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3.3 EFFECTIVE TEACHING OF MANAGEMENT SKILLS AND MODELS

Summary: Effective teaching of engineering economy, general management, management models and skills basically influence the future activity and success of engineering managers or industrial engineers. Engineering economy requires a coupling of technical analysis and economic feasibility to determine the optimal course of action for various engineering scenarios. The rational time, resource and cost planning, the correct decision-making process and the selection of the optimal versions are essential in case of an investment. The first aim of this paper is to present and prove how the different disciplines, management models and information technology can support the solution of technical-economic tasks in agriculture or industry. Some of the most important scientific areas, skills and models which are taught for our students will be briefly presented.
Effective teaching demands more than the acquisition of different skills. To adapt to the educational needs of a particular major, the teacher needs to understand the theory of learning and teaching, so that every teacher can develop his or her own methods. There are a lot of teaching methods in education to inspirit students for individual learning. The second aim of this paper is to characterize these teaching methods in engineering management educational programmes based on special literature and gathered experiences.

Keywords: functional management areas, project management skills, teaching methods

1. INTRODUCTION

Engineering managers' professional knowledge is very important, which means a deep theoretical background and practical skills in agriculture, industry or services. The technological knowledge is also important because technical resources and equipment play an important role in the whole producing or manufacturing process. All of these are really necessary, but not enough to manage a company or a complex project successfully, because economic and general management knowledge is also badly needed.

Management skills and the use of up-to-date management models basically influence the activity and future success of young engineers. There is an increasing need to use different types of software for the rational resource and cost management, the appropriate utilization of machinery, the correct decision making in investments and select the optimal version (Belcourt et al., 2000).

The first aim of this paper is to present and prove how the different methods and computer programs can support the solution of technical-economic tasks in agricultural or industrial projects. A detailed knowledge of general management is really useful, but a wide-range of functional management areas are also have to be known. All of these functional areas have different characteristics and an experienced industrial manager has to know most of them. In case of a small company or project these functional management areas are not separated, they usually appear as complex tasks. It is not easy to list the most important functional management areas because they are all necessary, but in this paper seven of them are examined.

The effective teaching and improving of these management skills are important tasks. It is especially difficult in the basic (graduate) level of studies when the students do not have enough experiences in managing and completing projects (Hartman, 1999). In the different courses it needs different approach, teaching methods and case studies. One of the important goals of education and training is to help students develop the ability to continue learning

after their formal education is complete, thus it is reasonable that they should have supervised experience in learning independently. They should gain experience in which the instructor helps students learn how to formulate problems, find answers, and evaluate their progress themselves. We might expect the values of independent study to be greatest for students of high ability with a good deal of background, since such students should be less likely to be overwhelmed by difficulties. Beside this, motivation and work habits are also very important (McKeachie and Svinicki, 2010).

The second objective of this paper is to characterize these teaching methods in engineering management education based on the overviewed special literature and on the gathered data and experiences from our colleagues and students.

2. MATERIALS AND METHODS

"Engineering Management" or "Industrial Management" is a relatively modern teaching programme (major) in Hungary. On our Faculty it has a ten-year history. This major provides complex knowledge and skills for the students. Comparing the different Hungarian and international curricula of the different engineering teaching programmes and courses it can be stated that the widest knowledge in engineering economy and in general and functional management is provided for engineering managers. The staff members of our Institute have been teaching different engineering students for more than thirty years.

Several teaching methods are used in our education to inspirit students for individual learning. I examined the project method and, within problem-based learning, the case method and simulations. Our colleagues have overviewed hundreds of syllabuses of several different courses (life-science, engineering, economy, management) and staff members and engineering management students were interviewed to find the correct answers for the following questions:

- Do our colleagues use project method to help students to prepare for independent study?
  - Do students have a clear question, problem or goal?
  - Can the methods help students to develop their strategic learning?
  - Do students get feedback on their progress from supervisor and fellow students?
- Is case method used in a wide variety of disciplines?
  - Is the given problem well clarified?
  - Do students develop hypotheses about the causes of the problem?
  - Are there conclusions and recommendations?
- Are computer simulations more effective in teaching research methods than traditional "wet labs" are?
  - Are students active participants rather than passive observers?
  - Do students make decisions, solve problems and react to the results of their decisions?

