World Transactions on Engineering and Technology Education
Vol.6, No.1, 2007

Fostering entrepreneurial engineers for sustainable industrial growth in the small-scale sector in India

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ABSTRACT: In this article, the authors discuss the role of education in developing an engineer as an entrepreneur who can face uncertainties in changing scenarios where the product lifetime cycle is reducing and technology is changing at a faster rate. In this context, the authors stress on the need for an engineer to also be an entrepreneur for sustainable industrial growth in India. In order to assess the input in engineering education and the inclination of engineering students to entrepreneurial ventures as a career option, the authors carried out a survey among faculty and final year students of engineering institutions in Haryana State. It was found that engineering students prefer wage employment than self-employment as a career option. As regards to the entrepreneurial concept and capabilities, students have entrepreneurial capabilities but this is lower than the entrepreneurial concept. The entrepreneurial concept reflects theoretical knowledge whereas entrepreneurial capabilities reflect skills, understanding and know-how. To improve students' entrepreneurial capabilities, the authors propose a model that will be helpful in enhancing the capabilities of an individual and make him/her able to face future uncertainties.

INTRODUCTION

Successful new business ventures and economic development are the result of the right environment, planning efforts and innovation. The entrepreneur is the key factor in this development process. Entrepreneurship is instrumental in economic growth, balanced regional development and job creation. Economies all over the world revolve around the entrepreneurial zeal and performance of their people. Those economies that have strong entrepreneurial cultures are prospering and flourishing. In changing scenarios, where technology is changing at a faster rate and the product lifetime cycle is shrinking, technical entrepreneurship has a prominent role in sustainable growth. It plays a pivotal role in the process of industrialisation, and contributes greatly to industrial development through innovations, product development and improvement in productivity and production processes.

Laukkanen states the need to fulfil what is called the *third obligation* where academia are expected to contribute by undertaking research, teaching and technology transfer [1]. Entrepreneurial education is the step in this direction. Technical education integrated with an entrepreneurship development programme can develop technical entrepreneurs for sustainable industrial growth.

Entrepreneurship

Samiuddin et al defined an entrepreneur as someone who detects and evaluates the new situation in his/her environment and directs the making of such adjustments in the economic systems as he/she deems necessary [2]. The entrepreneur conceives an industrial expertise for the purpose, and displays considerable initiative, grit and determination in bringing the project into reality. In recent years, entrepreneurship education has been developing steadily – although unevenly – in most nations worldwide [3].

Entrepreneurship education has been developed by professionals of different areas of knowledge; however, the predominance is in management, followed by computer science and engineering. There is still an ongoing debate about whether students can actually be taught to be entrepreneurs [4]. A 10-year (1985-1994) literature review of enterprise entrepreneurship and small business management education reported that *most of the empirical studies surveyed indicated that entrepreneurship can be taught or at least encouraged by entrepreneurship education* [5].

Muir et al have raised concerns about entrepreneurship education on two fronts [6]. Firstly, it implies that education is limited to the creation and development of an enterprise rather than on the wider development of entrepreneurial people. Secondly, focusing upon the economic phenomenon of an enterprise limits the understanding of entrepreneurship as a personal activity, and excludes disciplines of economic history, sociology, psychology and anthropology, as suggested by Swedberg [7]. Levie distinguishes between teaching *for* and *about* entrepreneurship [8]. The authors concur with this distinction and add the notion that entrepreneurship is not just limited to economic development, but is also inclusive of the personal development of the entrepreneurial individual. Entrepreneurship is perceived as a whole person activity that involves and aspires to both cognitive (knowing) and co-native (doing) excellence [9]. This belief and understanding then has implications for course content and delivery.

Engineering Education in India

Engineering education makes an important contribution to the economic viability of any nation. Bhaskaran sees the techno-logical dominance of the USA has largely been possible because of its educational system, which has supplied an abundance of scientists and engineers besides business strategists, managers, skilled technicians and skilled workers [10].

Engineering education in India is offered through three streams viz. *craftsman*, *technician* and *engineering* streams [11]. Through the craftsman stream, the system produces skilled workers and the training period ranges from one to two years. Training is imparted in 32 engineering and 22 non-engineering trades approved by the National Council for Training in Vocational Trade. For this purpose, industrial training institutes have been established in almost every district. The technician stream produces technicians – middle-level workers needed for a wide range of professional duties for the application of knowledge infield operation, production, construction, testing and development, etc. These courses are offered at polytechnics situated in various locations around India. Through the engineering stream, the system generates engineers (degree holders) for planning, managing, designing and conducting research in various areas of engineering and technology. Graduates of this stream are trained in engineering colleges, higher institutes of technology and universities.

