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Models of engineering education

Wojciech Zieliński

Silesian University of Technology
Gliwice, Poland

ABSTRACT: The paper defines the position of higher technical education within the structure of the higher education system in Poland. The analysis is based on the model of engineering assignments and the teaching strategies for future engineers in the traditional educational system have been defined. New trends involving the education of future engineers are presented in the article. Greater emphasis has been placed on training in the field of management, following an analysis of market demand. In this respect, developments at the Silesian University of Technology (SUT), Gliwice, Poland, are also shown.

THE POLISH EDUCATION SYSTEM

The educational system in Poland offers the opportunity to study at the following types of schools:

- Universities;
- Universities of technology;
- Pedagogical high schools;
- Agricultural high schools;
- Academies of economics;
- Academies of medicine;
- Physical education high schools;
- Universities of art.

A very distinctive segmentation is currently taking place within Polish higher education; this is based on the *branch of sciences*. Poland has technical courses at technical universities and that segmentation determines the activity of high schools, where the principle distinctive feature involves the introduction of different syllabi.

After the so-called Industrial Revolution of the 19th Century, the development of industry helped to generate the foundations of a technical university, its structure and syllabus, which still exist to this day. This also created a certain vision of a graduate whose basic criteria, in so as far as quality of education was concerned, included professionalism, which was understood as a thorough knowledge of a certain part of a technical field.

ENGINEERING TASKS

The model of engineering tasks could be presented on the basis of a concept of *a process of satisfying the needs* formed by Prof. J. Dietrich of the Silesian University of Technology (SUT), Gliwice, Poland [1].

The entire enterprise leading to the possibility of using the product or technical means can be seen as a logical sequence of assignments. This sequence includes the following key aspects:

- Recognition of needs;
- Design;
- Construction and the working out of relevant technology;
- Production;
- Exploitation.

This can be represented in a circular diagram, as illustrated in Figure 1.

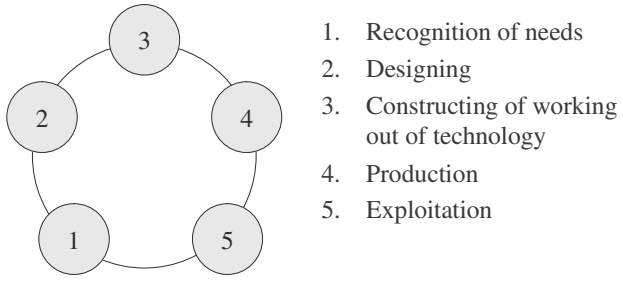


Figure 1: Circular model of engineering tasks.

The sequence of tasks presented above highlights only the basic and primary relationships between the particular key tasks, which combine elementary components of the needs involved in the recognition process. However, during the manufacture of a product or technical means, there must also be a level of information feedback, which would ensure that there is sufficient influence over particular stages of the enterprise.

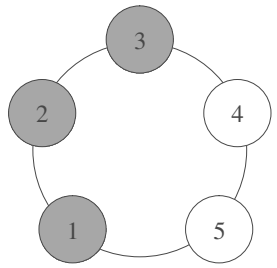
As educators, we must be aware of the fact that technical means occur in all phases of the design process. Yet at the stage of needs recognition, design or consultation, technical means exist as an abstract element; in each of the following phases, it occurs in an increasingly detailed form.

The last and conclusive stage of the abstract existence of technical means or product exists as a record of the construction or devised technology. In the fourth phase, or production process, the product assumes real shape created on the basis of the construction record or technological process. Obviously, the first model might not have all of the features that may be expected initially. Therefore, feedback from previous phases is necessary in order to introduce the required corrections.

The applicability and usefulness of a ready-made product can be tested in the exploitation phase, where it is subjected to certain processes (wear or aging). In the exploitation phase, the influence exerted on the product or technical means should bring about the possibility to determine its longest period of utilisation, which is connected with maintenance, adjustment, technical survey, overhauls and repairs of existing defects. The conclusions drawn from the exploitation process create the grounds for innovation of the product or technical means, which establishes a strong connection between the first and fifth phases of the enterprise. It also instigates technical progress that, in turn, leads to the manufacture of better, more reliable and cheaper products.

Thus, engineering tasks could be divided into three groups as shown in Figure 2, and are comprised of:

- Design-construction-technology tasks, which are covered in Groups 1, 2 and 3.
- Production tasks, which are covered in Group 4.
- Exploitation tasks, which are covered in Group 5.



A. Design- construction-technology tasks.
B. Production tasks.
C. Exploitation tasks.

Figure 2: Engineering specialisation.

The increasing complexity of engineering tasks has resulted in a considerable narrowing of engineering specialisations. Therefore, technical universities educate students who seek to become construction engineers (designers), engineers who specialise in production and those who specialise in the exploitation of technical means.

THE SILESIAN UNIVERSITY OF TECHNOLOGY

The Silesian University of Technology (SUT) is one of the largest technical universities in Poland, where students are taught in 10 faculties and have the choice of some 30 courses that offer professional knowledge in practically all branches of engineering.

SUT Register

The register of faculties and disciplines at the SUT is listed as follows:

- Architecture
  - Architecture and town planning
- Automatic Control, Electronics and Computer Science
  - Automation and robotics
  - Electronics and telecommunications
  - Computer science
  - *Macrodiscipline in English*: automation and robotics, electronics and telecommunications, computer science
- Civil Engineering
  - Civil engineering
- Chemistry
  - Chemical technology
  - Chemical engineering and apparatus
  - Management and production engineering (A)
- Electrical Engineering
  - Electrical engineering
  - Electronics and telecommunications
- Mining and Geology
  - Mining and geology
  - Management and production engineering (A)
- Power and Environmental Engineering
  - Environmental engineering
  - Mechanics and machine construction
- Mathematics and Physics
  - Technical physics
  - Mathematics
- Mechanical Engineering
  - Automation and robotics
  - Mechanics and machine construction
  - Management and production engineering (A)
- Material Science, Metallurgy and Transport
  - Material engineering
  - Metallurgy
  - Transportation
  - Management and production engineering (A)
- Organisation and Management (B)
  - Management and marketing (B)

- Sociology (A)
- Management and production engineering (A)

Another result of the growing complexity of engineering tasks has been the employment of large technical means and groups of people to solve such tasks. Obviously, it is necessary to manage and coordinate these tasks. So far, the ability to manage in the area of technology has resulted from individual predispositions, professional experience and intuition. Consequently, natural selection has been a long lasting process and achieving a high-level position has been possible for older candidates.

Management Skills

The growing demand for specialists who have both engineering skills and management abilities has changed the image of an engineer's role in the process of production.

A few years ago, the Silesian University of Technology established the Faculty of Business Administration and Management in order to meet the demands of the market; this made it the eleventh faculty of the University. This new Faculty introduced management problems into engineering studies, which modified typical engineering courses.

The course in Managing and Engineering Production has been introduced in the majority of faculties at the SUT because of the market demand. This course provides students with studies in the most important elements of management and is offered in conjunction with students' engineering education.

The most important elements of management include the following:

- Definition of strategies;
- Organisational structures;
- Realisation of activities:
    - Assignment planning;
    - Organising and realising assignments;
    - Motivating employees;
    - Controlling the completion of assignments.

CONCLUDING REMARKS

The knowledge in the field of management gives contemporary engineers additional opportunities so far as their activities are concerned and helps them adapt to the changes that are taking place in industry.

On the other hand, the changes that take place in the world also affect universities, especially technical universities, in that they can stimulate and modify the process of engineering education.

REFERENCE

1. http://www.polsl.gliwice.pl/