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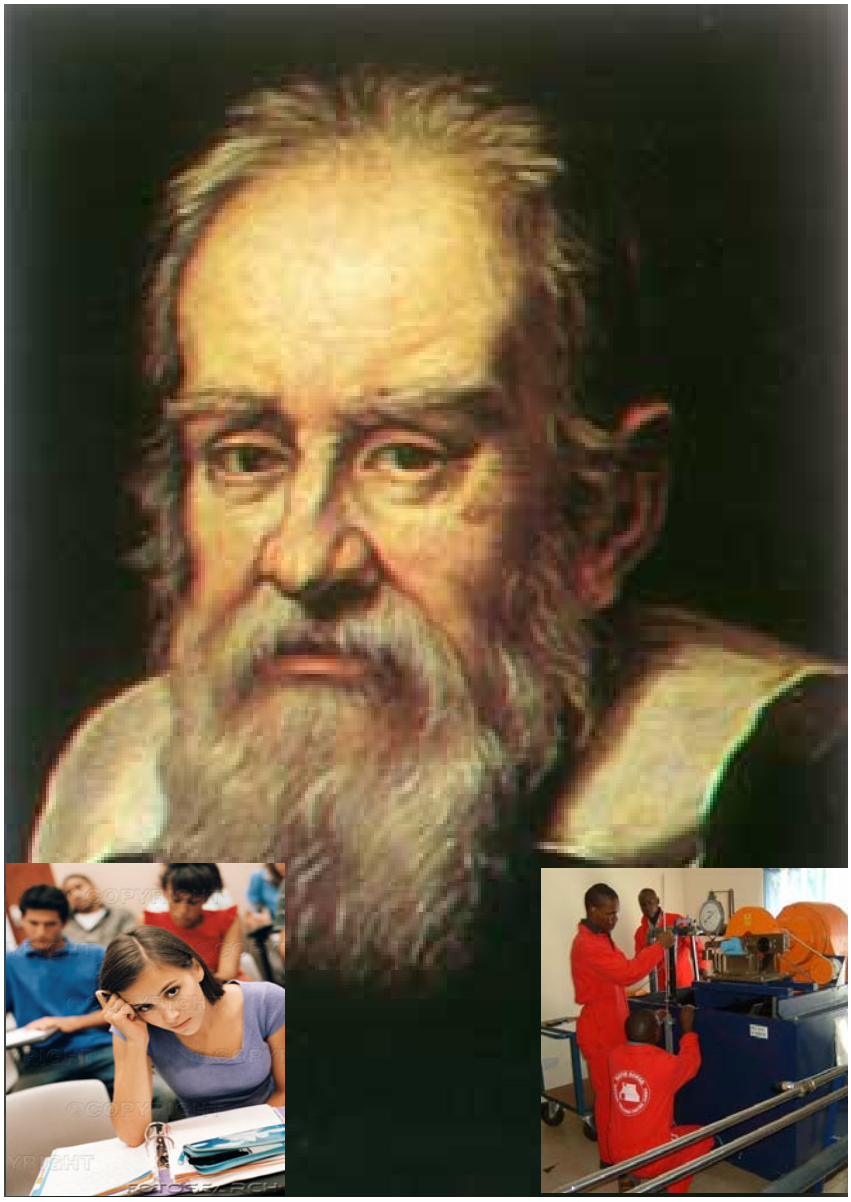

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INSIDE THIS ISSUE

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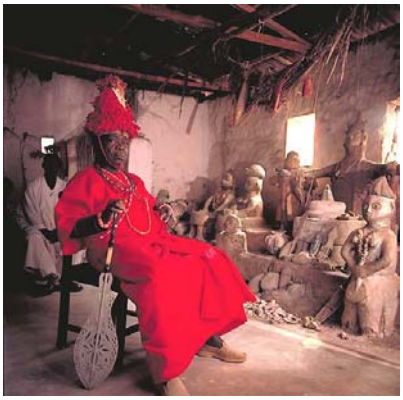

Front page photo: Galileo portrait from Rice University)

The Triple Helix of Innovation: Towards a University-Led Development Strategy for Africa

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Abstract

In knowledge-based societies, the interaction among a Triple Helix of university-industry-government is the source of innovation and development. Within a triple helix regime, university-government interactions can help jump-start the creation of firms if they are absent, or if present, expand their growth. The triple helix development model for Africa represents a radical departure from the conventional development models that has separated the three institutional spheres—higher education, industry and government and has consistently left out universities from development strategies and policies. The paper outlines the triple helix model of innovation and development and the emerging entrepreneurial university model as an academic reform strategy in the developing world, whereby higher education is refocused on issues of development, entrepreneurship and innovation.

Introduction

A Triple Helix of university-industry-government as relatively equal interdependent and interacting institutional spheres is increasingly becoming the requisite basis for innovation and development in a knowledge-based society. The emergence of a double helix of government-industry relations—a bi-institutional model of society—represents the great transformation of the 19th century. [1] On the one hand, the market became the organizing principle of social relations while, on the other, government moderated exchange relations to insure a living wage. The emergence of a triple helix of innovation, with the university as a key player, is the great transformation of the late 20th and early 21st century.

What is peripheral and what is central to innovation has been transformed in recent decades. Institutional transformation is reflected in the development of new legal frameworks that provide a basis for resolving conflicts that arise from the emergence of new modes of production. The Speenhamland Law of 1795 laid the basis for social relations in the UK's emerging industrial society, placing limits on exchange relationships in labour and guaranteeing workers a living wage. The US Bayh—Dole Act of 1980, and similar laws in Japan, Denmark and other countries, provided a framework for knowledge-based innovation, guaranteeing the sharing of intellectual property rights (IPRs) among academic inventors and their universities that provide the infrastructure for science-based innovation.

A stable regulatory framework for knowledge-based societies is a necessary but not sufficient condition for organizational innovation. The transformation of higher educational institutions, in particular universities, whether through internal or external impetuses from a teaching to a research and to an entrepreneurial university is a key element in creating a viable triple helix. Government actor's focus on innovation as well as traditional government activities is also a prerequisite. If knowledge-based industries are lacking; university-government interactions can help jump-start their creation. We argue that for Africa to integrate itself into the global knowledge economy, its development agenda should be organized around reinvigorated higher educational institutions that foster triple helix interactions.

1 The triple helix model

The triple helix model places a greater emphasis on interaction, external linkages and collaboration. It represents a radical departure from the conventional development models that has separated the three institutional spheres and has consistently left out universities from development strategies and policies. The new focus in bringing these three complementary but distinct spheres to work in tandem reflects an assisted linear model of science and innovation policy. [2] As a result, the triple helix system has altered the development field. It is now possible for technology transfer to play a residual role in support of the development of indigenous technological capability through learning by production, learning by adaptation and learning by innovation. [3] Conversely, the model can also be used to apply advanced science and technology in biotechnology and information technology to development problems in least developed countries.

The potential for future economic development increasingly lies within higher educational institutions, not only because of their research potential that may be underutilized, the so-called "European paradox", but also, because higher educational institutions have the students, an ever-renewing source of new ideas. Students may also be trained and encouraged to be entrepreneurs and be inspired to take up new roles as firm founders in a society lacking a strong entrepreneurial tradition, like Brazil, or add value to natural and raw agricultural product-dependent societies like Africa. New sources of economic growth are required to propel Africa and integrate it into the global knowledge economy. In current international competitive circumstances, innovation is too im-

portant to be left to the individual firm, or even a group of firms, the individual researcher or even a cross-national collaboration of researchers. Innovation has expanded from an internal process within and among firms to an activity that often occurs in other institutional spheres as well. It may take place within institutional spheres not traditionally thought of as having a direct role in innovation, such as, universities. Thus, while universities were in the past seen primarily as a source of human resources and knowledge, they are now being looked to for technology as well.

Many universities across the globe have developed the internal organizational capabilities to formally transfer technologies rather than relying solely on informal ties. Universities are also extending their teaching capabilities from educating individuals to shaping organizations in entrepreneurial education and incubation programs. Rather than only serving as a source of new ideas for existing firms universities are combining their research and teaching capabilities in new formats to become a source of new firm formation, especially in advanced areas of science and technology.

2 The triple helix transition

The triple helix begins from different starting points: separate institutional spheres that operate apart from each other or with one encompassing and directing the others. There is a global trend towards a mode in which the various spheres are autonomous but overlapping, not entirely distinct but not completely merged either. As this transformation takes place there is a shift from bilateral to trilateral interactions, from single and double helixes to university-industry-government joint projects. Examples include, the land grant universities in the US, the research schools program in Sweden, moving PhD students into firms to do their dissertations and firm researchers into universities to obtain higher degrees. In Ethiopia, efforts are underway to upgrade traditional industrial clusters by connecting them to foci of government funded research located at universities and research institutes that are encouraged to become more entrepreneurial. [4]

A typology of innovation systems incorporates various national perspectives and in triple helix terms, we can identify three such categories. First, there is a 'statist triple helix' in which the state encompasses academia and industry and directs the relations between them. Secondly, there is a 'laissez-faire triple helix', consisting of separate institutional spheres where government, university and industry operate apart from each other. In this model the university provides basic research and trained persons. It is expected that firms in an industry should operate completely apart from each other in competitive relationships, linked through the market. Government is limited to addressing problems that can be defined as market failures, with solutions that the private sector cannot or will not support. Thirdly, there is an 'interactive triple helix model', consisting of overlapping, yet relatively independent, institutional spheres.

Developed and developing countries both experiment with finding better mixes of functions and institutions in a triple helix of university-industry-government relations. For example, academia plays a role as a source of firm-formation and regional development in addition to its traditional role as a provider of trained persons and basic knowledge. Government helps to support the new developments through changes in the regulatory environment tax incentives and provision of public venture capital Industry takes the role of the university in developing training and research, often at the same high level as universities.

Most countries and regions are presently trying to attain some form of the third variant of Triple Helix, with its university spin-off firms, trilateral initiatives for knowledge-based economic development and strategic alliances among firms (large and small, operating in different areas and with different levels of technology), government laboratories and academic research groups. These arrangements are often incentivized, but not controlled, by government, whether through new "rules of the game," direct or indirect financial assistance. Thus, a triple helix strategy may be the basis of an alternative development model, relevant to a world in transition from an industrial to a knowledge-based format.

3 Changes in the field of development

Traditional development models focused on entry into industrial society. The contemporary international development agenda has become more flexible, combining old and new concepts, with development moving from a dyadic interaction of centre-periphery to a development triad of 'state-market-community/civil society. Within this context, development is the result of collaboration and interaction between these sets of institutions. The three alternatives might then be labelled 'state-led', market-led' or 'community-led', indicating alternative models for development practice. [5]

Prior to these reformulations, attempts were made to create new forms of economic organization by employing existing resources in different ways. [6,7] In this Schumpeterian vision, the overall development of the economy is derived from the novel combination of resources. Central to this formulation was the fact that these economic and organizational developments were endowed with their own laws and principles. As a result, the development of the economy as a whole appeared like a phenomenon emerging on the basis of the interaction among its constitutive elements, but energized by specific actors. [8]

Schumpeter anchors his model of endogenous economic development around the entrepreneur. He uses this concept to explain that changes in social structure emerge from the actions and social interactions of the individual entrepreneurs living in distinct and yet interacting sectors of social life. [8] This is a viable model for an industrial society whose root structure of organization is the firm, and the resources bundled within it. However, as knowledge becomes a more critical resource for economic development, the boundaries of the firm must

become more porous to absorb innovation and the locus of entrepreneurship expanded. Thus, the most critical agent of development has become an entrepreneurial university that has economic development functions in addition to teaching and research as its core remit. [9]

While the Schumpeterian entrepreneur was the driving force in industrial society, we propose a university-led development model, in cooperation with other institutional spheres, in an increasingly knowledge-based society. Our thesis is that the traditional stages and evolutionary models of development may no longer be as relevant to innovation and economic growth as they were in the past. These models were abstracted from an increasingly superseded industrial era where socio-economic growth was premised on the abundance of arable land, natural resources and the availability of a large pool of labour. If African countries continue in this outdated trail, they may be left behind again.

We need to blend development strategies so that we do not end up exacerbating the already volatile situation that faces most Africans. As noted by Myrdal, production and distribution are interrelated within the same macrosystem. [10] The assertion that the growth of production is a precondition for having more to distribute, which is still current in most discussions on planning in least developed countries, neglects this interrelation. [10] The successful planning and implementation of a bottom-up robust innovation and development strategy would work for greater equality, because the beneficiaries of development does not only know what they most need, but such collaborative ventures would enhance production.

While contending that the unhampered working of contemporary international market forces retarded the development of poor countries, [11] Myrdal sees the solution in education. He believed that education should be made into a people's movement, as it could be instrumental in creating effective pressure from below, which he considers to be largely missing, from most development reforms. That reforms aimed at re-organizing African higher educational institutions to take on an explicit economic mandate will promote greater equality is certain, but it is equally certain that they would increase productivity. [11]

A triple helix development model involves the transformation of higher educational institutions—the second academic revolution—that incorporates the classic ivory tower with a culture of entrepreneurship, innovation and technology transfer. In this transition, higher education and research institutions integrate into the production sector and into society in many ways. They develop capacities to translate research and education of youth into the formation of new organizations (firms, NGOs, cooperatives) that break the bounds of the traditional ivory tower university.

Heretofore, these boundaries were considered essential for the university to maintain its institutional integrity. However, since the growing interest in competence building will require expanded sources of support for development activities, there is the need for financial flexibility and autonomy for African higher educational institutions. This demands the delineation of the development task of higher educational institutions, such as, universities beyond party politics to enable them deal conveniently with changes in political regimes. This autonomy and financial flexibility can only be realised in the absence of political interference and within transparent governance structures across higher educational institutions, the state and other institutional spheres.

The creation, dissemination and utilization of knowledge have become more directly involved in industrial production and governance. [12] The more explicit utilization of knowledge in industry and government, exemplified by the invention of the discipline of “knowledge management” and the growth of “intelligence” give knowledge producing institutions that have the organizational capacity to recombine old ideas, synthesize and conceive new ones a greater import. [13] Thus, we propose, a triple helix development model that takes into account novel institutional sources, in particular the university, as a source for recombination and innovation.

4 The triple helix development model

The triple helix model comprises three basic elements: (1) a more prominent role for the university in innovation, on a par with industry and government in a knowledge–based society; (2) a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interactions among the spheres rather than a prescription from government or an internal development within industry; (3) in addition to fulfilling their traditional functions, each institutional sphere also “takes the role of the other” operating on a y axis of their new role as well as an x axis of their traditional function. Functional integration, as well as differentiation among institutions, takes place though interaction among the spheres.

Hybrid organizations are invented that embody elements of two or more institutional spheres to accomplish new goals. One example is the incubator facility that plays a dual role in the university, embodying industrial and academic elements. The incubator director serves as the translator between these two spheres, speaking the language of both spheres and having insider knowledge of each. The incubator facilitates linkages between start-up firms emanating from the university with sources of support in the industrial and governmental spheres. Thus, the university moves from playing a supporting role in training people and providing knowledge to other institutions to playing a leading role in creating an industrial penumbra around the university.

The ultimate source of knowledge-based economic development at the regional level resides in the ability to advance within and across technological paradigms. Irrespective of specific policy measures, it is increasingly realised that to promote innovation and socio-economic development require a strong interaction of institutions in order to enhance strategies for success. While successful instances are often reinterpreted to look like spontaneous developments, especially in laissez faire

societies, historical cases can always be traced to the active intervention of an individual or group. [14]

While MIT exemplifies a creative synthesis of academic research and educational formats it does so while playing an important role in the development of New England. [15] According to a report published by BankBoston, if the companies founded by MIT graduates and faculty formed an independent nation, the revenues produced by the companies would make that nation the 24th largest economy in the world. The 4,000 MIT-related companies employ about 1.1 million people and have annual world sales of $232 billion. That is roughly equal to a gross domestic product of $116 billion, which at the time was a little less than the GDP of South Africa.[16]

The Regional Innovation Organizer (RIO) is the individual or group that takes the lead in conceptualizing a strategy for knowledge based growth and activating hitherto untapped resources to realize a shared vision. In the context of Africa, we foresee higher educational institutions as the answer to the absence of an innovation or development organizer, especially at the regional level. Re-orienting universities to take up this challenge may lead the way in assisting least developed countries to leapfrog stages of industrialization that are now disappearing in their countries of origin.

Critics have argued that that African university systems are academically oriented and industries are either non-existent or too weak and governments too bureaucratic to play respective roles envisaged by the triple helix model. However, as the development of the Internet in Zambia has revealed, [17] the problem does not lie with the model, but the fact that in Africa, these triple helix entities seem to be weak because their elements tend to work in isolation. The Zambian example has demonstrated that when these entities work together; they represent a significant force for change, similar to those found elsewhere. In the triple helix development context, each institutional sphere maintains its core identity as it interacts intensively with the others.

While the triple helix institutions at their nodes are active and recursively selective according to their own specific functions and institutional constraints, the network system of university-industry-government relations provides the transaction spaces needed by these development actors to translate policies into goals. As such, a triple helix development model cannot be reified into a neo-corporatist arrangement because of its implied emphasis on the dynamics of change and the appreciation of differences in opinion, position, and interests of their partners.[18]

A triple helix development model is based on the following trends within the shift from an industrial to a knowledge-based society:

i. The transition from large scale physical technologies that mandate bureaucratic forms of organization to increasingly flexible smaller scale high technologies that can be utilized by smaller scale organizations
ii. The emergence of polyvalent knowledge, in such areas as biotechnology, computer science and nanotechnology, that is at one and the same time theoretical and practical; patentable and publishable
iii. The rise of an entrepreneurial university model that combines education and research with a culture of entrepreneurship, innovation and technology transfer.

5 From stage to spiral model in education

Some observers expect that least developed countries like Ethiopia need the chance to build dams and develop according to the same path as the advanced industrial countries did a century ago. The alternative thesis is that developing countries could pool their technology resources to take the lead in developing alternative energy technologies, such as photovoltaics, without disturbing the natural environment that is the basis for unique tourist industries such as the one that was emerging at 'Tis Abey' adjacent to the Blue Nile Falls. When a new power station reduced the falls to a trickle, destroying their natural beauty and the livelihoods of local tourist operators, this opportunity was lost. [19]

The form and content of education in the least developed world tends to mirror the prevailing concept of development underwritten mostly by donor agencies. Most African countries inherited a colonial educational system that was oriented to the developmental needs at the time. The goal of the educational system was to turn out clerks for the purchases of traditional agricultural export commodities, missionary proselytizing activities, and the colonial civil service. [20]

Technical education geared towards innovation and creativity was not on the colonial agenda. As Julius Nyerere wrote in 1967, colonial education was not designed to prepare young people for the service of the country. It was rather motivated by the desire to inculcate the values of the colonial society, and to train individuals for the service of the colonial state. [21] For instance, until 1987, Ghana, the first sub-Saharan country to attain political independence did not alter its educational structure modeled after the British system of education. This does not mean that there were no changes at all in the way education has been organized in Africa. New institutions have been founded; some built on research institutes specialized in local agricultural opportunities, and have developed curricula and research, expanding upon the original foundations.

In spite of this, the presumption especially in the educational policy formulations of the World Bank has been that mass primary and secondary education should precede the extensive development of tertiary educational capabilities. Nevertheless, the World Bank is increasingly aware of the role of universities in economic growth and innovation. Universities produce new scientific and technical knowledge through research and advanced training and serve as conduits for the transfer, adaptation, and dissemination of knowledge generated elsewhere in the world. [22] However, educational policies in Africa have overly focused on basic education, failing to take full advantage the potential of higher educational institutions as

a source for recombination and innovation.

Africa's educational policies underlie the stage model where growth is a discontinuous and dialectical process until a take-off stage of self-sustained advancement is reached. [23] This linear model whereby, the site of knowledge production is entirely separated from that of application [24] is outdated and no longer relevant to Africa's search for strategies to once again unleash the potential of its higher educational institutions like it did in training staffs for the colonial and post-colonial civil service. We call for a 'triple helix development' model that incorporates basic education with university-led economic development.

This spiral model of education, which is emerging as an academic reform strategy in a number of developing countries is refocusing undergraduate and graduate education on development. Some examples, in different directions, include the University for Development Studies in Ghana, the "Earth" university in Costa Rica and the Friburgo Campus of State University of Rio de Janeiro. Rather than developing undergraduate programmes focusing on existing industries, the Friburgo Campus of State University of Rio de Janeiro has developed a graduate research programme based on information technology (IT) that could be utilized to raise the level of a variety of local industries as well as create a new IT industry. The undergraduate programmes were projected to follow as a second step in the development of this university's full and extensive curriculum.

Thus, academic development leapfrogs the current stage of industrial development in order to seed new technologies and firms and upgrade existing ones. Academic reform may be used as a strategy to treat educational as well as research programmes and their combinations. This explains why the University for Development Studies (UDS) focuses its efforts on topics that will help address issues of rural poverty and community development, by including fieldwork projects as well as classroom training in its curriculum. [25] An even more radical project in Costa Rica involves both students and faculty in farming tasks so that they may inductively relate problems encountered in the field to course-work and provide a common framework for discussion.

6 Towards a university-led development for Africa

Utilizing African universities solely as a source for trained manpower may not be sufficient to attain the various developmental goals and ideals envisage in NEPAD and other development blueprints. There is the need for the reorganisation of Africa's development agenda to make it possible for higher educational institutions to play a leading role in the development process. The application of this concept may be extended to other levels of learning, such as colleges, research and technical institutes and polytechnic schools. [25]

First, universities need to undertake internal reform in partnership with various segments of society. Past experiences in other spheres of society and in regard to higher educational reforms done in isolation have failed in a large measure and increases inequality in terms of access and content. [25] For instance, past initiatives were relatively secluded from each other with, for example, clusters focusing on business development, and centres on inter-disciplinary academic research. Today, there is a movement toward synthesis through the creation of a series of organizational mechanisms within and outside the university to enhance linkages of clusters with universities and to provide a platform for firm formation. [26]

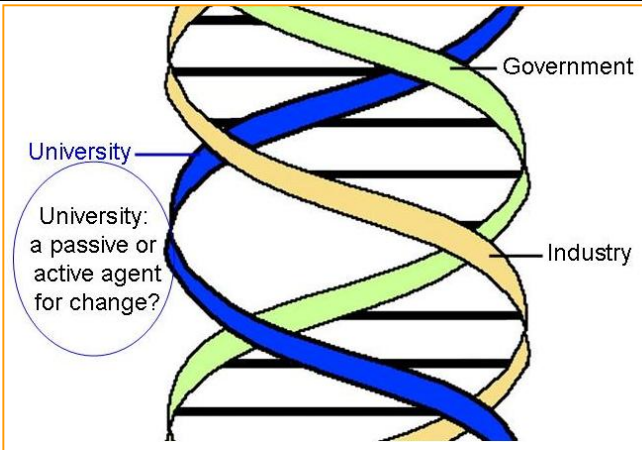

Illustration by V. Konde, - diagragm adapted from Seidman, M.M. and Glazer, P. M. (2003) based on *J. Clin. Invest.* **112**:487-494.

Since African public universities have grown from about eight in 1960 to over one hundred in 2006, the time has come to increase their S&T transfer and innovation efforts in order to further Africa's socio-economic development. The formation of science-based firms from university research should be the centerpiece of this strategy. As the development of the Internet in Zambia, the establishments of the UDS in Ghana and efforts in Ethiopia to connect the traditional industrial clusters to foci of government funded research located at universities have shown, even poor universities can plan, adapt, innovate and commercialize emerging technologies to benefit their populations.

