the quality of the former, but Capes data already show that a two- or maybe even three-tier system prevails in Brazilian HE.

There is a first rank, composed of the three Universities that belong to Sao Paulo State, of one or maybe two Catholic Universities, and of five or six Federal Universities, where most of Brazilian research is being made. A second rank may comprise some twenty Universities – two Paraná State, two Rio de Janeiro State, some confessional and several federal ones – that truly endeavor to give their students a good formation, even though their overall quality does not meet the same standards as the preceding ones. But the true problem lies within the third rank, where some two thirds or even more of Brazilian undergrads study, in almost two thousand different HEIs, whose main aim is profit and which have few faculty members that try to keep familiar with new research, even if they don't do it.

There have been and are genuine endeavors of our Federal government – which constitutionally is in charge of HE and is legally allowed to regulate it – in order to better this situation. But, even though there is a sort of strategy tous azimuts, wishing to improve the condition of the three ranks, it remains rather unlikely that the last and more numerous one will be able to give a good education to its students. It is not only a matter of splitting HEIs between research-orientated

ones and those whose only aim is to teach. It is a matter of having bad teachers and also bad students, since Brazilian educational system as a whole, with the sole exception of graduate studies, is quite insufficient. Most students that go to private, profitable HEIs in order to get a degree in Law or Business (which in Brazil belong to the level of undergraduate studies) are unable to exercise their respective professions when they end their years of study. A recent research conducted by Edson Nunes, the present chairman of National Council of Education, shows that, among the 43 professions that are regulated by law (meaning law determines you must have a HE degree in order to practice them), no more than 10% of Law degree holders are allowed to practice by Brazilian Bar Association, that no more than 30% of Business degree holders work in their field – and, even if the best data concern Medicine, no more than 70% MDs exercise their profession, which is a big problem, since we lack doctors and their training is too expensive for us to afford them in fields other than Medicine and Health. A very important reason for this failure is the bad quality of studies.

Evaluation is considered by many as the possible key to improve this situation. Cardoso's government has begun an evaluation of degree holders as they finished their studies, but for lack of time or for lack of political courage has not closed those HEIs with really bad results, even if they could do this according to Brazilian law. Our present government – which will end in late 2006 its four year-term – has improved the tools employed to evaluate courses, but has not closed the bad ones either. At the same time, Capes is completing in 2006 the 30th anniversary of graduate studies evaluation, and its example is respected in Brazil and abroad. My personal opinion, after two years as Evaluation Director at Capes, is that evaluation is really the key to change this bad panorama, but it cannot be considered as just a State policy. In order to become effective it must carry the strong political support of one or more of the following actors: leading researchers, the best HEIs, and students. This happens in the field of graduate studies, but not when at the undergraduate level: most HEIs aim only at profit, most teachers are not properly qualified and lack job stability, most students come to HE with an insufficient education and desire no more than a degree.

Practical suggestions to change this unfortunate landscape should include:

1) the definition of actors really engaged in the process of evaluating HE – I mean, undergraduate studies – as part of a political commitment that could transcend political parties and that should include students interested in really good teaching, teachers able to teach, HEIs, profitable or not, that could accept patterns of quality, and public opinion, including trade-union leaders and CEOs of important corporations;;
2) the acceptance of a two-tier system as something that could be converted in the future in a democratic one-tier system, but that would be, for the present moment, an improvement as against a situation where most students, teachers and HEIs do not meet minimum standards of quality. A practical goal could then ensure that undergraduate students would have good quality studies;;

3) the establishment of a complex but efficient network between the best universities and those HEIs desirous of a serious improvement in their performance. Agreements should be signed with precise goals and deadlines. Masters and doctors would be formed (most of them in public HEIs, with State-funded grants) in order to teach at second-rank HEIs, which in turn would commit themselves to receive (i) if they are private, a number of students that would pay no tuitions, (ii) if they are public, to engage themselves in affirmative action programs aimed at Afro- and Indian-descendents but most all at people who have studied in public schools before getting to HE (paradoxically, private schools are better than the public ones until the age of 17, and public HEIs are superior to private ones, so most of the students at the good, public HEIs come from private schools);
4) a new definition of the role of HE as such. This goes farther than we have discussed. The great problems we face today do not limit themselves to the question of funding or even to social inequality perpetuated by a 2- (or 3-) tier system. They concern some issues that can be summarized as such:
    a) a present day 17-year old has had so much information that he is not yet able to make a professional choice that will last for the 50 years he will probably have of professional life; so, the first years of HE should be more concerned with Bildung than with profession: they should try to convert information into formation;
    b) education should be permanent and degree holders should be encouraged to study again, from time to time, preferably not at the same HEI where they got their degree, and not even at the same field where they have previously studied;;
    c) culture and sports (or physical wellness) should be deemed a priority, in order to ensure people will be able to have a good quality of life in later years; it is completely different for someone to retire cultivating cultural and sporting interests and to retire as an old and incapable person;
    d) universities should then be able to offer society a complex and rich web of (i) basic education, (ii) professional education, (iii) later re-education, (iv) cultural programs and formation, (v) physical activities and courses.

This means we should not content themselves with a redefinition of the respective role of leading universities and second team ones – a matter that can be vigorously addressed by our suggestion number 3 – but we also should discuss in a very serious way how universities and HEIs can be part of a long living process. Today university copes mainly with students from 17 to 27 years old, until they get their PhD. In the future, HEIs should consider as their public people from all ages, or at least from 17 to their death. Today, universities concern themselves with scientific research (the best ones) and with professional formation (almost all universities). Future education will mean education will blend more and more with life, and knowledge will not be kept apart from intelligent leisure. Today higher education ends when people go to the market and work 5 days a week for 30 to 40 years. In the near future they can leave the university not

completely formed or trained, and if the world is intelligent they will work less hours per day or less days per week, mixing labor and leisure. They will not work as hard as we do, but they will not stop completely their work as they get old. A blend of all sorts – of labor and leisure, of reason and passion, of culture and sports, of jobs and education – should be a convenient motto for the world we are now entering.

Maybe we could say the main aim of HE should be to make both labor and leisure intelligent. It is not the case in our days, when we are ruled by media that do their best in order to spare us to think. But, if universities are not to disappear, they must be able to face the challenge of getting larger and larger shares of what today is no more than entertainment, but should in a not so far future be considered leisure, otium, scholè.

**Jaoua Mohamed**

## *« Une recherche mathématique appliquée dans un pays en développement, est-ce bien raisonnable? »*

Il fut un temps - pas si lointain - où parler de recherche dans un pays en développement passait pour un non sens. A moins que cette « recherche » ne fût productive à court terme, qu'elle portât sur les problèmes urgents du développement tels que l'éradication de la malaria, la gestion des ressources en eau ou la désertification. Nulle place dans un tel schéma pour la recherche fondamentale, ni même pour une recherche appliquée telle que celle que peuvent produire les mathématiciens appliqués.

La « stratégie » de développement scientifique consistant a ne s'intéresser qu'aux deux extrémités de la chaîne du savoir, c'est à dire à l'enseignement de base et à la recherche développement, a toutefois rapidement prouvé son inanité. Il est communément admis désormais qu'il ne saurait y avoir d'université sans recherche, et que cette dernière, tout comme le système éducatif, ne peut se développer que dans son ensemble, même si toutes ses parties ne le font pas au même rythme.

Il reste à savoir *comment*, et c'est là que les véritables difficultés surgissent. La première est que si le développement d'une recherche pertinente – c'est à dire de niveau international - nécessite la concentration de ressources humaines *critiques* sur un nombre limité de thèmes, celui de l'enseignement supérieur requiert au contraire une large diversité d'expertise. Le dépassement de cette contradiction est évidemment moins aisé dans un contexte de déficit généralisé de moyens - humains et matériels – où les pays concernés ne sont souvent maîtres ni de leurs financements ni donc de leurs stratégies. Lorsqu'on en vient à la recherche appliquée, la faiblesse du tissu économique susceptible de la motiver, et partant l'absence d'interlocuteurs industriels pour les chercheurs, ajoute encore de la complexité à la question.

Dans cette contribution, nous nous proposons de décrire l'expérience, initiée en Tunisie il y a un quart de siècle environ, de développement d'une recherche en mathématiques appliquées de niveau international, par ailleurs ouverte sur les applications industrielles, réelles ou potentielles. Le succès relatif de cette expérience ne lui donne certes pas valeur d'exemple, dans la mesure où elle a bénéficié de la conjonction de deux facteurs éminemment favorables : d'une part, la révolution numérique a replacé les modèles mathématiques au coeur des processus industriels, « redistribuant les cartes » et donnant une nouvelle chance aux PVD suffisamment préparés sur ce terrain de « rejoindre le peloton » ; d'autre part, le gouvernement tunisien a fait montre d'une volonté politique forte, notamment depuis la promulgation de la Loi organique sur la recherche en 1996, de promouvoir la recherche scientifique pour accompagner la forte croissance du tissu universitaire et du nombre d'étudiants.

