Entrepreneurship Education for Scientists and Engineers in Africa

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Abstract

To reap economic benefits of research and innovation, science and engineering graduates need to be equipped with entrepreneurial skills to enable them to engage in technology based business ventures. Entrepreneurial skills will also mitigate unemployment and poverty by empowering scientists and engineers with self employment capabilities, and shall help create job opportunities for the others. Universities have a potential role to play in producing such technically trained manpower. Two routes are perceived for entrepreneurship in science and engineering. One of the routes is through the process of innovation, generation and protection of intellectual property, technology transfer and commercialization of inventions. The other, less conventional route is the production, assembly and servicing of technological consumer goods and educational and research equipment, and provision of testing, measurement and calibration services. The paper discusses the training needs of the two models of entrepreneurship for scientist and engineers.

Introduction

"Entrepreneurs are the people who have the creative ideas, drive and determination to set up new small businesses: the seeds from which big enterprises can blossom" - ‘SMEs and Entrepreneurship’ in Enterprise & Industry (December 2009), p. 8.

Industrial and technological development is a natural outcome of value-added processing of raw materials and product manufacture capabilities. African economies have traditionally been raw materials based, as a result of which there has been very little industrial and technological development amongst most countries of Africa. This has also contributed to high levels of poverty and unemployment. To deal with problems of underdevelopment, unemployment, and poverty, there is need to create self employment opportunities for potential entrepreneurs who in turn will create job opportunities for others. Countries have created special funds to finance viable businesses, have setup advisory agencies to advise, train and instill business skills in aspiring entrepreneurs through workshops, short courses and counseling, and there are agencies to help small businesses access markets and to mitigate the risk of being forced out by big businesses. For example in Botswana, Citizen Entrepreneurial Development Agency (CEDA) and Local Enterprise Authority (LEA) are two main agencies to help citizens in all entrepreneurial matters. Such Government and parastatal agencies deal with small, medium and large businesses of all nature ranging from agriculture, poultry and dairy farming, traditional and consumer products manufacturing, marketing and trading etc. The focus of this paper, on the other hand, is technology and science based entrepreneurship for which besides business skills one also needs scientific and technical training, and research and innovation capabilities.

After decades of underdevelopment and with emerging globalization, African countries are now focusing on rapid progress through technology driven development to support industrial growth. In this respect universities and other tertiary institutions have a potential role to play in the training of scientists and engineers with entrepreneurial skills to enable them to engage in technology driven business ventures. Two possible routes are perceived for the entrepreneurship in science and engineering. One of the routes is through the process of innovation, generation and protection of intellectual property, technology transfer and commercialization of inventions. The other route is the production, assembly, and servicing of technological consumer goods, and educational and research equipment. Comparative merits, demerits, limitations, advantages, disadvantages and training needs of the two models of entrepreneurship for scientist and engineers are discussed. The paper is concluded with recommendations and an action plan.

Sub Theme 7: Innovation and entrepreneurial capabilities.
1. Entrepreneurship through IP generation and commercialization

The Institute of Physics (IoP), UK has developed a 16-week *Entrepreneurship Curriculum* for Physicists and Engineers which is available free of cost from the Institute on request in ready to teach Microsoft PowerPoint presentation format at tertiary institutions. The focal points of the curriculum [1] are the fundamentals of Intellectual Property (IP) generation, basics of patenting and IP protection, invention to product processes, business fundamentals, financing, getting started, and exit strategies. IoP in collaboration with Abdus Salam International Center of Theoretical Physics (ICTP), Trieste, Italy has also organized Entrepreneurship Workshops of one week duration at ICTP on a number of occasions. The fourth in the series was held in May 2010. Similar workshops have also been organized regionally in various countries. The first Workshop in Africa was held in Cape Town in November 2009 with co-sponsorships from the Institute of Physics (IoP), UK; American Physical Society (APS), USA; ICTP, Italy; South African Institute of Physics; iThemba , Stellenbosch; National Research Foundation (NRF), RSA; NanoAfNe, and Standard Bank, RSA. The objectives of the Workshop were [2]:

- To introduce to scientists and engineers the process of innovation, generation and protection of intellectual property, technology transfer and commercialization of a product.
- To enable science and engineering graduates to create self employment opportunities, and thereby enable them to create job opportunities for the others.
- To build capacity in sustainable development through the training of trainers in entrepreneurship and innovation management skills.
- To encourage universities in Africa to introduce entrepreneurship and business skills in science and engineering curriculum.
- To ultimately reduce brain drain by encouraging a culture of entrepreneurship among African Scientists.
- To encourage interdisciplinary and multi-stakeholder dialogue through bringing the following groups together during the workshop:
  - Physicists, chemists, life scientists, engineers and social scientists.
  - North – South cooperation: scientists from Europe working with African scientists.
  - South – South cooperation: scientists from India and China working with African scientists.