3. RESULTS AND DISCUSSIONS

3.1. THE IMPORTANCE OF DIFFERENT SKILLS

The educational program of the engineering management students consists of three main parts, life science, technical science and human and social science. These scientific areas provide the complex knowledge of our students. The different skills of engineering managers basically influence the successful running of a company or the final result of a certain project. Managing an agricultural farm or project is a very complex task with really different activities, technologies and responsibilities. Planning of the strategic goals and the

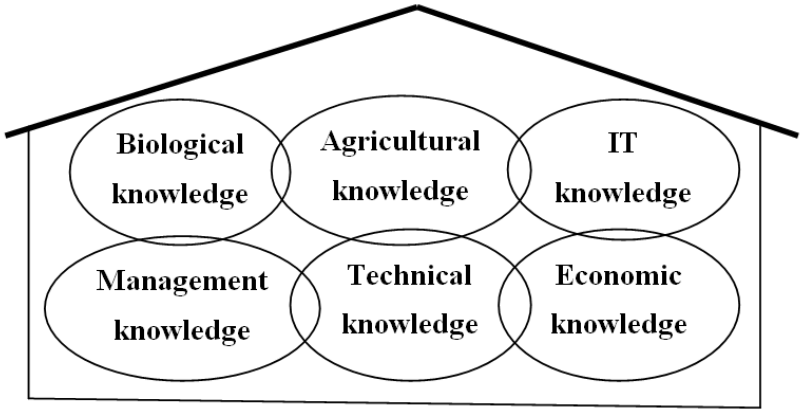
organization of the operative tasks all need theoretical knowledge, skills and experiences. The results of innovation appear continually in agriculture. New materials (chemicals, seeds), technical equipment (harvesters, cultivators) and modern devices (GPS, robots) force experts to use up-to-date farming technologies. It requires more time and knowledge to learn the rational operation of the machine park – according to the rapidly changing environmental law – which means a hard task for the managers. There is a great number of difficult decisions have to be made concerning technical resources, when we choose, buy or lease them. Applied information technology must be also mentioned as an important area. Without this basic knowledge it is impossible to make the optimal decisions.

All of these are necessary, but not enough to manage an agricultural enterprise successfully. Engineering and general management knowledge is also needed, the most important areas are strategic-, marketing-, cost- and machinery management. Management skills and the application of the different management models determine the activity and long term success of the agricultural company or the planned project (Goldratt, 1997).

It is really difficult to learn and obtain all these skills because these scientific areas are rather different (Figure 1). One has to have a wide range of interest to learn all of them.

- The *science of biology, chemistry and agriculture* can be interesting for those who are really close to nature and environment. Mostly these students like animals and rural life, but they are not fond of machines, engines or the marketing mix. They do not like managing people either.
- *Technical science* is really hard to learn. Mathematics, physics, mechanics, technical drawing, computer aided design, the operation and repair of machines are the basic courses. They usually like engines, vehicles, industrial equipment and the connecting activities very much, but they are not necessary close to nature and do not like applied economics and management at all because they consider them as unnecessary subjects.

Figure 1. Specific knowledge to manage agricultural farms and projects



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- *Information technology* is again a very special scientific area which one has to like and understand. Our IT students – based on their answers – are not fond of technical solutions and they do not like nature or agriculture. Managing people or organizing real life activities seem to be very complicated for them.
- *Economics and management* is popular today. Many young people choose this field of science all over Europe. They learn macro- and micro-economics, law, finance, marketing, tourism, rural development, etc. Most of them like it because it seems to be interesting for them and they try to become well paid managers of multinational companies as soon as

possible. They mostly do not like agriculture or they are not fond of machines except their own cars.