7 African universities and political regime change

In the early post-colonial era, most African countries, in particular the young and small university sector was invested with high national aspirations and public resources. The situation is very different today ranging from the reduction in the levels of public funding, incredibly expanded and diversified sector, to the questioning of the mission and mandate, the character, and the proper place of higher education sector, its institutions and their products in society. [27] The impact of these transformations were accelerated by economic and social changes specific to the African continent from the mid-1970s to the 1990s. These events include the virtual collapse of many national economies; the descent into autocratic military or civilian one-party or military governance systems in many countries, civil wars, and the bane of the HIV/AIDS pandemic. [27]

In addition to the historic handicaps of underdevelopment bequeathed by colonialism, these events blunted

the ability of African countries to take advantage of opportunities offered by globalisation, while exposing them to its negative effects. In relation to universities, the relevance of these developments was the general retreat of the state from social provisioning and the severe reductions in the level of resources for African higher education, [27] at the very time where academic research and knowledge has grown in social and commercial importance.

In most of Africa, relations between governments and universities have at times not been conceptualized in mutually beneficial terms. African governments and their universities have always had an uneasy and often antagonistic relationship. Most university heads or vice chancellors are appointed and controlled by their governments. Also, most governments and their functionaries consider universities as epicentres of criticism and political opposition. Rarely are higher education budgets determined through rational processes based on enrolments or strategic plans. [28] In fact, political interference in universities by governments has been a major drawback to university development and the development of nations on the continent. In an era of knowledge flows based on the utilization of university-industry-government partnerships to promote innovation, the interaction between universities and other development actors such as business, civil societal organisations and other constituencies are often non-existent in most of Africa.

Political interference in the affairs of higher educational institutions and the over dependence of African universities on their central governments to totally finance their budgets is a cause of this unnecessary confrontation and interference. The problem is exacerbated by the fact that when one regime is sensitive to the plight of the higher educational institutions by encouraging free interaction, the opposition political elements construe this as the politicization of the academy, and sought to punish the universities through budgetary squeeze and undue interference. As such, in other to enable African universities cope with political regime changes and lead the development of the continent, there is the need for political autonomy and financial flexibility. It should be pointed out that steps are being taken in some countries. For instance, in Ghana, the country's 1992 Constitution firmly stipulated that Vice-chancellors shall be appointed by university councils. [28] To consolidate this gain and reorganize African higher educational institutions to lead the continent's development agenda, there is the need to redefine the mission of African universities to include explicit economic development as found in other countries and regions.

Other possibilities for financial diversification include income generation through contract research, consultancy services, continuing educational programs, business enterprise, and fund raising through alumni associations. If financial diversification is to be successful, universities will have to become more efficient, goal-driven, innovative and enterprising. [28] To attain these ends, there is the need to establish an African higher education 'endowment fund'. This fund must be managed by the Association of African Universities (AAU) and representative of donors to deal with corruption and ultimately the effects of possible regime changes. For a start, such international money transfer organisations like 'Western Union' and African governments who receive commission on these funds should contribute a certain percentage of remittances into this endowment fund. Secondly, African universities should form various consortiums to liaise with international accounting and data management firms such as Nielsen, Price Waterhouse Coopers, Ernst & Young, to conduct marketing surveys, audits, and reports for both local and multinational companies within their countries to raise funds.

In addition, there is the need for institutional linkages between African universities and higher educational institutions worldwide. Institutions benefit from a well-established flow of knowledge. Institutional linkages offer the best prospect to improve the exchange flow of knowledge, ideas and partners. It can enhance the flow of information and the availability and more rational use of resources. As problems become increasingly global in nature, this movement of ideas and people will greatly increase in significance. [29]

The time has come for a new development paradigm for Africa, a development that prioritizes knowledge as a basis for economic transformation. The emphasis on knowledge should be guided by the recognition that economic transformation is a process of continuous improvement of productive activities, enacted through business enterprises. In other words, government policy should be continuous improvement aimed at enhancing performance, starting with critical fields such as agriculture. [25] The promising aspect of this transformation is that most African countries have in place the key institutional components needed to make the transition towards being a player in the knowledge economy. The emphasis should, therefore, turn to the realignment of existing structures and the creation of new ones where they do not exist. [25]

8 Policy Implications

Innovation can no longer be assumed to take a conventional linear path, whether from research through development or from identification of market opportunities to product introduction. Instead, innovation increasingly occurs through a non-linear configuration, with multiple nodes and cross-over points much like the Internet. Innovation in this sense is more organizational rather than strictly technological, involving new configurations of interaction and the internal transformation of traditional institutions.

Innovation was expected to largely take place within industry with other institutional spheres playing only a limiting contributing role, government, for example, acting only when clear market failures could be identified. In countries that, to one degree or another, relied on central planning, it has become accepted that government programs have an important role to play, not only

from the national level, top-down, but also from the local level, bottom-up, often in collaboration with other organizations in civil society.

It is clear that innovation policy can no longer be conceived only as a "top-down" initiative of national government but should also be seen as the cumulative result of interaction among governments at various levels, business persons, academics, and NGOs comprising membership from all of these spheres. It is necessary to better understand these new innovation processes and to identify and encourage improvements in the way they work. It cannot be expected that entrepreneurs can always do this by themselves. When bottom–up initiatives that have proved successful, such as the incubator movement in Brazil that arose from the university and was then supported by municipal governments and industry associations, are reinforced by national policies and programs, perhaps the most dynamic and fruitful result is achieved.

Conclusion: Reorganizing African Universities

Enhancing an academic focus at a local university with possible future relevance to local economic development is now viewed as similar to traditional physical infrastructure development. When the problem is framed in terms of science-based regional development, an entrepreneurial university becomes a necessity. For us, a triple helix of university-industry-government interactions is especially crucial to developing organizational innovations that are necessary to reinvigorate Africa's quest for innovation and development. The formation of science-based firms from the research of higher educational institutions should be the centrepiece of this quest.

In contrast to biological evolution, which arises from mutations and natural selection, social evolution occurs through 'institution formation' and conscious intervention. The triple helix provides a flexible framework to guide efforts, from different starting points, to achieve the common goal of knowledge-based economic and social development. The result is an interactive model, directed toward enhancing the interaction between human needs, research goals and resource providers; science, technology and society; university, industry and government.

The triple helix model provides a flexible framework for the transition of the African university from educating post-colonial elite to playing a more direct role in development, pointing the way for least developed countries to make the transition to a knowledge-based society. In order for African institutions of higher learning to play a dynamic role as leaders of innovation and development, there is the need for new institutional arrangements to be forged.

The potential for innovation and development in Africa, and elsewhere, resides in an entrepreneurial higher education sector, that is, ready and willing to take the lead in infusing knowledge, innovation, technology and enterprise into the entire society. Advice on science, technology and innovation needs to reach policy makers. It is true that advisory structures differ across countries. However, all over the world, an active university and civil society are the key element that characterizes a fully functioning triple helix. In the statist model, civil society is often actively suppressed; in the laissez faire model, it is relatively inactive. As universities take up this new role in promoting innovation, they become transformed as well. The entrepreneurial university, embedded in a series of triple helix interactions, constitutes a new model of development.

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E-Learning: Make it as simple as possible, but not simpler

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Abstract

This article summarizes our experiences trying to keep the instruction of computer sciences simple in an environment that is anything but simple. An analysis of the factors that contribute to the course's success shows that it is not the application of technology in various forms that is responsible but a careful instructional design based on sound pedagogical principles.

We developed course material that combines problem-based learning with e-learning to raise the motivation of natural science students taking an introductory information and communication technology class and to accommodate large classes

Introduction

Even though the amount of literature on e-learning is more than sufficient it is still difficult for the inexperienced to see the benefits of this educational technology or notice which pitfalls to watch out for when using computers to aid teaching. Reports such as 'The Future of Online Teaching and Learning in Higher Education' [1] make for interesting reading but are of little concrete help to someone faced with the challenge of establishing an online course.

This article summarizes the author's experiences over eight years of designing and employing e-learning classes for ICT and computer programming courses for natural science and civil engineering students at ETH Zurich. About 1000 ETH students complete these courses every year in a blended learning environment.

The materials we developed are also used complete or in part at other schools, and with the generous support of the North-South Center of ETH Zurich we are now translating the contents of the ICT course into English so that it can be used at a new research university in Zambia.

The observations I report here come not only from my work as an instructor, but reflect experiences I had during my four years as Head of Education of the Department of Computer Science. They also result from the numerous contacts I made while peer-reviewing the bachelor programs in computer science of many universities of applied science in Switzerland.

These contacts made it clear that in the context of e-learning it is particularly important for instructors to realize that they are exposed to many forces that result from priorities set and compromises made by those responsible for the educational system in which they have to function as teachers. The EDUCAUSE Current Issues Survey Report [2] summarizes some of these priorities. This survey, now in its eighth year, asks campus information technology leaders to rate the most critical IT challenges facing them, their campuses, and/or their systems.

Having said this, I begin this review with a sketch of the bigger picture before discussing the reasoning behind the design of our e-learning courses.

1 Stakeholders of an educational system

The history of e-learning goes back to the early sixties and the debate about how to use computers in schools has not stopped since. Whereas in the early days the field only attracted those interested in learning theories or in the commercial potential of computer-supported teaching, it is nowadays a topic with a life of its own, affecting almost everybody and particularly those involved in education. So why not first contemplate who the major players with a stake in e-learning are?

The ultimate stakeholder of a country's educational system is its *society*, represented officially by members of its *political body*. Responsibility at the operational level rests with the individual *school administration* which oversees its degree programs, each managed by a *program director*. The actual teaching is the domain of the *lecturers* and the *students*, possibly supported by *teaching assistants*. Thus one can readily identify seven levels of stakeholders, each with different responsibilities, their own expectations and consequently unique ideas about e-learning. It might be interesting therefore to wonder who takes the initiative for e-learning and how the others are affected by it.

1.1 Society

The interaction between society and technology has never been easy; it is mostly unpredictable and can be difficult to control. This point is clearly illustrated in the April 2007 issue of the ATDF Journal [3] where Victor Konde argues that the type of policies which a nation adopts to guarantee benefits from Information and Communication Technologies (ICT) can have profound consequences on the country's development. The situation with societies is also frequently ambiguous in that its individual members need not necessarily share the opinion the society expresses as a whole. For example, even though 20 years ago in Switzerland most would have agreed that computers affect everybody's life in one way or another, many individuals would not have seen the need to acquire the competences required to take advantage of this technology.

Even when Switzerland, together with many other so-

called information societies, was flooded by the e-learning wave in the mid-1990s, it took a dozen more years for its students to use the PC as a matter of fact. Those who were too old to grow into it, namely most teachers, still have a hard time incorporating ICT into their teaching or learning activities. Societies, as a stakeholder in e-learning, must live with this generational time lag.

1.2 Political body

One of a politician's major responsibilities is to provide the conditions that ensure both a society's well-being and its future competitiveness. Since the youngsters are the primary asset of a nation's future, the society's decision-makers must set the goals for an effective educational policy and provide the budget necessary for its successful implementation. In most societies, though, national decision-makers have neither the time nor the necessary expertise to become involved with instructional or pedagogical details of citizens' education.

Sometimes, however, local politicians cannot resist the glamour of powerful corporations, which can lead to dubious activities. Back in 1997 for example, the then Swiss Minister of Finance promised to donate 30,000 old Federal Government computers to schools in the following years. This effort was to flank the promise of Bill Gates, who offered to donate, free of charge, 5000 Windows licenses, including internet browser and introductory courses for teachers. The project was then downsized to 2500 computers and eventually cancelled, as only 450 schools expressed interest and only 120 computers were delivered.

Education is a complex system that cannot be controlled at the stroke of a pen, like rubberstamping a budget. Budgets are of course also an important part of the system and how important they are can be estimated from the numbers mentioned in the following paragraph. Considering that the amounts mentioned cover only some of the more important projects of only one university, the political body is an important stakeholder indeed.

1.3 School administration

A school's administration, controlling the distribution of the organization's resources, is in a position to decide how its funds are used, which makes it perhaps the most influential stakeholder in e-learning.

At ETH we have been fortunate in that the administration decided as early as 1986 to systematically support the use of ICT in teaching and learning via a five-year project with over $40 million at its disposal. In 1996 the school started a project called 'Network for Educational Technology' (NET) to specifically support lecturers in the use of new educational technologies. NET was institutionalized in 2002 and today it is the competence center for e-learning of ETH, with 6 full-time staff positions.

Most important, though, is that since the year 2000 the Rector has had between $1.5 and $2.5 million per year at his disposal to finance innovative teaching projects (Fonds zur Finanzierung lehrbezogener Projekte – FILEP). Needless to say, much of this money has gone into the development of e-learning materials. The author has also benefited: five of his requests to fund e-learning projects were approved (amounting to a total of over $660,000). Without these generous grants it would not have been possible to develop the e-learning materials that we can now offer to other non-profit institutions of higher learning at no charge.

It can be said without hesitation that at ETH the school administration has been instrumental in providing a fertile ground for e-learning, and I am certain that at other schools this organizational unit is also a key stakeholder. Unfortunately, however, the approach chosen does not assure sustainability, for the following reasons. When institutionalizing a service such as the NET, a school freezes funds for technology support, creating permanent positions taken by people who are competent in technology but are not involved in teaching. Without this commitment to teaching it can be difficult for the service staff to advise lecturers on the usefulness of certain technologies. For lecturers, however, content comes first, and the suitable technology to deliver it comes second. A teacher's adoption of e-learning methods can mean that a rework of his/her materials – and often the redesign of an entire course – is necessary to make them computer-compatible.

To those who teach actively it comes as no surprise that developing new course material can take many semesters and improving quality is a never-ending process. And yet it is precisely this crucial work which is supported only by impulse financing, typically with funds for a two- to three-year project. After that it is up to the lecturer to figure out how to maintain the course.

1.4 Program director

The job of program director at ETH is usually assigned on a rotation basis to a faculty member for the duration of two to four years. The position is embedded in a strictly democratic environment, which means that the director cannot implement procedures without the consent of a majority of his/her colleagues. The director cannot decide independently that an entire program be supported by e-learning, but might complement the support given by the rector to members of his department. All in all, not a stakeholder that matters greatly for e-learning at ETH.

This might be different at other schools, however, because a program director faced with budget cuts might decide to stretch resources by substituting regular lectures with e-learning materials.

1.5 Lecturer

If e-learning is reduced to the presentation of lectures using an electronic learning platform, one could argue that the role of the lecturer in e-learning is secondary compared to that of the school administration. If, however, the goal is to improve the effectiveness, efficiency and sustainability of teaching by harnessing a computer's strengths, then the lecturer becomes the prime stakeholder. His (or her) focus is teaching, he is responsible for the material he uses and

he must find the necessary hardware and software for support in this effort. If he does not ask what e-learning can do for him he runs the risk of putting technology before content.

Once a lecturer adopts e-learning as a method for presenting course material, he or she must be prepared to face a whole range of consequences. First of all, the material must be complete, because students interact only with the computer during long stretches of the learning process. If the material is flawed, frustration and anger result, both of which will not raise confidence and trust in the instructor. Second, provision must be made enabling students to verify that they are on track. Third, the role of the instructor typically changes from 'the sage on the stage to the guide on the side'. The pedagogical consequences are far-reaching.

Ideally, it is the lecturer who decides whether or not to employ e-learning, in cooperation with the school's administration. If this decision is one-sided, with one party being forced into it, the outcome is most likely to be dissatisfying.

1.6 Student

For better or worse, students are the stakeholders most affected by e-learning. E-learning can give them the opportunity to learn wherever and whenever they want, without the restrictions of an agenda. They typically benefit from the advantages that the internet offers, but they also suffer should this service not be available when they need it most.

Before e-learning, students just had to cope with the different teaching styles of their instructors. Now they are also exposed to the teachers' technological preferences, which could mean that they have to become fluent with many different learning platforms unless the school's administration (or at least the program director) prevents uncontrolled use of ICT systems to deliver and support teaching.

Normally students can influence the development of e-learning only indirectly by deciding either to sign up for such courses or to avoid them. Whichever option they choose can depend to a large extent on how successful a course has been in motivating students in the past.

1.7 Teaching assistant

In many courses the large number of students can only be managed efficiently by appointing competent teaching assistants. These people have the task of helping students understand the material that is presented during a given course. They are often responsible for creating suitable exercises, correcting the work that students hand in, and also for generating exam questions.

E-learning obviously affects the work of teaching assistants in a fundamental way. First, there are no exercise classes because students work on their own, each at his or her own speed. Second, exercises have to be restructured so that they can be presented electronically and the students' work be corrected automatically. Third, many of the student problems requiring help have to do with teaching technology, and not with content.

In consequence, lecturers must analyze their e-learning courses to find out where students need help and how, under these new conditions, they can incorporate teaching assistants into their work. Perhaps the biggest challenge we have encountered is how to train teaching assistance so that they can help students learn with the new materials without interfering in the learning process: in other words, how to prevent a teaching assistant from taking the mouse in her own hands when helping a student at the computer.

Summary

When considering this by-no-means-complete list of issues in connection with stakeholders, one can see that an educational system is indeed a complex one. And, of course, each key player in this system wants to use technology to his advantage. So, how can we as lecturers cope with new technologies and remain unscathed? I have learned to summarize the insights that have emerged over the years in one sentence: *Do not ask what you can do for e-learning; ask what e-learning can do for you*.

2 E-Learning to support problem-based learning

All natural science students at ETH must complete introductory computer science courses. Ideally, in such a course students not only hear or read about computers but become competent in using computers to solve problems. Computers are complicated tools that demand from their users not only skills but also a strong motivation 'to keep at it' throughout the semester. We have observed that motivation wanes rapidly if the learning objectives are reduced to memorizing facts or going through routine drills with application software. This is understandable, because it is difficult to detect sense in material that is presented as a collection of loose fragments.

2.1 Concepts as teaching objectives

To embed our courses in a stimulating framework, we make *concepts* rather than a compilation of facts the center of our teaching objectives. Concepts can provide structure and thus help students to see the course content in a meaningful context; but to be useful during the learning process concepts must be 'connected' to useful skills. Combining concepts with skills requires an instructional design and pedagogical preparation that leads to a course in which students learn more than the sum of the concepts taught and acquire new capabilities. By this we mean that a representative set of concepts must be embedded in a process that guides students through increasing levels of 'computer competency'.

Instruction that relies on *problem-based learning* (PBL) supports this process best, because learners come into contact with the concepts through their own activities

and thus can better differentiate between them. This differentiation lays the ground for a perception of the underlying ideas that enables students to construct the concepts by themselves, to successfully apply them, and do this while they are in control of their own learning process. The crucial point, however, is that the problems which guide them through this process must be interesting, relevant, realistic and, if at all possible, also entertaining. We have learned that these are the primary ingredients for instruction that motivates. But we also quickly realized that PBL is easier said than done, because for it to work it is imperative that the chosen problem's difficulty is adapted to the student's level of competence.

Our course is structured as follows. A biweekly two-hour lecture covers major topics of ICT and their underlying concepts. To complement theory, every two weeks our students start a new set of problem-based exercises originally handed out as printed tutorials, to be worked through at a student's own pace. The tutorials – on average about 15 pages long – guide a student step by step through a problem that he or she solves using a given software application (e.g. a database program). At the end of each tutorial, students are required to solve a different, but related problem independently and then demonstrate and explain the solution to a teaching assistant.

Each student must complete a total of six tutorials, covering the following topics: internet publishing, simulation with spreadsheets, visualizing multivariate data, managing data with spreadsheets, managing data with a relational database, and macro programming.

2.2 Supporting teaching activities with *E.Tutorials*®

When we started to redesign the ICT course for the natural science students at ETH eight years ago, we had the following goals in mind: incorporate active, problem-based learning for the reasons mentioned above; teach large classes without sacrificing individual support; provide the means for student controlled learning. We also set out to investigate the potential of e-learning to support these goals.

Intuitively it seems clear that a computer can be of great help to provide individual support. The large number of students, however, forced us to apply instructional concepts which can provide a maximum of support – particularly for less experienced students – with limited personal resources. But we also had to come to grips with the problem that such a course's content has both to challenge students already experienced with computers and avoid overtaxing those who lack these skills. Student controlled learning can help to keep the balance on his pedagogical tightrope walk.

Even before the development of the World Wide Web and the e-learning wave that followed, complaints were voiced that students are acquiring extensive theoretical knowledge but that they cannot use this knowledge outside of school or university. Trusting in problem-based learning to tackle this problem, we created written tutorials to guide students through six conceptually different application programs while solving a well-defined task. At the center of this effort is the problem-solving process, not the operation of the software.

As it turned out, using electronic media to deliver the PBL tutorials helped us solve the problems we faced, particularly the stubborn qualitative problem of inactive knowledge. We have called the learning material based on this combination *E.Tutorial*®. Tutorials for an ICT course are natural candidates for e-learning, because when guiding people through a software application with written instructions it stands to reason that the instructions themselves be presented together with the application on the same computer screen.

The user interface of an *E.Tutorial*® is shown in the center of Fig. 1. It consists of an application window (e.g. a spreadsheet program), in which learners are led step-by-step through small problems via instructions that are displayed in an instruction window. In a separate verification window students can check whether or not they are on the right path in the problem-solving process. The guidance in the instruction window must be structured in such a way that learners are neither overtaxed nor under-challenged.

Producing the e-learning materials was one thing; embedding them successfully into the teaching process was quite another. This embedding should not be simpler than the requirements dictated by sound pedagogy. After many attempts, an instructional design we call the four-step model finally emerged.

3 The four-step model

We have found that instruction is the most effective and efficient if it makes the learning process 'brain-friendly' by breaking it up into four discrete steps [4]:

See: students must be given the opportunity to ***see*** the concepts

Try: students should have the chance to ***try*** to apply concepts actively with appropriate guidance

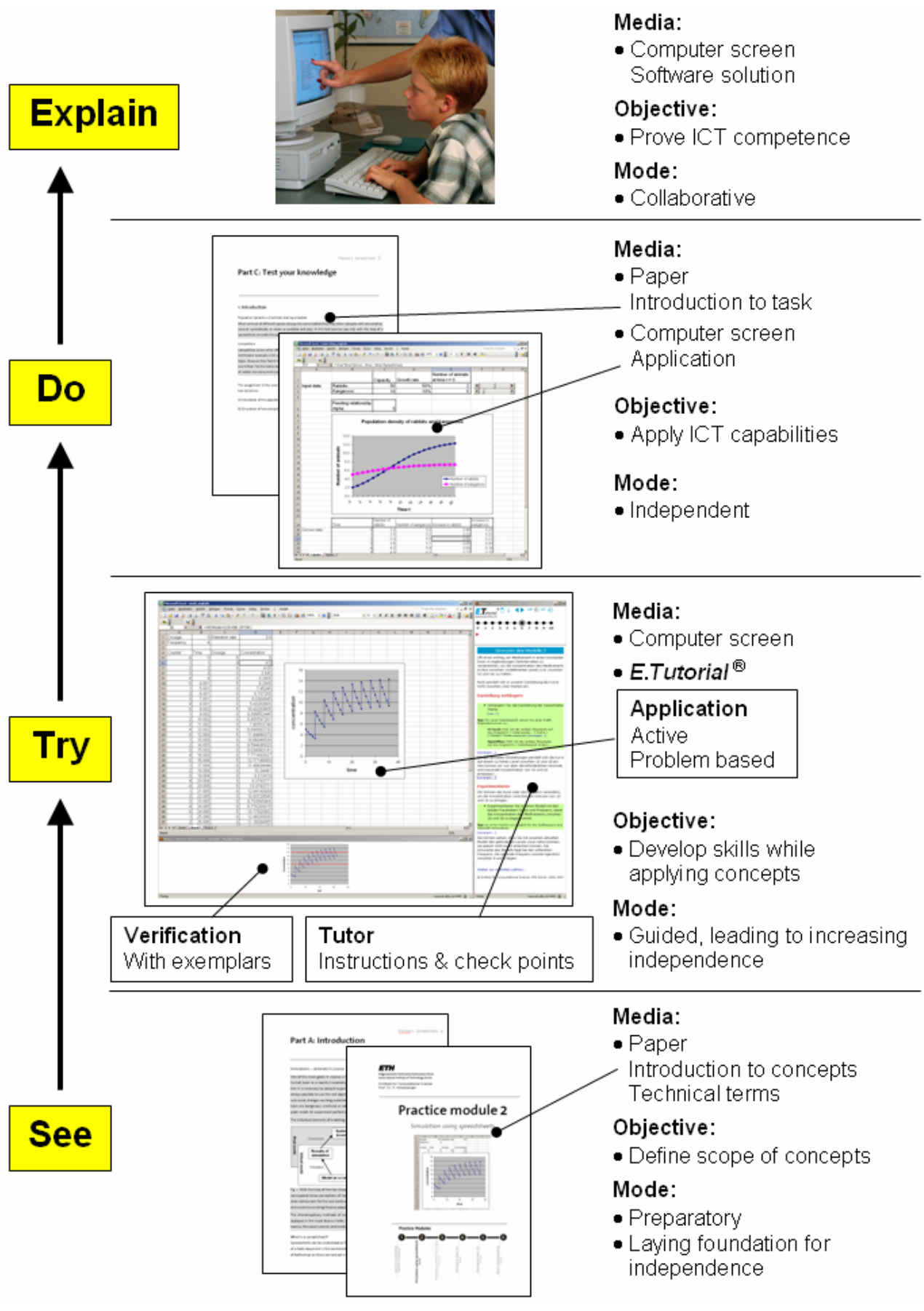
Do: then they ***do*** [apply] them independently

Explain: to verify their competence, they ***explain*** their solution to an instructor

All the tasks of our introductory courses are organized around these four steps. Figure 1 illustrates how *E.Tutorials*® are integrated into the blended learning environment in which students complete the four steps mentioned above. For each step we have chosen a medium that best suits its purpose and content.