The high point of the workshop was the preparation of mock business plans by groups of participants which were presented and adjudicated for prizes. The *IoP Entrepreneurship Curriculum* was also presented with a view to train the lecturers and academics to deliver and to adapt it to their needs where necessary.

These workshops and training programs are highly advantageous for individuals who have the opportunity to be involved in research and innovation, and could benefit from commercialization of their research. However, in view of the prevailing state of science and engineering education and limited research opportunities in most parts of Africa with the exception of South Africa, innovation driven entrepreneurship has limited scope. The following observations represent a fair picture of science education and research for most of Southern Africa with the exception of South Africa, and many sub-saharan African countries.

- After completing secondary/ high school education students enter tertiary education through a performance based selection process. Only the best are admitted to fill the available places.
- At the university, science students do a common year or two after which they are streamed into different sciences and engineering disciplines. The best performers are designated to study professional and high employability programs for example medicine and allied programs, engineering, computer and information technology courses etc. It is only the low performers who are left to be shared by the basic sciences and the education programs.
- Not only do such students have a weak background in their respective subjects; having missed the opportunity to enter high paying professions, they are often less committed, less motivated, and fail to perform at their very best to be able to pursue a successful research and innovation career.
- Some of those who perform well are recruited by tertiary education institutions in the country for staff development programs to be trained for faculty positions. Others take up teaching positions in the secondary school system, or enter jobs in the government technical departments such as the meteorology, mining, geology, environment, and energy etc.; secondary school teaching being the least preferred option. Government jobs generally are administrative, involving administrative and policy matters with none to minimal opportunity for research and innovation.
• Engineering graduates invariably take up employment where ample jobs and opportunity for rapid progression exist as against a research career which is not as rewarding.
• Research councils, research laboratories and formal research, development and innovation infrastructure in most countries are lacking or underdeveloped. It is only at the universities that some research is undertaken, and that too, in the absence of adequate equipment, more often than not, is theoretical with none or little industrial potential.
• Many universities also have expatriate academics employed on renewable contract basis of short duration of two or so years. They are unable to attract research funding due to the very nature of their employment conditions.
• Most universities place high emphasis on published research for the purpose of progression and the renewal of expatriate contracts.
• IP registration and patenting is a long drawn-out and costly process for which either the resources or the skill or both are lacking at most universities. Although, some universities are now beginning to introducing intellectual property patenting and commercialization advisory cells within their research management units, there is still not enough inducement for staff to take up the high risk commercializable research and innovation where odds of success are not so favourable.
• The industrial base is also weak, and there is very little or no in-house research, development and innovation in the industry. There may exist small quality control units in some cases, and any research and innovation where needed is either done by the mother company based out-side the country or is outsourced on piece-meal basis. Results of such work accrue to the company and not to the researcher.
• There may be some innovation and development in the informal sector, the factories and the workshops. Such work is often exploited by the company itself and it is not necessarily patented or may not be patentable.

This shows that in most parts of Africa there is very limited opportunity for IP generation and commercialization of innovation for financial gains. Even in developed countries only a very small fraction of research and development research that has a commercial potential, is patentable and an even smaller fraction of that lands in the production line to become viable and successful enterprises. At the same time many start-up companies fold up within a short period of five years or less.

2. Non-IP driven entrepreneurship for scientists and engineers in Africa

As the job market approaches saturation, the certainty of finding a job on graduation declines. It is, therefore, imperative that the science and engineering graduates are imparted with adequate skills for self employment. For this we need to revisit the strategy of inculcating entrepreneurship amongst young science and engineering graduates which is not necessarily IP driven but makes use of their basic training and background where they have a better chance of success as compared to a non-technical person. There are a number of areas where opportunities for entrepreneurship ventures exist because of the following prevailing circumstances.

• There is a shortage of teaching-laboratory equipment in schools and higher educational institutions. Generally the equipment is imported at a high cost whereas, at the same time, there is often a scarcity of foreign currency and its use is strictly regulated.

• Most consumer goods are generally imported in finished form, and their repair and maintenance is scarce. It is for this reason that the use of solar energy devices has failed to reach a desirable level of implementation in Africa. The devices are costly, and after-sales service for repair and maintenance is lacking.