The level of personal motivation to obtain this complex knowledge is changing on a wide range. The student's family background, previous studies, personal characteristics and skills play important role in motivation.

3.2. THE ROLE OF MANAGEMENT KNOWLWDGE AND SKILLS

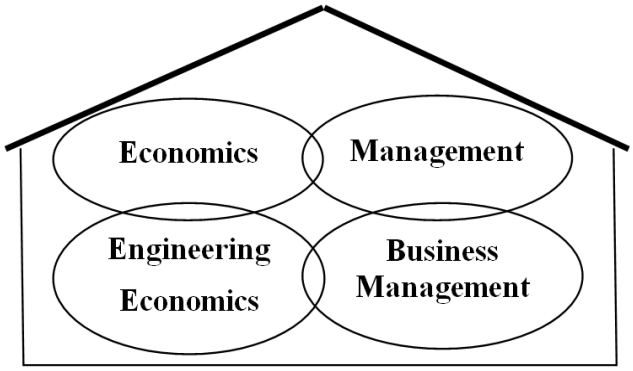
Economics and general management provide a solid theoretical background. Microeconomics include theory of demand, theory of the firm, demand for labour and other factors of production. Macroeconomics covers the forecasting of national income the analysis of major economic factors the role of fiscal and monetary policies, economic growth and determination of consumption and investment levels. General management studies can cover the practice of management, approaches to management, organizations, delivering change, enhancing customer relations, enabling continuous improvement (*Figure 2*).

Engineering economy is the discipline concerned with the economic aspects of engineering; it involves the systematic evaluation of the costs and benefits of proposed technical projects. The principles and methodology of engineering economics are an integral part of the daily management and operation of different companies, government units or agencies.

The obtained principles are utilized to analyze alternative uses of financial resources, particularly in relation to the physical assets and the operation of an organization (Sullivan, et al., 2011).

Business management provides students with the tools they need in order to launch and manage a business successfully. Building the business plan, beginning considerations, marketing and financial considerations, sources of funds, managing inventories, controlling and managing people are the most important topics. Business management can be a useful synthesis of the different management areas (Scarborough, 2008).

Figure 2.: Specific knowledge of economics and management



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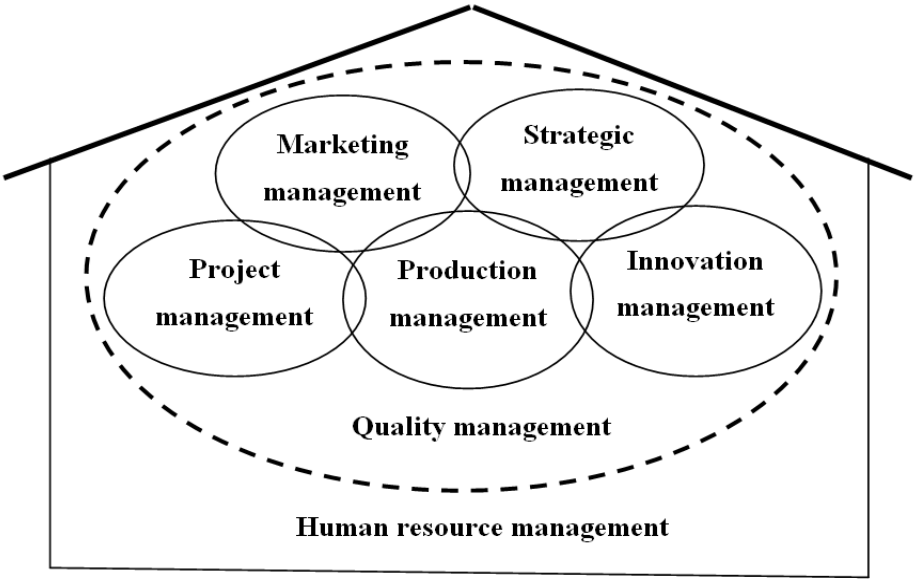
A deep knowledge of general management is really useful, but a wide range of functional management areas also play important role. All of these areas have different characteristics and an experienced manager or project manager has to know most of them. In a case of an agricultural project these functional management areas are not separated, they usually appear as complex tasks. It is not easy to determine the most important functional management areas because they are all necessary, but the following seven of them are taught for engineering managers on our basic and master levels (see *Figure 3*).

