



TECHNOLOGY, ECONOMICS, MANAGEMENT AND TRANSPORTATION ENGINEERS' EDUCATION

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Abstract: The history of industrial development was in every stages connected with the managerial changes. The current approach to the future situation is influenced through the following items: the change of environment, the change of customers and the change of competition. All these changes will cause the quite different future development of management. It comes the time of flexible business finding the new opportunities through information technologies. The new organisations must be created to be able to manage the new opportunities. Technology has been changing the traditional role of the engineer. Technology operations as a design, prototype, manufacture of product, communication services, transportation, shipping, forwarding can be provided in a fraction of the time because of the recent advance in computer and information technology. The engineer, for this reason, must take a broader role in business, otherwise will be relegated to the position of technician as profession. To emphasis on profits, the changes coming with the global economy require the education system preparing students for more complex role at the beginning of their careers.

Keywords: Technology, Life Environment, Damages, Changes, Management, Organisation, Economics, Education, Concept, Transportation, Communication.

1. Introduction

Rapid changes in technology development are influenced by the phenomenon called global economy. Global economy brings the new approaches to the business thinking and creates new economic paradigm with changes in the enterprise culture, in its environment, especially in the requirements of suppliers and customers.

These rapid changes do influence not only economic system, industry and enterprises, but also the engineering education system must be changed to economic needs.

The problems must be viewed from a system perspective and be able to deal with multidisciplinary. This approach means that engineering student will become not only an engineer but also a manager. He or she must understand besides technical and technology aspects also the social, environmental and political ones of solved problems. In other words, they must do more than design, production or service, but must be involved in all phases of product life cycles while managing complex system (project) with complex persons. All these

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aspects bring us the challenge for education system.

2. Technology impacts

Technology is changing the traditional role of the engineer. The technology operations as design, prototype and manufacture of product or services included transportation, forwarding and shipping, postal services can be provided in a fraction of the time because of the recent advance in computer and information technology. The engineer must take a broader role in business, otherwise will be relegated to the role technicians as a profession.

In the past and current situation the industry senior engineers who passed technical education and operating experiences have filled these broader roles (e.g. given by experiences in Czech Republic). The background of these people has been based on the hard knowledge as the mathematics, physics, technology, statistics, modelling and accounting.

These persons had started as young engineers and were allowed to design, to operate, to make mistakes and errors and grow in the position of middle management. Some persons of middle management had continued and worked up through the system and were allowed to train and develop managerial concepts, communication skills and leadership, less the environmental problems connected with the business operations.

To emphasis on profit, the changes coming with the global economy require that the education system must prepare student for complex role at the beginning of their careers.

Generally said, the public opinion associates with engineer or engineering student as a person having good technical and technological skills (for these ones is hired), poor social and environmental skills and will be promoted for leadership and management.

3. Environmental Competence

With the global economy the new technologies (internet business, telecommunication technology, etc) have been coming. In spite of these new technologies, energy production and generation and transport sector still remain based on combustion of fossil fuels and energy is being substantial production factor.

If we take into account that today, fossil fuels cover about 70 - 90% of total world supply and nuclear and renewable energy sources the rest of 30 and 10% due to the regions, we are standing before two problems: environmental impacts of fossil fuels and possibility to replace these energy sources. Displacing fossil fuels from their current dominate position as our chief source of energy leads to a discussion of alternative sources, especially renewable energy: solar, wind, water, biomass. Renewable sources have their limitations. These limitations suggest the need for a long-term strategy to find and develop new energy sources and production technologies.

The simply restriction of the use of fossil fuels will generate adequate incentives to develop and use new energy sources, and will create abundant new energy technologies that do not rely on fossil fuels. But it is apparently belief. There are reasons to doubt that changing relation prices and thereby incentives to use fossil fuels, will bring forth alternation forms of energy in the amounts demanded. The main reason is in fact that fossil fuels are concentrated form of energy and other ones, specifically renewable forms, are dilute.

There are two problems before us: global climate changes and damages caused by using of fossil fuels and energy problem how to replace the fossil fuels which are relatively abundant by no acceptable energy.

4. Organisation and Teamwork

Team is very important base of new organisational structure. Teamwork involves personal and social skills, team creation, interdisciplinary training, conflict solution, encourage ability and to maintain diversity. To create education programme of management concepts, as has been mentioned in previous part, is a perfect working model for the study of teamwork.

The teamwork is connected with two problems of education: technical proficiency and interactive problem solution.

Technical proficiency is one of set elements called the hard knowledge. This proficiency can be demonstrated through such subjects as mathematics, physics, engineering disciplines, experimental approaches, data interpretation, system construction and application.