Alternate routes to science and technology based entrepreneurship for Africa could include:

• Manufacture, assembly, innovation and adaptation of such consumer goods and laboratory equipment including teaching and research glass ware where IP issues are not involved. For this, there would be a need for some training in business skills and some basic technology transfer may be involved.

• Provide repair and maintenance services for teaching and research equipment and technological consumer goods.
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3. Research, Innovation and Networking

Research and innovation at the forefront of science and technology to meet the global challenges requires more than the resources of a single laboratory or even a single nation. Networking and collaboration has become a prerequisite for excellence, relevance, and multidisciplinarity. Pooling skills and resources not just aggregates the skills and talents, but they are multiplied. In commercially viable collaborative research and development, not only can there be multiple financial rewards, there is also the possibility of developing side-products and services that can add to the gains for the researchers.

In recent years, a number of research networks involving regional and/ or continental universities and research organizations, have been formed in Africa. These networks have varied objectives ranging from human resource, skills and capacity building to researching of indigenous products and resources to develop them in to globally marketable...
consumer goods. Five such networks have been funded by grants from the Carnegie Foundation and the Institute of Advanced Studies, USA under the Regional Initiative in Science Education (RISE) [3]. The African Materials Science and Engineering Network (AMSEN) of the Universities of Botswana (coordinated by P K Jain), Nairobi, Namibia, Witwatersrand University, RSA and Federal University of Technology, Akure, Nigeria, is one of the Carnegie – IAS RISE network actively involved in the study and development of new materials for industrial applications, and training of graduate students and staff at Masters and PhD degree levels.

4. Recommendations

- In view of the present state of science education, research infrastructure and potential, the first priority for technological entrepreneurship for scientists and engineers in Africa should be the non-IP driven ventures.
- At the same time, there should be focused efforts to improve the quality and quantity of research potential. To achieve this, it is recommended that the following should be carried out:
  - Develop the research infrastructure and facilities.
  - Provide incentives to retain good students in sciences, and encourage them to take up research and innovation careers.
  - Increase industry participation in the training of science and engineering students.
  - Support post graduate education leading to research degrees by providing bursaries for students and research grants.
  - Strengthen research management and administration departments at universities to actively assist researchers in seeking grants, and to provide IP protection and commercialization services.
  - Universities must give due weightage to innovation and patents for progression and contract renewals of staff.
  - Create research centers and laboratories with the sole business of research and innovation. A strong research council and a strategic national research policy must be in place to support the research bodies in the country.

By the time a strong and vibrant infrastructure and environment for research and innovation in the country is established, the first generation of non-IP entrepreneurs would have reached a mature stage for them also to be contributing to IP generation and innovation in their respective ventures and to provide support services for research laboratories and scientists.

5. Action Plan

In order to lay the foundation for entrepreneurship among scientists and engineers the following action plan is proposed for immediate implementation.

i. Organize a Regional Workshop of one week duration for practicing researchers and inventors to train them on IP generation, protection and commercialization. This can be done in collaboration with IoP and ICTP who have conducted a number of such workshops successfully over the past several years, and have assembled a team of experts and facilitators.

ii. Introduce optional/ elective Entrepreneurship course(s) in science and engineering curriculum for students who wish to pursue such a career path. The entrepreneurship course developed by IoP can be adapted to suit the local needs.

iii. Organize Short course(s) (of 4 to 8 weeks duration) to train Faculty in the teaching of entrepreneurship courses, and to train the IP professionals to advise researchers at the universities on related matters.

6. Financial Implications

The cost implications of the proposed action plan are as follows.

i. The cost of Regional Workshop for 40-50 delegates to meet the local expenses (local transport, meals, accommodation) is estimated at US$50,000/= Delegates shall provide their own travel to workshop. IoP and
ICTP can be approached to fund the travel for facilitators and experts. More than 50 delegates per workshop are not recommended, as each expert/facilitator closely mentors 5 to 6 delegates to impart practical skills.

ii. **Entrepreneurship course(s):** Salary and benefits for one staff to teach the course who could also act as IP consultant for researchers is estimated at US$60,000/= pa.

iii. **Short Course(s) to train Faculty:** Salary, travel and hospitality for one expert to teach the course is estimated at US$25,000/= This can be organized in collaboration with more than one university/institution in the country to share the cost.

7. **Conclusions**

- Because of lack of infrastructure, at present and in the near future only non-IP driven science and engineering entrepreneurship can be promoted successfully.
- IP-driven entrepreneurship can be implemented successfully only after quality of science education is improved, and infrastructure for quality research and innovation has been created.
- In the meantime, there is need to organize training courses and workshops as proposed under the action plan.

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**References:**

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