Some typical techniques and methods concerning the following functional management areas are also listed in brackets:

- *Marketing management:* Students mostly like this course and they consider that it is useful for them. Agricultural and industrial marketing aspects are also covered. Market segmentation, targeting and positioning, product strategy and new product development, distribution strategy, industrial marketing communication and planning are the most relevant topics. (e.g. marketing mix, PEST analysis, MABA analysis)
- *Strategic management:* Hungarian enterprises do not pay much attention to strategic planning which makes their situation hard in a crisis. This course is taught on MSc level. Students have to learn the theoretical background and the practical application of different management models to analyze the factors associated with customers, competitors and the company itself. All of these can provide the basis for maintaining optimum management practices. (e.g. SWOT analysis, BCG, GE Mc Kinsey, 7-S framework, Benchmarking, Business process redesign)

Figure 3. Functional management areas (Kocsis et al., 2002)



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- *Project management:* Engineering management students learn it on a BSc and MSc level, they mostly enjoy the classes. The three primary forces behind project management are the growing demand for complex customized goods and services; the exponential expansion of human knowledge and the global production-consumption environment. Project management, though not problem-free, is the best way to accomplish certain goals (Meredith and Mantel, Jr., 2000). (e.g. Gantt-chart, CPM/PERT, WBS)
- *Production management:* Students find some parts of the course material really hard to learn and understand but they do think that they need this knowledge. Our students have to learn to coordinate and control the various activities required to make a product or a service. The curriculum covers effective control of scheduling, cost, performance, quality and waste requirements. They have to examine the key international issues, new technologies and the financial side of product management (Gorchels, 2005). (e.g. Activity-based costing, MRP, TQM, JIT, Lean-thinking, Six sigma, FMS, CIM)
- *Innovation management:* Managing innovation is challenge in any organization and demands a wide range of skills. Engineering management students mostly find this course interesting and most of them understand why they have to learn it. Some groups of

students learn it as "Technical Development" that is part of innovation management. In business, innovation often results from the application of a scientific or technical idea in decreasing the gap between the needs or expectations of the customers and the performance of a company's products or services (Goffin and Mitchell, 2010). (e.g. Brain storming, Road-mapping, Innovation circle, Philips-66, Delphi)

- *Quality management:* Many of our students write their theses about this topic, spend their professional practice or work after graduation on this special field. Quality in the different size of organizations can be achieved with intelligent use of various concepts, principles, tools and techniques. For students coming to the subject for the first time, these philosophies associated with quality management can be quite overwhelming. The curriculum covers the basic concepts of quality and quality management, the ISO regulatory frameworks, the ways of thinking about quality and achieving quality. Managing quality in practice using the process approach (Hoyle, 2012). (e.g. PDCA, Kaizen, Root cause analysis, Pareto analysis, Poke-Yoke, QFD, EFQM)
- *Human resource management:* Managing people as human resources is essential in agricultural and industrial companies of all sizes and types. As our former students – engineers and engineering managers – reported their professional difficulties basically originates from managing people. As part of the business management studies the curriculum covers the following HRM functions:
  - Strategic HR management.
  - Equal employment opportunity.
  - Staffing.
  - Talent management.
  - Total rewards.
  - Risk management and worker protection.
  - Employee and Labor relations.