In the first step, the concepts and technical terms involved are briefly introduced on paper (See). They span the space of the learning process and lay the foundation for the second step, in which the concepts will be applied when students work with the *E.Tutorial*® (Try). The Try step combines PBL with constructivistic methods in an e-learning environment. It is during the second step that knowledge becomes active and learners become increasingly independent as they progress through the learning material. We count on this independence dur-

Figure 1. The instructional design based on the four-step model used to organize an e-learning environment with *E.Tutorials*®. See text for details.



ing the third step, when they have to solve a new problem on their own (Do), applying the knowledge and the skills learned while working through the *E.Tutorial®*. The fourth step concludes a learning unit with a short oral presentation (Explain), in which students are given the chance to show what they have learned and an instructor can evaluate the learning outcome. At this stage students typically interact with the teaching assistants, whose task is to verify authorship of the results and confirm that concept and theory have been correctly understood and applied in the right context.

This four-step model with its explanations, check points and discussions provides a scaffolding to help our students feel that they are in control of a learning process during which they acquire skills that they can confidently apply. Both this sense of control and their self-confidence motivate them to learn more about computer science.

The crucial parts of this process from an instructional design point of view are steps two (Try) and three (Do), because with PBL the right problem for each competence level must be found. Our approach is that for both steps we first define the level of competence required before we construct a problem that represents the concept in question. Next we divide this problem into a set of smaller tasks that allow step-by-step instructions for the Try phase and that facilitate continuous verification to provide the learners with checkpoints on their journey through the *E.Tutorial®*. Establishing the subject matter of these steps typically requires several iterations until a satisfactory design has been found. Each ICT application has its own individual *E.Tutorial®*, but all are conceptually embedded in the same four-step model.

4 The difficulty of keeping it simple

Our e-learning materials are technically as simple as can be: text documents and hypertext documents. The only software needed is a browser ('as simple as possible'). The content of the documents, however, is anything but simple, and neither is the pedagogical environment in which they are used, as illustrated in Fig. 1 ('but not simpler'). The technical simplicity evolved over time as a consequence of keeping our focus on instructional effectiveness, student motivation and just common sense.

Designing and implementing the six *E.Tutorial®*s of the ICT course based on the paper tutorials took approximately one year. But we then spent more than two years refining the course to improve its quality. This section discusses some of the issues that arose during this process. Please note that the comments made in this section relate strictly to our work; certain techniques that we found inappropriate for us might very well be useful in other e-learning applications.

4.1 Learning platform

When selecting the operating environment for our tutorials we also considered learning platforms, as these seemed to be the epitome of e-learning. Upon closer examination none of the reasons why one might want to use a learning platform corresponded to our needs. These systems help students to manage their e-mail, their agenda, their files, their contacts, and other office-type functions. Students have already automated these tasks as part of their daily lives; if there is anything they do not need it is one more system to do this.

Learning platforms were also unable to provide us with support in managing our content, namely to organize the problem-based learning materials in a way suitable for application-oriented instruction. In the end we decided to use the simplest web technology and design an interface consisting of three windows using HTML and JavaScript. The technology needed was (and still is) available free of charge, we were not bound to any proprietary standards, and it made the software open.

For our purposes a learning platform would be more of a liability than an asset. Nevertheless, anyone who operates a learning platform can easily incorporate our material into it.

4.2 Collaboration

Another buzz word in e-learning is 'collaborative work' and lecturers are repeatedly encouraged to use software to support it. We also felt obliged to provide our students with a service that would allow them to share their thoughts and their work easily with each other and the teaching staff – but not one student used it. Instead, they engaged in lively discussions in the computer room and during the lecture, sharing experiences in solving the problems of the exercise.

Early in this project we noted that students collaborate on their own if the course content encourages this type of exchange among peers. Unfortunately, at the beginning it is often unclear what exactly fosters collaboration and therefore it is important to observe how students behave during e-learning.

4.3 Electronic textbook

Once we decided to use hypertext documents, it seemed a logical extension to also create an electronic version of the lecture notes and link its content with the tutorial and the glossary. We learned, however, that availability of information in itself is not a major problem when instructing. Linked hypertext pages and text databases with search facilities provide novel access simply, but they do not reduce the complexity or place the abundance of information in the right context. The information presented in detail in a textbook is too remote from the information which students require to solve their immediate practical problems. Theory must therefore be reworked into smaller units that relate to a concrete problem and become part of the instruction.

4.4 Animations, videos

To visually support the step-by-step instructions of the *E.Tutorial®*, we first experimented with short video sequences. When we realized that animations and videos

are instructor-centered and do not support the student's activity, we dropped them altogether. Evaluations showed that the students did not miss them. As soon as learners themselves can control the learning process, they no longer view animations and videos. We observed that illustrations that show intermediate results (Fig.1, 'Verification' in step 'Try') are much more effective, and that they are greatly appreciated by learners.

4.5 Time management

Since we started using a problem-based approach combined with *E.Tutorials®*, students spend more time on the learning materials than before, they are more motivated, and they work less superficially. E-learning therefore does not reduce their workload during the semester; but because they must work continuously their learning process is complete at the end of the semester. This frees up the time they previously spent on exam preparation.

Problem-based learning allows us to distribute activities such that time is more effectively utilized.

4.6 Media

Because studies have shown that for reading longer texts most people prefer paper over computer screens, we have chosen to hand out detailed information on paper. Figure 1 shows that this is preferred when a new topic and its technical terms are introduced (step 'See'), and for describing the problem students have to solve independently (step 'Do').

Any electronic medium can be used to store the hypertext files of the *E.Tutorial®*. We make them accessible over the web, on CD-ROM and more recently on USB memory sticks. Memory sticks have the advantage that students can save their work together with the e-learning materials on the same medium so that their activities are not tied to a particular computer anymore.

Interestingly, if given the choice most students prefer the memory stick over the web even when they have free internet access in the school's computer rooms.

4.7 Teaching assistance

Even though our students have the option to work anytime, anywhere, we organize teaching assistants during fixed hours. This allows students to build a relationship with real persons, which anchors the learning process in the real world. As mentioned in Section 2, the role of the teaching assistant has changed from information broker and example problem-solver to that of a coach who can answer technical questions, observe the learning progress and provide feedback.

Working in a computer room dedicated to the purpose animates students to help each other out more frequently and collectively answer many small questions themselves. This makes other mechanisms to encourage and support collaborative work superfluous.

4.8 Assessment

A potential side-effect of PBL is that learners indeed understand the problem but may have difficulty disengaging from it to reach a level allowing generalization. To verify that students achieve this level of competence, we introduced oral presentations during which they summarize in their own words what they have done (Fig. 1, step 'Explain'). The assistant's feedback on this presentation becomes a reward for a student's efforts which counts more than the credit points at the end of the semester.

Assessments are, in general, limited to providing data for a grading process which typically takes place at the end of an instructional unit. Grading often fails to include the instructional process as a whole. Instructors want to give a good and interesting course, but they also have to separate successful students from unsuccessful ones. To be of any value, the selection must take place at a cognitive level that corresponds to the cognitive level of the instruction. For this reason, our students must also pass an hour-long application-oriented exam at the end of the course.

5 Assuring quality

We have argued in Section 2 that an educational system has many stakeholders, each with his own goals, priorities, constraints and means. But, no matter how diverse their opinions on e-learning are, they surely would agree on one desideratum, namely that no matter who delivers education and regardless of the method chosen, it must be of the highest quality. Traditionally, schools try to control quality by having their classes evaluated. We also think that evaluations are important, but to be meaningful they must include the assessments.

5.1 Evaluation

That teaching is a complex system became clear to us when we realized that we were spending more time optimizing our e-learning instruction than we had spent putting it in place originally. To guide our optimization we evaluate the course in such a way that we can observe how the entire process behaves. First, course acceptance is evaluated regularly with questions concerning the lecture, the *E.Tutorials®* and the exam. Second, course effectiveness is assessed via an application-oriented test at the end of the semester. This provides us with a realistic estimate of what students have actually learned.

The most useful feedback, however, is the set of results from the 10-minute verbal assessment session at the end of each tutorial (Fig.1, step 'Explain'), during which students explain to a teaching assistant how they solved the problem that follows the *E.Tutorial®* (Fig.1, step 'Do'). These assessments show that our students not only became more motivated, but that they now also learn more. This observable output has become our dominant quality criterion.

5.2 Assessment

In traditional courses students are often required to solve application-oriented problems during an exam even though they never really applied their knowledge during instruction. The resulting failure rates often tempt the instructor to fix averages by adjusting the grading scale accordingly. PBL-oriented instruction reduces this side effect. We have become convinced that if instruction and assessment are to be effective, both must be designed to operate at the same cognitive level.

In another project we are examining methods for administering exams electronically, with individualized tests that include application-oriented questions. The underlying database of questions will also be accessed during the course, allowing close coupling of instruction with assessment so that students can verify their progress. First experiences are reported in [5].

Summary

E-learning systems must be simple, otherwise they cannot be incorporated into a complex teaching environment without dominating it. To guarantee high quality in teaching, however, an e-learning system must not be simpler than the complexity that results from combining a sound didactic model (PBL) with an effective instructional design (4-step model).

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Meeting the Needs for Skills Upgrading in SMEs through Mobilisation of Science Parks and Incubators: Swedish Experience and Issues for Developing countries

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Abstract

Relevant and effective competence upgrading is of crucial importance for firm competitiveness as well as regional and social development. R&D is important for innovation in many kinds of firms but takes secondary importance in many situations. In Africa and other developing regions it is crucially important to identify what mechanisms can effectively support the upgrading of relevant skills broadly in the economy, drawing on and combining what useful capabilities are available. Sweden, being a country with high R&D-intensity, strongly internationalised big business and extensive research in universities, presents some specific examples of new approaches in this area. Reviewing the experience of Science Park Jönköping in cooperation with Jönköping University, the paper presents lessons and conclusions how, and by which actors, more relevant capabilities and matching roles may be nurtured. Particular attention is paid to the challenges confronting SMEs in the upgrading of skills. Measures bridging the supply of general training by universities and the demand for idiosyncratic skills on the part of SMEs should be paralleled by those that mobilise more complementary contributions of external professional service providers. Rather than general knowledge promotion, programmes need to strongly emphasize local adaptation and specialisation.

1 Introduction[1]

Scientific discovery and technical progress are often viewed as natural drivers of innovation and economic growth. Consequently, many countries around the world view R&D as a vital component of their overriding economic policy objectives. Although there is a significant relationship between R&D and some measures of competitiveness and growth across countries, the relationship is an evasive one. In practice, a range of factors influence to what degree technology is diffused and applied in an economy. Among the most important and difficult questions is the issue of how small and medium-sized enterprises (SMEs) become able to utilise technology. This is in part because of the sheer number of such firms, their importance for social and local development, but also because of what is seen as their growing importance in the area of technical change and economic renewal.

Technical progress, falling costs in information and communications technology (ICT), and the globalisation of goods and factor markets are opening up new avenues for small and medium-sized enterprises (SMEs) to pursue wider business options. With the rapid diffusion notably of information and communications technology (ICT), market opportunities are becoming known and easier to identify for firms anywhere in world, including in developing regions, provided that businesses and individual human beings can acquire the knowledge that is relevant for their particular situation. On the other hand, sharpening competition is pushing for greater focus by firms on core business and a decompartmentalisaton of production chains across national borders. While SMEs may enjoy a relatively high degree of flexibility at firm level, and combine that with capturing of economies of scale and scope through networks with other firms, they face difficulties in accumulating the skills that are required for managing specialised production systems and international interactions.

Not only are SMEs in a weak position to acquire the training they need, they also experience difficulties in estimating the value of investing in skills internally as well as accessing external expertise. At the same time, the weaker their skills basis, the less capable firms are in handling external counterparts, the weaker their bargaining power and the greater the risk that they are bullied by larger and more influential suppliers or customers. This may be particularly serious in developing countries, where market mechanisms tend to be relatively undeveloped resulting in less transparency and more opaque information on prices and qualities. However, barriers to skills upgrading worsen because of complications in incentive structures internal to firms. In particular, the prospect of worker mobility tends to reduce the incentive of employers to invest in the general-purpose skills of employees. Again, developing countries may be lacking regulated conditions in support of employment stability, especially for SMEs and in the informal sector, resulting in high churning of labour and little confidence on either part of the employer-employee relationship that their contractual bond will last for an extended period of time.

Whereas the needs of SMEs for upskilling may be idiosyncratic, universities tend to focus on acquiring high-profile generic scientific competencies. In relations with society as regards skills upgrading and training, they opt for supplying general skills packaged in sufficiently large quantities. University offers are compounded by traditional incentive structures which put up barriers to entrepreneurship and tend to nurture attitudes that are weakly compatible with the appreciation of business relations.

What measures are thus warranted to address the issues confronting SMEs in competence development? National policies have an important role to play in promoting public goods in the form of scientific and basic knowledge,

[1]This paper represents a revised version of an invited paper presented at the IASP World conference in Beijing, September 2005. Comments from Piero Formica, Kathryn Proulx and Clas Wahlbin are gratefully acknowledged.

but also in ensuring sound conditions for risk-taking and entrepreneurship. The interplay between universities and enterprises as regards matching the supply and the demand of skill development represents part of this mission. Special issues arise because the properties of effective interaction of this kind are largely determined by specific local conditions, and such relations must primarily be managed locally. In this context, not only the competencies but also the organisational structure and attitude of universities matter.

Other kinds of actors, which can provide vital fora for the interface between universities and business, are also important, however. Science parks and incubators are clearly relevant in this context. Although it has generally not been seen as their prime mission, these organisations can fill specific functions in addressing the issues that arise in skills upgrading for SMEs. This paper takes special note of experience accumulated in this context by Sweden. It should be noted that Sweden is a country that is characterised by high R&D-intensity, big internationalised business and extensive R&D in universities. The country is nevertheless faced with distinct challenges to foster competitive SMEs, an agenda that has grown in importance as the large firms have become increasingly internationalised and footloose (Andersson, 2006). The focus here is on a specific innovative approach which helps illustrate more generally valid aspects of what is needed in order to shape a locally adapted approach that can help enhance the diffusion and use of technology broadly in the economy. This is the case of *Science Park Jönköping in cooperation with Jönköping University*. The latter is one out of only three universities in Sweden that is not owned by the government, the implications of which are further reflected on below.

The paper is organised as follows. Section 2 discusses the importance of skills upgrading in SMEs. In Section 3, we take note of the mismatch between the actors involved in this area. The role of science parks and incubators is introduced in Section 4. In Section 5, attention is turned to the experience of Science Park Jönköping in Sweden, including which issues it is currently confronted with and what more lessons can be learned for African countries specifically. Section 6 concludes.

2 Skills upgrading and SMEs

Among developed countries, broadly speaking, there is a positive relationship between R&D-intensity and GDP per capita, as illustrated by Figure 1. There is no one-to-one relationship; however, as can be observed in many individual countries a range of factors influence the presence of links between R&D and economic performance. Whereas the EU views its relatively low R&D-intensity (compared to the US and Japan), as a major factor contributing to its weak economic record in recent decades, individual EU-member countries, such as Finland and Sweden, have a high R&D-intensity. As illustrated in Figures 2 and 3, these countries indeed display a healthy position with regard to scientific publications and patenting. With the Lisbon Agenda in 2000, the European countries committed to undertake a series of reforms which would lead to higher R&D-intensity, and enable a better environment for, e.g., patenting and the start-up and growth of new business. Progress, however, has been meagre.

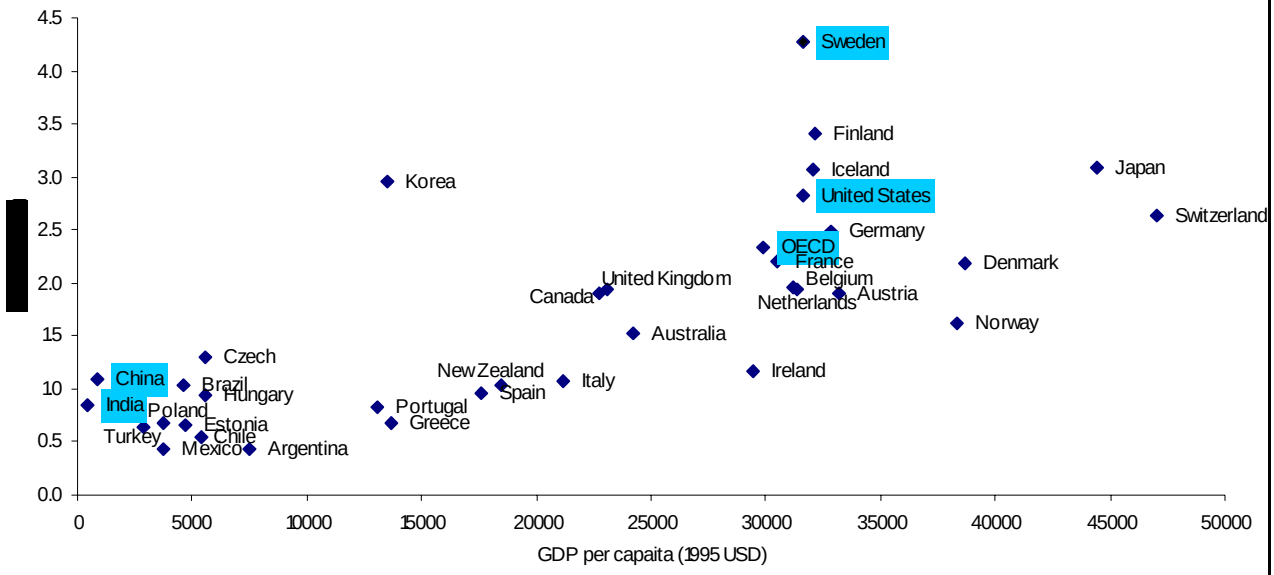
Another priority area for most countries is that of educational attainment, which traditionally has been viewed as greatly important for economic performance. Though the share of the population attaining higher education has increased in both developed and developing countries, the notion of a simple relationship between quantitative measures of education and economic performance has faded (Barro and Lee, 1996; OECD, 2001). The contribution of human capital to society and the economy crucially depends on quality, and how skills are put to use. Some of the potential impact of human capital emanates from the link to better use of technology, innovation and entrepreneurship.

A fuller understanding of how human capital, training and renewal can contribute to societal progress requires consideration in a number of factors. Compared to tangible assets, knowledge and skills are typically less visible to competitors and more difficult to imitate, providing a viable basis in many firms for building sustainable and robust advantages. This aspect reflects the broader phenomenon that intangible assets and intellectual capital are gaining ground as decisive determinants of industrial competitiveness.

Technical progress, combined with reduced costs for diffusing and accessing information, now opens up a range of opportunities for individuals and firms to become more efficient by learning from a wider range of experiences, and emulating (after due adaptation) proven “best practices”. At the same time, a desire to rely on past successes tends to induce established groups to act so as to hinder adjustment processes. Excessive reliance on given contacts and tacit knowledge in combination with neglect of external linkages and lack of foresight may account for lock-in effects due to the dominance of established practices (Amin and Cohendet, 1999; Martin and Sunley, 2001). The adoption of new work practices can thus be at odds with learning accumulated collectively through previous success periods, leading to the gradual failure to recognise changing trends, and thereby a distortion towards excessive reliance on incremental improvement at the expense of openness to radical renewal (Harrison and Glasmeier, 1997).

