DEVELOPING AN ENGINEERING EDUCATION THIRD MISSION
PROMOTING THE DIFFUSION OF KNOWLEDGE AND TECHNOLOGIES
TOWARDS BUSINESS ENVIRONMENT

Borek Sousedik

Abstract - This contribution to the International Conference on Engineering Education, ICEE 2001, explores what the new priorities for engineering education should be, and tries to define broad education policy lines and strategies for engineering education restructuring in the next years. The key concept and principal mover in the concerned area is the concept of innovation and strategies of which the implementation may lead to realisation of the needed restructuring. It is assumed that introduction and incorporation of innovation related programmes into the overall body of university engineering education represent an essential aspect of engineering education restructuring, and a focus on change, as articulated by the IEEE Education Society in the recommendations from the 1994 Report of an NSF Workshop on Engineering Education. The objective is to identify factors that directly influence the functioning of the university engineering education system as one of the key interfaces in the innovation system.

Engineering education innovation policy should embark on implementing new horizontal policy linking traditional structures of the technical university engineering education with new structures for technology transfer required by the knowledge-based worldwide economies. New administrative structures, based on the systemic nature of innovation and technology transfer, should be introduced at the universities. An awareness of the need to develop strategic vision and innovation foresight scenario for the engineering education should be built by the combined effort of university management and leaderships of individual faculties and departments. Development of all-university coordination structures for R&D and technology transfer are crucial, so as to overcome fruitless struggling and territorial thinking among university individual faculties. Regarding innovation and technology transfer, some redefinitions of faculty competencies are needed to ensure meeting the objectives of innovation fostering. In this respect, university management acts as a catalyst to enhance individual faculty policies, measures and initiatives, by performing innovation benchmarking, improving technology transfer regulatory framework, promoting networking and dissemination of good practice at the level of the university. 


CURRENT SITUATION AND EXIGENCIES

Innovation and enterprise require that engineering education and advanced engineering training systems at technical/technological universities are capable of delivering the right skills and attitudes to their students. There is lack of graduates and students with innovation relevant qualifications. The number of students studying innovation-linked subjects is too low. Further development of the links with business is essential in HE sector, together with a positive attitude towards innovation among the academics and in the learning process as a whole. Equally important will be the provision of lifelong learning opportunities, especially in view of the ageing of the labour force and the increasing pace of innovation and change.

There continues to be a lack of cohesion in the sense of wide differences in the performance of individual engineering education universities and the regions they are operating in. The full benefit of the university engineering education networking initiatives will not be realised in the current situation of persistent fragmentation of the technology transfer practices as especially exemplified by the weakness in R&D alliances between universities and enterprise sector. Efforts of university management and regional business bodies should be combined to remedy the situation if the goal of improvement is to be achieved.

The speed with which new technologies flow from the university knowledge base to entrepreneurial application is many-faceted and involves many components - institutional and fiscal incentives to inventors, entrepreneurs and employees, availability of scientific and business skills, supply of suitable capital, predictability of the regulatory framework for confident investment decisions. When all the components are linked, innovation is self-reinforcing. A critical mass of commercially oriented research attracts entrepreneurs. They draw investors and consultants and create favourable condition for the birth of fast-growing, high-tech companies, which in turn are a magnet for new talent and new money.

Shortages of skill and qualified staff emerge as a major obstacle to innovation. Universities should give more attention to lifelong learning to facilitate the assimilation of new technologies. Higher education institutions have an important role in remedying weaknesses, for example providing ICT training for employees in the service sector.
Society has often been reticent about change. The advantages and disadvantages are not always distributed equitably. Engineering education may be instrumental in making both the opportunities and risks of new technologies as transparent as possible. It can take into account the potential economic and social costs of non-innovation scenario, for example in the area of technological innovation to reduce pollution and enhance eco-efficiency. The aim must be to educate a well-informed graduate, capable of mature debate on innovative developments, and not handicapped in discussing innovation, or in applying developments, by a weak understanding of the innovation science and issues as well as the processes of change in general. Technology foresight exercises might serve the purpose to discuss and share views of how the opportunities and impacts of science and innovation influence the future of the regional economy and social organisation structures.

Globalisation has raised the stakes for firms and their need for R&D application and innovation. A good flow of ideas with commercial potential emerging from higher education research represents one of key contributors to such innovation. Only the knowledge-based economy can be competitive worldwide and capable of sustainable economic growth with more and better jobs and greater social cohesion. Innovation should permeate economy of current still nation states and be embraced by their societies for the goal to be achieved.