Strategic management and human resource management are the weakest fields of the Hungarian companies. Top management often forgets that "People as human assets are the "glue" that holds all the other assets, such as financial and physical ones, together and guides their use to better achieve results. As a field, HRM is undergoing significant transformation. Human resource management is designing management systems to ensure that human talent is used effectively and efficiently to accomplish organizational goals" (Mathis and Jackson, 2010). *(e.g. Strategic human capital planning, Competing values of organizational effectiveness, Six thinking hats of de Bono)*

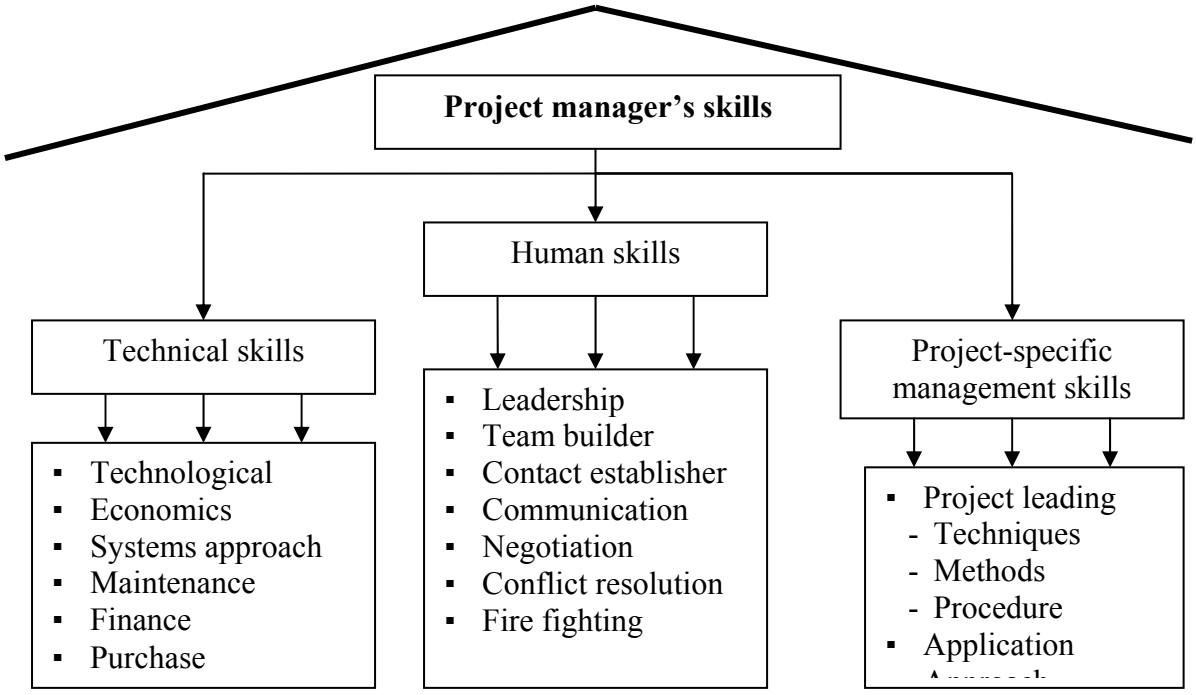
There are two further management areas information and change management. These very important subjects are mostly taught as parts of the General Management course in some related postgraduate teaching programs.

Information management is also about the application of various management techniques to collect information, communicate it within and outside the company and process it. *Change management,* within a few classes we teach about the role of managers, how to minimize resistance and how to avoid critical mistakes during change.

3.3. SPECIAL DEMANDS ON THE PROJECT MANAGERS

Project management is a special bridge between strategic and production management. That is why it has special techniques, methods, approach and requires special skills as well. Relying upon Görög's (2006) findings Figure 4. shows the structure of management skills.

Figure 4. Project manager's skills



Source: own construction (based on Görög, 2006)

A number of demands are unique to the management of projects, and the success of the project manager depends to a large extent on how capably they are handled. These special demands can be categorized under the following three headings.

3.3.1. Technical skills

Technical knowledge the project manager (PM) is not expected to have an expert's knowledge of each of the technologies that may be germane to the project. The PM should be able to explain the current state of the project, its progress and its problems to senior management. He should also be able to interpret the wishes of management and the client to the project team.

Systems approach to be successful the PM must adopt the system approach. The project is a system composed of tasks which are, in turn, composed of subtasks, etc. The system, a project, exists as a subsystem of the larger system, a program that is a subsystem in the larger system, a company, which is…etc. The PM must understand the influences and their impacts on the project and its deliverables.