Entrepreneurial Potential among Engineers

In spite of the fact of the substantial quantum of science and technical personnel, India is facing problems of massive unemployment, low work efficiency and low productivity. This situation has been aggravated by the Indian education system itself, which moulds the student more for job/wage employment than self-employment [12]. To identify the problem of the reluctance of engineering students to select self-employment as career option, the authors conducted a diagnostic study among final year students at an engineering institute. A questionnaire was given to students after detailed discussion by the authors. The responses received and the findings derived are shown in Table 1.

FINDINGS

It was found that the entrepreneurial capability and entrepreneurial concept of students opting for self-employment is on a higher side than that of students choosing wage-employment. Furthermore, the entrepreneurial capability of the surveyed students, both in self-employment as well as wage-employment, is less than the entrepreneurial concept of the students. Also, the total number of students opting for wage-employment as a career option is more than the number of students choosing self-employment as a career option.

DISCUSSION

The entrepreneurial capability of students is lower than their entrepreneurial concept. This concept is developed by theoretical lectures, whereas capability is developed with the product-oriented practical exposure and field experience of the student. The total number of students choosing self-employment is less than number of students opting for wage employment is due to insufficient inputs in the curriculum on entrepreneurship development. This is due to the lack of awareness, opportunities and avenues in the entrepreneurial field.

Technical institutes concentrate on developing students' technical capabilities and very little emphasis is given to inculcating students for entrepreneurship as a career. This is the situation despite the fact that various schemes (eg science and technology entrepreneurship park, entrepreneurship development cell, industry institute interaction cell, community polytechnics) have been introduced at various technical institutions. The idea of these schemes was to stimulate those students who possess the latent entrepreneurial qualities to set up their own ventures. Due to the lack of proper support from educational administrators, these cells are on the verge of death or have not been able to achieve the expected results.

Entrepreneurship Development: a Necessity

Jackson sees the role of education is not only to educate, but also to develop and examine ideas across the discipline and further relates them to the world of practice [13]. Universities and academia can contribute for a successful technology-driven knowledge economy as follows:

- It functions to educate scientists, engineers, technologists and technological leaders for industry, government and education;
- The basic scientific research conducted at universities and by academia is critical for innovation, new technologies and economic development;
- Universities and academia can foster entrepreneurship with this process involving not only translating new knowledge to applications but also commercialising those new applications as new business ventures.

Smilor and Gill have given the four key factors that appear essential in the formation of a new technology-based industrial venture: talent, technology, capital and know-how [14]. Talent refers to entrepreneurs who recognise market opportunities and organise units to take advantage of these opportunities. Sources of talented technology entrepreneurs are universities, technical institutions, technology-oriented corporations, and public and private research laboratories. Technology concerns the ability to generate idea that has real market potential within a reasonable time. Every dynamic process needs to be fuelled. The fuel for the entrepreneurial process is capital and is the catalyst for entrepreneurial chain reactions. Capital provides the financial resources through which the ideas of the entrepreneur can be developed, tested and commercialised. Know-how is the ability to leverage business or scientific knowledge in linking talent, technology and capital in emerging and expanding enterprises; it is the ability to find and utilise expertise in a variety of business and scientific disciplines to turn technological devices into marketable

Table 1: Students' responses to the questionnaire.

Year	Self-Employment Option			Wage-Employment Option		
	Number	Entrepreneurial		Number	Entrepreneurial	
		Capability	Concept		Capability	Concept
2002	22	0.5495	0.8558	22	0.5283	0.7845
2003	25	0.6735	0.8687	15	0.5844	0.8448
2004	18	0.6329	0.8888	27	0.5815	0.8281
2005	09	0.6396	0.8524	25	0.5946	0.8075

products. Synergy among talent, technology, capital and know-how is essential for the success of a venture [15]. If one of these essential factors is missing, then the probability of failure increases.

Challenges before Engineering Education

Engineering practice has changed dramatically and irreversibly due to the following:

- Growing global competition and industry restructuring;
- Shifts in the sources of engineering employment from defence work to private enterprises;
- The explosion of information and development of Information Technology (IT) [16].

Engineering success requires more than up-to-the-minute technical capabilities, namely:

- Ability to communicate;
- Ability to work in teams;
- Ability to think creatively;
- Ability to learn quickly;
- Ability to value diversity.

