TECHNOLOGY, ENVIRONMENT, ECONOMICS, MANAGEMENT: 4 FACTORS OF ENGINEERING EDUCATION IN THE GLOBAL WORLD

Bedřich Duchoň, Veronika Faifrová, Zdeněk Říha[1]

Summary: The history of industrial development was in every stage connected with managerial changes. Future changes might be the change of environment, the change of customers and the change of competition. All these changes will cause quite a different future development of management. The time of looking for new opportunities through information technologies for businesses is coming. New organisations must be able to manage the new opportunities. Technology has been changing the traditional role of an engineer. Technologic operations as designs, prototypes, and manufacture of products, communication services, transportation, shipping, and forwarding have to provide results in a fraction of time. Recent progress in computer and information technology can facilitate the coordination of all activities. For this reason, an engineer must take a broader role in a business; otherwise, he will be in the position of a mere technician. Changes brought by the global economy thus require students to be systematically prepared for taking roles that are more complex at the beginning of their careers.

Key words: Technology, living environment, damage, changes, management, organisation, economics, education, concept, transportation, communication.

INTRODUCTION

The phenomenon of global economy will influence the rapid changes in technology development. Global economy brings new approaches to business thinking and creates a new economic paradigm with changes in corporate culture, in the corporate environment, especially in the requirements of suppliers and customers.

These rapid changes do influence not only the economic system, industry and enterprises, but also the technical education system if it is to fulfil economic needs.

System and multidisciplinary way could help these problems. This approach means that a student in an engineering discipline will become not only an engineer but also a manager. Beside technical and technologic aspects, he or she must also understand social, environmental and political implications of solved problems. In other words, they must do more than design, production or service; they must be involved in all phases of product life cycles while managing a complex system (project) with complex human resources requirements. All these aspects present a challenge for the education system.

[1] Prof. Ing. Bedřich Duchoň, Ph.D., Ing. Veronika Faifrová, PhD, Ing. Zdeněk Říha, PhD., Czech Technical University in Prague, Faculty of Transportation Sciences, Department of Economics and Management, Horská 3, CZ-128 03 Praha 2, Czech Republic, Tel.: +420224359164, Fax: +420224918304, E-mail: duchon@fd.cvut.cz

1. TECHNOLOGIC IMPACTS

Technology is changing the traditional role of an engineer. Technologic operations as designs, prototypes and manufacture of products or services including transportation, forwarding, shipping, and postal services will provide results in a fraction of time. Recent progress in computer and information technology facilitates coordination of all activities. An engineer must take a broader role in a business; otherwise, his profession will be rendered to the role of a mere technician.

In the past and at present, senior engineers who acquired technical education and operational experience (as experience in the Czech Republic shows) have filled these broader roles. These people feature “hard” knowledge such as mathematics, physics, technology, statistics, modelling, and accounting.

They started as young engineers by designs and operational activities, making mistakes and growing up to the position of middle management. Some middle managers continued and worked up through the system, being training in and to develop managerial concepts, communication skills and leadership, but not environmental problems connected with business operations.

Changes brought by global economy thus require students to be systematically prepared for taking roles that are more complex at the beginning of their careers.

Generally, the public views an engineer or an engineering student as a person having good technical and technological skills (for which they are hired) and poor social and environmental skills, and as prospective leaders and managers.

2. ENVIRONMENTAL COMPETENCE

Global economy brings new technologies (e-commerce, telecommunication technology, etc.). In spite of these new technologies, energy and transport sectors remain based on combustion of fossil fuels with energy as a substantial production factor.

Taking into account that today, fossil fuels cover about 70-90% of total world supply and nuclear and renewable energy sources cover the remaining 30-10% depending on a region, we face two problems: environmental impacts of fossil fuels and a possibility to replace these energy sources. Fossil fuels take their current dominant position as our chief source of energy. Discussion on alternative sources concentrate especially on renewable energy: solar, wind, water, and biomass. Renewable sources have their limitations. These limitations necessitate a long-term strategy to find and develop new energy sources and production technologies.

A simple restriction of the use of fossil fuels will generate adequate incentives to develop and use new energy sources, creating abundant new energy technologies that do not rely on fossil fuels. However, it is apparently an unrealistic idea. There are reasons to doubt that changing price relations and thereby incentives to use fossil fuels will bring forth alternative forms of energy in the amounts demanded. The main reason is the fact that fossil

fuels are a concentrated form of energy and other forms, specifically renewable ones, are much slighter.

There are two problems before us: from the environmental perspective, there are global climate changes and damage caused by using fossil fuels, and from the energy perspective, there is a problem how to replace fossil fuels.

3. AN ORGANISATION AND TEAMWORK

There are two problems before us: from the environmental perspective, there are global climate changes and damage caused by using fossil fuels, and from the energy perspective, there is a problem how to replace fossil fuels.

A team is very an important basis of a new organisational structure. Teamwork involves personal and social skills, team creation, interdisciplinary training and conflict solution, encouraging abilities, and maintaining diversity. A perfect working model to study teamwork is to create an education programme including management concepts, as mentioned in the previous part.

Teamwork requires education and training in two areas: technical proficiency and interactive problem solution.

Technical proficiency is a set of elements called “hard” knowledge. Subjects, such as mathematics, physics, engineering disciplines, experimental approaches, data interpretation, system construction, and application, develop proficiency.