Maintenance means actions necessary for retaining or restoring machines and equipment to the specified operable conditions to achieve their maximum useful life. It includes corrective and preventive maintenance. Many minor technical difficulties occur, always at inconvenient times, and need to be handled rapidly.

3.3.2. Human skills

Communication, the PM must be a person who can handle responsibility. The PM is responsible to the project team, to senior management, to the client, and to anyone else who may have a stake in the project's performance or outcomes. Much project communication takes place in meetings that may be run effectively if some simple rules are followed. In virtual projects much communication is via high technology channels. Above all, the PM must keep senior management informed about the current state of the project.

Negotiation, the acquisition of resources requires negotiation. Dealing with problems, conflict, and fires requires negotiation and conflict resolution. The same skills are needed when the PM is asked to lead the project to a successful conclusion – and to make the trade-offs required along the way.

Fire fighting, should be organized so that fires are detected and recognized as early as possible. This allows the fires to be assigned to project team members who specialize in dealing with specific types of fires. Although this procedure does not eliminate crises, it does reduce the pain of dealing with them.

3.3.3. Project-specific management skills

Techniques for new PMs, training in win-win negotiation is as important as training in PERT/CPM, budgeting, project management software, and project reporting.

Methods several different management methods are used by PMs in strategy oriented project management one of them is the WBS.

A project manager without these skills cannot be successful. In addition, the PM should be a leader, and adopt a participatory management style that may have to be modified depending on the level of technological sophistication and uncertainty involved in the project. Another critical project management skill is the ability to direct the project in an ethical manner (Meredith and Mantel, 2000).

3.4. THE ROLE OF EDUCATION

The large scale of different skills listed above have to be taught for future managers. Our colleagues usually pay much attention to use the different teaching methods to teach engineering manager students during their university studies.

3.4.1. Project method

The student who completes a project often has a sense of mastery going well beyond that of completing a conventional assignment. Students working on a project have to solve real problems and to use their knowledge in new ways – characteristics of learning situations that both motivate and facilitate more lasting learning.

Projects sometimes fail to work well. *What can be done to increase the probability of success?*

- Be sure the student has a clear question, problem, or goal.
- Help students be explicit about the strategies they plan to use, about their time management, and how they will monitor their progress.
- Have students compare notes and get feedback on their progress from fellow students.

3.4.2. Case method

Teachers can write his/her own cases, but one can find cases already written that are appropriate for given purposes and are motivating for the students. Typically case method involves a series of cases. One of the goals of the case method is to teach students to select important factors from a tangle of less important ones which may form a context to be considered. Usually cases are presented in writing, digital video disk or role-play of a problem situation can be used.

Before assigning the case study, *the following aspects should be clarified*:

- What is the problem?
- Develop hypotheses about what causes the problem?
- What evidence can be gathered to support or discount any of the hypotheses?
- What conclusions can be drawn? What are the recommendations?

When the teams report, the teacher's role is primarily to facilitate discussion, i.e. listening, questioning, clarifying, challenging, encouraging analysis and problem solving, and testing the validity of generalizations. He/she can make a summary of points established, additional information needed, and the evidence supporting alternative approaches.
If the case is one that actually occurred, students will want to find out what actually was done and how it worked out. Sometimes the teacher might bring in someone working in the field so that students cannot only see how an expert analyzes the case, but also ask questions about what really happens in practice (McKeachie and Svinicki, 2010).

3.4.3. Simulations

Many simulations are available on computers. Research and laboratory simulations are available for courses in the sciences, and interactive social simulations can be used to teach foreign languages. The effectiveness of simulations depends on the degree of instructional support or structure. Research on traditional as well as non-traditional teaching has shown that students with low prior knowledge tend to benefit from a higher degree of structure than students with greater knowledge or intelligence (Cronbach and Snow, 1977)

Simulations sometimes fail to work well, *the following aspects should be taken into consideration*:

- What is the complexity of the simulation like?
- Does the simulation fit the time and facilities limitations?