Pour autant, elle n'est pas exempte d'enseignements généraux. Le premier est le caractère crucial de l'indépendance de l'expertise scientifique vis à vis de l'autorité politique : sans elle, les mathématiques appliquées n'auraient ni vu le jour ni survécu au contexte du milieu des années 80, durant lesquelles la crise politique se doublait d'un discours où il n'y avait de place que pour la recherche développement et les « programmes nationaux mobilisateurs » qui n'ont jamais mobilisé au-delà de leurs concepteurs dans l'administration. Le second est que pour assurer cette indépendance, les scientifiques ont besoin d'une légitimité et d'une liberté d'action que seule la reconnaissance internationale de leurs pairs est en mesure de leur offrir. Le troisième est que si une agrégation fondatrice peut effectivement s'opérer au niveau de petits pays tels que la Tunisie, la diversité et la pérennité d'une activité scientifique ne sauraient en revanche être atteintes dans des cadres aussi restreints. La recherche scientifique est en effet internationale ou elle n'est pas. Pour y prendre toute leur part, les PVD ont un besoin crucial de regrouper leurs forces au niveau régional afin que leurs partenariats avec le Nord s'inscrivent dans une perspective de co-développement où chaque partenaire est gagnant, plutôt que dans celle de l'aide au développement. Ces partenariats sont en outre essentiels pour la recherche appliquée, dont la nature ne peut être que largement *prospective* et *anticipative* en l'absence d'un tissu industriel suffisant pour la mouvoir.

Nous décrirons de quelle manière ces différents paramètres, *a priori* contradictoires, ont pu être conciliés dans le cadre d'une stratégie polymorphe, croisant toutes les possibilités et partenariats tout en prenant soin de préserver l'indépendance de la décision. Le laboratoire LAMSIN[20] a constitué le creuset du développement de cette recherche appliquée de niveau international, portant sur un petit nombre de sujets phare, et s'exerçant en interaction avec un vaste réseau de partenariats. Cette recherche a nourri une formation doctorale en Mathématiques Appliquées mise en place au sein de l'ENIT[21] au début des années 90, elle aussi très ouverte à l'international, comme elle s'est nourrie d'elle. Les deux composantes ont progressivement gagné une large crédibilité internationale, dont les premières manifestations spectaculaires ont été l'association du LAMSIN à l'INRIA[22] (2000) et à l'IRD[23] (2002). Le franchissement de ces seuils a ensuite ouvert la porte à une meilleure diversification thématique de l'activité scientifique, ainsi qu'à sa structuration sur une échelle régionale plus vaste. Mutation que la labellisation « Pôle d'Excellence Régional AUF »[24] et l'obtention de la Chaire UNESCO « Mathématiques et développement », tous deux survenus en 2003, ont fortement accélérée. Nous décrirons l'articulation de l'ensemble de ces éléments - entre eux et avec l'extérieur – ainsi que la perspective désormais plausible qu'elle ouvre d'inscrire de manière organique la

[20] Laboratoire de Modélisation Mathématique et Numérique dans les Sciences de l'Ingénieur (www.lamsin.rnu.tn)

[21] Ecole Nationale d'Ingénieurs de Tunis (www.enit.rnu.tn)

[22] Institut National de recherche en Informatique et en Automatique, France (www.inria.fr)

[23] Institut de Recherche pour le Développement, France (www.ird.fr)

[24] Agence Universitaire de la Francophonie (www.auf.org)

composante mathématique appliquée maghrébine dans l'espace scientifique euro-méditerranéen. A n'en pas douter, celui-ci constitue la dimension incontournable pour assurer l'essor, la durabilité, et finalement la survie d'une activité scientifique de niveau international dans un pays tel que la Tunisie.

**Kayrooz Carole**

## *"The role of autonomy in social science research: the view from UK and Australian universities".*

This presentation is based on a collection of essays 'Autonomy in social science research: The view from UK and Australian universities' edited by Kayrooz, Akerlind and Tight (Elsevier 2007). As editors and contributors, we have increasingly debated the effect of pressures on autonomy. These pressures include the massification of higher education post World War 11, followed by the economic downturn of the 1970's, and the trend towards globalisation. The subsequent decline of public funding for universities has led to intense institutional competition, increased engagement with industry partners and the commercialisation of university research. At the same time, societal and governmental calls for accountability have placed new perfomative stresses on universities and their members (eg. Tight, 1988a; Slaughter and Leslie, 1995; Marginson, 1997; Vidovich and Currie, 1998; Marginson and Considine, 2000). These pressures have affected profoundly UK and Australian universities' structures, cultures and practices, and in particular, their integration with the external community (Schuller, 1995; Smyth, 1995).

As a further accountability requirement, national assessment of research quality is due to be implemented in Australia in 2008 in the form of the Research Quality Framework (RQF). This is similar to a scheme in force in the UK since 1986, the Research Assessment Exercise (RAE). It is timely to speculate on the likely effect of the Australian assessment exercise on the social sciences with respect to the UK implementation and in the context of reported deterioration in freedoms experienced by academics and institutions across both countries. The Australian university policy framework can provide a protective mechanism for individual and institutional freedoms in the implementation of the RQF. This paper will review several Australian university policies for their protective relevance to the emerging context. An outline of benefits and risks to autonomy is essential to convince others, notably government and university administrators, that individual and institutional autonomy play an important role in a pluralistic democracy.

**Khasawneh Mohammed A. & Malkawi Abdullah I.**

## *"Gearing academic research endeavors towards achieving sustainable development in third world countries"*

Tertiary education in the developing world, in general, and around the Arab world, in particular, has witnessed a pronounced downturn in recent years. The decline in the quality of delivered product from these tertiary systems serves as a direct indicator to the lingering issues that pose some pressing needs to be addressed and coped with seriously and adequately.

As most university systems in third world countries are comparatively new, and are more qualified to join the domain of teaching-only institutions, it is rather difficult to find academic institutions in the developing world that can readily fulfill the status of research-strong institutions. With the witnessed recent downturn, academic institutions in the third world can neither reap properly the status of teaching-only nor research-strong institutions! Furthermore, because of the lack of stringent requirements by legislative bodies in developing countries on academic accreditation, a great many number of academic curricula have gone off-track in keeping apace with what a given academic curriculum under a specific domain should be like. This has drastically impacted the academic performance of university systems in an adverse way; where the binding force to update academic curricula in the developed world lies primarily with efforts undertaken to keep academic curricula current and coherent with standardized accreditation requirements, one would find little reason to pursue such venues in the developing world, especially that acquiring some form of recognition by means of international-grade accreditation normally requires prohibitive budgets and efforts that only few of the academic institutions involved are willing to undertake.

In the absence of stringent requirements on acquiring accreditation, the end product of the process, being the graduates, ends up in many cases not market worthy and face many challenges in securing and retaining jobs in highly competitive job markets. The issue is further compounded by a lack of industry-grade research since the underpinning economies cannot support real industries, and where industries exit, they only are considered as light industries that cannot rise to the status of real or core industries; traditionally, research-strong institutions have worked around industry bases that can, also, foster academic research. Academic institutions with strong industry-grade research bases have long been known to support quality teaching efforts and to produce the graduate of the right quality to suite the job market needs.
Countries with no core industry bases can still compete satisfactorily when properly guided, initially, through partnerships with countries that have them. When India, around the Mid 50's, for instance, decided to industrialize its economy it set out by creating links with world-class academic institution in the US. In just under three decades, India managed to get hold of a

significant share of the global Software Industry market that many countries in the third world aspire to follow the Indian model. Ireland poses yet another example at transforming its economy into an industry-supported one; in just few years Ireland, with its tiny population of 3+ Million, managed to transform itself into one of the largest software exporting nations world-wide towards the late 90's. Ireland now exports around $40 Billion worth in software annually, where its economy once depended heavily on agriculture

In this paper, we propose a model, which when followed by the incumbent third world countries, is bound to transform agriculture-based or natural-resource based economies into industry-supported ones. The focus would certainly be on tweaking existing academic systems in third world countries towards fulfilling the needs of some suitable industry bases for the underlying economies and the supporting markets. This paper will directly address Research Capacity, Productivity, and Utility within the underlying academic institutions as applies to transforming rather primitive economies into economies that can foster some core industry that would eventually lead to some form of sustainable development for the given country/ies involved.