As a response to the challenges of globalisation and the new knowledge-driven economy, a strategic programme for building knowledge infrastructures, enhancing innovation and economic reform, and modernising social welfare and education systems is to be conceived. A good flow of ideas with commercial potential emerging from university research might prove a key contributor to innovation both locally and in the wider perspective.

Innovation is essential for enterprises to be competitive, and is therefore a major component of enterprise policy, as well as one of the main objectives of research policy. Enterprise and university research and engineering education policies are mutually enriching, notably where technology-based innovation is concerned.

Conditions under which innovations are created and disseminated are shaped by the increasing attention paid to ecological aspects of human existence. Sensitivity to the natural environment is leading to a growing demand for new products and services, which improve efficiency in the use of resources, aid environmental protection, and reduce impact on the climate. As well as helping to secure sustainable development, innovation contributes to the lasting business and job prospectus emerging in this area. Environmental innovation represents a logical province of research and education activities at universities in general and technical universities in particular. This regard might direct the development of agendas for future-oriented engineering education and engineering business activities. Environmentally oriented business activities, as well as related entrepreneurial attitudes of students in the broadest sense, should be fostered and all possible support provided during their studies. Centres of ecological research should be developed at universities, which would add to this specific field and capitalise on its research potential complementing to general innovation policies.

Although technology diffusion and absorption by SME’s have, for some time now, been priority of current innovation strategies, there is still room for significant improvement. In spite of various relevant projects, for example CRAFT, co-operation between firms and universities is still not very well developed. Such development does not necessarily involve only high-tech sector. One of the features of the modern knowledge economy is the increased breadth of knowledge base in all industrial sectors. Knowledge intensification in traditional sectors based on collaboration with universities seems as likely to generate employment and wealth as the emergence of entirely new industries. In the developed economies, traditional industry will be able to compete only by becoming more knowledge intensive. In many industries conventionally regarded as low-tech, many firms innovate by buying new equipment. New technology does not reach them directly from the academic knowledge base but percolates through suppliers and advisory services. For these firms, innovation is not directly founded on research, but on management methods, new business models built on information and communication technologies, invest-ment in new equipment and new skills, and net-working. It is an obvious conclusion that such suppliers may be in the sphere of university spin-off business and consultancy services.

An innovation divide, separating regions according to whether or not they are able to benefit from and thrive in the new information-driven economy, is an emerging danger. To combat this, there is a considerable scope for raising innovation performance by learning from good practices of the same-predicament-regions and trying to bridge the gap between those able to adapt and those finding it difficult to overcome resistance to change and structural obstacles to innovation.

Innovative activity is not a matter just for research, high-tech industry and individual entre-preneurship. Every business sector, in manufacturing and in services, is concerned by innovation, including the traditional industries. Many actions are most effectively conceived at a regional level, since it is at this level that the needs of enterprises and the environment in which they operate can best be assessed. Innovation should become an inclusive phenomenon. It should permeate the economic and social fabric of the region, and concern both traditional and new business.

A more cohesive approach is required in fostering and promotion of cross-border trans-university net-working activities concerning technology partnership, professionalisation of technology transfer and innovation support structures and the diffusion of good practices.
European universities tend to be less open to relationships with business than their counterparts in the United States and the European Union currently proposes to assist European universities to set up a network or association to promote knowledge diffusion and best practices in technology transfer. The year 2001 has been set as the timing for the action.

The knowledge society opens the opportunities for all sectors and firms to be bearers of innovation. The most obvious example is the inclusion of computer electronics and software in an increasing variety of products.

The necessity of extending the standing higher education overall mission for the third dimension, the so called technology transfer (apart from the traditional educational and research dimensions), has been recognised by the authorities of the European Union and the importance of innovation was highlighted by the March 2000 European Council in Lisbon. The European Commission is currently identifying possible supportive measures for action to this effect.

**DEVELOPING THE UNIVERSITY TECHNOLOGY TRANSFER MISSION**

Innovation arises from complex interactions between many individuals, organisations and environmental factors, rather than being a linear trajectory from knowledge to new product. Innovation used to be thought of as an event, a kind of a triumphant discovery. Since the 1980’s, it has been treated as a process from new knowledge to new product. Now the innovation is recognised as neither singular nor linear, but **systemic**. It depends on complex, ongoing interactions between many individuals, organisations and environmental factors. **It is critical that researchers address real social and industrial needs, and that enterprise sector have access to the latest research results.**

Traditional approaches to the generation and use of knowledge should be adapted to the **systemic** vision of the innovative process. To this end, new relationships should be established especially between engineering education universities and enterprises.