Webster has emphasised engineering education should equip graduates to demonstrate key attributes, namely:

- Ability to apply knowledge of basic science and engineering fundamentals;
- Ability to communicate effectively with engineers and the community;
- In-depth technical competence in at least one engineering discipline;
- Ability to undertake problem identification, formulation and solution;
- Ability to utilise a system approach to design and operational performance;
- Ability to work effectively as an individual practitioner;
- Ability to work effectively in multidisciplinary and multicultural teams;
- Capacity to be a leader or manager, as well as an effective team member;
- Understanding of social, cultural business and environmental responsibilities;
- Understanding of and the ability to apply sustainable development principles;
- Understanding of and a commitment to professional and ethical conduct;
- Mentally prepared to undertake life-long learning [17].

These capabilities and attributes are similar to entrepreneurial characteristics. In technical education, emphasis has to be given to nurturing entrepreneurship to enable students to be the champions of a product, process, market systems practices and to help in professionalising Indian industry.

Strategies to Develop Technical Entrepreneurship

It has been observed that sustainable entrepreneurship could be developed with proper education and training provided to those persons with entrepreneurial zeal. This has been realised when Khursheed carried out experiment in two towns of Andhra Pradesh in collaboration with the Small Industry Extension Training Institute, where some young businesspersons were given an orientation course designed to stimulate the imagination, etc [7]. The study revealed that the trainees displayed a more active behaviour, worked long hours, started new ventures, etc. It is a universal fact that the education and training of potential entrepreneurs has a significant bearing on the successful pursuits of entrepreneurship, yet the question arises what training inputs are needed for potential entrepreneurs. The entrepreneur of the SME sector has to discharge the twin functions of an *entrepreneur* and multifarious *manager* so the need is to make them:

- Highly knowledgeable with vision and dynamism;
- Fully aware about the different schemes/incentives being offered to the SME sector and the procedures thereof;
- Understand the different laws, regulations and procedures to be followed in the establishment of a unit;
- Develop entrepreneurial vision, attitude and motivation and make them understand what behavioural competences are important for successful entrepreneurship;
- Understand the importance of financial discipline;
- Knowledgeable of the different stages of growth of an enterprise, how to face uncertainties and meet competition;
- Understand how to forge good relations with different individuals and organisations looking after industrial development;
- How to seize an opportunity, conduct market survey studies, and prepare project and feasibility reports;
- Fully capable of know-how, ie how to marshal and utilise their knowledge and resources in an effective way for the success of an industrial venture.

Secondly, in the context of globalisation and liberalisation, industries should respond to the emerging calls for quality assurance and cost-effective production strategies. Therefore, the management of new enterprises has to respond to challenges of the management of technology growth and innovation. This challenge of growing competition has necessitated a high degree of application capabilities and innovation spirit among entrepreneurs. Innovation is to be initiated by entrepreneurs by seizing opportunities in changing situations by discovering how to: make sure that all innovations create customer delight and meet high quality standards; build innovativeness into every important and crucial process from planning to communication to feedback systems; find paradigms to keep on the cutting edge of change; study the past, analyse the present and forecast the needs of tomorrow's customer; establish a shared vision that involves all unit members in fostering and achieving important innovations; synthesise opportunities in the marketplace with the capabilities of the organisation and needs of stockholders.

The Necessity of the Engineer as an Entrepreneur

New trends in industry place more emphasis on other aspects of products, not just their price and performance in the market. The innovative nature of a product and its appeal to appreciate the need to allocate resources to develop innovative products is being tested for its sustainability to the marketplace and its performance in relation to a competitor's product. Further, present trends in the competitive market tend to place more emphasis on products with shorter lifecycles. Therefore, Matani stresses that R&D activities be encouraged to help bring products into the market quickly and efficiently [18].

For the SSI sector in particular, entrepreneurship is a one-person show so the success of unit revolves around the capability of an entrepreneur. Technical entrepreneurship can make a contribution to industrial development through

innovations, new product/process development and productivity improvements. Innovation requires innovators to process some kind of technical skills. Technicians and technocrats can play the role of innovators comparatively with ease because they have characteristics such as the propensity to adopt new knowledge and technology more rapidly.

Baburao sees that engineers, who learn sufficient science and engineering, acquire capabilities to know *why* and *how* various theories and can design products and services based on their knowledge and skill competences [8]. The development of engineers' entrepreneurship skills is an effective mechanism for a luminous renaissance in technology innovations and the industrial development of a nation. Through entrepreneurship, engineers can bring a technical revolution that can meet the challenges of emerging globalisation and liberalisation with the key element of competition rather than protection [19].

FINAL WORD

Education in general, and technical education in particular, plays a vital role in the development of human resources. Technical education that stresses entrepreneurship development can help in employment generation and the sustainable development of the small-scale industrial sector in India. Technical education curriculum should be from an occupational and vocational angle to develop diagnostic skills, management skill, computer handling skills, plus an awareness of national and international standards and quality control operations. These skills are prerequisites for entrepreneurs and intrapreneurs. Entrepreneurship development programmes should be practical in orientation and its contents can be categorised into five steps: pre-operational drill, operational drill, post-operational drill, functional and structural parameters, and competence building for decision making. Of these, the first three are for technical competence building and the remaining for managerial competence building.