**Kirsch Max**

***"Universities and the generation of knowledge: knowledge for whom?"***

The author argues in this paper that the traditional role of Universities as generators of benign knowledge generation for the cultural benefit of individuals and the populations in which those individuals are a part is now being challenged. The primary drivers of this change are managers of globalization, the war on collective activities and the neo-liberal policies that have been created to justify and rationalize the changes that globalization has produced.

The result of these struggles have been a more corporatist stance in education in the capitalist intensive countries, where students are referred to as customers and professors are rated by the production, in numbers, of their research papers and the ratings of their student evaluations. Job security, once an assumption, is no longer a given. Significantly, public education is no longer seen as a right and the underfunding of universities, like secondary education, has resulted in the deterioration both of educational pedagogy and the physical plants in which universities and colleges exist. While public universities deteriorate, a few elite universities see growing endowments and a more elite student body and professorate. This pattern in the public/private domain is reminiscent of research and education in the neo-colonial states during the 20$^{th}$ century as well as the position of education and research during the period of early industrialization in the capital-intensive countries.

While post-secondary education in the public sector has been devalued, there has been a consequent growth of bureaucratization of research activities. It is now usual for budget and dean's offices to make decisions regarding the direction of professorial research and publication, resulting in the decline of research methodologies in disciplines in which the growing bureaucracies have no expertise. The author argues that the only way that this progression in the deterioration of research and education can be deterred is by the unionization of teachers and professors and the education of the public on the importance of universities and colleges in preserving an educated public for the maintenance of collective rights.

**Kreimer Pablo & Meyer Jean-Baptiste**

## *« Tous égaux au sein des réseaux ? Certains le sont plus que d'autres. La collaboration scientifique à travers les réseaux internationaux : une démarche latino-américaine »*

### 1. Le problème et son contexte

La présentation proposée part du constat suivant : la recherche scientifique et son rôle dans le développement ont pris une importance accrue. Pourtant, les problèmes de développement auxquels sont confrontés les pays du sud semblent rarement traités par la recherche qui s'y effectue. Une hypothèse forte d'explication sera ici émise à ce propos. L'inadéquation (*abstract relevance*) de la recherche locale périphérique vis-à–vis des problèmes sociaux, économiques et environnementaux est liée aux pratiques scientifiques, fortement déterminées par les modalités de coopération internationale provenant de la recherche émanant du centre. Un cas particulier amplement démonstratif permettra de révéler cette logique : celui de la maladie de Chagas, pathologie tropicale prévalente en Amérique Latine.

### 2. Le cadre politique actuel

Les tendances globalisantes des dernières décennies, comme la massification des communications électroniques, ont sans doute renforcé l'intensité des collaborations entre chercheurs et ont créé la fiction d'une autonomisation des contextes spécifiques dans lesquels ils sont insérés. Ceci semble comporter un élément de « démocratisation » dans les rapports universalisés en ce qui concerne la production des connaissances.

Mais l'effet le plus important provient des nouvelles formes de définition des politiques et du financement de la recherche. De nouveaux instruments sont issus de la concurrence entre les États-Unis et l'Union Européenne. Face à l'énorme masse de ressources que les Américains ont destiné aux activités de R&D par le moyen des agences publiques et privées, l'U. E. a mis en place un ensemble d'initiatives de financement différentes de ce qu'elle avait mené jusqu'aux années '80. Les derniers Programmes Cadre privilégient des méga-programmes réunissant des acteurs nombreux scientifiques mais aussi industriels, réunis, par exemple, dans des « Réseaux d'excellence ». Ces concentrations incluent volontiers des équipes de pays tiers et notamment du sud mais dans une position minoritaire et subordonnée. Elles se trouvent ainsi captées et orientées vers des problématiques, des priorités et des objectifs éloignés des préoccupations de leurs milieux nationaux.

### 3. Résultats de recherche appuyant cette analyse

Ces tendances de la coopération scientifique internationale sont à l'œuvre et visibles sur le cas de la maladie de Chagas. En effet, malgré une recherche fondamentale menée localement et couronnée de succès, aucun nouveau vaccin ni aucun nouveau médicament n'a été produit depuis les années 70. Par conséquent, il convient de se poser la question suivante : pourquoi cet

ensemble considérable de connaissances prestigieuses, produites dans le contexte « académique », n'a pas été transféré au secteur industriel et/ou incorporé dans un ensemble de nouveaux médicaments ?

Le résultat d'une telle situation provient paradoxalement du fait que les chercheurs –biologistes, médecins, etc.- travaillant sur la maladie de Chagas ont réussi à s'insérer avec succès dans les réseaux internationaux. Ils bénéficient ainsi des ressources, d'une reconnaissance et d'une visibilité internationales, mais en échange, ils doivent travailler sur les sujets déjà établis par les *leaders* de chaque réseau. En conséquence, la construction de l'utilité locale des connaissances devient abstraite, dans la mesure où aucun acteur, aucun usager intermédiaire ne peut faire usage de ces connaissances, qui sont orientées vers les besoins des gros réseaux. Ceux-ci sont, à la fois, fortement déterminés par les états des pays industrialisés, les institutions supra-nationales (UE) et les entreprises privées des pays développés, qui pourront utiliser les connaissances en question.

## 4. Recommandations aux décideurs

* Mettre en relation la définition des besoins sociaux, l'établissement des priorités de production des connaissances scientifiques et les politiques de coopération internationale.

* Promouvoir des réseaux régionaux pour contrebalancer le poids des déterminants induits des acteurs des pays industrialisés.

* Réorienter la circulation à l'intérieur des réseaux, vers la périphérie.

La concrétisation des options évoquées dans la section antérieure peut s'envisager selon quelques modalités exploratoires.

Des accords régionaux de coopération scientifique et technique sont susceptibles de voir le jour et offrent de réelles possibilités aux pays qui y prennent part. Le cas du Cône sud latino-américain, dont les Etats viennent de signer un tel accord, en est un exemple.

Les diasporas scientifiques et techniques -réseaux de chercheurs et ingénieurs expatriés oeuvrant au développement de leurs pays d'origine- offrent de réelles possibilités. En ce faisant artisan du retour, souvent sous formes virtuelles à travers les TICs, de compétences élaborées et en même temps avocats possibles des demandes de leurs régions d'origine au sein des grands réseaux, ils peuvent réorienter les flux au sein de ces derniers, d'une façon moins unilatérale et mieux distribuée.

**Lebeloane Mokula Lazarus Donald**

## *"Increasing research capacity and productivity to facilitate improved university output. The case of UNISA"*

Research is one of the primary vehicles which facilitate development in any society. Universities serve as, among other things, as venues from which research is conducted to create knowledge and disseminate it. They also serve as venues at which research capacity is built. It is also in those venues, among others, that both research capacity and productivity are increased to facilitate improved output.

Like other universities, University of South Africa (Unisa) has one of its defining characteristics as the long term investment in the creation of new knowledge. Knowledge is also improved by adding the latest developments which come about through basic and fundamental research at Unisa. Unisa, like the rest of the universities in the world, also strives to increase its research capacity and productivity in order to improve its output.

This paper wishes to focus on increasing research capacity and productivity in order to improve output at Unisa. In order to do that, a brief background of Unisa will be provided. That will be followed by a description and discussion of what Unisa does to increase its research capacity and productivity in order to improve its output. Unisa's research policies and the management thereof will, among others, constitute the discussion. It is from the above description and discussion that conclusions will be drawn.

**Leisyte Liudvika**

## *"The effect of New Public Management on research practices in English and Dutch universities"*

This paper presents the preliminary findings of an international comparative study[25] of higher education policy influence on the basic units of knowledge production in biotechnology and history at public research universities. The aims of the paper are twofold: to find out how higher education reforms in England and the Netherlands have influenced research practices of certain basic research units; and, second, to explore how do basic research units respond to the posed pressures from the changing immediate and external institutional environment. The paper uses the interview data collected in 2005, supplemented with the document and secondary literature analysis. In order to understand change in the research practices of basic research units we explore four dimensions: teaching-research nexus, their freedom to choose lines of research, types of research and determination of research outputs.