The applied simulation may be either too simple or complex to achieve the kind generalization of concepts or principles that the teacher desires. It can be hard to find a simulation that fits the time and facilities limitations of typical classes. Devising someone's own simulation can be fun but also time consuming (McKeachie and Svinicki, 2010).

Based on our experiences we can state that students coming from grammar schools after graduation are usually used to have some alternative teaching methods, such as project methods or case studies. They learn how to work with other students in groups, and how to present their findings. These methods make education a lot more interesting and fascinating. Without these, the traditional lecture-discussion education at the university level seems less interesting and motivating for them. University lecturers have to make a lot of effort to raise the students' attention to the course material as effectively as they can. Not only to inspire them to attend their courses but also to have them to pay attention while they are on lectures. According to our experiences these teaching methods are not so commonly used at our university. Problem-based learning is more often applied in master courses. If our master students are to learn how to think more effectively, they need to practice thinking.

Beside applying the different teaching methods it is a difficult task to develop or create a new teaching material. When developing some parts of the curriculum or course syllabuses the following **"***5 Ws+H"* method can be used (Table 1).

Table 1. How to follow the "5Ws+H" method?

What is the question?		**What is the answer?**
WHOM?	**do we have to teach?**	Engineering manager students
WHAT?		Courses/subjects/knowledge/skills…
WHEN?		BSc/MSc/PhD levels, year, semester…
WHERE?		Classroom/lab/field/workshop/internship…
WHY?		The objective of the course/knowledge/skills…
HOW?		Teaching methods: traditional/project/case method…

Source: own research

Our faculty members have to renew the course syllabuses year by year. The content of the above listed subjects like economics and general management, enterprise, innovation, marketing, production, quality and project management have changed a lot after the transition. New subjects appeared and a wide range of management techniques, methods and new special software have become part of the curriculum. Economics and management is a rapidly developing scientific area, thus the continuous improvement is essential.

Our students have to write special assignments and we ask them to work in teams. We teach the basic rules of teamwork and try to apply the problem solving in practice. During the summer time our students spend some weeks in a company dealing with professional tasks and real problems. They gain a general overview about the material flow and about the management tasks of the organization. They spend some time on the different departments and work with the technical managers. By the end of the practical period they have to write an assignment or their theses.

We also offer short term postgraduate courses in a wide range of topics. It can be connected to a certain functional management area or to a management technique, method or software package. The teaching method is usually different for them, because after a short theoretical background they get a really practical oriented case study or a special training developed for the daily need of the company. Education and training are very important, but they cannot substitute practice and experience.

4. CONCLUSIONS

Successful business or project management requires experienced managers with different knowledge and skills. In the case of an agricultural farm or project the degree of complexity is even higher because technical, agricultural, biological, IT, economic and management knowledge and skills are really essential.

In the frame of this paper, I proved the importance of the different skills and I have briefly characterized the main (seven) functional management areas which are taught for our engineering manager students. Project management is a bridge between strategic and production management and it plays a very important role in technical development. I have listed in a structured way the project manager's skills. Our students and the future project managers have to learn the related techniques, methods and the use of professional software. A young manager without - at least - the basics of these skills cannot be successful in managing projects. An experienced project manager should be a leader and has to direct the project in an ethical manner.

On our Faculty, well trained teachers use project method, case method or simulations. These effective teaching methods are valuable parts of their teaching strategies. The general principle is that students like to solve problems that offer a challenge but are still solvable is important. Motivation is not the only reason to use problems. If students are to learn how to think more effectively, they need to practice thinking. Moreover, knowledge learned and used in a realistic, problem-solving context is more likely to be remembered and used appropriately when needed later.

Based on our experiences it can be stated that our students coming from grammar schools after their graduation are usually used to have some alternative teaching methods. They learn how to work with other students in groups, and how to present their findings. When our staff develops a running course or create a new course syllabus for our students, they are recommended to use the "5 Ws+H" method.

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