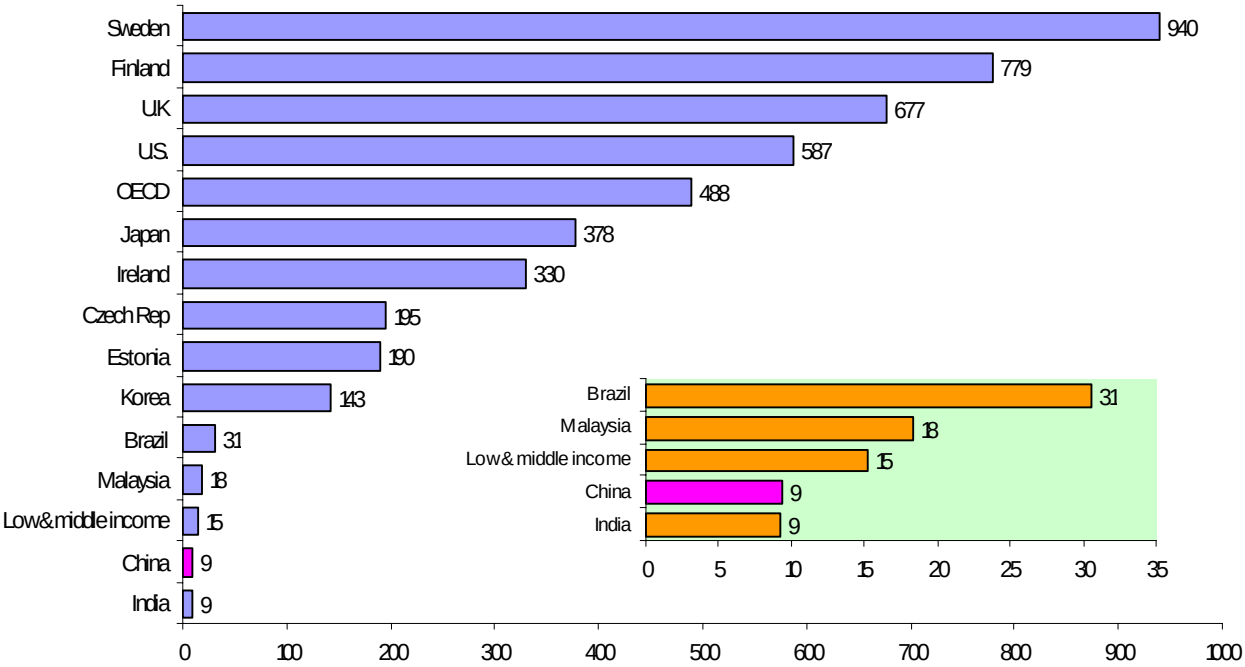
Meanwhile, competitive pressures are also intensifying across a spectrum of economic activities. Whereas basic education represents a building block, follow-up through better targeted skills upgrading is often required. Further, SMEs account for the bulk of employment in practically all countries except for the United States (OECD, 2005*b*) .These firms usually possess less managerial as well as work force skills and also make disproportionately small investments in vocational training. Yet, SMEs are now known to be important for the overall vitality and dynamism of most economies, in part due to their higher

Figure 1. R&D intensity (i.e. R&D expenditures relative to GDP)



Source: OECD (2003)

Figure 2. Number of scientific publications per million people, 1999



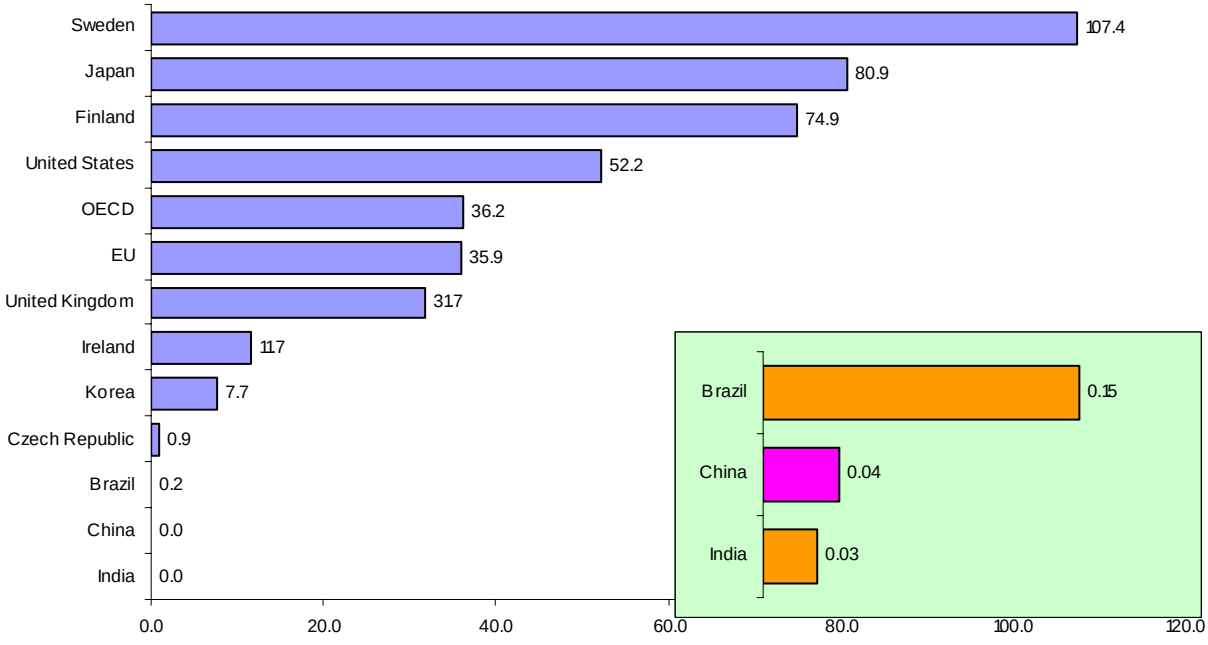
Source: World Bank (2004)

Box 1: Main methods for improving the competence base of human resources in SMEs

Method	Mode	Arena
1. Visiting expos/trade fairs	Formal activity	External activity
2. In-house training courses	Formal activity	Internal activity
3. External courses	Formal activity	External activity In./Ex. activity
4. Work rotation	Informal activity	External activity
5. Study visits outside firm's location	Formal activity	Internal activity
6. Delegation of work tasks	Informal activity	External activity
7. Financing professional literature for reading after working hours	Informal activity	Internal activity
8. Permitted/encouraged (Permitting/Encouraging) reading of professional literature during working hours	Informal activity	Internal activity
9. Personal development meetings	Informal activity	Internal activity
10. Regular meetings with employees incl. elements of education	Inf./For. activity	Internal activity
11. Recruitment of for the firm new competence	Formal activity	External activity
12. Tutor/mentor for newly-employed	Informal activity	Internal activity
13. Senior tutor/mentor for already employed	Informal activity	In./Ex. activity
14. Cooperation with external competence	Inf./For. activity	External activity
15. Linking competence development to salary by e.g. a bonus system	Formal activity	Internal activity
16. Project work	Formal activity	Internal activity
17. Participation in networks	Informal activity	External activity
18. Study visits at the same location	Informal activity	Internal activity
19. Temporary work in another firm	Formal activity	External activity

Source: Andersson et al. (2007).

Figure 3. Number of triadic patent families per million people, 1998



Source: OECD (2003)

flexibility and ability to assume risk in new business activities (Jovanovic and Nyarko, 1996; Peneder, 2002). In addition, the performance of SMEs and what conditions they can offer the workers matter greatly for local progress, and for the conditions and outlook facing disadvantaged groups.

The importance of skills in developed countries shows up, e.g., in a positive correlation between the availability of qualified personnel, the share of successful innovators in a population of firms and the share of new products in the turnover of firms (OECD, 2005*a*). Both the managerial and economic literature has shown that human capabilities critically influence firm performance, including what returns can be earned from R&D (Black and Lynch, 2001; Piva and Vivarelli, 2007). Whereas this is more or less universally applicable, special issues arise for SMEs, and in developing countries.

Although the heterogeneity of SMEs needs to be kept in mind, the challenges of accessing and governing the right mix of skills, as well as mobilising appropriate complementary external skills, are inherently severe for this category of firms. This situation, however, also in itself offers business opportunities. Responses typically applied are presented in Box 1. Practices include sending off employees to specific expos and trade fairs. Show floors may provide a mix of established and potential customers as well as suppliers, and may therefore serve as a venue for useful networking and fostering of new business relationships. Other methods include reading professional literature, internal meetings for knowledge exchange, personal development meetings and work rotation (in-house or in other companies).

Furthermore, under conditions of rapid technical progress, capturing the gains from skills upgrading in an individual activity requires an enhanced capacity to relate to and exploit other connected, complementary skills. For instance, in order to cope, SMEs often need to upgrade, in parallel, the following kinds of competences: i) specific technical skills related to modern communication tools and equipment, materials and substances, methodologies, etc.; ii) marketing and sales channels and competencies that are crucially needed for enabling them to adapt to and exploit their specific products within an increasingly globalized economy; iii) upgrading process and product development capabilities, including the management of protection of intellectual property rights, brand names, etc., and; iv) in organising an effective, constructive and dynamic division of labour vis-à-vis other enterprises within networks or clusters.

Ample evidence from both the United States and Europe shows that an increasing number of SMEs are in the process of outsourcing and off-shoring parts of their production activities, in part to developing countries. This is by many firms viewed as a prerequisite for remaining competitive. It is in some cases also a condition for retaining links with internationalising larger customer firms. Many SMEs in developed countries are thus forced to renew their combined business and market approaches to cope with a global production environment, and to manage distributed product development within global supply chains.

Several studies demonstrate that SMEs commonly fail to cope with the requirements of this situation. Not only are SMEs bestowed with limited skills acquired through formal education, but SMEs commonly lack the experience, information and planning capabilities to judge what is required to succeed with respect to internationalisation. Embarking on rapid technical and organisational upgrading in an internationalised environment, many SMEs can be observed making mistakes and, as a result, are subjected to high costs. The result may be an accelerated decline of industrial production and employment.

SMEs play a critical role in job creation and social cohesion. Peripheral regions may thus be struck by a thinning of their production structures, industrial decay, unemployment and migration problems. In managing to raise their work force and management skills, SMEs can increase their adaptability while also strengthening their position relative to large industrial firms and invoke healthy competition effects. All in all, notably in developed countries, such progress may be greatly important for enabling globalisation to stay on a course which is viewed as socially and economically acceptable, thereby counteracting pressures for protective barriers or state subsidies in order to halt, rather than embrace, needed structural adjustment. In developing countries, much fewer SMEs are in a position of opting for internalisation of their production activities. Yet, in these countries too, SMEs now meet with both new pressures and with new opportunities to develop strategies for coping with enhanced competition at home, as well as succeeding in penetrating foreign markets. The priorities in needs for skills upgrading differ from those in developed countries but, similarly, the issue is greatly important and the precise challenge highly specific to the case of the individual firm.

Sweden, although part of the European Union policy framework, displays an exceptionally high R&D-intensity, second in the world only to Israel. Similar to other countries with high R&D, it is primarily the highly internationalised multinational firms that originated in Sweden, which account for the bulk of R&D. There is also a strong emphasis on public support of R&D in universities. For a long time, there have been favourable relations between R&D in big businesses and in universities. Sweden also has a significant SME-sector. The subcontractor industry commonly consisting of SMEs has strongly contributed to the competitiveness of the giant industrial firms.

Yet, in a sense, the Swedish innovation system displays signs of a dual, polarised, structure, reliant on two main poles. On the one hand there is an advanced and highly internationalised community of large, R&D-intensive firms, on the other hand, a well-established university sector which receives the bulk of public R&D support. In between, the SME-sector has low R&D-intensity as well as workers with relatively weak formal education. Levels of entrepreneurship are low, and one may speak of an "under-performance" in the creation of new high-growth firms.

The Swedish situation may be viewed as extreme, but the issues displayed are high on the agenda in devel-

oped and developing countries alike. The large EU countries present structural deficiencies that are generally worse but related to those plaguing Sweden, and which suggest that increased R&D in itself does not present the answer to sluggish growth performance. Nevertheless, given its investments in knowledge assets, the Swedish economy is viewed as underperforming relative to its potential, especially with regard to commercialisation of its science and technology assets. While there has been a noteworthy improvement in recent years, there is little doubt that a stronger human capital accumulation in the SME-sector, coupled with a better supply of entrepreneurship and risk-taking in growth-oriented businesses, could account for further improvement (Andersson, 2005).

3 Mismatch in response to the SME-issues

SMEs are commonly observed to be reactive in their training activities and unfamiliar with strategic plans for training. A number of studies emphasise the particular importance of direct communication if such firms are to act differently (Prahalad and Ramaswamy, 2000). The most important information is "tacit" rather than "general/codified" (Polyani, 1962). Insights needed for putting information to good use must often be gained through the personal exchange between managers and staff on the one hand, and relevant partners and customers on the other hand, in ways that enable an effective articulation and manifestation of the firm-specific needs for training and competence upgrading.

Another aspect is that the question of what particular skills, and combinations between them, are relevant in the individual case, is likely to vary radically. Some needs are likely to be idiosyncratic. At the same time, there is also a notion of "task-specific human capital" that cuts across particular sets of firms, possibly interwoven with local or regional societal and industrial commonalities, traditions and particularities in local skills profiles (Gibbons and Waldman, 2005; Balmaceda, 2006).

Whereas the demand of SMEs for upskilling is far from straightforward and requires careful attention, a key issue concerns what mechanisms are available to mobilise a supply side for the provision of what they need. For their highly specific requirements to be met it will not suffice that universities or other training and service providers simply offer their general lectures and programmes for skills upgrading. Serious issues arise because of the incompatibility of incentives, traditions, and established means of communication between several of those actors which have a bearing on whether an effective matching between supply and demand in this area is possible.

A fundamental difficulty for SMEs to manage the challenge of upgrading their skills has to do with the fact that their requirements far from always are well understood by firms themselves, especially in the early stages of firm formation, or at the midst of stages marked by rapid technological and organisational renewal. The level of management skills and strains in work organisation, including severe time pressure, compounds the difficulties. In part connected with the situation is a second factor, namely that their needs tend to be highly idiosyncratic (Hamel et al. 1994, Becker, 1993). SMEs thus often sense the urgency of obtaining certain specific capabilities, whereas general purpose-skills may not be in demand.

The latter consideration involves a contradictory interest between employers and employees. Upgrading the skills of employees may increase the risk of poaching by other firms, i.e. employers investing in skills upgrading may subsidise competitors (Leroy 2002). Employers may thus have to pay higher salaries to maintain a worker once he or she has become trained, lowering the return on investment (Becker, 1993). The relevance of such arguments depends in part on the distinction between "specific" and "general" human capital. Specific human capital refers to skills or knowledge that is useful only to a given context, possibly only a single employer (who will then be more willing to pay for it), whereas general human capital (such as literacy) is useful to all employers.

If a company invests time and money in upgrading the skills of an employee, and if the employee comes to possess rare knowledge needed for efficient production, the individual also risks being loaded with increased work. Fear of extended responsibility in combination with limited time, e.g. due to family responsibilities or low possibility of career development in spite of the extra effort invested at work, may reduce the incentives for an employee to attend such job training activities. Problems are worsened by progressive taxes and social attitudes reducing appreciation for social upgrading.

Factors such as these may typically hinder or impair demands for the upgrading of skills within enterprises, particularly SMEs. For fear of losing control, management may be hesitant to accept increased independence of employees as well as to involve outside specialists. According to the ENSR Enterprise Survey 2002, lack of skilled labour had been the main constraint for the business performance of European SMEs in the preceding years. The fact that SMEs underline the importance of upgrading of skills may, in itself, be viewed as an indication of the problems they are confronted within this area.

Throughout most economies, universities serve as the prime authority in knowledge creation. Their coverage is traditionally based on broad scope, stability, and resistance to change (Martin 2003). At the same time, there is a common perception that programmes within higher education institutions encounter difficulties to raise students' ability to apply their knowledge, skills and understanding of the workplace, i.e. education is confronted with challenges to meet market needs (Storey 1998).

In developing countries, and to a very high extent in Africa, policymakers and academics enter an alliance to establish mechanisms that can support the evolvement of an internationally competitive science base. This challenge is in itself daunting and it is often believed that the actors involved cannot afford any disruption in such efforts. At the same time, strong belief in the value of rigid

administrative principles and fear of leaving room to manoeuvre to individual judgement in specific cases, leads to a high tendency of applying forms of regulation and distribution of public funding that in effect ensures highly standardised strategies and profiles of academic institutions.

In developed countries, it is increasingly recognized that universities cannot operate in isolation. Their position is becoming viewed as integrated with society. The new expectations are exemplified by the notion of the entrepreneurial university (Clark 1998; Hay et al., 2002), and the importance of co-operation with both the public sector and industry as elaborated within the Triple Helix (Etzkowitz and Leydesdorff 2000). It is also increasingly understood that the potential for learning and successful innovation is dependent on conditions allowing for effective buy-in by the actors concerned, and for constructive interactions between different kinds of assets and competences.

For various reasons, the functions that breed scientific progress, technical progress, innovation, and skills upgrading in the workforce, meet with particular matching problems in the case of the SME-sector. Educational programmes in universities and other formal education institutions are typically generalised in ways that are incompatible with SME needs. Too theoretical, not tailored for the needs of the specific company, not adjusted to fit contemporary problems, not provided in the near vicinity or at manageable hours, are some of the features pointed out as typical reasons for not sending employees to formal training courses. These issues reflect fundamental factors affecting the general direction and nature of knowledge development in universities. For a host of institutional reasons, traditional academic institutions lack interest to engage in commercial activities[1], notably with SMEs and for the purpose of supporting entrepreneurship. Differences in culture and language between entrepreneurs and academics fortify the barriers that hinder the offering of programmes that are relevant to SMEs.

According to some scholars, the observed difficulties are not inherent, but academics may be well placed to develop entrepreneurial qualities (Hay et al., 2002). Today, there are also well-known instruments available to support spin-outs of commercial ventures from universities (Wright, 2004). The academic, governmental and business spheres may go through stages of mutual adaptation during which such linkages evolve (Etzkowitz and Leydesdorff, 2000). On the other hand, it is less known what conditions and institutional set-ups can help support such processes in a constructive manner. Progress may be contingent on certain enabling factors. It may also not be spontaneous but hinge on mechanisms that can allow for the build-up of those capacities that are required for the outstanding needs of SMEs to be articulated and communicated, for impeding factors within universities to be countered and overcome, and for a critical mass of network-building drivers to be in place (Amin and Cohendet, 1999; Martin and Sunley, 2001).

Additional factors limit the ability of universities to respond to the needs of SMEs. First, it is problematic to identify which training capabilities are indeed relevant, in part due to the difficulties of SMEs to articulate their needs, as discussed above. This also brings difficulties in knowing what potential services could potentially be packaged effectively in ways that would allow a critical mass of customers to be formed. Second, adjusting to the concrete, perhaps somewhat trivial and repetitive needs that characterise skills upgrading among great numbers of SMEs, may square oddly with the incentives of academic institutions, which above all strive for scientific excellence.

For such reasons, industrial institutes and other agencies that are specialised in diffusing skills and technologies to industry, have an important role to play. At the same time, such institutions are more weakly placed than universities when it comes to linking to education, and also with regard to linking to academic research as well as arranging with spontaneous connections between multiple areas of knowledge creation. While industrial institutes still matter, their role thus has limited reach, and it will not be subject to any further detailed consideration in this study. Another set of relevant actors is that of science parks and incubators, which may operate in closer conjunction with universities, and may be relatively well-placed to combine some of those disparate functions that need to go together if the gap between SMEs and knowledge-generation in universities is to be overcome.

4 Options for science parks and incubators

The role and efficiency of science parks and incubators vary depending on context. Many are explicitly mandated to take a responsibility for contributing to regional development. Often this focuses on supporting new businesses as well as generating new employment. There are also other kinds of expectations, generally reflecting a science park working within a specific community/context. Most science parks are characterised by the following, however:

⇒ formal and operational links with some kind of major centre of research;

⇒ a structure designed to encourage the formation and growth of knowledge-based businesses; and

⇒ a management function actively engaged in the transfer of technology, mobilising finance and management skills to the organisations on-site, but also handling basic administration such as office space.

Business incubators are related technology-based entities devoted to the establishment and growth of young entrepreneurial companies with high-growth potential (Lavrow and Sample, 2000). Boundary crossing is in both cases at the heart of the mission, applying to: i) the boundary between idea and firm, i.e., between university-based knowledge or technology and the firm which bears the potential to commercialise it; ii) the boundary between the firm and the wider network in which the firm is situated, which serves to bridge the rise of complementary skills and thus local specialisa-

learning processes, may be equally demanding for these firms.

Rather than the uniqueness of such features, however, the prime issue of interest here has to do with what general lessons can be derived from this example. As in the case of most other countries, notably in Europe and in Africa, the Swedish university system is dominated by public universities which have to obey public laws and regulations that detail the nitty-gritty of their governance structure. Only three universities are not owned by the government but have greater freedom to organise themselves appropriately. Of these, two are basically oriented towards big business, i.e. the Stockholm School of Economics in Stockholm and Chalmers Institute of Technology in Gothenburg. Being the third institution, located in Jönköping - the 10th largest city in the country and the main centre of the entrepreneurial southern province of Småland – Jönköping University is dedicated to relevance to SME-development[4]. In the region, there is widely-spread appreciation of the virtues of entrepreneurship, and of "subsidy-free culture". At the same time, sharpening international competition and the rapid internationalisation of industry now under way have led to vocal demands for closer university-industry interface, both to offer training and in support of higher rates of knowledge-intensive start-ups.

Whereas the region (country of Småland) is entrepreneurial, academic traditions are weak and, because of neglect, Jönköping missed out on opportunities to be selected as the location of a new university when new institutions were planned in the 1960s and 1970s. A gradual reassessment of the situation led to a widely-shared conviction among the main regional players that an institution for higher education and research was indeed needed. In contrast to the common striving for traditional generalist university institutions, the regional actors early opted for the establishment of a more specialised institution which would be able to develop a sharp profile mirroring the special values and assets of the region. An unexpected opportunity arose in the mid-1990s when the centre and right-wing government of the time opted to create two non-government owned *university foundations* in Sweden, to be less bounded by public laws and more prone to experimentation and specialisation. The selection eventually came down to Chalmers Institute of Technology and Jönköping University.

A few years after the university foundation had been set up, Science Park Jönköping was established as a non-profit association and a collaborative platform for the creation and growth of new enterprises. The responsible parties included the university as well as each of the municipalities of the wider county. In effect, the general assembly was more interested in diffusion than intensive firm development in the park itself. The municipalities were basically moving to raise their own performances, and were less engaged in exercising strong influence on the central unit. Meanwhile, novel strategies of the young SME-conscious university and the science park were developed in tandem. For instance, as the university pioneered the development of entrepreneurship research, Science Park Jönköping developed its own platform for the experimentation and creation of new enterprises by students. As the university developed a vast network of companies mentoring its students through their educational programmes[5], the Science Park was able to exploit the engagement of the individual municipalities of the region and develop new structures for local engagement in processes of firm creation and competence upgrading.

The reach of the Science Park in supporting entrepreneurship and business renewal in the region more broadly, was extended through the adoption of a science park system. This consists of several nodes in the county where each can be characterised as a micro-version of the Science Park. The objective is to extend the accessibility of essential infrastructure in the form of:

⇒ *venue* (i.e., a knowledge-intensive meeting place where a critical mass of mechanisms in support of the development and exchange is able to evolve),

⇒ *services* (value creating services to stimulate start up, development, and growth of new companies and business areas) and

⇒ *knowledge* (links to university, research institutes, and other sources of knowledge).

Further, all specialities cannot be found within a single physical location. The extended geographical system offers possibilities for bringing together multiple regional initiatives in novel ways that allow for capturing of economies of scale at the level of the network as a whole.

Reflecting the philosophy of the key actors and the objectives of the main activities, the structure of Science Park Jönköping was designed to differentiate between, while also linking, three distinct phases of company development: i) the Business Lab; ii) the Business Incubator, and; iii) the Business Growth part. These three fit respectively the themes *start-up*, *development*, and *growth*. Special attention has been paid to the operations of the Business Lab, which operates as an "open-source" environment where ideas originating from students/researchers, as well as from the surrounding business environment, are allowed to be tested[6]. The university pays the rent of the lab, and some university training courses are offered there. Through appropriate linkages with the Business Incubator, a high "deal flow" of ideas and a progression in multiple forms of "learning environment have been engineered", even if only a fraction of the firms started in the Business Lab can be housed in the Business Incubator. In Business Growth, the Science Park houses companies originating from academia as well as from established businesses and R&D-units.

The main components of the student entrepreneurship system are: (i) a 5-week course in "Entrepreneurship & Business Creation", which is mandatory in the first year for all students in undergraduate programmes in business administration and engineering and; (ii) a support system run by the Business Lab of the Science Park where any student, or more commonly, a team of stu-

dents that have an idea can freely enter and get advice and support. Because the university is closely aligned with private companies in several ways, students are used to working together with companies. As a result, they can relate their studies more effectively to the business community, gain more practical entrepreneurship training which can be used in another context or they may exploit the possibility to start a new company backed by the business support of the Science Park through the Business Lab.

The way this environment was shaped from the outset and has continued to interact with the university, students are inspired to visit the Science Park and are encouraged to start new companies in parallel with their studies. The various educational programmes of the university offer an understanding of entrepreneurship, but these activities only have limited scope and thus allow students to divert plenty of time and effort from other studies and learning exercises. The day the inspiration for getting to know more about a concrete opportunity arises, students become aware of the entrepreneurial avenue as an option, and also of a physical site and professional hub at which they can visit and feel welcome.

As a result, the number of companies started in the business lab, mostly by students, has grown rapidly to reach over 70 in 2006. Whereas the majority are started by business and engineering students, interest is noticeable among health and teaching students as well, where levels of entrepreneurship are overall extremely low in the Swedish university system. Not only do students of Jönköping University thus start firms to a higher degree than elsewhere, but the student support system is highly cost-effective in financial terms. The cost per firm started is estimated at approximately €5000, an order of magnitude significantly lower than the cost in "Entrepreneurship Schools" at other universities. Survival rates are also reasonably high, although distinctly lower than at some much higher-investing institutions such as Chalmers[7]. On the other hand, benefits accrue not only because some companies survive and grow, but also because entrepreneurs bring their experience with them to other new ventures, and also other professional careers.