Recent decades have witnessed changes in public governance. Modes of coordination and governance throughout Europe have evolved. Some have been inspired by New Public Management (NPM), which deliberately alters the structure and policy-development process in public-sector organizations with the purpose of making them more efficient and effective (Clarke & Newman 1997, Ferlie et al. 1996, Pollitt & Boeckaert 2000). The management models of the 1980s and 1990s entailed a much more direct ideological and political attack on institutional and professional autonomy of universities that could not be covered by political rhetoric (Meek 2002: 172-173) But the process of structural changes was not that simple centralization of power in higher education institutions. Henkel (2000) argues that there were parallel moves to decentralize, at least in the context in the UK higher education scene. In other words, a feature of management, "centralized decentralization", which is based on the assumptions that creative peripheries need strong central values and strategies, has gained importance. (Henkel, 2000: 27)

In the English case, the research practices have been influenced by higher education policies. After 1980s reforms, university management gained importance which brought an interventionist and less trustful approach to the university in England that challenged the practices of academics. The loss of control of academics here meant the restriction on their academic freedom and autonomy to some extent. The segmentation of academic activities showed an increasing emphasis on strategic research. This has lead to the further separation of teaching from research and certain restrictions of the research themes, since due to financial pressures, researchers have

[25] The study is a PhD thesis that looks at how shifts in governance influence research practices in biotechnology and medieval history in England and the Netherlands (to be completed December 2006).

to adhere to the research council's or other donors' strategic themes and be accountable to them for the results of the research. The increasing selectivity of research staff and further stratification of universities have been clearly visible in the English university system in the past twenty years. However, the adherence to disciplinary norms and acknowledgement of the importance of basic research have remained fairly strong in the academic self-governance in England. (Leisyte et al. 2006)

In the case of the Netherlands, the last twenty years can be described as the years of change and stability for Dutch universities. There have been two major changes. One concerns the universities' attitude and second concerns the organizational embeddedness of research. Universities are more tightly managed with a more commercial attitude. (De Boer et al. 2006) The influence on academic work, especially on research has been visible in the increasing evaluation of research, increased transparency with the help of accountability and push for the economic relevance of research. In general, the nature of scientific research thus has been changing. There is a structural transformation towards a team work, towards multidisciplinary research and towards international cooperation and orientation. Interestingly, the traditional disciplinary based research is still important in earning credibility for individual researchers as well as collectives. However, it is increasingly combined with the prestige gained from attracting projects with the third party donors, such as industry or business.

In terms of structural policies at work, the institutional stratification, the policy of "building on excellence" is a worrying trend expressed by weaker departments in both countries. England stands out as an example where institutional management is free to make decisions on redistribution of funds bridging the gap of "haves and have not's" as well as closing "unnecessary departments" in the extreme cases.

In terms of research activities, in both countries there has been the rhetoric of the relevant research for the economic development of the country, sometimes accompanied with the rhetoric of relevance to the larger society as well. This rhetoric was transformed into the reality by the change of values, attitudes and lack of trust in academics at universities.

**Marmolejo Francisco & Jaana Puukka**

## *"Supporting the contribution of higher education to regional development: lessons learned from an OECD review of 14 regions throughout 12 countries"*

Following decades of expansion in higher education, policy attention in OECD countries has begun to focus on the outcomes of higher education including how universities and other higher education institutions contribute to regional development. With the processes of globalisation and localisation, the local availability of knowledge and skills and the transfer of technology and innovation to SMEs are becoming more and more important. In recent years there have been many initiatives across OECD countries to mobilize higher education in support of regional economic, social and cultural development.

What is higher education's regional engagement all about? What are its drivers and barriers? What does it mean to the governance and management of higher education institutions (HEIs) and how does it fit with the pursuit of world class academic excellence?

Higher education institutions can and do make a significant contribution to regional economic, social and cultural development. In a globalised economy, the relevance of the various activities conducted in those institutions is growing in importance and is subject to increasing scrutiny. Too often, however, failures of communication between regional stakeholders and higher education institutions reduce the effectiveness of their teaching, research and public service efforts and limit the understanding at the local level of their impact. These communication failures are often associated with due to weak or unclear policy signals, and conflicting agendas.

In order to respond to this dilemma, the Organisation for Economic Co-operation and Development (OECD) has been conducting, during 2005 and 2006, a comparative review of how these issues are addressed in 14 regions across 12 countries, with the objective of reinforcing the partnerships between institutions and regions.

This paper attempts to draw preliminary lessons from the OECD study entitled "Supporting the Contribution of Higher Education Institutions to Regional Development". This thematic review project managed by OECD's Institutional Management Higher Education Programme (IMHE) involved the participation of higher education stakeholders, policymakers, businesses, and community based organisations in each of the fourteen regions studied.

Preliminary findings suggest that if countries want to be globally competitive, regional innovation systems need to be strengthened. In order to achieve this, cooperation between higher education institutions, public authorities and the business sector becomes vital. Currently, many regions are characterized by an abundance of activity involving higher education in regional

development in some way, but there is limited evidence of coherent action. It is also evident that there are often no proper incentives, indicators nor monitoring of the outcomes of this type of activity. Finally, a cultural change within HEIs is necessary since regional engagement, academic excellence, and research are often not seen as complementary activities.

**McGlennon David**

## *"Building research capacity in the Gulf Cooperation Council countries: strategy, funding and engagement"*

The UN Arab Human Development Reports used numerous indicators as evidence of weak progress towards the development of knowledge economies in Arab States, and recommended the consolidation of knowledge acquisition and its effective utilization as one of three key drivers for progress. But the Arab States are not homogeneous and national differences in performance, trends and policy responses require more careful consideration. The Gulf Cooperation Council (GCC) countries have developed world levels of GDP per capita and yet investment in R&D remains at developing world levels. This paper reviews developments in research, development and innovation performance in the GCC since the early 2000s, analyses current developments in higher education, particularly in Qatar and the United Arab Emirates (UAE), and proposes strategies for improvement.

The most recent international indicators related to research capacity have shown little or no improvement for GCC countries. For example, the 2006 Global Competitiveness Index (World Economic Forum) ranking of 125 countries showed competitive disadvantages for participating GCC countries that included quality of scientific research institutions (ranked between 49-117), industry / university collaborations (ranked 60-121), availability of scientists and engineers (ranked 60-96) and company spending on R&D (ranked 42-116). Additionally, the 2006 World Bank Knowledge Economy Index showed all GCC countries rated below the world average for the Innovation sub-index and the Education sub-index world rankings improved for the UAE and Bahrain only.

The development of research capacity and production is highly dependent on higher education in these countries as the private sector funds little R&D (UNDP 2002). With the exception of the UAE, funding of higher education is generally within or exceeds the range of 4-6% identified as optimal in developed economies (Steier 2003). And yet dis-satisfaction with the quality of education is high and research productivity is low. The UAE and Qatar have embraced cross-border delivery of higher education in recent years. The UAE has opened its doors to international providers and currently has at least 56 institutions in addition to the three federal institutions. Qatar has taken a different approach by inviting selected international institutions to establish single programs on one campus, with the stated vision of establishing Qatar as a leader in innovative education and research. The contribution to research capacity, production and utility of internationalized higher education is discussed.

The development of research capacity, production and dissemination cannot be analyzed in isolation of the economic development policy environment. Several GCC countries have

adopted a cluster-based development strategy by developing themed free zones and industrial clusters with the purpose of building critical mass in strategic industries. This strategy requires a number of key elements to be successful, including a highly skilled workforce of engineers, technicians and scientists, and strong basic research infrastructure in universities. The failure to concurrently develop these areas along with the physical infrastructure leaves some doubt on the sustainability of these ventures given the competitive global marketplace for skilled labor.

An integrated approach to developing research capacity is needed and, in the case of the GCC, the resources are available. A concerted effort is needed to develop university / industry / government interaction to establish a coherent, prioritized, well funded research strategy. A strategy is also needed to engage GCC nationals in the research endeavor, at scientific, technical and management levels, to ensure sustainability and relevance. This can be achieved by developing research based graduate programs within countries and by providing incentives for nationals returning from overseas graduate degrees to enter research employment rather than government management positions. The engagement of nationals will ensure that research capacity is linked to the twin needs of economic development and national employment through entrepreneurship and innovation.

**Muchie Mammo**

## *"The Challenges and opportunities of re-inventing higher education institutions as centres of research capacity building"*

If the assumption that nations require to enter into international competition is correct, there can be no argument that can be used to deny nations from building their knowledge base to create wealth. Academic capital or knowledge is now a necessary condition for making and creating the wealth of nations.

Nevertheless, higher education has often been seen as a luxury or even a 'white elephant' in poor countries. Knowledge bearers are often suspected to be no more than self-interested and distinct communities who use education to acquire power and money. In radically unequal societies where some may flaunt opulence whilst the many have difficulty surviving, it may appear that spending more on building the knowledge base of society may be a misguided venture. In fact, such unflattering considerations have been used to de-legitimising universities in Africa and more broadly countries that went through the process of structural adjustment. Sadly, this has deprived countries from relying on their universities to create a system of research based- higher education and human resource development.