Interactive method can be demonstrated through effective communication, ability to work together with a team, professional, ethical and social responsibilities, professional development, managerial behaviour.

5. Communication Skills

There are two attributes of communication skills: oral and written expression. The presentation in both cases must be tailored to certain level of readers or listeners. The broad spectrum from engineers to workers or different members of parliament or municipal boards, etc.

The student must be supported in his/her abilities to communicate well alone or in groups. The student or engineer must be able to formulate and present parts of solved problem that a team is writing or verbally presenting. It would be useful to train how to choose, to develop and to employ the suitable technical means of presentation.

Integration of communication skills, management skills, teamwork and leadership into curricula is also needed. Educator would develop implementation and integration of all disciplines that will engage students in teamwork. The focus must be aimed at case studies as a useful part of education project and the possibility how to get the real engineering, management and decision problems to the classroom.

6. Management performance

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

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

Project management is connected with specific projects, in which an industrial system has taken the responsibilities. This subject includes skills as planning including possible future environmental problems connected with the next activities as design, production, operation, maintenance and investment.

We must take into account the fact that both approaches are very close connected with team of educators and industry participants from all areas: technology, environmental

sciences, economy, quantitative methods, psychology, sociology. It is very important the involvement and interest of industry to help to train students and to educate the engineers and managers from participating firms.

7. Education concept

The problems discussed in this article can provide the base for general idea of proposal of education system suitable for engineering students. The main problem is in fact how to get real situations to the class. The recommendations that could better serve to broaden skills might include:

- Universities being involved with industry.
- Replication of business whenever is possible. It can be used technical presentation, written or oral work, analysis beyond the technical aspects of a problem, teamwork with team manager.
- Introducing business economy in all solved problems.
- Solution of problems from the point of view of broad skills.
- Making a foreign language a viable elective in the project.
- Developing non traditional approaches in traditional programmes.

In the long term, the education process will be influenced by demand of customers (from students to the industry client). The education system must be reengineered and changed with the respect to the differently teaching.

The student profile can be presented by the several groups of subjects who might be divided to the following groups:

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

First group of subjects can include such courses as mathematics, physics, computer, general engineering and other courses relating to the engineering faculty tasks.

Second group can include such subjects as damages of environmental life or management of life environment.

Third group is connected with the management knowledge base and is devoted such courses as economics, resource management, time management, cost management. Personal development is oriented to the interpersonal skills, personal skills and ethics including professional, social and personal aspects.

One idea how to bring together all subjects needed for advance engineering education is to develop a standard engineering courses including elements of environmental sciences, management, economics, teamwork and communication so that through this approach is possible to prepare very complex case studies.

For such approach would be necessary to use advance presentation technologies. It is very economic way how to spend time and money for institution. The main problem especially for Central European Universities is in beginning investment cost. Second way how to prepare needed courses could be based on the curricula the four groups of subjects above describing. The schedule of these courses would be common for all branches of

engineering (master) study and would be finished by case studies from certain engineering specialisation.

8. Example of Transportation Engineers' Curricula

Practical solution of this approach for transportation engineering can be presented through the following courses as a basic disciplines. Other facultative ones that would develop the 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.

9. Conclusion

The new ways in global economy and industry is to provide that engineering students after their graduation will be more than only production engineers. The economic pressures result in the need for students to point at the work place with other value adding skills.

It must be to take into account besides technology competence the knowledge as an economics, management, teamwork, communication skills and leadership. The future engineering managers will be able to solve problems that require integration of technology, environmental sciences, economics, management and public policy.

The changes connected with the global approaches in economy could bring light to the education system. In this sense, it can be remembered one name connected with system approach: Karl Ludwig von Bertalanffy. He was born in the first year of past century and died in 1972. His challenge for all us is given by his system thinking how to solve ethically and ecologically the global problems.

Reference:

- [1]: FARR, J.V. *The Impacts of Technology on Engineering Education*. In: Journal of Management in Engineering. November/December, 1996, pp. 25-26.
- [2]: DUCHON, B. *Management and Technical Education*. In Workshop 98. Prague: Czech Technical University, 1998, pp. 1049-1051.
- [3]: DUCHON, B. *The Future Changes and Management Education*. In Proceedings of International Conference. Prague: Czech Technical University, Faculty of Transportation Sciences, 1998, pp: 24-27. (in Czech)

- [4]: DUCHON, B.: *Environmental Sciences as a Part of Economics, Management and Technology Education* , In: Proceedings of 6th International AUDES Conference, University of Venice, 2001, pp.75-79
- [5]: DUCHON, B.: *Economics, Management and Technical Education*, International Conference on Engineering Education, ISSN 1562-3580, ICEE'99 Ostrava,1999