CONCLUSION

Entrepreneurship development programmes in engineering institutions can be helpful, not only in solving the problem of unemployment, but also for the sustainable development of SMEs in India. For the sustainable growth of the small-scale sector in India, it is imperative to make it competitive. To develop capable entrepreneurs, an entrepreneurship development programme should be planned in phases, ie identifying the right persons, developing entrepreneurial an vision, concept and capabilities (ie know-how development); guiding and supporting entrepreneurs during the pre- and post-training stages to enable them to stand on their own feet and face uncertainties more confidently.

Entrepreneurship should be accepted as a discipline and needs to be learned and practiced. Preparing for a job cannot be the sole objective of education. It is important to motivate young talents in science and technology to become entrepreneurs as a viable pursuit of excellence. Integrating entrepreneurship education at technical institutions should not only stimulate innovation, but also enhance the level of creativity and value consciousness in entrepreneurial ventures.

In today's society, it is technology that drives the economy, since engineers create this stuff; they are the real masters of society. Engineers as entrepreneurs should be inculcated on the hard fact that technology to be adopted in new ventures should be omnipotent, omnipresent and omnieuphoric for its sustainability.

REFERENCES

1. Laukkanen, M., Exploring alternative approaches in high level entrepreneurship education: creating mechanisms for endogenous regional growth. *Entrepreneurship & Regional Development*, 12, 25-47 (2000).
2. Uddin, S. and Rehman, H., *Entrepreneurship Development – a Key to Economic Growth*. In: Uddin, S. (Ed.), Entrepreneurship Development in India. Delhi: Mittal Publications, 49-57 (1989).
3. Muir, E. and Edwards, L-J., Mastering Entrepreneurship: The Challenge of Educating Entrepreneuses", NCGE Working Paper Series 20/2006 (2006), http://www.ncge.org.uk/research.php
4. Swedberg, R. (Ed.), *Entrepreneurship: the Social Science View*. Oxford: Oxford University Press (2000).
5. Levie, J., Entrepreneurship Education in Higher Education in England: a Survey. London: Dept for Education and Employment (1999).
6. Edwards, L-J. and Muir, E.J., Promoting entrepreneurship at the University of Glamorgan through formal and informal learning. *Proc. 12th Nordic Conf. on Small Business Research*, Kuopio, Finland (2002).
7. Khursheed, B., Small entrepreneurial education: approach and methodology. *Abhigyan*, 17, **4**, 35-44 (1999).
8. Baburao, G., Promotion of technical entrepreneurship: role of humanities and social sciences. *J. of Engng. Educ.*, 88, **1**, 7-11 (1999).
9. Sanghi, A.N., Promotion of technical entrepreneurship through technical education. *Indian J. of Technical Educ.*, 19, **2**, 42-44 (1996).
10. Bhaskaran, R, Technical education and global competition. *Indian J. of Technical Educ*., 19, **3**, 28-31 (1996).
11. Aggarwal, D.P. and Raina, K.B., Technical education in India – retrospect and prospect. *Indian J. of Technical Educ*., 19, **4**, 1-6 (1996).
12. Krishnamurthy and Sanghvi, Role of technical institution in entrepreneurship motivation and development. *Proc. National Seminar EDC*, Delhi, India (1994).
13. Jackson, S.A., Meeting the Challenges of the New Economy: Education as an Engine for Growth and Innovation. Presidential speech, Kuala Lumpur, April (2001).
14. Smilor, R.W. and Gill, M.D., *The New Business Incubator: Linking Talent, Technology Capital and Know-How*. Lexington: Lexington Books (1996).
15. Smilor, R.W. and Feeser, H.R., Chaos and the entrepreneurial process: patterns and policy implications for technology entrepreneurship. *J. of Business Venturing*, 6, 165-172 (1991).
16. Natarajan, R., The role of accreditation in promoting quality assurance of technical education. *Inter. J. of Engng. Educ*., 16, **2**, 85-96 (2000).
17. Webster, J., Engineering education in Australia. *Inter. J. of Engng. Educ*., 16, **2**, 146-153 (2000).
18. Matani, A.G., Managing new product innovation. *Industrial Engng. J*., 28, **4**, 21-23 (1999).
19. Sharma et al, Role of industries – R&D organizations and academic institutions in entrepreneurship and technology development. *Proc. National Seminar EDC*, Delhi, India (1994).