Whilst these issues are important, they do not provide sufficient argument for countries to refrain from taking seriously the matter of building their science, technology and innovation capacity as part and parcel of national strategies and missions to create capacitated individuals, peoples and societies. It may sound counter intuitive, but it is precisely because of poverty that knowledge must be created, acquired and used to 'make poverty' history. Actions motivated to help the poor with good intentions may paradoxically create long term development problems. Instead of trying to adjust knowledge and universities to the situation of poverty, it is infinitely better and wiser to think of how knowledge can be created by conceptualising a nation's higher education and university system as capability generating innovative and experiment-laden institutions with missions of learning to learn as the core driving engine of the knowledge creation enterprise. What is needed is the innovative university to create the innovation economy and society by centring research capacity and research based education for training and creation of knowledge.

I shall use the example of the Globelics initiative with its regional correlates such as Africalics, Lilalics, Asialics and Cicalics to introduce a model of how researchers from the poorer world can plug effectively with existing international research networks. In addition how a non-costly and efficient model of building research capacity can be developed by encouraging a triangular communication of researchers and networks in the West, East and South will be explored.

The paper will concentrate on how to conceptualise the universities and other higher education

centres as research capacity building innovative institutions within broader national system of innovation.

How to bring this about in poorer economies with barely rudimentary national systems of innovation is a formidable challenge that will be explored. The challenge is thus to make the university a research university along with making the national system of innovation with mutuality and reinforcement.

It will be critical thus to contextualise and conceptualise the research capacity system within the broader national system of innovation in the sense of looking precisely what the Government, productive activities and university linkages are in terms a number of indicators.

I will then try to use the case study of the Globlics experiment as a research capacity building effort and come up how Globelics may facilitate both research capacity and system of innovation building in the poorer economies.

I hope to contribute and demonstrate a model of research capacity building using the Globelics initiative as an exemplar.

**Nouroudine Abdallah**

## *« La Recherche universitaire aux Comores: entre enjeux théoriques et enjeux pratiques»*

### 1) Adéquation et inadéquation des projets de développement et de la recherche universitaire aux Comores

Aux Comores, comme dans beaucoup de pays du tiers-monde, le développement au sens de l'amélioration des conditions de vie et de perfectionnement des moyens d'existence, est un enjeu central. On retrouve cette idée dans la plupart des discours politiques et dans les recommandations des différents partenaires internationaux. Toutefois, il est difficile de trouver la démarche à adopter pour faire converger les initiatives politiques, économiques, sociales...avec l'objectif de développement. La méconnaissance des réalités locales entraîne l'insuffisance ou l'absence de prise en compte de celles-ci. Quand les réalités sont relativement connues, il est difficile de trouver la démarche et la méthode pour intégrer les paramètres de ces réalités dans l'approche du développement.
L'institution universitaire, émergente aux Comores, est doublement concernée par ce problème. En premier lieu, si on considère l'institution universitaire comme un « projet » ou un « outil » de développement, il pourrait subir l'échec enregistré par beaucoup de projets de développement si elle ne parvenait pas à trouver l'adéquation nécessaire avec les réalités de la société comorienne. En second lieu, en tant qu'institution d'enseignement et de recherche, l'université est particulièrement concernée par la question du rapport entre l'action (transformation de faits existants) et le savoir (connaissance des faits et de leurs relations dans une situation donnée). La recherche peut favoriser l'enracinement de l'université dans la société en faisant des problèmes et des solutions de vie de la société, des objets de réflexion. Elle peut aussi participer à créer des conditions de changement dans la société en mettant en place des dispositifs de co-élaboration des savoirs avec divers partenaires.

### 2. La « participation » dans les projets de développement et de l'extrapolation vers la recherche universitaire

Les organismes qui interviennent dans le développement durable ont tenté de résoudre le problème de l'adéquation entre projet de développement et réalités locales en adoptant la méthode de la « participation » sous la forme du RRA (Rapid Rural Appraisal) puis de la MARP (Méthode Active de Recherche et de Planification participative). La constante dans les méthodes de la participation est l'implication des populations locales. Mais, l'insertion des acteurs dans une structure participative ne produit pas toujours les résultats escomptés.

*Est-il pertinent de parler de participation au sujet de l'université ?*

Si la méthode de la « participation » est une tentative de réponse au problème de l'inadéquation entre un projet et une réalité, alors il est pertinent de réfléchir aux conditions de possibilité pour la « participation » concernant l'université. Mais pour pouvoir poser judicieusement ce problème, il convient d'inscrire l'université dans un contexte où elle est une institution parmi d'autres institutions qui doivent former un ensemble cohérent. L'exigence de la participation des acteurs et des institutions concernées dans un projet est un problème épistémologique et politique qui doit être examinée sur deux plans : a) l'enracinement de l'institution universitaire dans la société et b) l'adéquation entre la recherche, les projets de développement et les besoins réels.

*Le modèle de fonctionnement de l'université ne favorise pas la participation*

Aux Comores, le modèle selon lequel l'Université est conçue ne permet pas toujours de mettre en œuvre une recherche utile qui serait pourtant conforme avec les orientations adoptées. L'orientation novatrice en matière de recherche se heurte à un fonctionnement et organisation qui restent conformes à un modèle universitaire classique. Des obstacles qui caractérisent ce modèle contrarient l'élan novateur concernant la recherche :

- Cloisonnement relatif entre l'université et la société : Conformément à sa vocation scientifique, l'université s'applique à travailler les concepts, mais elle peine à s'emparer des questions, des problèmes, des contradictions…de la vie sociale pour en faire des sujets et des problématiques de recherche.
- Cloisonnement entre les disciplines : Le cloisonnement des disciplines est partiellement lié à la façon dont l'objet d'analyse est perçu. Un fait théorique et construit est plus aisément désarticulé et analysé en tant que fait unidimensionnel induisant une réflexion unidisciplinaire. Au fil du temps, les disciplines se rigidifient et se cloisonnent.

A ce double cloisonnement, il convient d'ajouter deux autres problèmes :

- L'université est conçue selon des modèles étrangers : Les filières, les départements, les facultés, les diplômes, la pédagogie, les cours, les laboratoires de recherche…sont souvent les mêmes que ceux de l'ancienne puissance coloniale.
- La culture scientifique des enseignants chercheurs est décontextualisée : Les modèles théoriques, les méthodes…portent souvent sur des références étrangères aux réalités des pays d'origine.

Ces facteurs de décontextualisation ne permettent pas de mettre en œuvre une recherche qui participe à créer les conditions d'amélioration des conditions de vie.

## 3. Que faire pour favoriser l'utilité de la recherche ?

Une des manières d'inscrire l'université dans un processus qui rend possible une recherche utile est de lever les cloisons qui, en même temps, éloignent l'université de la société, séparent les disciplines les unes des autres et discriminent les savoirs académiques et les savoirs issus de la vie. Pour cela, il est nécessaire que : a) les structures de recherche créent des modes de collaboration avec des institutions dans lesquelles la vie des populations est gérée ; b) les chercheurs collaborent avec des acteurs qui n'appartiennent pas aux institutions classiques de production du savoir ; c) l'« inconfort intellectuel » consécutif aux deux points qui précèdent soit assumé par l'université et les chercheurs.
La question de l'utilité de la recherche se situe au cœur de ces rencontres à provoquer, de ces collaborations à trouver et de ces exigences à assumer.

*Valoriser des approches de recherche au sein de collectifs de « co-élaboration » des savoirs*

La participation dans les projets de développement est de nature à favoriser la réussite des projets de développement. Mais, il est important de réfléchir aux conditions de dépassement de certaines de ses limites. L'approche conçue en ergologie pour tenter de comprendre les situations d'activités humaines en vue de leur transformation éventuelle peut faire progresser la réflexion sur l'utilité d'une recherche articulée à des exigences de développement. Le « Dispositif Dynamique à Trois Pôles » développé dans cette démarche vise à rendre possible la production et la rencontre entre des savoirs académiques et des savoirs issus de différents lieux et de multiples formes d'expériences.

**Omosa Mary**

## *"Research utility and national development goals: the interplay between poverty alleviation strategies and social science research in Kenya"*

This is in response to the call for papers towards the forthcoming Global Colloquium of the UNESCO Forum on Higher Education, Research and Knowledge, scheduled for November 2006. The paper focuses on the extent to which social science research at the University of Nairobi has contributed to Kenya's national development agenda and poverty alleviation in particular. Discussions draw from research activities at the Institute for Development Studies, within the College of Humanities and Social Sciences at the University of Nairobi spanning a period of slightly over 40 years.