Box 2: Main methods for a Science Park to improve the competence base of human resources in SMEs

(n.a = not applicable)

Method	Creation of new firms	Supporting local clusters	The Science Park system in the region
1. Visiting expos/trade fairs		X	X
2. In-house training courses			
3. External courses	X	X	X
4. Work rotation	n.a.		
5. Study visits outside firm's location		X	X
6. Delegation of work tasks	X	X	
7. Financing professional literature for reading after working hours		X	
8. Permitting/Encouraging reading of professional literature during working hours	n a	n a	n a
9. Personal development meetings		X	X
10. Regular meetings with employees incl. elements of education			
11. Recruitment of new competence for the firm	X	X	
12. Tutor/mentor for newly-employed	X	X	
13. Senior tutor/mentor for already employed	n a		
14. Cooperation with external competence	X	X	X
15. Linking competence development to salary by e.g. a bonus system	n a	n a	n a
16. Project work		X	X
17. Participation in networks	X	X	X
18. Study visits at the same location			X
19. Temporary work in another firm		X	

Due to its unique set-up, combined with the special features of the region, Science Park Jönköping is unusually well-positioned to play a constructive role in meeting the needs for upskilling among SMEs, as discussed in the preceding sections. The region is not only "SME-intensive", but the share of firms in manufacturing is exceptionally high (accounting for 60 per cent of employment in some municipalities), whereas supportive business services are weakly supplied. The new firms created in the park tend to be oriented towards professional services, and are marketing and selling their competencies to other SMEs in the region (as well as nationally). Service firms in particular complement the traditional manufacturing SMEs and may help to support specialisation through more effective carving out of core competencies in their customer firms. An example is a firm started by a media and communications student in the Science Park which took on an assignment in media training for the management group of a medium-sized manufacturing company that sells its products on a world wide market. Other examples are spin-off firms in the Science Park working with project management, product design and the development of ICT-services that strengthen information logistics and knowledge management in client companies.

By developing a forum for match-making, linking established business and the aspirations of new knowledge-based firms, Science Park Jönköping positions itself to cherish complementary processes of firm formation and continuous and mutually-rewarding skill upgrading in existing SMEs. Complemented by other collaboration with the university, such as mentorship programmes, the Science Park moves to encourage and train firms to articulate their specific skills needs. The Science Park moves to make the supply of skills more prone to be driven by the demand for value-enhancing services in individual businesses.

As complementary mechanisms for exercising this task, Science Park Jönköping has exploited three channels. As depicted in Figure 5, these are: (i) The creation of new companies and the development of skills for Science Park firms, mostly with SMEs in the region as their prime customers; (ii) the support of local clusters by developing programmes for SMEs together with Science Park firms, and; (iii) the collaboration between actors in the region that work according to the Science Park idea in a system, the Science Park system.

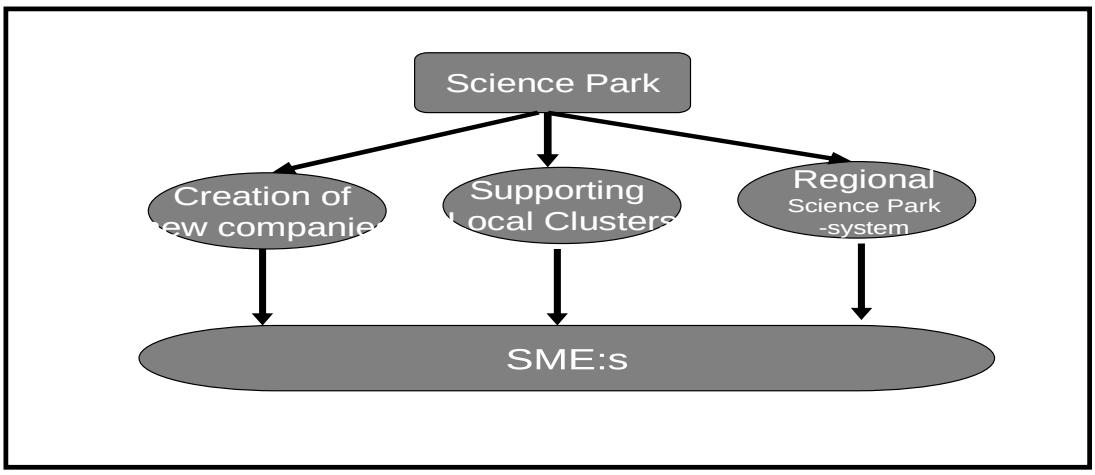
Through the creation of new enterprises, new knowledge is put to action. By selling their new technology and services, the new firms diffuse their knowledge to more established businesses. By getting access to a wider supply of complementary services through the interface with a "trusted" intermediary organisation and arena for exchange, these firms also gain the confidence of increasing their specialisation, focusing harder on developing skills that are central to their key business in parallel with developing an increased reliance on the external services. Through these processes, both of which allow firms to adopt new knowledge and technology, existing firms and industries gain opportunities to become more competitive on the global market. Also, through the creation of and activities developed by new companies, learning processes are shared between actors in the Science Park and the SMEs of the wider surrounding region.

To what extent can the Science Park support the development of "relevant" skills within the new companies? For nascent firms (whether housed in the Business Incubator or not) as well as for growing companies, an extensive range of services is provided, related to training. The training is hands-on, based on the need of the specific company, and often organised in a setting where three or more companies cooperate. An example is a two-day strategic sales-training programme which is hosted by the Science Park each year. The basic methods and instruments are communicated to all companies participating but applied to different problems. Business coaches from different areas of expertise are coordinated and combined for the purpose of analysing and adjusting the existing models so that they can meet the specific needs of each individual company in a "task force" manner. Another example is arranging a joint "kick-off" for the companies that are too small to arrange such a meeting on their own. A law firm has, for instance, allocated one employee, one day every second week, for free counselling for Science Park firms. If the firms require more expertise in intellectual property rights the office of a national patent firm with five employees, located in the Science Park, can provide support. Also, the former owner of the local law office is employed by Science Park Jönköping as a senior consultant for science park firms. As a special consideration, at least one of the available business coaches needs to have relevant expertise in intellectual property rights.

Science Park Jönköping also attempts to identify and strengthen emerging clusters. In the local community, the Science Park firms working within the area of robust electronics and embedded systems together with other firms form a cluster with skills upgrading high on the agenda[8]. Learning processes are based on exposure to specific problems confronting individual companies and how they can be resolved in the specific situation, followed by exercises of comparison and generalised conclusions. By bringing together a group of companies representing a certain area of expertise, various new solutions can be identified and compared. Processes are engineered to trigger mutual exchanges and learning experiences. Many of the ideas that are rejected, i.e. not applied to the specific problem/need at hand, are in effect reintroduced and applied in another context.

Based on the experience of Science Park Jönköping, Box 2 summarises a number of measures that a science park can adopt to improve the competence and human resource base of SMEs, applying the methods shown in Box 1 and distinguishing between the three enumerated modes. While the "X" markings are, of course, judgemental, their sheer number illustrates the need for a science park to develop a comprehensive strategy for what it can and cannot do, in support of communication, planning, implementation and, not least, the creation of synergies between the different aspects of its operations.

Figure 5: Science Park support model - three modes of strengthening local SMEs



Source: Andersson et al. (2004)

As the strategy of Science Park Jönköping has evolved over the years, efforts have been made to strike a combination between flexibility/adaptation on the one hand, and preserving a clear and effective structure on the other. A key aspect has been the continuous effort of the park to keep its main collaborative actors, including the university and the businesses, on "speaking terms" with each other, within the realm of a market-oriented view of entrepreneurship and skills upgrading. In many respects, the role of Science Park Jönköping is that of a broker. As such, it must acknowledge and seriously consider the cultural differences between e.g. academia and business, but identify the points of mutual benefit and build upon them, thus building trust between different parties. This includes creating a climate in which lack of time to handle administrative hurdles or participating in discussions for discussion's own sake is appreciated, where business failures are accepted, and where the virtues of both uncompromising competition and fruitful collaboration between companies are stimulated.

On a more operational level, the inclusion of several kinds of activities in its agenda creates a challenge for Science Park Jönköping to measure the effectiveness of disparate kinds of efforts, and to guard incentives structures that can allow for an orderly cherishing of good results in each of them. From the start, Science Park Jönköping adopted a *balanced scorecard reporting model* of activities. In 2003, as a commercial business intelligence system was implemented, the burden of collecting extensive data was rationalised, in part through a software system that systemised the daily interactions and information developed between business coaches and companies.

Whereas Science Park Jönköping made great strides in many respects, there are also outstanding challenges. The entrepreneurial spirit has not embraced all parts of the university. To date, students in potentially important growth areas such as health and education have played a minor role in the set-up of new firms. This comes as no surprise, as these sectors are dominated by public interests in Sweden (and in Europe more broadly), feature mainly female students (which have generally been less prone to start their own company), and also because the processes leading to entrepreneurship in these areas may take on special features due to special restrictions. Another weakness is that although the growth part has come to host a good number of established companies, the provision of relevant professional business services allowing this category of knowledge-intensive firms to grow vigorously has lagged. This, again, is not surprising given the fundamental priorities and objectives of the key stakeholders. Revising the fundamental ownership and governance structure of the Science Park so as to make it more conducive to the development of a dynamic internal environment for growth, bringing in financial and other complementary kinds of expertise from other regions without degrading the local entrepreneurial climate, represents a priority for reform in this particular case.

Concluding remarks

This study has described and examined challenges confronting SMEs with regard to the upgrading of skills, potential high-growth entrepreneurship, and the role of universities and science parks in responding to resulting opportunities. Measures bridging the supply of general training by universities and the demand for idiosyncratic skills on the part of SMEs should be paralleled by those that can allow for an effective mobilisation by firms of external professional service providers. Science parks and incubators can play a crucial role in fostering an effective combination of measures, including a constructive interface between academia and business.

Sweden, being a country with high R&D-intensity, strongly internationalised big business and extensive research in universities, displays examples of novel approaches to foster competence upgrading and enhanced competitiveness in its greatly important population of SMEs, including in traditional industries and in some of the (relatively speaking) peripheral regions of the country. Reviewing the experience of Science Park Jönköping in cooperation

with Jönköping University, the paper presents observations how capabilities and effective matching roles may be nurtured through methods that enable high adaptation to unique local features.

Although the precise design of measures will depend on specific circumstances, in regard to SME development, we have seen that science parks and incubators may operate so as to:

1. Increase early exposure of SMEs to the demands of markets. Strengthening a more customer-oriented development process from early on is instrumental, especially for technology-based start-ups.
2. Operate so as to effectively support stronger and more beneficial cooperation between the university on the one hand and companies on the other. Culture, incentives and agendas on the two sides differ for natural reasons and the Science Park may fill the gap as a broker that can help make the two sides realise mutual benefits in exchanges.
3. Link up with other nodes and local learning centres in a wider region so as to enhance the accessibility of skills upgrading for SMEs.
4. Exploit advantages of geographical proximity between individuals, companies and universities, capture synergy effects between the supply of academic skills and the demand for skills upgrading in SMEs.
5. Devise an interface with respects to measures bridging the supply of training by universities and the demand for idiosyncratic skills on the part of SMEs, in parallel with fostering conditions that can allow for strengthening professional business services. Progress in these two respects can be mutually enforcing.
6. Build a network of experts that can provide business development services to the companies that the science park is serving. The science park can develop expertise on *managing* this network for the purpose of supporting business development by more professional servicing of company needs. A science park should not strive for providing the full scale of business development services in-house.

The case of Jönköping is atypical in several respects. High ambitions to support business links are found in many places. Many science parks, in Sweden and elsewhere, have been able to channel much greater flows of funding to start-ups. Noteworthy for Jönköping is how much has been achieved with very little external funding and little reliance on economies to scale at firm level. Another aspect which should be greatly relevant from the African viewpoint is the combination of focus on start-ups and competence upgrading among SMEs, the geographical scope of the scheme as the Science Park organises a wider nexus of learning nodes in the wider surrounding region, and the adoption of a consistent systemic approach in support of SME-development and entrepreneurship. In these respects, Science Park Jönköping further combines its own focus with that on entrepreneurship in education at Jönköping University. The two are not in conflict but specialise in a mutually compatible and complementary manner.

The key to achieving consistency may be found in context-specific factors, such as the prevalence of SME culture in the region, and the profiling of entrepreneurship at Jönköping University. In a more general sense, fundamental success factors include the ability of the university and the science park to identify a mutual win-win situation from developing an active interface between them. The prevailing attitudes, as well as the presence of objectives and activities on both sides that could draw benefits from the start-up of new firms by the students and the development of long-term relations with the SME-sector, embracing both training and the strengthening of professional business services, have been helpful in the present case.

In the next phase, weaknesses of the governance structure of the science park need to be addressed. A fundamental measure, mutually identified by the university and the park management as a priority for reform, is the need of separating the science park system from the central park unit. This emanates from the fundamental importance of mustering a more intensive engagement by a narrowly defined set of stakeholders, which is more local in nature but which extends to include not only the academia and the local policy sphere, but also experienced and established leading business interests. International experience from successful science parks provides ample evidence of the crucial importance of engaging real business insight in the management of science parks. In this sense, the interface between the university, the science park and society needs to adapt and evolve. This is also needed if the previously public-sector dominated domains are to open up to entrepreneurial opportunities. The latter in addition, however, requires the adoption of new means to introduce the part of the schools that so far were organised primarily towards the public sector, notably health and education, to the fabric of the science park, while adding new required elements so as to allow for a boosting of successful entrepreneurship activities in these areas as well.

Most fundamentally, the success as well as the still outstanding challenges of Science Park Jönköping centre on the opportunities, mechanisms and the abilities to shape long-term collaboration, teambuilding, communicating and implementing its strategies in ways that allowed it to address outstanding coordination problems among its main counterparts and to interact with them in such a way as to add value for all the relevant key actors.

A foundation of trust needs to be created which is consolidated through frequent meetings in an informal setting. A science park should participate in creating these types of arenas and networks, but engage the university and business representatives in the process. A science park must structure its operations, while at the same time adapt to continuously evolving wider environmental conditions, thus adopting a strategy of emerging development over time.

tion processes, and; iii) the boundary between the local environment and outer structures, in the form of national innovation systems or international networks and markets. Science parks can put their member firms on a larger map through, amongst other things, media coverage and branding.

The scope of the activities that fit within the agenda of science parks requires consideration (Ferguson, 1995; Formica and Sanz, 2003). Should science parks and incubators serve the firms in the park/incubator as well as firms that they have helped create[2], or should they also serve "firms at large" in their local environment? There is no universal answer. In fact, the proper strategy will depend on what needs are most urgent, whether other players and functions operate in the field, and what competencies are available. But even under circumstances when the proper answer is the restricted one, a science park could serve as a "test-bed"/lab for developing programmes to identify and articulate needs, programmes, etc., which can eventually be applied to larger groups of firms.

By supporting the creation of new firms, the science park/incubator contributes to its local community by the fact that these firms "sell" skills upgrading by their work in SMEs. By providing local SMEs with services/functions, knowledge that originates from the university is packaged and distributed to companies through these start-ups, providing new competence and solutions in response to a specific task or problem.

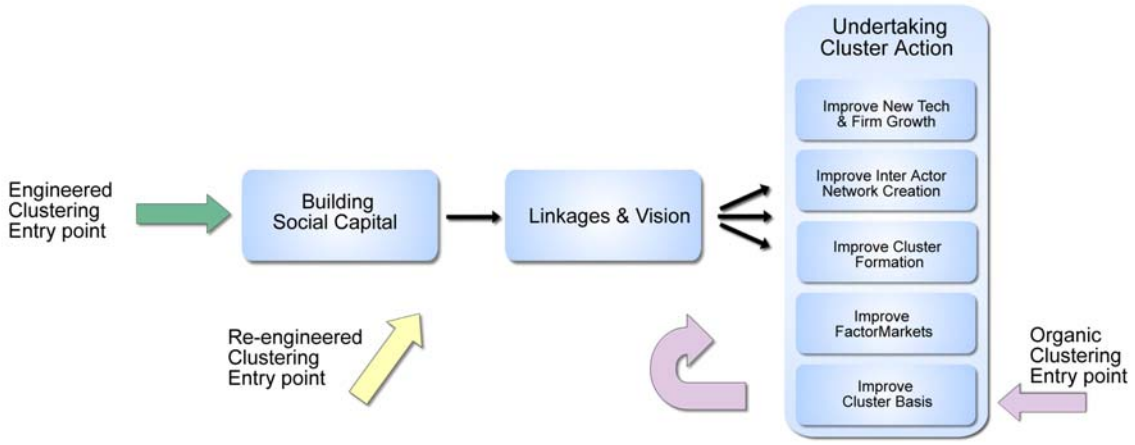
It is worth reflecting on possible processes through which so-called "regional clustering processes" may be catalysed, as illustrated in Figure 4. The *engineered clustering process* is generally top-down. However, both policymakers and private individuals may be active, and the approach needs to include the exploitation of existing social capital to anchor networks. Alternatively, *organic processes of clustering* are bottom-up. Multiple actors in inter-firm collaboration may trigger the organic formation of clusters. These initially display spontaneous developments towards the establishment of linkages and joint strategies (Nauwelaers, 2003). From such a platform, a more structured exchange in response to joint opportunities may result. A third process is that of *re-engineered clustering* which, in effect, is a hybrid of the previous two. Existing relations are hindered from progressing for some reason. Key linkages are broken, or imbalanced, or other factors are blocking constructive interface. In this case, linkages and relations may be improved by the breaking of adverse rigidities, or through the communication of a new vision or strategy for joint initiatives. International organisations often try to *re-engineer* regions in developing countries by supporting historically vivid traditional clusters.

Irrespective of the entry point, the general phases of establishing potentially beneficial linkages are basically the same. In a stylised sense, they amount to: i) building of social capital and the creation of trust; ii) defining strategic linkages; iii) defining a strategy and vision, and; iv) bringing interlinked actors together in process of knowledge-generation and business formation. To the extent that a science park attains a key role in supporting the creation new knowledge-intensive firms, it may serve as the natural platform for bridging the gap in competence upgrading between the university and local SMEs. In order to make a real difference, however, it needs to operate "in tandem" with both sides.

Broadly speaking, three kinds of outstanding tasks can be identified: i) programmes are needed to enhance the capacity of SMEs to identify and articulate their specific skills needs; ii) measures are warranted to package and aggregate these needs, and to mobilise the supply side to respond, which is a task requiring cooperation between institutions that are close to SMEs and universities, public research labs, etc., and; iii) broader, community-wide programmes, possibly with a cluster-based element, to establish synergy between skills upgrading internal to firms and the strengthening of the supply of skills offered by external professional services providers.

Success in addressing these issues requires specific competencies. These include an ability to operate bottom-up in

Figure 4. Clustering processes and entry points



Source: Andersson et al. (2004)

bringing together and establishing trust and belief in mutual purpose among relevant local actors. In this context, science parks and incubators potentially stand to play an important role. Science parks are, according to the IASP-definition, professional organisations that, among other things, stimulate and manage the flow of knowledge and technology amongst universities, R&D institutions, companies and markets, and provide value-added services. Thus, taking an active role in i), ii) and iii) above is, or at least should be, part of the "core business" of a science park.

In many cases, however, science parks perform weakly in developing those links that are key to their ability to play a constructive role vis-à-vis private business, applying both to their internal structure and their external interface. Local context and governance play a decisive role, including formal as well as informal institutional frameworks. A perception of trade-offs often complicate relations, e.g., a feared conflict on the part of many universities between being perceived as "an entrepreneurial university" and having a high intellectual eminence. Career paths also seem to deviate rather than run in parallel (Delmar et al., 2005). Further, conflicts in objectives with regard to most sources of funding complicate the process of identifying relevant core business. Universities are in general funded by the government while science parks tend to be funded by public authorities mandated to support science-industry linkages, regional authorities and business interests. The match is seldom a happy one which may result in formal or informal resistance from a range of actors, in effect stressing the old linear model, favouring push of science and research output and punishing those institutions and individuals that are open to two-way communication with real-world business interest, notably on the SME-side.

The way that regional authorities and the other actors engaged in science parks confront these challenges influences the way in which outcomes are likely to move in terms of boundary-crossing, commercialisation and growth. The ability of a science park and its management to stimulate opportunities for exchange often hinges on the openness of the other actors to "coming to the table", and for the various actors to join forces in creating room for adjustment to fit the specific regional setup. Existing businesses tend not to champion sound conditions for newcomers when their own interests are at stake. On the other hand, the already established industrial strongholds must serve as a breeding ground for new enterprises. Fruitful tracks can be catalysed through the interface between the competence needs of business and the supply of knowledge that spring out of research and universities. Still, although less so than in the African context, in Sweden and other European countries alike, public funding for research and innovation continues to be marked by a "supply side" doctrine that leaves a combination of public officials and traditionalists with critical influence on what can and should be done. These actors seldom have a good understanding of what it takes to generate new industries and businesses, or what is required for adaptation of regulations and programmes to special local conditions.

The question thus arises who can play the role of catalyst for change. We argue that policymakers and other stakeholders concerned with enterprise and regional development alike should view science and technology parks as potential partners and actors to be engaged in efforts to build the "right" context for cultivating aspiring entrepreneurs. A requirement, however, is that their agendas should start out with the ability to engineer, and to practice, a clear-cut process of business incubation and competence upgrading in what should be destined for a population of knowledge-based enterprises in their specific region. For this to be possible, the quality of the interplay between university and industry is a major factor. In this perspective, within the science park or incubator, a primary role ought to be conferred to invention teams, where researchers, business strategists, sales forces, and patent experts are brought together and devote time to customers in order to really come to grips with the kinds of concrete problems and needs that must be addressed in their particular context[3].

For science parks and incubators to be effective, they need to apply, or be subjected to, proper measurement of relevant performances. In reality, many parks are governed with a view to objectives such as maximising rented space or income from rents, which may well run contrary to their objective to nurture new business with growth potential. Even the assessment undertaken by the European Union in the early years of the new millennium applied a range of such obscure and misleading indictors. For science parks to fulfil their real missions, they need to be judged on the basis of meaningful performances. This has to do with how many companies are created and developed within their premises, which does represent a common measurement today, but also their ability to spur value-creating exchanges between universities, research institutes and SMEs - an exchange that requires hands-on methodology, professional approaches to linking academia and business, and to be truly relevant to real-world business development processes (Deiaco et al., 2002; Andersson et al., 2005*b*).

5 The Case of Jönköping

In this section, we highlight the experience of one particular science park and its connections to the neighbouring university and business sector. This case, which is that of Jönköping Science Park, is unique in several respects. Several factors stand out, such as the uniquely high propensity of students at Jönköping University to start their own business, which they mostly do through the institutional interface established between the university and the Science Park in the form of the business lab of the latter. Another unique feature has to do with the intertwined connections of the two institutions with industry, and notably the communities of SMEs which occupy the surrounding region. Another feature, of relevance for lessons for African countries, is that the surrounding region is dominated by SMEs operating chiefly in traditional industries, and which are more reliant on soft (non-R&D) sources of innovation, rather than the science base or high-tech R&D. Having said this, achieving industrial sophistication, and high-quality

Endnotes

1. Such resistance is not unique to university. In various spheres of society, specific privileges for incumbent actors in effect counteract and impede linkages to, e.g., customers or industry. In the health sector, traditional professional responsibilities coupled with sensitive integrity and security aspects, commonly account for resistance to organisational change and the adoption of new work practices.

2. In general, an incubator (within a science park) houses only a fraction of spin-off that has been supported by the activities of the park/incubator.

3. By reviewing operating experiences in the United States, China, Brazil, Korea, the United Kingdom, Sweden, Finland and other selected countries, Rustam Lalkaka argues that "Success in the Olympiad of venture creation ...depends essentially on five inter-linked rings: Public policy, private partnerships, knowledge affiliations, professional networking and community involvement". See Lalkaka, R., "Best Practices" in Business Incubation: Lessons (yet to be) Learned", in: Formica, P. and Sanz, L. (Editors), *Frontiers of Entrepreneurship and Innovation. Readings in Science Park Policies and Practice*, IASP, Malaga, 2003.