On the other hand, effective communication, teamwork, professional, ethical and social responsibilities, professional development, and managerial behaviour can be improved by interactive methods.

4. COMMUNICATION SKILLS

There are two attributes of communication skills: oral and written expression. Each type of reader or listener has different presentation demands (engineers, workers, Members of Parliament, councillors, etc.).

Students have to develop abilities to communicate well both individually and in a team. A student or engineer must be able to formulate and present parts of a solved problem that a team is writing or verbally presenting. It would be useful to train how to choose, develop and employ suitable technical means of presentation.

Education curricula need the integration of communication skills, managerial skills, teamwork, and leadership. An educator would develop the implementation and integration of all disciplines that will engage students in teamwork. The focus is on case studies as a useful part of the education project and an opportunity to get real engineering, managerial, and decision-making problems in the class.

5. MANAGEMENT PERFORMANCE

Global economy will influence the complex role of an engineer in the following sectors: engineering, environmental approach to certain technology, economics, and leadership (managerial behaviour). The system approach to industry and business from the holistic point of view of managerial skills falls into two categories: business (enterprise) management and project management.

Business management is aimed at an organisation to be profitable; therefore needed skills include engineering economy, strategic planning and allocation of human resources, leadership, managerial behaviour, teamwork, marketing, and quality management.

Project management concerns specific projects for which the industrial system has taken responsibility. This subject encompasses planning including possible future environmental problems connected with activities such as design, production, operation, maintenance, and investment.

We must take into account the fact that both approaches are strongly interconnected with a team of educators and industry practitioners from all areas: technology, environmental sciences, economics, quantitative methods, psychology, and sociology. The involvement and interest of industry is very important for training students and educating engineers and managers from participating firms.

6. EDUCATION CONCEPT

The problems discussed in this article can provide a basis for a general idea of a proposal of an education system suitable for engineering students. The main problem is how to get real situations in the class. Recommendations how to broaden skills might include:

- Universities and industry - members of one family,
- Replication of a business whenever possible. Its forms might include a technical presentation, a written or oral work, an analysis beyond technical aspects of a problem, teamwork with a team manager,
- Mentioning business economy together with all solved problems,
- Solution of problems from the point of view of broad skills,
- Elective use of a foreign language in the project,
- Developing non-traditional approaches in traditional programmes,

The demand of customers (from students to industrial clients) influences the education process in the long-term.

Curriculum might consist of several groups of subjects:

1. Science and basic technical subjects,
2. Environmental sciences,
3. Managerial subjects supporting managerial knowledge,
4. Personal development.

The first group of subjects can include courses such as mathematics, physics, computer technology, general engineering and other courses relating to technical faculty tasks.

The second group can include subjects such as environmental damage or environmental management.

The third group, the managerial knowledge base, demands courses such as economics, human resources management, time management, and cost management. Personal development focuses on interpersonal skills, personal skills, and ethics including professional, social, and personal aspects.

One of the possibilities how to bring together all the subjects needed for advanced engineering education is to develop a standard engineering course including elements of environmental sciences, management, economics, teamwork, and communication so that it is possible to prepare very complex case studies.

Such an approach would require advanced presentation technologies. It is a way of economical spending time and money. The main problem, especially for Central European universities, lies in initial investment costs. Another way to prepare the needed courses starts from the curricula of the four groups of subjects described above. The schedule of these courses would be common for all branches of (master) engineering study. Projects and case studies aim at certain engineering specialisations.

7. EXAMPLE OF TRANSPORTATION ENGINEERS´ CURRICULA

Following basic courses for transportation engineering present a practical example of this approach. Facultative ones developing basic knowledge enrich the basic subjects:

1. Transportation and Communication Technologies,
2. Environmental Management
3. Quantitative Methods and Modelling,
4. System Engineering,
5. Information System,
6. Logistics,
7. Economics in Transport and Communication,
8. Management.

CONCLUSION

It is necessary to ensure in global economy and industry that students of technical branches are not only production engineers after their graduation. Economic pressures result in the need for students to develop other value adding skills.

Beside technologic competence, they must feature knowledge such as economics, management, teamwork, communication skills, and leadership. Future engineers-managers will have to be able to solve problems that require knowledge of technology, environmental sciences, economics, management, and public policy.

Changes connected with global approaches in economy could shed light on the education system. In this sense, we remember one name connected with the system approach: Karl Ludwig von Bertalanffy. He was born in the first year of the past century and died in 1972. His challenge for all of us is in his system thinking - how to solve global problems ethically and ecologically.

REFERENCE

(1) FARR, J. V. The Impacts of Technology on Engineering Education. *Journal of Management in Engineering*. November/December, 1996, s. 25-26.

(2) DUCHOŇ, B. Management and Technical Education. In *Workshop 98*. Prague: Czech Technical University, 1998, s. 1049-1051.

(3) DUCHOŇ, B. The Future Changes and Management Education. In *Proceedings of International Conference*. Prague: Czech Technical University, Faculty of Transportation Sciences, 1998, s. 24-27. (in Czech)

(4) DUCHOŇ, B.: Environmental Sciences as a Part of Economics, Management and Technology Education. In: *Proceedings of 6th International AUDES Conference*, University of Venice, 2001, s. 75-79.

(5) DUCHOŇ, B.: Economics, Management and Technical Education. In: *International Conference on Engineering Education.* Ostrava: ICEE´99. ISSN 1562-3580.