At independence in 1963, poverty was, alongside hunger and disease identified as Kenya's main developmental challenges. Currently, over 2.5 million households live below the poverty line and this translates to about one in two Kenyans. Three quarters of these poor people live in rural areas and majority of them are characterised by a lack of secure livelihoods, few assets if any, limited or no access to health and educational facilities, inability to plan their lives, and large families. They also constitute a majority among the landless, people with mental and physical impairments, female headed households, households headed by people without formal education, pastoralists in drought prone districts, unskilled and semi-skilled casual labourers, AIDS orphans, subsistence farmers, urban slum dwellers, and unemployed youth.

Over the years, government has pursued several policies with the aim of alleviating poverty. However, poverty remains elusive. Average incomes remain very low and the actual incubators of poverty are yet to be identified and adequately addressed.

This paper aims therefore to assess the extent to which social science research has been consistent with the country's development agenda. In particular, the paper looks at the relationship between Kenya's poverty alleviation efforts and the type of social science research that has taken place over the years. Among the topics covered are: the issues under investigation; the geographical coverage; source and type of data; and the mode of dissemination. It is generally observed that the research dissemination strategy has shifted over the years, moving from making of recommendations to government for uptake if they so wish, to the current mode where central government works closely with other stakeholders in the search for answers to developmental challenges. The paper concludes with suggestions on what is required for governments to truly embraced research as the starting point in the endeavour to realise national development.

**Osotimehin Folarin**

## *"Strengthening STI Capacity: the case study of Nigeria"*

Universities and other higher educational and research institutions in Africa are greatly endangered as statistics show that their research capacity and productivity have greatly diminished. Moreover, policy makers, industry and national financial institutions question their relevance as they have had very little impact on the development of the region where they are located. The paper argues that UN development agencies can contribute in addressing the external and internal factors which affect research capacity, productivity and utility by supporting developing countries' efforts to revitalise the higher education system as recommended in major reports such as the Blair Commission. Particular attention must be given to the strengthening of science, technology and innovation (STI) capacity.

The paper describes an on-going UNESCO-assisted science reform and governance programme for Nigeria which is an integral part of the economic reform agenda. A core component of the programme is a pre-investment analysis of the performance of the science and technology policies, programmes and institutions in the country with a view to identifying the measures to revitalise the system and increase its effectiveness in meeting society needs particularly for economic competitiveness. It involves self-evaluation of the government ministries, higher educational institutions (universities and polytechnics) and government institutes involved in science, technology and innovation. The goal is to develop a Plan of Action for Science, Technology and Innovation which be used by government as a framework for investment guidance at the national level and for dialogue with donors.

An important feature of the programme is the provision of policy advice, including in the design of institutional mechanisms for coordinating STI in Nigeria. The main mechanism proposed is a high-level science governance council to be chaired by the President of Nigeria. The major policy recommendations, proposed by a UNESCO International Advisory Board, which have been approved by the Nigerian government are: selection of six universities to be upgraded to the class of the top 200 universities in the world by 2020; creation of knowledge-based business zones in each of the 36 states of the country; and the creation of a $5 billion endowment fund for the establishment of the National Science Foundation of Nigeria.

The paper stresses that reform interventions will result in increase in contribution of S&T to GDP growth; improvement in the quality of research and innovation outputs; reduction of brain drain; increased business sector investment in research & innovation; attraction of research and innovation expenditure of multinationals to Nigeria; creation of high technology SMEs; and increased international funding of research. The main recommendation of the paper is that

NEPAD's African Peer Review Mechanism should include a "window" on science governance so as to integrate the higher education system in the national economy.

Keywords: Africa, African Peer Review Mechanism; Blair Commission, development agencies, innovation capacities, higher educational institutions, NEPAD, Nigeria, reform, science and innovation system, SMEs, universities, UNESCO.

**Oyewole Olusola B.**

## *"The Research and Development Centre (RESDEC) of the university of agriculture, Abeokuta, Nigeria. A model research coordinating effort in an African university"*

The University of Agriculture , Abeokuta, Nigeria was established in 1988. Within its short life, it has come to be rated as one of the best Universities in Nigeria. In the maiden and second Universities Research Fair organized by the National Universities Commission in Nigeria, the University of Agriculture, Abeokuta was rated in the first position as the best research University in Nigeria in 2004 and 2005. The major moving force to the success of the University in research is the Research and Development Centre (RESDEC) of the University. Funds for research were low but the University was focused in making research to be relevant to its mandate. Some constraints to the development of research in sub-Saharan Africa were highlighted. This report is focused on the vision, policies and management of research in the Centre which can serve as a model to many African Universities in view of the paucity of funds for research in the continent. Some of the strategies adopted by the centre to promote research include:

- Extra funding for research through internally generated revenues.
- Organization of training programme and Workshops that promote research –
- University matching grant for externally funded research
- Establishment of the Centre for International Cooperation and Linkages to support research collaboration and networking.
- Promotion of Annual Research Fair and local research extension festivals
- Collaboration with local industries and their involvement in the University activities.
- Special lecture series – Extended openly to any foreign researcher visiting the University
- Promoting active participation in national agricultural research networks
- Hosting of national research oriented meetings and conferences.
- Participation in national research fairs

Research productivity which is the recognizable output of research is an important concern to the University. The responsibility for assessing the Institutional Research productivity is hinged on the government and the government agency for regulating higher education and factors that are considered include:

(i) Relevance of research to local needs and developments
(ii) Local impacts as testified by local end-users
(iii) Students applications, quality and innovations
(iv) Contributions to local and international Journals, books and other publications.

The conventional method of assessing research productivity by the number of publications is in use at the University of Agriculture. However, there are additional requirements for quality and

relevance of publication which is usually ranked by at least two superiors, within the Faculty. A national exercise had been carried out by the National Universities Commission to rank local Journals and the ranking of the Journal affects the ranking of the publications. In addition to research journal publication, the University of Agriculture also introduce the assessment of research extension and the ability to attract external grants as criteria for assessing productivity, and the ratings of these equally assessed by at least two superiors in the faculty. The following suggestions were proffered for Promoting research productivity:

- Regular institutional staff research need analysis,
- Promotion of research leadership and management training programmes,
- Research environment, and infrastructural enhancement,
- Continuous Capacity Enhancement for researchers,
- Promotion of Linkages and Collaborations,
- Funding improvements,
- Research efforts recognition.

**Papoutsaki Evangelia**

## *"De-westernising research methodologies: alternative approaches to research for higher education curricula in developing countries"*

This paper will be looking at the impact of western research methods in training researchers in developing countries and how much of the research carried out in universities in developing countries is directly relevant to their needs and suitable to their socio-cultural context.

The paper focuses on research utility, which looks at research quality from a society's or a region's specific knowledge needs, placing more attention on external factors such as the role of, and the value attached to, foreign research training. The author is particularly interested in looking at alternative perspectives that reflect different socio-cultural contexts that can inform relevant research approaches alternative to the predominant western research paradigms.

Although one of the prerequisites in building high research capacity in a university is to have competently trained researchers, one needs to question what that 'competence' means and by whose terms. Research is more likely to benefit a society's knowledge needs if its objectives and priorities are determined in the country itself. Yet, most universities in the developing world are relying too heavily on western research approaches by relying on westerners to train local researchers and coordinate local research, by sending local researchers to a western university to receive education and by using teaching material produced by western academics in their curricula.

The paper is theoretically informed through emerging literature from different parts of the world that is affirming the existence or the potential for developing alternative ways of learning and distinctive understandings of local knowledge and the need to make them part of formal educational curricula.

There is a need to build on this work and encourage young local researchers to provide their insights on the role of research in their countries development and encourage them to seek local alternatives to studying their cultures and societies. There is an increasing need to generate indigenous research and address thus the lack of locally trainer researchers in order to balance the view of western researchers and the overpowering foreign and donor driven research agendas. The expansion of theoretical and research studies from alternative perspectives would contribute to developing interlinked indigenous/non western research cultures in various disciplines amongst these countries.

There is a need to acknowledge the significance of indigenous perspectives on research and discuss how to strengthen them through curriculum at HE level and re-examine western research methods as they reinforce dependency and unfit solutions to development for local cultures. It is argued that research is one of the ways in which the underlying code of western dominance as it is now expressed through globalisation and neo-colonialism is both regulated and realized.