4. The county has the largest percentage of private sector employment in Sweden, particularly in SMEs Sweden in a general sense has a small share of the work force in SMEs and low rates of entrepreneurship. As of 2004, the country holds the 30th place in the ranking of 34 countries in the yearly Global Entrepreneurship Monitor (www.gemconsortium.org), and has been ranked at places 5-7 from the bottom during the 5 years the study has been conducted.

5. Practically all programme students in business and engineering at Jönköping University have a host company during their first two years of study. Presently, there are about 850 host companies following more than 2000 students through their programme studies.

6. Ideas emerging in the intersection between university, students, researchers and local companies can be upgraded in the unique setting of the "Business Lab". The core of the Business Lab is about providing hands-on value-creating business development ideas and to match new ideas with combinations of entrepreneurial teams, generally with a multidisciplinary background. Out of some 80 projects which exploited the Science Park Business Lab in 2004, 35 are viewed as potentially promising new enterprises.

7. The Royal Swedish Academy of Engineering Sciences, and its national student council, organized a seminar in March 2007 comparing the strategies of the wider approach to entrepreneurship practiced at Jönköping with the "intensive" approach of Chalmers. See also Reitberger and Wahlbin (2007).

8. Electronics (broadly defined) offers an example of the role of Science Park Jönköping in developing local clusters. Some of these firms have worked extensively with SMEs in the region, providing both new technology and skills. In Science Park Jönköping, 27 per cent of companies operate in electronics.

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Exploring the Linkages of commerce, higher education and human development: A Historical review

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Abstract

Throughout history, institutions of higher learning emerged in response to a thriving culture of commerce and innovation. Yet, the idea of an entrepreneurial university that seeks to create new employment through the practical application of knowledge in the private sector has stirred up public anxiety. Resistance comes from those who fear that this would result in a loss of academic freedom and those who have a vested interest in opposing change. Often, this leads to unholy alliances that portray themselves as guardians of the public interest at home and the cultural identity of non-Western societies abroad. This paper uses historical evidence to illustrate that the entrepreneurial university is neither a particularly Western invention nor did it subvert academic freedom or discourage the pursuit of wisdom.

African universities, which were either set up by colonial powers or coached by them, were mainly designed to educate local bureaucrats. As such, they represent a historical anomaly because they were not meant to serve the needs of the local growth-oriented private sector. As a result, these universities turned out to be ill-equipped to function as driving forces of endogenous economic development and social empowerment. Institutional reform and financial incentives are required to unleash the power of entrepreneurship at African universities and enable it to better integrate the local private sector into the global knowledge economy.

Introduction

In academic literature, the entrepreneurial university is largely portrayed as a product of the modern knowledge-based economy in which universities are encouraged to employ their human capital, knowledge and intellectual property to create commercially viable technological innovation and contribute to economic development [1][2][3][4][5][6]. Though it is admitted that universities in the United States and Germany were already key in facilitating the national industrialization processes in the 19th century [7], it is argued that these institutions of higher learning did not at that time perceive themselves as independent entrepreneurial entities [8]. This is certainly true in view of recent organizational innovations (e.g. technology transfer offices, technoparks, etc) that improve the formal structures of collaboration between universities and industry and thereby making universities more conscious about the potential economic value of scientific innovation. It has given university researchers more incentives to set up a spin-off firm and become entrepreneurs.

Yet, curious researchers with an entrepreneurial mind are not a product of Western capitalism but have been a great asset of institutions of higher learning ever since. Depending on the responsiveness of society and its institutions to innovation and private sector development, such entrepreneurial researchers were either allowed to thrive or prevented from doing so. They tended to thrive particularly during periods of economic globalization and intense knowledge exchange. Such periods were characterized by economic and technological change and a geographical expansion of the private sector. The pressure from a growing private sector to make institutions of higher learning more responsive to a fast-changing business environment enabled the renewal of such institutions in spite of strong internal and external resistance from those who benefited from the *status quo*.

Thriving international commerce always resulted in an accumulation of new facts and the development of new technologies that again helped to enrich the research base at institutions of higher learning and encouraged them to be more bold and innovative in the search of new insights. In a more practical sense, they engaged in the classification and application of new knowledge and techniques in different fields of research. Their research findings subsequently provided the local growth-oriented private sector with better orientation in terms of market trends and geography and enabled its actors to reduce uncertainty in strategic decision-making. Moreover, it increased the chances of the local business to gain a competitive edge through innovation.

Did this development undermine academic freedom? The answer is likely to be the opposite. The knowledge collected by private sector explorers helped enrich and improve the quality of research in higher education. Moreover, private sector funding merely represented one additional source of funding that enhanced the choice of potential sponsors of research at universities.

Nevertheless, contemporary universities in affluent societies tend to be split up in two groups of academic departments with rather different views: The first group positively engages with the private sector but also contributes to the advances in the basic sciences. It closely observes business trends, engages in the development of technological innovation in collaboration with research foundations and private firms, files patents and sets up spin-off firms. It could be called the 'entrepreneurial' part of the university. The second group is mainly dedicated to the general advancement of science, art, law and human values. The insights produced by its scholars often contribute to human development and their policy advice has become important to governments and international organizations. However, quite often this second group feels morally superior to the former. Convinced that their normative research has the potential to improve the institutions of

society and make the world a better place, they actively engage in public debates and influence policy outcomes. Their goal is to incorporate normative principles and cultural values into a global concept of sustainable development. Yet, in the course of this endeavor, they hardly ever consult with researchers in the first group implying that they would not care about ethical principles anyway since it would stand in the way of using knowledge for commercial purposes. Even though this second group also reveals considerable entrepreneurial talent in its efforts to gain public attention and funding, its researchers still claim to follow the tradition of the ancient Greek Academy and its detachment from private sector activities.

This article questions this aloofness of the second group by means of historical evidence. The history of institutions of higher learning did not start with the Greeks, and the anti-business ethos of the Greek Academy was mainly a result of the geopolitical context at that time. Its hostile attitude towards commerce should rather be understood as a form of cultural resistance against the first wave of economic globalization that was initiated by the Phoenician trading empire [9].

In addition to the Phoenician case, this paper further uses the examples of the early Islamic World, Renaissance Italy, the Golden Age of Dutch Commerce, 19th century industrialization in Europe and the rise of the United States in the 20th century to illustrate that growth-oriented commerce did in most cases not undermine the quality of research but rather enhance it. The great achievements in arts and sciences were accomplished because scholars were driven by an inquisitive and entrepreneurial mind *and*, at the same time, committed to higher ideals and ethical principles. In other words, there was no divide between the first and the second group. Both were united by humanist values that reconciled the self-interest to take advantage of economic opportunities with a passion for excellence, disciplined scholarship and the pursuit of virtue. Independent of the research area the scholars were active in, their principal motivation was the quest for new insights, an active life and a strong engagement with their social environment [10] [11] [12]. Their research resulted in technological as well as philosophical innovation and eventually transformed society and the natural environment on a large scale.

Such transformations through innovation are however only possible if society approves of them. The willingness to accept change depends again on how people expect to benefit from it. Even though affluent societies are the largest beneficiaries of the advances in business, science and technology, they tend to turn against change arguing that technological and economic advances are producing social inequality and involuntary risks to society as whole [13]. This trend can be observed in many parts of Europe and it helps explain its resentment of the innovation-driven economy of the United States that is perceived to impose unwanted technological and cultural change on the rest of the World.

The United States may suffer from a worldwide loss of confidence in its political leadership [14] [15]; yet, the constant ability of its entrepreneurial system of higher education to churn out technological innovation and contribute to the advancement of the arts and sciences is transforming the world to a much greater extent than its political or military interventions. This knowledge-induced transformation should be welcomed because ultimately, the great environmental and development challenges of the 21st century must be addressed by mobilizing people's creativity to find sustainable and innovative solutions not just in rich but also in poor countries [16].

Entrepreneurial universities in the United States and elsewhere also proved that the more they excel in the quality of research and teaching, the more likely they get into a position where they can choose the partners they want to collaborate with in business, government and society. They are also more likely to attract highly motivated students. This strengthens their financial autonomy, raises their capacity to innovate and enhances their freedom of action [17]. And it is not just the first group that benefits from this development. The second group may resent the restless attitude of the first but indirectly it enhances its reputation and its funding base as well.

In this context, it is wrong to merely associate the modern entrepreneurial university with an eagerness to seek funding from the private sector and serve business interests. Its basic philosophy is more related to an independent and positive attitude towards change and an active engagement with society and the global economy. Since it refuses to be elitist or merely address elitist concerns, it also contributes to social empowerment and human development.

Unfortunately, African universities were not designed by the colonial powers to be entrepreneurial and address the needs of the local society and economy [18]. Instead they trained the local population to be local clerks and teachers (in the British case) and loyal bureaucrats (in the French case) that would help run the host country in the interest of the home country [19]. This stands in contrast to earlier institutions of higher learning that were set up by African kingdoms in response to the growing knowledge exchange with the then thriving Islamic World [18] [20] [21].

Unsurprisingly, the institutional set-up of the colonial-style university was not able to properly perform its function as an engine of social, economic and technological change. After independence, many African governments attempted to make their universities more responsive to the goals of national economic development. Yet, in spite of such efforts, there is still a lack the financial and institutional incentives that would induce universities to engage more with the local private sector and contribute to development [20].

African governments may have to revamp the institutional set-up of their national systems of higher education in order to make them more conducive to private sector collaboration and more active in the search for collaboration with relevant partners at advanced research institutes

abroad. Yet, this would also require Western donors to support such efforts. It would enable African universities to re-engage with society, enhance the quality of its research and teaching and contribute to economic development by applying new knowledge to local business development [22].

Successful reform of higher education, whether in Africa or elsewhere, requires that people better understand the influence of commerce on the history of higher education. Its positive role in the general advancement of arts and sciences is hardly ever discussed because affluent societies tend to stick to the popular view of the ivory tower scholar that pursues knowledge for its own sake. This myth, in combination with a general anti-business ethos, is nourished at many academic departments. It has its roots not just in ancient Greek philosophy but also in the Bible. Together they form the pillars that make up the cultural and religious identity of Western societies. The negative attitude towards the commercialization of knowledge may therefore be linked to a feeling of guilt for betraying ancient Greek and Biblical values. The following chapters will show however that the rage against trade and technology in ancient times had little to do with ethical concerns and a lot with incumbent interests. It may therefore be premature to feel guilty about the entrepreneurial university.

1 The origin of the anti-business ethos at Western universities

The hostility towards international trade expressed in the classic works of antiquity must be seen in the context of the first wave of globalization in human history initiated by the business-minded Phoenicians. What they primarily achieved was the effective commercialization of Mesopotamian and Egyptian art, science and technology through large-scale manufacturing of popular goods and trade across the Mediterranean Sea [9]. In this context, Phoenicia seemed to have played a crucial role in the development of Greek as well as Jewish civilization [23] [24] [9].

Both people, the Greeks and the Jews, eagerly learned from the Phoenicians and bought their goods; but they also strongly resented them for imposing a global culture on them that weakened established beliefs and identities and posed a threat to the incumbent interests of the landed gentry. The hostility against Phoenician traders may therefore help explain the strong anti-business ethos in the ancient Greek Academy.

The great Greek philosophers Plato and Aristotle expressed a strong disinterest in private sector activities and resented the practice of using knowledge to advance private material goals [25]. In the dialogue 'Protagoras' [26], Plato particularly resented the sophists who were willing to sell their knowledge and wisdom by teaching rhetoric. Moreover, Plato describes Phoenician traders in 'the Laws' [27] as narrow-minded and greedy

Like Plato, Aristotle strongly emphasized the supremacy of the state and looked at markets as necessary evils. In Book VII of Politics [28] he probably refers to the Phoenicians when he argues that '*[A state] should practice commerce for itself, but not for others. States which make themselves market places for the world only do it for the sake of revenue; and since it is not proper for a polis to share in such gain, it ought not to have such an emporium*'.

The anti-business ethos also proved to be virulent among the great prophets of the Old Testament who warned the People of Israel not to disregard the Will of God and seek cultural and economic exchange with other cultures. The concern was that this would lead them to adopt foreign religious rites and betray the covenant with God. All the catastrophes that happened to the Jews in the form of foreign invasion and internal division were attributed to the punishment of God for breaching the first commandment against idolatry [29]. This idolatry also included the 'worshipping' of money[1].

The strong resentment against Phoenician merchants expressed in the Old Testament must be seen in the light of the fatal attraction of rich and culturally advanced Phoenician cities such as Tyre and Sidon that bordered the Jewish homelands and led to a significant brain drain of Jews who preferred the intellectually more stimulating and financially more rewarding business of international commerce to farming and animal husbandry back home [9]. The prophets that cursed Phoenicia were essentially defending Jewish identity against the irresistible attractions of international trade and cultural exchange. The power of Tyre and its pragmatic approach to religion and commerce [9] was felt to be a threat and cultural offense to Jewish identity. The resentment against the business-minded Phoenicians is expressed in the Bible [30] in many chapters of the books of Kings (Kg 1: 11, 21; Kg 2: 9) Ezekiel (Ez: 26, 28), and Isahia (Is: 23). The anti-business ethos then continues in the New Testament. There is, for example, the famous sentence in the gospel of Matthew (Mt 6:24) that nobody can serve two masters (God and Mammon).

2 Phoenicians and institutions of higher learning

In addition to their trading activities, the Phoenicians also developed a culture of learning that enabled them to make use of all the fragmentary knowledge and techniques developed by ancient bronze-age civilizations and convert it into new products and technologies. Prior to the rise of the Phoenicians, institutions of higher learning were less engaged in learning but rather the mere reproduction and preservation of art and science that was handed over from previous generations [31]. These pre-Phoenician institutions depended almost exclusively on the funding of the ruling religious (temple) and political (palace) elite [9]. They acted primarily as gate-keepers of knowledge diffusion. This enabled them to ensure that the acquisition of knowledge remained the exclusive concern of the elite and that its use serves elitist interests only. The Phoenician merchant class finally weakened the monopoly of the religious and political elite on access to knowledge. They set up institutions of higher learning that combined the acquisition and preservation of traditional knowledge with the generation of new knowledge in order to create innovation that served a practical purpose. This eventually led to the democratization of access to knowl-

edge and technology and resulted in the empowerment of the people that did not belong to the traditional elite.

In addition to that, the Phoenicians introduced the modern alphabet[2], maritime technology, modern city culture [32] [9] as well as ancient Mesopotamian wisdom and epics in the Mediterranean area [33]. It is therefore too simple to argue that the great Phoenician cities at the shore of the Levant (Tyre, Sidon and Byblos) were just engaged in trade and money-making. They also established institutions of higher learning that were engaged in the collection and categorization of knowledge and their use for the good of society and the pursuit of wisdom.

In the Book of Ezekiel (Ez 28:4,5) for example, it is stated that Tyre's unique affluence was a result of great and unrivaled wisdom and insight. Moreover, the great wisdom and wealth of king Salomon is widely attributed to his eagerness to acquire knowledge from the Phoenicians and his general openness to trade with other cultures. According to the Book of Kings he excelled all kings of Earth in affluence and wisdom (1 Kg 10:22).

3 Islam and the second wave of economic globalization

The great awakening of trade and its link to flourishing institutions of higher learning was made possible again with the Arab conquest that stretched from India to Spain in early medieval times[3]. Under the umbrella of Islam, an interregional commerce space developed that also included Coptic, Armenian, Byzantine and Lebanese (formerly Phoenician) Christians, Jews, Turks, Persians, and Hindus. They all represented ancient cultures that were eager to participate in trade and knowledge exchange. The result was a lot of cross-cultural fertilization. In fact, the conquering Arabs employed Coptic, Byzantine and Sassanid artists to build the first great mosques in Cairo, Damascus and Bagdad [34]. Moreover, arabesque decoration used to be an art developed by the Coptic Christians and the abacus and algebra were adopted from Hindu scholars [35]. Considering the thriving commerce and the subsequent accumulation of new knowledge, it is not surprising that the first university was established in the business and trading hub of Cairo (Al-Azhar) and that many great discoveries in science happened at that time all over the Moslem world [36]. It is interesting that one of the pillars of Islam *zakat* (annual payment for helping the poor) was not just meant as alms-giving but to fund hospitals, universities and research establishments. They were meant to empower the people and improve society as a whole. This culture of learning and inquiry used to be part of *tawhid* (total way of life of Islam) [18].

4 Italian merchants and the great awakening in Europe

Italian Renaissance would not have been possible without the intensive cultural cross-fertilization between the Christian and the Moslem World. One of the prime channels of knowledge transfer was trade between Italian and Moslem merchants [37] [38]. Moreover, joint centers of learning were established in Sicily and Spain where European Christians, Jews and Moslems peacefully coexisted [36].

Italian merchants had to handle a lot of complexity and uncertainty when dealing with business partners in the Islamic World. In order to maintain trust and loyalty with their partners, who often spoke different languages and had different cultural habits, Italian merchants were in need of broadly educated people that were not just familiar with accounting skills and commercial law but also able to converse with people from other cultures. Italian universities were ill-equipped at that time to provide this new sort of human capital because its professors were still concerned with highly specialized scholastic and legal debates and took pride in being detached from the real business world. Many successful merchants and bankers therefore resorted to the emerging humanist movement who had little patience with the university elite and a great passion for learning, not by merely looking at books but also at objects, using a method that had no clear ancient counterpart [11]. This humanist movement eventually managed to change the curriculum of universities in a way that made these institutions more responsive to the needs of the growing private sector, and, at the same time, enhanced the quality and innovativeness of its research.

These developments in Italy enabled social mobility for the bright offspring of poor families to become part of an educated middle class, and for the rich merchant and banking families to enhance their social prestige and eventually marry into aristocratic families or win a high position in the Catholic Church [39] [40].

One way merchants used to impress the ruling class was by investing in innovative artists. This again opened the way for the entrepreneurial artist who combined technical, scientific and historical knowledge with a shrewd business instinct, artistic skills and a strong desire to innovate [41].

In this context, humanists realized that there should be no cultural divide between preserving and reproducing the great achievements of great Greek philosophy and using knowledge to create new goods, ideas and technologies, invent new art, develop new methods of investigation and earning money through trade.

They emphasized the importance of leading an active and autonomous life [10]. Such a life however had to be earned through a life-long commitment to learning and self-improvement [11] [42]. In this sense, they thought that it is not just a matter of self-interest but also of ethical responsibility to realize one's own potential in life. They recognized that the acquisition of knowledge and experience is a prerequisite for informed moral judgment. Moreover, they argued that before trying to find out how things should be (normative research) one must first investigate how things actually are (positive research)[4]. To be good meant therefore more than just having good intentions.

5 The birth of modern science in the age of Dutch commerce

Humanism once again flourished in the Golden Age of Dutch commerce in the 17th century. A recent book by Harold Cook [43] shows that international commerce

was not just providing a material basis for excellent empirical and experimental research at Dutch universities but was actually its major stimulus. He argues that the emerging culture of the exchange economy (a predecessor of the knowledge economy) had enormous consequences for the organization of research at universities. Facts collected by the different stakeholders that participated in the Dutch trading empire were brought to the universities and induced professors to abandon their ivory tower mentality and actively engage in this culture of exchange. The basic insight of his book is that, *'like commerce, science arose not from liberating the mind from the world but from the keenly interested engagement with it'* [43: 2]. Determined investigations into matters of fact laid the groundwork for generalizations about nature. These matters of fact could however not just be adopted from previous work but had to be unearthed in risky ventures of exploration. In other words, good science required curiosity and passionate entrepreneurship.

The great philosopher Spinoza who was largely a product of this stimulating academic environment also turned out to be one of the greatest humanists (even though he tends to be classified as a rationalist). In his major work 'Ethics' [44] he uses a geometric method to prove among other things that the evolution of body and mind cannot be regarded separately since we can only think through our bodies. In other words, the fatal split in academia between those who focus exclusively on the body and material issues and those who focus on the mind and immaterial issues would not have happened if modern academic institutions would have embraced his genuinely holistic view. Instead, Descartes' divide of soul/mind (*res cogitans)* and body (*res extensa)* was adopted; primarily because it was more popular and more in accordance with the ruling church doctrines at that time [45] [46].

6 The humanistic roots of the modern concepts of democracy and the market economy

For a long time, the split in academia was not important because it was just a tiny elite that really cared for the advancement of science. However, with the onset of industrialization in the 19th century, it became increasingly clear that the use of factual knowledge to produce new technologies, goods and services was at the root of economic development and the advancement of science [7] [13]. It also induced profound cultural change that manifested itself in increased social mobility, social empowerment and the questioning of the legitimacy of power vested in aristocracy and clergy. The newly educated and entrepreneurial middle-class expressed its desire for democratic change in order to make government institutions more conducive to business needs and more respectful towards ordinary citizens. In fact, not great revolutionary thinkers but the pragmatic attitude of this taxing-paying and civic-minded middle-class strengthened the institutions of democracy and the market economy in the process of early European industrialization. This makes sense considering that the rules of democracy and the market economy are based on the general assumption that people primarily pursue their self-interest [47]. In best humanistic tradition, there was a general agreement that as long as the individual pursuit of self-interest does not limit the freedom of others to pursue their self-interest, it should be encouraged for the greater good of society. At the same time, everyone was free to participate in particular value or religious communities, as long as there was no attempt to impose their respective belief or value systems on society at large by force. In this sense, democracy and the market economy were primarily designed to serve human development and make war less attractive [13] [47].

7 Capitalism and its enemies in the 19th century

The unleashing of the creative power of economic liberalism and technological innovation did however also produce negative side-effects in the form of social inequality and general threats to public health (e.g. accidents, urban diseases, abuse of technology, labor exploitation). Democracy proved to be a responsive system to address these challenges because it allowed victims to organize politically and fight for their rights. Moreover the emerging mass media was responsive to their concerns and amplified their grievances. Nevertheless, the ceaseless reporting of business scandals and unfair practices generally created widespread resentment against the culture of capitalism. This resentment was especially fuelled by a disillusioned cultural elite that tended to embrace soulful nationalism or romantic socialism as alternatives to soulless capitalism [13]. Ironically, the younger generations that already grew up in relative affluence thanks to the earlier achievements of capitalist society proved to be most receptive to such ideas – especially if they decided to study humanities or social sciences because that is where the cultural elite managed to introduce the general anti-business ethos. It contributed to the shaping of new belief systems that were based on the superiority of one's particular nation, race, class, religious sect or ideology. They also nurtured a feeling of hatred against the alleged agents of capitalism (often associated with Jews portrayed as greedy and soulless merchants) as illustrated in Robert Musil's Novel 'The Man without Qualities' [48], which covers the gloomy mood of the declining Austro-Hungarian Empire at the beginning of the 20th century. These rather bad ideas eventually trickled down into the far-reaching national education system and resulted in a general belief that people must make a choice between the pursuit of wealth in a valueless and decadent society and the heroic fight for better world that is based on a shared cultural, religious or ideological identity.

On top of it, psychoanalysis further confirmed people's belief that 'the iron age of capitalism' [49] would force them to repress their libido and personal development. Freud argued that civilization inhibits a man's instinctual drives, which result in guilt and unfulfillment [50]. Ironically, this sort of reasoning encouraged people to become even more selfish in their eagerness to meet their personal needs. In this sense it is an irony that psychoanalysis may well be one of the major driving forces of Western consumerism.

Psychoanalysis also implies that people should be inward-looking (esoteric) rather than outward-looking (exoteric) in the search for truth. People that pursue an inward-looking life or just interact with those who share their particular views and values, run however the risk of becoming boring to others. They ignore that personal development is a result of active engagement with the world and a willingness to expose oneself to risk and uncertainty in order to learn and evolve [51]. Refraining from interaction across boundaries and merely focusing on personal feelings and their disclosure to other members of one's intimate value community [52] comes close to a voluntary form of stunted development.