In addition to their traditional roles in education and research, universities should develop their third mission: **Promoting the diffusion of knowledge and technologies, especially towards their local business environment. Universities and their research and education programmes should be encouraged to benchmark their activities in technology transfer and partnership with enterprises.**

One of the key interfaces in innovation networks (the other being interfaces between companies and financial markets or advisory services and technological markets) is the interface between university R&D and regional enterprise environment. It is especially effectiveness of this interface functioning that contributes to better grass-root assimilation of knowledge and fruitful diffusion on innovation throughout community.

It is up to technical university management to pick up the challenge of innovation and show their creativity in extracting the maximum innovative benefit for the regional economy development from the university research effort. It is up to Rector’s managerial team to create a friendly environment for starting up and developing innovative businesses that would percolate from the first movers to invigorate the entire regional economic and social fabric.

There should be more coherent career structures for university researchers throughout their working lives. It particularly concerns geographic but also to some extent inter-sectoral (university, industry) mobility of researchers that should be explicitly encouraged.

They might easily stimulate innovation by embarking on strategies of removing legal and to some extent moral obstacles for its development, as well as introducing a variety of measures for innovation fostering and regulative rules for doing business at universities. The latter would in particular concern intellectual property rights of academic researchers and overheads charged to them as related to R&D projects.

**Immediate Objective**

Initiatives by the university management should be embarked upon that would lead to the strengthening and professionalisation of innovation and business support structures and provision of technological and economic intelligence, i.e. the dissemination of information on technological markets available for university research. University overall development strategy should include innovation-enhancing measures so as to organise, at the all-university level, the right environment for a strong university innovation capacity. The immediate objective for the current university academic management is to introduce effective **professional university technology transfer structures**, which would encourage innovation and provide support to academic - student, doctoral, post-doctoral - innovators and potential innovators, through the interface with advisory services and technological markets. What should be done to progress towards this high priority objective?
Main Activities to Be Implemented by the University Management

Summarising the main lines for action, university management acts as a catalyst in enhancing individual faculty policies, measures and initiatives, by benchmarking innovation performance, improving technology transfer regulatory, management and administrative framework, and by promoting networking and dissemination of good practice. University management in particular

- Embodies the promotion of innovation in the overall university mission,
- Encourages development of engineering education and training programmes in entrepreneurship and innovation management at all university levels
- Systematically pursues innovation in specific research programmes of individual university faculties and departments,
- Stimulates and co-ordinates faculty initiatives and faculty actors to participate in devising and implementing integrated programmes for university research and innovation that would take into account the needs of regional business and industry,
- Facilitates the implementation of lifelong learning programmes to improve the general assimilation of new technologies and remedy shortages of skills needed for the future oriented sustainable development of regional economic and social structures,
- Up-grades their innovation management methods and gives a more focused attention, in addition to the traditional missions of education and research, to promotion of the diffusion of knowledge and technologies,
- Benchmarks their action in technology transfer and partnerships with enterprises by relating their technology transfer and networking activities to the activities of other similar institutions in an effort to add a global dimension to these activities.
- Benchmarks university human resources, creation of new knowledge, transmission and application of knowledge, and innovation finance, output and markets,
- Tests methodologies for university assistance to enterprises to assimilate knowledge as a step toward entering global markets.

It is obvious that such action and initiative ask for major revisions of the current university management and organisation structures. It is not easy to expand the traditional HE dual mission of the modern society - education, research - for the third post-modern aspect of technological service to the immediate post-modern environment of the knowledge driven economy and society in which the university operates. It is not easy to ask academics to be practical. A lack of practical-mindedness in a professor character is proverbial and a quality that many academics understand as their species right.

CONCLUSION

The post-modern university asks both for independence and global orientation, as well as close affiliation to local condition and region that mediate realism and counterbalance the abstract character of too broad decision-making process.

The first step is to denationalise the university that does not necessarily means its transfer from public to private ownership but rather dismissing its nationality or national characteristics. University academic freedom is a must, which must be accompanied by economic independence from the national State.

The second logical step is to develop the university third dimension in technology transfer, making it dependent on the demand of knowledge and technology market. Within the knowledge driven economy and information society, the knowledge is increasingly less produced for the sake of university science alone, as the role of knowledge outside the ivory tower of academy is increasingly important and decisive for the welfare of the local community and the State in which communities function.

Refusing to comply with the course of post-modern societal and State organisation change would bring university to the significance margin and degrade its impact to that of secondary education. This is valid for any university. It is twice as valid for technical universities and as a consequence for the engineering education as a whole.

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