The paper also reflects the author's interests generated by her experiences in teaching research methods and conducting research on issues of higher education curricula and communication developments in countries (south pacific, post-communist Central Asia) where western research models have not produced the desired outcomes. It is reflecting on the kinds of epistemology that underlie for instance survey research, and what happens when they are translated to a context that values the 'correct answer' rather than the 'diversity of opinion', 'group thinking' rather than 'individual opinion'. It is also reflecting on approaches to research that see objectivity and neutrality as a pre-requisite to conduct research which creates problems for local researchers that can do valuable research in their own communities by bringing their insights as insiders.

'Development' is included in the argument as the paper refers to developing countries mostly (in transition from one political system to another or in a post colonial condition) and most research in these countries is linked to or has an impact on development. Examples will be drawn mostly from the south pacific and the field of communication research.

The paper will look at different approaches (qualitative/quantitative, ethnographic action research, participatory research, social market research etc) and how these can be adopted in different socio-cultural contexts. It also discusses how higher education institutions can nurture research as part of their curricula in ways that nurture local research.

**Santoso Purwo**

## *"Managing transformation towards an international research university: lessons-learned from Gadjah Mada University"*

- Benefited from liberalization policy, the tradition of autonomous research communities within Gadjah Mada University gathered momentum in improving its institutional capacity to perform as a world-class research university.
- Reviewing how the university dealing with internal problems as well as external challenges allows us to important lessons. This is particularly important to situate a leading university in the developing country within international research system.
- The ability of GMU in boosting its research capacity relies on its ability to bring together a sense of well-managed institution and autonomous atmosphere. Having restructure the management scheme, the governing body gears at employing a market-based instruments by the way of standardizing research quality and research institutions, and ensuring the supply side (research activities within the university) meet external demand. In doing so, GMU has no luxury competing with Research University in the developed countries, which perform as vanguard of science and technological development. Research capacity building at GMU means enhancing the capacity to solve the problem its counterparts in particular and resolving the pertaining problems of developing countries.
- The best way for enhancing GMU's research capacity is by the way of facilitating internal reform which eventually improve its ability to deal with developing country's issue.

**Sanyal Bikas C & Varghese N. V.**

## *"Research capacity of higher education sector in developing countries"*

The present phase of development is characterized by knowledge-based production. The knowledge economy places greater value and stronger emphasis on the production and distribution of knowledge – R&D. Knowledge production used to be an activity coordinated by the public authorities and public universities played an important role in R&D activities. At present, knowledge production in many developed countries is critical for industrial production and has become an important corporate concern.

Based on the available sources of information, this paper argues that the knowledge divide is deep and is heavily tilted in favor of developed countries. Developing countries suffer from a lack of both financial and human resources in R&D. They need to improve their capacity to produce knowledge domestically and absorb the knowledge produced elsewhere. This can happen when allocation of financial resources to R&D activities increases, human resources are trained in adequate numbers and an institutional framework to carry out R&D activities is created.

While universities play a less significant role in funding and carrying out research, their role remains unchallenged in the area of research training. Changes in the investment priorities in education during the structural adjustment regime paved the way for a decline of higher education and research in public institutions of higher education in developing countries. There is a need for reviving and strengthening the university system in developing countries to strengthen their research capacities. This change should be reflected in resource allocation to higher education and research, and in the provision of opportunities to expand graduate programmes and improve female participation rates. The experience of developed countries shows that the private sector investment in R&D increases when the research environment and facilities improve in the country. Therefore, the initial investments to strengthen research capacity in developing countries have to come from public sources.

**Siemieńska Renata**

## *"Research productivity in Polish universities and its determinants at the beginning of the 21st Century"*

The second half of the twentieth century brought an enormous rise in the education level in almost all Eastern European countries, especially in Poland. Education became a mass phenomenon. Many new universities (mainly private ones) emerged, the number of their employees, engaged in research and teaching, increased.

The social structure of students, as well as the structure of research and education staff, is changing [Scott, 1995]. Politicians and businessmen are looking for experts and advisors in the academic world. They engage in complex relations with universities, where they earned their diplomas, as well as with other persons, who completed their education at the same university, and later become the members of political, economic and cultural elites. Being "products" of specific universities, due to positions occupied in the structures of power and significant interest groups, they influence the reality, opting for certain solutions in politics and economy, which are often consistent with the theoretical concepts dominant at the universities, where they used to study. They also allocate the resources for research and they have some say with regard to the education policy, and they support it selective [for instance, Dickman 1993, Nisbet 1980].

The decision of choosing a certain direction in education, and, which follows, the type of strictly academic career (which can be, nonetheless, based upon various reasons), combined with roles performed outside (as experts, politicians, businessmen, managers etc.) or treated as a stage in the career outside the academic world, are conditioned by many different factors during different stages of education and after.
The basic hypothesis that will be examined here refers to the relation between the situation of science and education offered by universities in Poland in the nineties of the 20s century and at the beginning of the 21st century and the course of academic careers. The decrease of funds for education and research, as well as worsening of standards of living of persons employed by these institutions results in a slowdown of academic careers, measured by time intervals between earning consequent university degrees.

Another hypothesis refers to the changes in structure of the discussed profession. The worsening situation of its representatives with regard to two aspects – chances to conduct scientific research and achieving satisfying material remuneration for work at research institutions and at universities – results in a change of structure of the employees. Due to these reasons, as well as in effect of the increase of the percentage of women among the students, the number of women working as university lecturers is increasing, although slowly. A question arises (1), whether we

have to do with a well-known pattern, according to which when a material situation of a given professional group worsens in comparison with other groups, men withdraw from engaging in this type of work, shift to another type or try to work out an adaptation strategy, which will allow them to counteract the lowering of the standard of living quite effectively, or (2) whether it is a tendency of equalization of opportunities of men and women in a profession, traditionally perceived as designed for men. Morever, changing situation on a labor market, growing unemployment makes academic career with its relative stability again attractive for those who in other situation would look for jobs outside of academe. In other words, several men decide to stay in higher education institutions shaping different proportion between men and women working in higher education institutions.
The course of academic career is shaped differently due to different social roles, played by women and men outside their professional careers. Number of employed women as faculty members varies depending on type of higher educational institutions (technical, economic, medical etc) mirroring students' segregation in the areas of study during the last decades.

The unsatisfactory conditions in academia cause that domestic brain drain and migration abroad (temporary or permanent) significantly change structure of the faculty members and the scientific productivity of Polish universities.

The paper will show main results of analyses of statistical data and the public debate on the situation of academic institutions nowadays in Poland and findings of two national representative studies on scientific productivity and its determinants (1) full professors - conducted by the author as part of the cross national study in 2003 and (2) parallel study on the national representative sample of young scientists (in 2005) showing individual, social and institutional conditions (role of participation in international cooperation, obtained grants, number of publications etc).

**Vaezi Seyed Kamal**

## *"A Review of monitoring and evaluation. Roles in research development program"*

Sustainable development & improvement of every country is due training, preserving & maintaining its technological, research & scientific assets, researches improvement, promotion scientific technological development of country and finally its widespread sustainable development. Therefore identifying making contact and supporting this powerful stratum of the society in order to make use of their scientific cooperation and participation in various fields to produce science and technology is a strategic trend for sustainable development based on a national research development program. This study analyzes the monitoring and evaluation of state research development program, evaluation and monitoring procedures and standards, including the different actions taken by evaluation and monitoring agencies and association. (Governmental and non governmental).

In an indirect process for determining the eligibility of research institutions to participate in state development research programs it has directed that institutions are eligible for participation if they meet two fundamental conditions:

1-Be able to evaluate ,monitor, analyze and predict fundamental changes in science and technology in order to keep abreast of the global fundamental changes in science and technology.

2-Be able to develop priorities plan to organize technological activities of the country to reengineer nationwide development of science and technology and to provide a sustainable structure for research development program.
Evaluating the national research system for developing strategic priorities towards science, research and technology emphasizing on decentralization and independence of universities and research centers in terms of administrative, financial, employment and organizational affairs .It also devising a comprehensive assessment system for research and technological affairs in national level For improving information technology through supervision of research programs for promoting the role of scientific associations and research organizations through their involvement in the decision-makings and supervision processes and also planning to boost the share of public and private research in the GDP and the state budget.
In this process supporting the implementation of state-run research projects by universities and research centers as a means to diversify their financial resources and also encourage faculty members to play more effective parts in national research activities are a strategic career.

By using a systems analysis approach based on role definitions, the problems of development and utilization of national research development program can be monitor in logical perspective. This perspective fall into two major categories:

- Those relating o effectiveness oriented approach.
- Those relating to efficiency oriented approach.

The first set of roles can be verify by making some changes in the design and performance of agencies providing various kinds of researches and also research monitoring actions and also to provide effective bridge between the functional elements .
In this process monitoring and evolution of research development program should be better balanced and more effectively geared to the national needs for national development.