All this highlights the deep ambiguity that is inherent in the institutions of modern democracy and the market economy: on the one hand, these institutions unleash unprecedented social, political and economic empowerment and lead to great achievements in arts and sciences, on the other hand, they may breed the very forces that lead to a reversal and eventual demise of this empowerment and civilization process - as happened with the onset of the first World War in 1914 [13] [48].

8 The United States and Occidentalism in the 20th century

The general resentment against capitalism in large parts of society in the late 19th and early 20th century eventually turned into something that could be called 'Occidentalism' after World War II [29]. Occidentalism is a term that refers to stereotypes about the cold, rational, soulless and materialist Western Society. These stereotypes had a lot in common with the earlier stereotypes about the greedy merchant who undermines a society's great and heroic ideals. At that time, they were mainly nurtured by German and French scholars and directed against Jews and the Anglo-Saxon culture. After World War II, such stereotypes became a global phenomenon but were now mainly associated with 'American imperialism'. Today, Occidentalism also provides the mental frame of anti-globalization movements and Islamic fundamentalists.

As the unrivaled new power after World War II, the United States designed the institutions for a new world order that were to prevent another World War by restoring the shattered institutions of democracy and the market economy on the global level [53]. The new world power America turned out to have a lot in common with ancient Phoenicia in the sense that its expansion is based on trade as well as the commercial use of knowledge to generate cultural and technological innovation. In analogy to Phoenicia, its institutions of higher learning are rooted in practicality [54]. The practical approach to science became institutionalized with the US Land Grant College Act (Morill Act, 1862). It demanded that knowledge not be kept inside the heads of a few, but to encourage the men and women educated at these new state-funded colleges to show other people how to transform understandings generated on the campus to meet their everyday needs [55].

The resulting system of higher education that combined state and private universities has achieved great advances in basic science but also proved to be very responsive to private sector needs. It encouraged its graduates to innovate and generate welfare for society as a whole [16]. In terms of cultural achievements, one has to bear in mind that the United States is a country of immigrants. This means it absorbs culture from all over the world, transforms it into something new, and finally commercializes it on a global scale [56]. To talk of 'cultural hegemony' is therefore misleading.

There is always the risk of super-power hubris and bureaucratic capitalism that undermines the humanist ideals of an entrepreneurial and active life which characterized the United States especially in its early stage; yet the country also proved to be resilient and capable of renewing itself again and again [16]. There may be lots of reasons to resent the US government for its revealed incompetence [14] [15]. But there is no doubt that the overall hatred against the United States is not related to what it currently does but to what it stands for in general. This symbolic Anti-Americanism manifests itself in a European version reminiscent of the aloofness of the ancient Greek philosophers and an Islamic version that rather follows the tradition of the identity and purity-obsessed Jewish prophets in the old Testament.

8.1 A Déjà Vue?

Like the Phoenicians in antiquity, the United States today tends to be perceived by established cultural elites as an unwanted source of social, economic and technological change. Both cultures were and are accused of adjusting religion to their needs rather than restrain their needs to serve religion [9] [54]. In this sense, Orientalism (resentment against the Phoenicians) in antiquity may have become Occidentalism (resentment against the United States) today. Yet, while Orientalism in ancient times nevertheless resulted in great cultural achievements (Greek and Jewish civilization), Occidentalism today is more of a *déjà vue*. It represents a general rejection of holistic humanism (which was not the case in Greek and Jewish culture) in favor of a dividing and self-indulgent postmodernism that basically defines truth as what is generally felt to be true. In other words, there is a general indifference to truth, not meant in a metaphysical but a practical sense [57] [58]. This indifference indirectly endorses all the current forms of self-righteous 'value-*Ummas*' whether related to religious zeal, neo-luddism, stale rationalism, or the general postmodernist remixes of Marxist and Freudian theories.

8.2 Modern Humanism and Anti-Humanism in Germany

Germany, which pioneered the entrepreneurial research university in the 19th century [8] [59] and boosted European capitalism as a relentless innovation machine [7] also turned out to be the cradle of Occidentalism and anti-capitalist sentiments [29]. The cultural divide at its universities is therefore more pronounced than elsewhere in Europe.

After the end of World War II, one would have expected the Germans to dump their anti-humanist and anti-science

philosophers such as Sombart, Spengler, Schmitt and Heidegger who fuelled Occidentalism and provided the theoretical underpinnings of Nazi Germany. Yet, by enthusiastically embracing the purely negative and elitist dialectics of the Frankfurt School (Theodor Adorno and Max Horkheimer), they once again turned fiercely against a culture of scientific inquiry and humanist ethics [60]. This is all the more astonishing in view of the strong German humanist tradition of which philosophical anthropology is its most modern representative. Exponents of this school of thinking such as Wilhelm Dilthey, Helmut Plessner, Arnold Gehlen and to some extent Norbert Elias put the active human being again at the center of attention [61].

Elias [62] criticizes British empiricism (from Hume to Berkeley), French rationalism and existentialism (from Descartes to Sartre), as well as German epistemology and metaphysics (from Kant to Husserl) for its attachment to the belief in '*esse est percipi*' (to be is to be perceived) which implies a static view of the human being that ignores the life-long process of human development through learning by interaction with the social and natural environment. We never 'perceive' as lonely, passive and detached individuals but as an integral and active part of the social and natural environment in which we evolve [62].

Gehlen [63] argues that mankind is essentially characterized by its instinctual non-specifity (Mängelwesen). Unlike animals that have in-built instincts that allow them to survive in a particular natural environment, men are unspecialized and therefore vulnerable to extinction unless they become actively engaged with their environment by inventing tools and create different forms of social organization. In other words, mankind has to permanently transform nature into culture because it cannot survive in nature alone. In this context, Gehlen maintains that only humans engage in trade and develop new technologies. Trade and technology are therefore not 'dehumanizing' forces, as the German anti-humanists would say, but in fact make us human in the first place.

8.3 Postmodernism as sophisticated Occidentalism

Many influential academic departments today that represent the basic social sciences, law, humanities and public policy tend to ignore the basic insights of humanism and prefer to adopt different forms of postmodernist/ constructivist thinking (again largely based on *esse est percipi*). This trend encourages a sophisticated Occidentalism that looks at world trade and advances in science and technology as Western concepts that should not be imposed on other cultures - obviously unfamiliar with the Orientalism that prevailed in antiquity. Academics that have embraced this type of sophisticated Occidentalism largely ceased to look at real life, conduct empirical research or search for best practices in public policy. Instead they are just happy to represent a particular school of thought or a particular value community. The loss of empathy for people's real lives, the outsourcing of empirical research to students and professional firms and the lack of curiosity to look beyond one's own academic boundaries have led to a widespread culture of self-indulgence and self-gratification in the social sciences that also undermined the overall quality of its research [64].

8.4 Unholy alliances between Occidentalists and vested interests

Occidentalists tend to yearn for a fictitious past when universities were still autonomous, people still lived in harmony with God, their 'inner self' or nature, and when shared common values still provided meaning and orientation [65]. Such views resonate well with a public audience in affluent societies that looks at technological and economic change as a source of unwanted change and rather than an enriching source of new knowledge and wealth. A public that prefers to be in a state of denial regarding the reality of technological change and is mainly concerned with people's personal vulnerability to change may not be in the best position, or simply not willing, to address the challenges and opportunities of technological innovation in a responsible way [66] [67]. Instead it encourages people to abstain from participating in the world of messy politics, withdraw into the intimate sphere of their particular value community and merely endorse those stakeholders in the public arena that claim to defend their particular community values, no matter how intolerant they are towards people who do not share their values [52] [68]. This trend helps explain why Western Occidentalists believe to have many things in common with 'enlightened' Islamic fundamentalists called Reform-Salafism [69].

Even though these sophisticated Occidentalists may look subversive and progressive at first sight, it actually turns out that they tend to strengthen the position of incumbents. It is therefore not surprising that they are often sponsored not by progressive but rather conservative forces in society. For conservative forces such as large state and corporate bureaucracies this is a 'win-win' situation because they direct the wrath of Occidentalists against uncomfortable agents of change and potential competitors and, at the same time, enhance their own reputation in public as socially responsible actors that are 'concerned' about the environmental and socioeconomic risks of technological and economic change [67]. Sophisticated Occidentalists in turn are also happy to have sponsors that finance their advocacy work and enable them to stay in the public limelight. The victim of this unholy alliance is the innovative entrepreneur who, throughout history, proved to be the most progressive element in society. As an agent of change guided by humanistic principles, s/he ensures that a society maintains its ability to renew itself, facilitate institutional change and enable social empowerment.

9 The ignored human right to innovate and grow

Occidentalism, especially the neo-luddite branch, ignores the fact that uneven access to technology and preserving the *status quo* by advocating preventive regulation of new technologies may be a larger risk for society and the environment than the potential risks

that might emerge from its adoption [22]. Furthermore, Occidentalists in affluent societies tend to denounce the unsustainable 'growth' ideology [70] [71] [72] [73] that would still prevail in Western civilization. This merely reveals a frightening ignorance about the very nature of the human being. Human beings and the societies they form grow by their very nature, physically and mentally [74] [75] [51]. If you prevent them from growing by depriving them of the necessary material conditions, or by limiting their freedom to innovate, it may well result in a sort of stunted development. Stunted development may be acceptable if it is based on a voluntary choice, but to impose it on others raises ethical questions. It may even be regarded as a serious offense against human rights. However, this offense is hardly ever addressed in the human rights discussion because it is primarily shaped by Occidentalists who look at technological innovation and global economic development as a zero-sum game in which some people get rich at the expense of the poor and the environment. That is why they do not understand that genuine social empowerment cannot be ensured by asserting, preserving and defending cultural identity but must happen by enabling the poor to participate in the global knowledge economy and increase their capacity to innovate in order to address their particular economic and environmental concerns in an effective and sustainable way.

10 The entrepreneurial university as a trust-buster of vested interests

The unleashing of genuine social empowerment can only happen through dynamic institutions of higher learning and their outreach activities. Such institutions of change do not, however, emerge naturally but must be eked out from society and its incumbent interests. It requires a particular type of entrepreneur who acts as an agent of change that struggles to make things happen and is willing to confront strong resistance. The golden age of Swiss industrialization in the 19th century is largely linked to such an entrepreneurial leader. Alfred Escher was an industrialist and politician who recognized the crucial importance of human capital, physical infrastructure and a reliable financial system to make Swiss business, science and democracy thrive. He fought for the establishment of a Swiss Federal Institute of Technology (ETH Zürich) arguing that it would be more responsive to the needs of the emerging technology-based industry in Switzerland than the cantonal universities. Moreover, he helped setting up the '*Kreditanstalt*' (the first Swiss investment bank) that later branched out into Swiss Life, Swiss Re, Zurich Financial Services and Credit Suisse. It provided the financial infrastructure that helped Swiss business to grow and become international. Finally, Escher was also one of the major driving forces behind the enhancement of the Swiss public transportation network that also enabled Northern and Southern Europe to grow closer together [76]. Often such leaders are not driven by higher ideals but by a strong feeling of discontent about cultural and economic stagnation due to institutions that favor established rents-seekers and discriminate the ordinary hard-working citizens in their efforts to set up businesses and grow.

Agents of change whether in civil society or the private sector have to struggle against incumbents who benefit from the *status quo*. Yet, once these incumbent stakeholders give in due to increasing consumer or public pressure, agents of change eventually become established and mature stakeholders as well. They will become increasingly bureaucratic, defend their vested interests in the political arena and prevent new agents of change from emerging [68]. Therefore, a culture of permanent vigilance is necessary to ensure that especially institutions of higher learning remain committed to free inquiry and resist the temptation to merely address incumbent preferences or become subservient to public opinion.

This culture of vigilance is a distinctive feature of the entrepreneurial university that quickly responds to the new economic and technological opportunities and finds practical solutions to new social and environmental challenges by means of a process of trial and error. As an agent of change, the entrepreneurial university also assumes the role of a trust-buster who enables the disruption of powerful rent-seeking coalitions. In earlier times, it dismantled feudalist coalitions (clergy, aristocracy) and gave birth to a new middle-class that created more wealth and new knowledge - knowledge that was not just relevant to the elite but to society at large. Its focus on the needs of an emerging innovation-oriented private sector helped disbanding rent-seeking state monopolies and enabled economic prosperity in Europe in the 19th and early 20th century [77].

The formation of rent-seeking coalitions (government, big business, unions) in the mid 20th century turned out to be more difficult to bust because university departments were increasingly co-opted by the rent-seekers [78]. This is even more true in the early 21st century. The unions may have lost some of their influence in the rent-seeking coalition of bureaucratic capitalism but, at the same time, Occidentalists in academia and civil society have moved from a progressive force outside the establishment in the 1970s to a reactionary force within the establishment today. For example, they inadvertently contributed to a highly burdensome regulatory environment and an increase in non-tariff trade barriers that essentially benefits bureaucratic capitalism at the expense of innovative entrepreneurship and poor developing countries.

11 Liberating African universities from sophisticated Occidentalism

The plight of African universities goes back to the colonial period when many of them were set up by the European colonial powers. The colonial powers were mainly interested in educating and indoctrinating a local elite that would then serve as loyal bureaucrats and run their country in the interest of the home country [19]. Investing in natural sciences, engineering and entrepreneurship never had priority for these powers because the main goal was to develop an emotional attachment to the home country, create respect for its great scientific achievements and foster a contempt for the achieve-

ments of the own native culture [20]. Yet, the native cultures used to be much richer in entrepreneurial activities than Western scholars dare to admit. Africa used to have many kingdoms that actively participated in the previous waves of economic globalization. For example, the firm integration of large parts of Africa into the Moslem trading empire enabled many African kingdoms to benefit from the resulting knowledge exchange. They responded by creating their own depositories of practical knowledge and set up early types of institutions of higher learning [20] [21]. The imposition of new systems of administration, law and education by colonial powers largely obliterated the previous tradition of higher learning that came with an Islam that still looked at science and trade as integral parts of the way of life of a devout Moslem. Western education instead taught the colonized to accept a distorted version of their own history and to regard their own science as not being 'real science' [18] [20].

After the process of decolonization even the newly established African universities remained rather artificial constructions because they largely remained in the tradition of the colonial-type university. National governments may have undertaken serious efforts to upgrade the quality of natural sciences and engineering at universities because they realized that they can no more rely on imported human capital from the former colonial power. Yet, the African rulers themselves were often former graduates of these same universities and therefore were trained as bureaucrats rather than entrepreneurs. They developed an enthusiasm for European ideologies and longed for greatness and acknowledgment by the European cultural elite in order to eventually become part of their social clubs. At the same time, they tended to neglect the needs of the growth-oriented local private sector – or, if they cared, they addressed them with the mindset of a Western-educated bureaucrat rather than an innovation-oriented entrepreneur. Because African universities were never meant to contribute to endogenous economic development and African leaders continued to regard them mainly as training centers for bureaucrats, they failed to function as engines of economic and social change. In fact, since the skilled graduates often had no other choice than to enter government (unless they wanted to move elsewhere), this led to inflated government bureaucracies that tended to make conditions worse for small entrepreneurs through overregulation (falsely assuming that is what governments are supposed to do).

The bitter irony is that Western donors and investors also refrain from supporting innovation-oriented research projects at African universities arguing that this would either be of no priority to the local poor or not desirable because it would eventually breed local competitors. In this sense, a new unholy alliance is taking shape once again. It consists of governments, the international aid bureaucracy and big multinational companies with corporate social responsibility strategies. None of them is really committed to economic and technological change in Africa. Instead, they try to primarily gain the favor of Occidentalists by embracing and funding the new ideology of development. It is based on the assumption that poverty in Africa can be eliminated if only the international community would show sufficient financial commitment. This assumption is neither new nor did it prove to be successful in earlier periods. It implies that development needs to come from above and sees in the growth-oriented local private sector a necessary evil rather than the seed of prosperity [79].

11.1 The way forward

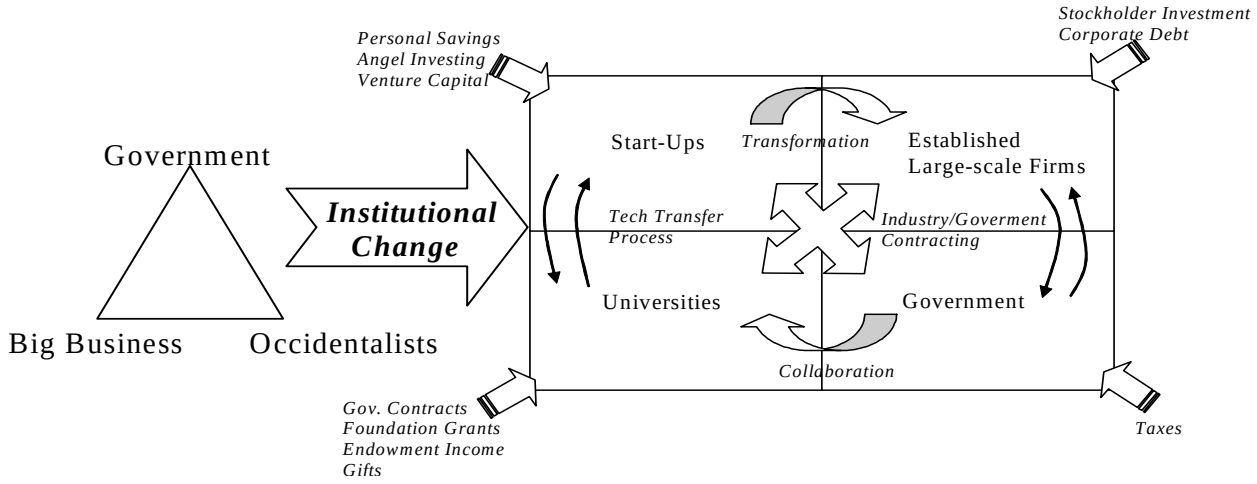
Fortunately, not all institutions involved in African development are responsive to Occidentalist views. In fact, there is a growing divide within these institutions between those who want change and those who do not. For example, African governments slowly realize that they must invest in new knowledge and human capital (and retain it) in order to facilitate economic growth and increase tax revenues. Big multinationals may have an increasing interest in the emergence of a reliable and local private sector that is able to supply it reliably with services and components. Finally, Western donors tend to question the current social planning approaches of development and experiment with new concepts that focus on social empowerment through entrepreneurship.

If the reform-minded parts in each of the three groups would join forces and invest in the emergence of entrepreneurial universities then trust-busting would be possible. Governments would cease to merely cater to incumbent interests and instead strengthen their collaboration with universities and conduct institutional reforms that create incentives for researchers to use their knowledge for practical purposes. Technology transfer offices would be in charge of coaching an emerging new breed of spin-off companies and improved access to venture capital would ensure that they grow by continuously investing in innovation. Finally, established firms would become interested in the emerging new companies and eventually integrate them into their global system of subcontractors (see Figure 1).

11.2 The way backward

In turn, if there is no desire for change among the main sponsors of development, then this would be a clear sign that Occidentalism prevails. In this case, African universities should become more wary about Western donors because the few research projects they tend to sponsor largely reflect their priorities and particular concerns – not the local concerns. For example, there is great fear among Occidentalists in Europe that their universities may lose their intellectual autonomy as a result of increasing private sector collaboration. They therefore tend to sponsor research projects in Africa that are of no interest to the local private sector. It gives them the good conscience of not having endangered the cherished autonomy of the university. They seem to be unaware however that they themselves are undermining the autonomy of these universities by imposing particular research priorities on them through their funding. Moreover, Africa is already the continent with

Figure 1: Enabling institutional change and empowering the entrepreneurial university (adapted from Schramm 2006 [16])



least private sector investment in local universities (with the exception of South Africa and a very few excellent universities in other African countries). No one celebrates this as a great achievement of intellectual autonomy in Africa.

11.3 Rediscovering the roots of the African entrepreneurial university

Instead of waiting for new signals among Western donors, African governments could also initiate action themselves by setting up new (or reform existing) institutions of higher learning that are guided by a culture of humanism that has strong roots in the history of their own culture. Such modern institutions of higher learning would be in constant exchange with the respective international research community and, at the same time, collaborate with the local private sector to make the new knowledge work for development. The chances of success to make it work may increase through the more effective use of Information and Communication Technologies (ICTs).

These newly empowered institutes of higher learning could embark on a bold step by only selecting the best bits of the existing compartmentalized social sciences and integrate them into a more comprehensive and integrated humanistic approach to social science that follows the tradition of Spinoza rather than Descartes. It would avoid the artificial and fatal divide of mind and body and embrace cultural and economic change as a precondition for human development and an active life. It is very likely that this approach would also be more compatible with the previous traditions of higher learning in the African kingdoms that participated in the Islamic trading zone before the European expansion. Yet, as it was the case with 'Zakat' in early Islamic times, African universities need support from wealthy and enlightened donors that are genuinely interested in facilitating change and contributing to the general improvement of the quality of life in Africa.

Conclusion

Institutions of higher learning emerged in response to the needs of a growing local private sector that had to compete in international commerce and aimed at gaining a competitive advantage through innovation. Great achievements in the arts and sciences as well as the acquisition of virtue and wisdom were welcome side effects, but never the primary purpose of institutions of higher learning. Phoenicia, the first empire that became wealthy and powerful through trade rather than military conquest, proved to be a civilizing force in the Mediterranean area by bringing knowledge and prosperity to its different regions. It was not a zero-sum game.

The Phoenicians realized that their success in international commerce depends to a great extent on the constant acquisition and use of new knowledge in the area of geography, history, culture, technology as well as economic and political organization. The private sector, however, would be unable to produce this knowledge all by itself and is not in a position to generate the necessary human capital to convert this knowledge successfully into new goods and services. A thriving business is therefore dependent on a government that invests in people, promotes the production of new knowledge and encourages its concrete application in the private sector. Through its institutions of higher learning it supports the local private sector in its efforts to remain competitive and innovative in the international market. The private sector in return invests in the specialized training of its employees as well as in the art of converting crude ideas and prototypes developed at general institutions of higher learning into commercially viable products and services. The increasing wealth that results from this successful public-private partnership benefits not just the private sector but also governments, which get higher tax revenues, and society at large, which enjoys more public and private goods as well as a rapid expansion of widely accessible new knowledge.

Moreover, people find exciting new employment opportunities and enjoy a greater choice in the market. Technological innovation that results from the commercialization

of knowledge again feeds back into university research by supplying researchers with new knowledge, tools and technical instruments that can be applied to improve measurements and make new discoveries. As a consequence, research becomes more specialized and accurate and this again enhances the range of research activities and improves their quality. At the same time, increasing collaboration with the private sector often turns out to enhance rather than subvert academic freedom if the university shows sufficient entrepreneurial spirit and public leadership to make autonomous choices and prevent the internal divide within the university into two academic groups that refuse to collaborate. Yet, basic conditions for a university to be in a position to set its own terms of references are high quality in research and teaching as well as a general ability to innovate and actively engage with society. This makes it an attractive partner for many stakeholders in society because demand for its high-quality research and advice is outstripping supply. It therefore has more freedom to choose with whom to collaborate and under which terms.

Renaissance Italy and Dutch enlightenment already had these holistic and empowered institutions of higher learning, partly inherited from the Phoenician and Islamic trading empires. These highly cultured societies did not see a contradiction between the use of new knowledge for commercial purposes and the achievement of scientific excellence. Instead they were still guided by the principles of humanism that emphasized the need of human beings to pursue an active life in order to become virtuous as well as to live in peace with oneself and the social environment.

The sophisticated Occidentalist today would argue that this is all just a Western strategy to impose capitalism on African tribalism. Yet, African tribalism is not as 'wild' as they wish it to be and their view of the entrepreneurial university as a Western construct turns out to have its origin in the Orient. The African continent was part of the first two waves of oriental economic globalization. African kingdoms actively participated in trade and knowledge exchange within the Phoenician and later the Islamic trading zone and in response to this knowledge accumulation, they used to have their own entrepreneurial institutions of higher learning. The rediscovery of the entrepreneurial roots and its successful integration into a new concept of higher education could lead to a genuine African Renaissance of endogenous economic development – but only if the incumbent stakeholders are willing to collaborate with agents of change in a joint effort to promote the freedom to innovate.

Endnotes

1. Karl Marx, whose grandfather was a Jewish Rabbi remains in the strong tradition of the Jewish prophets when he attacks capitalist Jews in the following words: 'The bill of exchange is the real god of the Jew. His god is only an illusory bill of exchange'[80].
2. According to Herodotus [81], the Greeks referred to their letters as Phoenician-things (*phoinikèia)* because the Phoenicians introduced them
3. The Roman Empire had of course also the potential to initiate economic globalization but it did not really encourage it. Its infrastructure mainly served military purposes and it saw its cultural heritage in the Stoic school, a branch of the ancient Greek Academy rather than in the more merchant friendly philosophy of Phoenicia [49].
4. This kind of positive research has nothing to do with positivism as practiced in modern social science. Positive research as pursued by the humanists started with the important inductive process of searching for possible explanations (creating a working hypothesis out of many observations). Subsequently, a method was developed to test the theory empirically. Positivism today has cut off the inductive part and dedicates itself exclusively to the deductive process of testing already existing theories [81].

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The History of Education Institutions in Developed Countries has Lessons for the Reform of the System of Higher Education in Africa

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Abstract

Universities in African countries are widely considered to be a colonial relic that is in desperate need of reform. This article argues that useful lessons for such a reform may be drawn from the developed countries' own education policy debates and history, especially as those relate to development. In that history, innovation-oriented industrial employers that advocate adjustment and institutional change at universities often clash with the vested interests of the educated elite and its desire to buttress its privileged social position with restrictions on entry into various professions and occupations. Any reform proposals should be cognisant of 'hidden' prestige projects masked in the rhetoric of the public good. It is also argued that in developed countries, schools and intermediate technical institutions were historically more important than the universities at early stages of development and continued as useful complements to the stock of the technically educated in later stages of development. It is therefore suggested that the proper basis for university reform in Africa is to ask first whether the range and quality of educational institutions is appropriate to the current state of private sector activity. Such an enquiry may find, for example, that improving technical schooling should be a priority in any educational reform of a country that is in an early stage of industrial development.

1 Responsiveness of higher education to practical needs: Lessons from the British debate

In the 1980s in Britain two books by historians were published that supported the thesis that there had been a form of 'institutional failure' in British higher education. Corelli Barnett argued that British technical education was generally inferior to the German and especially that Oxford University had failed at the turn of the nineteenth century to lead in the provision of engineering and science degrees as they became useful to industry [1]. As the title of Norman Wiener's book 'English Culture and the Decline of the Industrial Spirit' suggests, Wiener proposed that English culture in general lost interest in industrial issues and specifically that the universities turned away from practical education [2]. If universities were able to do this in the developed countries, it might support those who argue that the colonial legacy of universities in anglophone Africa is a poor one.

However, the subsequent debate over the historical role of the universities in Britain provides a different picture. According to the historian Michael Sanderson the common belief in the 1980s was that British universities were not only 'out of touch with industry but actual breeding grounds of anti-business snobbery... overemphasizing the arts and denigrating science and technology' but he believed that this was '...nonsense. It was true of Oxford at the end of the 19th century but it was not true of the civics [the British civic universities such as Sheffield, Leeds and Birmingham Universities]and has certainly not been true of universities in contemporary times' [3: 103].

The mistake is to think that the most prestigious universities should perform all the functions that a modern university system provides for the private sector. The 'civic' universities that Sanderson refers to in the quote above were founded by successful British entrepreneurs in such industrial cities as Liverpool, Sheffield and Birmingham from the turn of the 19th century. Unlike Oxford and Cambridge their role was not to educate the national governing class, but to provide new forms of vocational education for their communities. Sanderson comments on those that prospered that, 'The conclusion was clear. Those civic universities located in industrial regions flourished because they gained the support of the business classes and were conducive to their needs for locally relevant human capital. Those that did not, did not' [3: 93]. Given the source of their funding, the research instituted by these universities was also directed to very practical ends; Sanderson argues that between 1880 and 1914 and before the widespread institution of corporate R&D departments, the civic universities were crucial providers of research of great practical significance to local industry [3:99].

The 'bottom-up' source of funding for the English civic universities in this period is a significant feature: after-World War II, the British state took over the funding of these universities through the tool of the University Grants Committee (UGC). This is how it became possible that the output gap evident in the 1900-1910 period in terms of number of qualified graduate scientists and engineers between Britain and Germany (see below for an analysis) could be reversed so that by 1964, 'Britain had a larger stock of science graduates than any other Western European country and employs a larger proportion of them in industry.... British industry, far from being short of scientists is more richly endowed with them than is any country except the USA....' [4:55]. The subsequent performance of the British manufacturing industry should cast doubt on popular beliefs that 'more' scientists are always useful or necessary for development; Britain probably came to educate too many by the mid-1960s. Generous state-funding has the danger that it will pro-

This article is a development of material from a chapter in my book on the management of development, Howells, J. (2005) [19]. The Management of Technology and Innovation: Technology and the Shaping of the Market Economy. London and New York, Sage.

mote the over-supply of educated professionals who will consequently experience falling salaries and poor career prospects – as the scholar Terence Kealey[1] - argues has been the experience of British scientists during the post-WW II period [5]. If the policy problem is understood to be how to keep educational institutions responsive to actual demand for education and research it will always be dangerous for the state to fully substitute for private sources of funding for higher educational institutions.

2 The Significance of dedicated Elite Technical Education Institutions is less than it first Appears.

An element of Barnett's critique of British higher technical education was that there was no English equivalent to the dedicated German engineering schools, the Technische Hochschule and it is tempting to believe that the high quality and higher numbers of graduates from these institutions represent a better form of practical education than that provided by the English civic universities of the same period. Edgerton quotes figures for graduating engineers in the period 1900-1910 as 1000 per year in Germany compared to 400 per year in Britain. However when adjusted for the 40% greater German population in this period it is not quite as impressive [4: 53]. As for research, Pollard gives figures for 1914 of 250 teachers and 400 students in research bearing on industry in Britain against 673 teachers and 3000 students in Germany [6: 195]. Here is another quantitative advantage in favour of Germany, but Pollard notes that the German dye industry with its exceptional demand for industrial research chemists accounts for almost all of the difference. The British 'failure' then was restricted to this 'missed opportunity' earlier in the nineteenth century when the dye industry in Germany was establishing itself and benefiting from German universities' early preparedness to introduce chemistry departments and doctoral programmes in chemistry. This they did largely because of the prestige chemistry attracted as a result of the spectacular practical applications demonstrated by the German chemist Leibig [6:158].

Apparent clear quantitative evidence in favour of German institutions' superior ability to produce higher numbers of qualified scientists and engineers (hereafter QSEs) and the existence of distinctive German institutions (the Technische Hochschule), once adjusted for population and special cases (the dye industry and its special demand for university-educated chemists) suggest that British and German institutional supply of higher technical manpower was more similar than it first appeared in that both supplied appropriate numbers of QSEs for experienced industrial demand. The general case that British universities 'failed' to supply QSEs in either numbers or quality given prevailing industrial demand cannot be sustained; indeed, Sanderson and others join Barnett in suggesting that if there was a problem it was with the large number of British employers who failed to experiment with the employment of QSEs. Divall has a particularly convincing institutional explanation in 'pupillage' for a degree of British employer tardiness in demanding the institution of universities. The best employers were paid to train the sons of wealthy middle class families to become engineers and this source of income was valued by them and according to Divall, blunted their motivation to organise an external standard source of higher technical training in the form of universities [7].

France provides another example of a distinctive institutional arrangement that one might be tempted to think highly significant in its effect on industrial practice in the two elite Napoleon-era higher technical institutions, the Ecole Superieure and Ecole Centrale. With their restrictive academic merit basis for student recruitment and their position at the top of the French academic status hierarchy, they appear to represent today the realisation in another country of the one-time ambitions of the nineteenth century German 'academic engineer' interest (see next section). However, as these institutions proved insufficient to meet mid-nineteenth century industrial demands for a more practical type of engineer, the French state responded with the founding of the Ecole National Superieure des Arts et Metiers (ENSAM). Then after the Second World War the state founded the 'petites écoles' in an effort to increase the supply of engineers and help modernise French industry [8: 136]. So the critic might be right that these institutions had a narrow curriculum and were over-concerned with educating an elite, but for our purpose this would be besides the point as other institutions did the job of supplying sufficient number and range of technical labour to meet industry needs, as happened in Prussia/Germany. France Britain and Germany illustrate different historical patterns in technical education institutional innovation, but in all three countries what appear as outstanding differences in institutional provision are less outstanding on closer inspection. The full set of technical institutions in each country arguably fills the obvious gaps with respect to gross industrial demand for technical expertise, whether in terms of practicality or number, or 'level' of engineers. The reason is that each state was willing to respond to clear industrial demands for new forms of technical education provision.

There is arguably a policy problem in the period before an employer interest has developed sufficient strength to articulate its technical education needs. Relevant here are the Anglo-German historian Pollard's rather caustic observations on the state of Prussian, then German universities as they developed from the early nineteenth century, when 'the position of Germany appears to have been not unlike that of the less developed countries today: a shortage of technicians coincided with an over-supply of highly educated Arts graduates crowding round the high-prestige, highly paid traditional State jobs'[6: 146]. At the secondary level of education the German Kaiser admired the English public school system and copied such schools' typical classics curriculum into the German Gymnasium school, so that it became a 'training ground for the learned and the elite, and it did indeed survive into the modern era as a fortress of privilege and exclusiveness.' [6: 149]. Those engaged in commerce established 'Realschulen' in despair at the hopeless curricula of the Gymnasien [6: 150] and this type of school also survives today. In schooling as in higher technical education then, the distinct German institutions of today were founded in despair of reforming the inherited classic curriculum and elite-oriented institutions.

If it is accepted that the German story of development is not about spectacular out-production of qualitatively superior technical personnel from somehow superior higher education institutions, then the more interesting German story is how a practical engineering curriculum was instituted and developed *despite* the constant temptation to design 'technical' education on the model of the liberal arts education which fitted students for the higher prestige government posts.

3 Technical Education for Social Prestige or for Practical Utility – Lessons from German History

Since the universities would not teach engineering, by the mid-19th century, German engineers were educated in technical schools 'separate but unequal' to the universities in prestige whether their careers lay in industry or state service [9: 79]. An essential problem of early technical education policy is illustrated when both Pollard and Gispen comment that German industry being technologically backward at this time, an industrial engineering career had relatively low prestige as did engineers in general. Raising its prestige in order to attract better students would seem to be a good idea, but the danger of misdirected reform effort is illustrated by Gispen's story of how Grashof (head of the VDI, the German professional engineering organisation) in 1864 made an effort to raise the status of engineers to the level of the established professions and civil servants *through imitation of the curricula* associated with these high-status professions. Grashof's 'vision' of engineering reform through the new, high prestige institution of the technische Hochschule is worth citing from Gispen's work;

'Workshops and laboratories were to be dismantled as much as possible because they were unworthy of the pure science that engineering education was to become. On the other hand, the technische Hochschule would incorporate generally cultivating disciplines such as languages, history, literature, economics and aesthetics in its curriculum, because "familiarity with them guarantees a higher cultivation of the mind, which corresponds to that social rank for which the higher technical institute is to give the final preparation" [9: 79].

German governments enacted it wherever the technische Hochschulen were established, but as German industry continued to develop and grow, by 1880 the result was a rising level of industry criticism of the impractical technische Hochschule graduate, unable to adapt to industrial life and tending to irrelevant speculative work [9]. The VDI began a successful campaign for the (re)-introduction of a compulsory year of workshop training in the technische Hoschschule (Gispen 1989). The detail of what became a trend towards a more industrially-useful engineering education is significant; the widespread adoption of laboratories for empirical research and training, the diffusion of compulsory drafting and design courses and the fascinating 'anti-mathematician' movement, a deliberate attempt to expel complex techniques such as calculus wherever it was possible to use simpler graphical methods [9]. The dramatic transformation of the curriculum is demonstrated by the change in laboratory and drafting hours in the Berlin Technische Hochschule: it rose from 35% of instruction time in 1881-82 to over 70% in 1898-9 [9]. Many of the liberal arts subjects were lost.

Yet as a result of the successful changes in support of the formation of useful engineers, the 'elite' status of the technische Hochschule graduate now depended only on the high academic standards for entry, the four-year fixed period of instruction and the restricted number of students admitted. These restrictions on supply enabled the rise of a fascinating private educational challenge to the intended 'engineering elite', in the form of 'graduates' from a new kind of non-academic engineering school. These private forerunners of today's Fachhochschulen were initially founded to meet strong demand from employers and workers and were widely understood to be necessary to supplement the meagre numbers graduating from Technische Hochschule. Even the VDI supported the rise of the non-academic engineers, because in their ideal world the graduates of such schools would be subordinate to the graduates of the Technische Hochschulen and would release the elite from the burden of the more routine and tedious forms of technical work. Unfortunately for the would-be elite, by the First World War, 'the opposite happened' as employers promoted the upstart workplace and private school-educated technical employees over the technische Hochschule graduates [9: 160]. Employers argued that the individual abilities of non-academic engineers were underestimated by the academics.

The professional engineering 'status' crisis of unstructured competition between the different technical schools and colleges led the government to create a 'Committee on Technical Education', which rationalised and standardised the competing and overlapping institutions on a national scale [9: 211]. Within this committee the academic engineering elite sought to buttress its status and privileges through devices such as legal restrictions on the forms of employment allowed to those promoted from the shop floor. However the large employers dominated the committee and they defended the non-academic engineering schools and consolidated the workplace-based route into engineering and management to parallel the 'graduate' route represented by the technische Hochschulen.

The German 'dual system' is widely admired, but Wolf reports that the attempts by other developed countries including the US and South Korea to copy it have failed [10: 158]. It may be surmised that, although today it is the regulated order of the German technical qualifications that seem most impressive, in Gispen's account that order was only the prompted-formalisation of the preceding period of excessive supply and unchecked competition between different technical qualifications. It was from that chaotic period that the employers gained confidence in the effective utility of the Fachhochschule-enabled route to engineering status for the shop-floor skilled workers. The difficulty of imitation today of Germany's 'ordered' system may be explained by the absence elsewhere of the unique historical cir-

cumstances of high demand combined with multiple sources of supply of engineering skills that preceded the formalisation of the German workplace-based route to engineering status.

There are many other examples of prestige or status issues threatening to limit the effectiveness of higher technical workers in the work place. The British institution of pupillage has been mentioned above. In the Finniston proposals for engineering reform in early 1980s Britain, there was a proposal to limit access to certain engineering occupations to accredited engineers – but as in the German story, employers blocked it [11] [12]. A more ambiguous example is Divall's history of British higher engineering education in which he describes how a consensus formed between university engineering academics and a small group of enthusiastic employers in the 1940s to change engineering curricula in the direction of 'engineering science': the theoretical analysis of the physical aspects of engineering [7: 94]. Divall shows that the new theoretical curriculum became dominant in British universities post-WWII and through the 1970s [13]. Many British civic universities dropped 'practical' activities such as workshop training. Divall points out that the change suited academic engineers' desire to pursue research in order to establish parity of prestige with respect to other university academics. It also suited the R&D intensive employers in aeronautical engineering and electrical goods who had promoted the change – their engineers would work within R&D. What it did not do was to enable graduate engineers to be quickly and effectively deployed in the production environment in the private sector when this was arguably the greater need of British industry in the post-WWII period, as British production dropped behind world class standards.

4 Chartered professional bodies as limitation of the flexibility of higher technical education curricula

Some time ago Child et al. argued that there is a general tendency in Britain for those engaged in specialised work functions to aspire towards status-seeking 'professional' objectives at the expense of practical attainment within the firm [14]. A recent comparative study of engineer and architect education between Britain and Germany described what might be understood as one of the roots of this syndrome: British higher education and training is generally under the control of professions granted a charter by the institution of the Privy Council [15]. English patents were once granted by the Privy Council [16] and a charter may similarly be regarded as the award of the exclusive right to a single body, in this case to determine the content of education and training for professional accreditation.

University curricula must meet the demands of the professional bodies if graduating students are also to gain professional accreditation. For Clarke and Hermann the monopoly of the charter contributes to a destructive fragmentation of higher technical education and a destructive perpetuation of the divide between higher and lower technical education, for they find 'seemingly uncrossable institutional divides, in particular between professionals and operatives' in the technical qualifications of the British construction industry when compared to its German counterpart [15: 128]. Technical qualifications seem to reinforce a class divide between those who work on the shopfloor of construction and those who obtain a professionally-accredited higher education. In their words,

> '...the exclusive privileges granted through the charters have created deep divisions and fragmentation in built environment professions. There are altogether seven main chartered bodies – the RIBA [Royal Institute of British Architects], the Institution of Civil Engineers (ICE) , the Institution of Structural Engineers (IstructE), the Royal Institute of Chartered Surveyors (RICS), the Chartered Institute of Building (CIOB), the Chartered Institute of Building Service Engineers (CIBSE) and the Royal Town Planning Institute (RTPI) and a myriad of other professional organizations' [15: 135].

In contrast there are only two significant German construction industry professions, architects and engineers [15: 143]. The multiple British chartered professional bodies with their jealously guarded exclusive rights over fragments of technical knowledge limit the universities' ability to adapt teaching curricula to practice, whether to pioneer best practice, to remove obsolescent practice or to reduce duplication between curricula. The broader significance of this example is that it may be a mistake to assume that reform should be directed at universities alone. Universities' relations to professional institutions matters and may have to be considered in any reform proposal.

Conclusions

If we return to consider the original question, given the diversity amongst university-level education, unless one thought that the goal of the colonial power was a benevolent wish to educate indigenous talent to enable self-directed and therefore ultimately independent development, one ought to be surprised if the colonial universities had managed to contribute towards this objective. A better question to ask is whether the range and number of HE institutions match the range of purposes and demand for higher educated labour that society and economy have. There may be a role for a few universities specialising in the liberal education of a governing elite, but where are the civic and technical universities to provide the technical education of a developer-class of entrepreneurs and how do they relate to the schooling system?

There is no space here to review the many disastrous state-initiated technology development 'missions' in developed countries that share many of the organisational characteristics of the top-down 'development' projects in African countries [17]. As Aerni argues, it is the failure of many well-funded projects to meet effective social and economic needs that is most persuasive in favouring an entrepreneurial and 'bottom-up' approach to development. This after all, is how developed countries achieved development; their large firms were once initiated by entrepreneurs in an earlier stage of their history as economic powers and it has long been shown that continuing entrepre-

neurial activity is an essential feature of a developed economy (for example in [18].

Pollard [6] judges that at early critical junctures it was the will of the German state to promote effective practical reform that was critical in shifting institutions and curricula in that country. Reform is always difficult to conceive well and carry out, but resort to developed countries' educational histories can indicate some of the practical difficulties in conceiving and executing reform in African universities today.

Endnote

I. Kealey's book is a rare attempt to present the case against state funding of science. Following John Stuart Mill's maxim from 'On Liberty', as such it deserves to be read more widely and carefully than the many tracts promoting the value of state-funded science and state-educated scientists, especially if one wishes to test the robustness of the pro-state support view.

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11:00 Intellectual Property Management in the Knowledge economy
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12: 00 Networking and Lunch

14:00 Finance and Investment in Technology Development
Discussants: Prof. P. Jain, Dr. P Nkanza, Mr. B. K Tembo.

15:00 Coffee Break and networking

16:00 Entrepreneurship and Technology Commercialization
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The challenge

One of major challenges facing Africa is unemployment and an institutional setting that discourages entrepreneurs in the informal sector to grow and move into the formal sector. As a consequence, many young and talented Africans migrate to Europe, North American and other developed regions of the world in search of employment opportunities. This undermines the development of Africa and presents many challenges for developed countries, some of which respond by erecting ever growing barriers. Efforts to improve health care or eradicate hunger and poverty, among others, are intricately linked to the ability of countries to provide opportunities to their citizens to provide quality products and services and contribute to national revenues

ATDF believes that one way of achieving such a goal is to help individuals turn their ideas, research outputs and concepts into viable enterprises, products and services. This would provide employment, generate revenues and, in the process, empower communities to meet their needs. However, there are two major gaps that hinder individual and teams to turn their ideas into commercially viable products and services in Africa:

1. Financial and support gap: In developed countries, government grants, public incubators and science parks and venture capital firms often fill in this gap.
2. Skills and knowledge gap: In developed countries, technology development and transfer institutions and associations help firms learn, adapt and acquire emerging technologies.

Taken together, aspiring entrepreneurs face a steep learning curve as they have to be profitable within their first 2-3 months or they will not survive. Globally, start-up firms need up to 5 years to become profitable. It explains why many individuals are trapped in the informal sector for a long period of time (accounting for over 70% of the total employment in some African countries). This in turn makes service delivery, quality control and economic planning almost impossible.

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ATDF Entrepreneurship Hub is an independent corporate unit of Africa Technology Development Forum (ATDF) based in Lusaka, Zambia. The primary goal of the Hub is to promote entrepreneurship and innovation, to facilitate development of businesses, products and services as a way of creating wealth and jobs and reducing poverty. ATDF Entrepreneurship Hub offers five main products:

1 Entrepreneurship Support Investment (up to US$ 50'000!)

The Entrepreneurship Support Investment is equity financing designed to promote Zambian men and women, especially those below the age of 45, with innovative business ideas and the necessary discipline and skills to convert their ideas and concepts into successful companies that create new products, services and employment for the Zambian people. Teams

and start-up firms seeking administrative, technical and financial support are highly encouraged. In exceptional cases, the Hub may invest up to $100,000 or more than 30% of the firm's share capital. Selected individuals, teams and firms will have to be based in Zambia.

2 Entrepreneurship Challenge Award 2007 (up to $5000)!

This investment is designed to help young people (below the age of 40) to refine their business concepts, conduct market research and interact with seasoned entrepreneurs. In addition to the modest funding, selected entrepreneurs will also access technical and commercial services through the ATDF network of entrepreneurs and R&D centres. Successful projects may apply for Entrepreneurship Support Investment.

3 Business incubation and commercialization.

Often, firms and R&D centres may wish to commercialize or spin-off a unit that is no longer considered part of its core business, could become self-sustaining or is loss making. Rather than shutting these units down, The Hub could bring in investment, management, technology and leadership to facilitate their growth and become viable firms.

4 Business Intelligence Support

One of the challenges African firms and institutions face are the limited sources of market, technology, investment and business information. The Hub will collect, synthesise and disseminate emerging trends in the domestic and external markets. It will collect information that helps firms to strategically manage their intellectual assets, seek partnerships, identify emerging markets and regulations.

In addition to a small business and technology relevant library, it will also run a depository of creative, marketable and thoughtful business ideas. Many individuals with brilliant ideas may not be talented business managers, have difficulties in accessing technical and financial institutions or lack the right platform to launch their business. The depository will assist them by serving as a meeting point of potential partners or the sieve for refining and recombination of business ideas.

5 Entrepreneurship Course

The Entrepreneurship course is designed to stimulate entrepreneurial creativity and innovation, facilitate commercialization of research output and encourage development of private and public enterprises to create jobs and reduce poverty. It shall enable entrepreneurs to quickly spot and evaluate business opportunities, solve entrepreneurial challenges and enhance the entrepreneurial drive, networks, resources and skills of candidates to communicate and implement business ventures effectively.