Based on the state national development program a large proportion of resources are devoting to the research section and it could be served best by improving the efficiency of the exiting evaluating system.
The second set of categories can be alleviated by a major change in national development objectives which would give very high priority to a research development program of rural transformation.

It emphasizes the choices made by monitoring and evaluation agencies at different times as how they would conduct evaluations and what standards they would use.
This issues and circumstances are surrounding the initial development of evaluation and monitoring and major changes in procedure and standards. Also attention is given to some of the challenges that presently are posing for evaluation procedures as growing complexity, globalization and advances in instructional uses of electronic technology allow new forms of research provision to emerge.

The exiting policies need to be re-examined, and new policies developed. While research innovations must be recognized, it is also true that monitoring agencies have greatly assisted their career. In this process monitoring agencies serve as a public brain system to advocate changes that will improve research practice.
For national research development program monitoring and evaluation agencies need necessary process of innovation and ability of response to changing circumstances to move forward in a national oriented way. These centers may experiment with new approaches but must submit their plans to an outside review by other public or non-public evaluation agencies.

The recommended items for monitoring should be assessed alongside an organization's role for national project, including whether they are fulfilling the responsibilities including monitoring commercial research.

By such methods, monitoring and evaluation agencies not only guide the development of innovative practices but they also serve to lend credibility to emerging forms of research innovation. They need to set certain terms of good practice and encourage certain types of practices, while other practices are discouraged or banned. This represents a soft approach.

**Varghese George**

## *"Declining trends in science education and research in Indian universities"*

Universities are knowledge based organizations whose functions are largely confined to teaching and research. They are designed to operate to discover and disseminate knowledge by possessing significant and relevant expertise in all disciplines. India has a very vast structure of education and its higher education sector is now highly advanced, compared to its neighboring countries. The vast network of state funded Indian universities appears to be sinking into a state, where academic performance both in teaching and research become partially marginalized. Erudition and scholarship are no longer pre-requisites for advancement through academic ranks. Research both in science and the humanities, gets back the backseat and mediocrity has become glorified. A regressive trend has been observed in the past few years in science education in universities. Science seems to be losing out to other disciplines, particularly the professional courses in attracting students. The recent trend observed in secondary and tertiary education sectors is toward non science courses. Inadequacies in the policies of the government, negligence of its importance by political parties and social organizations, etc., have accelerated the decline. The widespread impression among students is that unlike professional courses, a career in basic science is not lucrative.

Universities have long abandoned the accent on research and have become mere teaching centers. Research aptitude in students is not properly developed during their course of study. Their curriculum is neither research oriented nor updated. For many reasons majority of teachers with doctoral degrees in science are unwilling to undertake research projects or collaborative research. The academic ambience persisting in many universities do not encourage the research pursuits of faculties. Research management in universities is another very serious problem faced by many Indian universities.

Careful analysis of the situation is necessary for elucidation of this trend and finding effective strategies for strengthening science education. An extensive study was made to establish the nature of science education of the Indian universities and the current trend. The study focused on the following topics.

- Policies and practices existing in the higher education sector
- Analysis of the pattern of enrolment in science degree programmes in Indian universities
- Centrally and state funded universities and their academic performance
- Quality assessment mechanism
- The central funding schemes in research and their distribution among universities and research institutions

A model survey was conducted in this context to explore the mindset of the students and teachers about the issue. Students from selected colleges who study science as major was given a questionnaire for extracting their opinion towards the present system of education, the course, their aptitude towards research and similar issues. Teacher survey reflected their attitude towards teaching and research. The sample survey indicates many inadequacies at the level of teaching and learning. Remedial measures are necessary for rejuvenating the interest in science and for ensuring productivity. The conclusions made here suggest immediate action on the following areas.

- Teachers must be equipped to design the curriculum with interactive teaching component giving emphasis to research.
- Competency of the students should be measured at a collective level
- The career in science must be made attractive
- Support must be given to application driven research in basic science
- Research management strategy must be strengthened.
- Teaching work and research work must be separately counted
- Research productivity must be rewarded
- Identification and exploitation of intellectual property right

Long term planning and flawless polices are required to sustain the existing talent and induct new aspirants to meet the challenges of a competitive world.

## Varis Tapio

### *"Global university in the knowledge societies"*

As noted in the UNESCO Report on Knowledge Societies (2005) there is a general agreement of the appropriateness of the expression "knowledge societies", the same cannot be said of the content. We have to ask which type of knowledge are we talking about. Are we endorsing the hegemony of the techno-scientific model in defining legitimate and productive knowledge. Also the term "Digital Age" has been questioned as a Western concept and some speakers prefer multicultural world instead. Art is needed as means to learn from another culture. Furthermore, there are grave imbalances and obstacles that mark the access to knowledge both locally and globally.

However we define the 21st century societies there are some trends that seem to have consequences in all spheres of life. Globalization and digitalization have fundamental consequences in educational and learning life, working life and in governance. Not only money and technology are moving but markets and partnerships become global and labour becomes increasingly mobile. The issue of multiculturalism becomes central and people live in media environments of multiple identities. There is also the threat of becoming marginalized and excluded.

We are facing a third major educational invention in technology. The first was the phonetic alphabet, the second printing, and now the third is telematics, which means computers connected to networks. There is a need for a new global strategy for promoting the role of information and communication technology (ICT) in different fields of the working life of the emerging knowledge societies and developing educational and training approaches on how to learn the use of ICT and become digitally literate in the spirit of sustainable development.

Traditional alphabetical competencies include basic operational competencies related to texts, psycho-cognitive competencies related to alphabetic signs, basic reading and writing, basic mathematical and textual comprehension, and socio-communicative competencies. Digital competence include basic operational competencies related to screens and computers, psycho-cognitive competencies related to computer signs, basic computer competence, interactive media and on-line competence, and global socio-communicative competence associated to cyberspace.

Digital literacy is a fundamental element of the knowledge society. In Europe it is now seen as a right for all. Ensuring that everyone has the necessary skills, competences, experiences and attitudes to make effective use of ICT is probably the biggest challenge of all. The illiterates of the 21st century are not those who cannot read and write but those who cannot learn, unlearn, and relearn. Different terms are being used in different countries to refer to media education and

media literacy. While the educational approaches are discussed in some countries under the title "media pedagogy" and traditional literacy is extended to include "media literacy", "digital literacy", "technological literacy, "visual literacy", "cultural literacy" etc a more broader approach has been also developed under the title "media competence." A most recent demand comes come e-media and e-learning which covers a wide set of applications and processes such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration

It is widely understood that the most important skills of the future would be communication skills. Today everyone is able to access vast amounts of data without a mediator. Critical thinking skills are needed as a productive and positive activity. Critical thinkers see the future as open and malleable, not as closed and fixed. They are aware of the diversity of values, behaviours, social structures, and artistic forms in the world. Critical thinking is a process, not an outcome, and it is emotive as well as rational.

According to the UNESCO International Institute for Educational Planning higher education institutions worldwide face significant challenges related to providing increased access, while containing or reducing costs. Meeting increasing and increasingly varied demand for quality higher education is an important consideration in policy debate and institutional development in many countries. New developments in higher education – from virtual universities and cross-border education to e-learning, blended learning and open educational resources – all speak to the efforts on the part of the traditional higher education community, as well as new providers, to address the challenges they face in increasing provision. (Unesco International Institute for Educational Planning 2005)

Globalisation is consolidated by the extraordinary invasion of higher education by new technologies, especially the Internet. The development of communication and information technologies makes it possible for distance teaching institutions to strengthen their position in the educational landscape. They also pave the way for lifelong education for all and at the same time are spreading the traditional universities, more and more of which use distance teaching methods in their activities, thereby making the distinction between the two types of institutions virtually meaningless. There are an increasing number of university networks of this kind all over the world, and the use of computers in the learning process, access to the Internet by students as a vehicle for self-directed learning, educational broadcasting and video-conferencing are all being stepped by.

In the information society, knowledge forms the foundation for education and culture and constitutes the single most important production factor. Information and communications technology significantly promotes interaction and exchange of information between individuals, business enterprises, and other organizations, as well as the provision of, and access to, services. The extent to which the information society is implemented in schools and libraries, health care,

the promotion of business and industry and other administrative services, as well as enhancing transparent decision-making, largely depends on the decisions made and the measures taken by local authorities.

The vision is a society, which develops and utilizes the opportunities inherent in the information society to improve the quality of life, knowledge, international competitiveness and interaction in an exemplary, versatile and sustainable way.