Learning for Life—PBL in Continuing Education*

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This paper describes a Master's Program on Management of Technology (MMT) at Aalborg University. The program is a post-experience education focusing mainly on engineers with more than three years of practical experience. The idea underlying the division of the MMT program into four terms is primarily to create an understanding of strategy and strategic challenges (first term) and to relate these to organizational options and challenges (second term). Subsequently, the program strives to ensure a basis for holistic planning of corporate development. During the third term, focus is on planning of corporate development, and during the fourth term managerial aspects in connection with implementation are addressed. As a part of the curriculum at Aalborg University the program is designed as a problem-based and project-based learning initiative.

Keywords: problem based learning; management.

INTRODUCTION

MOST ENGINEERS experience substantial changes in their work tasks after only a few years of professional life. They have been taught an engineering curriculum largely based on an 'engineering science' approach in which engineering is taught only after a solid basis in science and mathematics. After a short time in industry many engineers find themselves working increasingly with project management activities, or they move to management positions where they are occupied with larger technology development projects.

Confronted with the new type of work they realize that the traditional engineering science view of technology does not seem sufficient to achieve success in a business context [1]. It appears that addressing multi-disciplinary complexity becomes the main challenge. Simon's description of complex systems captures the essence of the problem, 'Roughly, by a complex system I mean one made up of a large number of parts that interacts in a non-simple way. In such systems the whole is more than the sum of the parts, not in an ultimate, metaphysical sense but in the important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole' [2].

At the time when engineers realize these challenges, they feel an urgent need for new and different methods and tools to cope with the challenges. To support this need for post-experience education the MMT (Master in Management of Technology) program was launched at Aalborg University in 1997. Today the program is furthermore accredited as an executive MBA program.

KEY FEATURES OF THE MMT PROGRAM

The MMT program is based on four key features. These features have driven the continuing development of the program since the launch in 1997 and we consider them to be the main reasons for the continuing success of the program. The key features are:

- *Integration of business development, technology and organization is the overall theme of the program.* Technological development and the opportunities it offers are seen as means for developing and sustaining new business opportunities and should be linked to a thorough understanding of organizational issues to ensure implementation.
- *Theory and practice are combined in individual semester projects.* Like the other educational programs at the Aalborg University, the MMT Program has adopted the problem-based and project-based learning principles and methods. In each of the four semesters the student will carry out an individual project dealing with issues from the participants' own organization. The subject depends on the theme of the semester and the current situation of the company. Carrying more than half of the credit hours, semester projects become pivotal for learning by relating theories and methods, offered in readings and seminars, to a practical company situation.
- *Change agent in own company.* It is expected that the student in the semester projects addresses issues that are relevant for the company and that managers and employees become involved in developing and implementing an innovative solution. In this way the student will develop

competency in planning and staging organizational change processes.

- *The companies will also benefit.* In addition to getting a better educated and trained manager back into the organization after graduation from the MMT Program, experience shows that the company will also benefit. Semester projects represent opportunities for addressing complex issues that normally would not be dealt with, or by external consultants at high costs

In the following we will elaborate further on these four key features of the MMT program.

Integration of business development, technology and organization

In 'Zen and the Art of Motorcycle Maintenance', Pirsig describes how he drives through USA on a motorcycle, and how he lovingly keeps resetting the engine to the circumstances, tinkering with it and adjusting it. He carefully works with his machine to get it just right, and describes the patience it takes as well as the pleasure it gives. Small repairs become creative challenges, and make him fonder and fonder of his own machine. Meanwhile he ponders the attitudes of his fellow travelers toward technology. They see technology as an artificial and alien thing which interferes with people's lives and estrange them from a pristine and happy 'natural' state [3].

Pirsig's experiences are very similar to the professional experiences of many engineers. The problem of sustaining competitive advantage requires continuous and synchronous adjustment of the technology, organization, and business focus. In essence the problem of integrating business, technology, and organization perspectives is a design task [2]. The design task requires due considerations of the different structural elements of the three perspectives and the different time and timing aspects.

Emphasis is placed on developing innovative holistic visions of future scenarios as a way of integrating different perspectives and disciplines in an innovative manner.

As all elements are dynamic the management tasks are to forecast, control, and facilitate change processes in the company. Some of these change processes have high strategic impact and some are concerned with improvement of efficiency in daily operations.

An interesting feature is the exchange of experiences across industries. The participants experience that the same theories seem to apply whether engaged in innovative product development, design of supply chains, software industry, hospitals, etc.

Theory and practice are combined in individual semester projects

'Nothing is quite so practical as a good theory'. This statement was originally formulated by Lewin in 1945 [4] and later discussed in details by Van de Ven [5]. Good theory is practical because it advances knowledge in a scientific discipline, guides research toward crucial questions, and enlightens the profession of management.

In the MMT Program the interplay between theory and practice is facilitated through close association to the research community at the Center for Industrial Production at Aalborg University and through the application of project-based and problem-based learning throughout the whole program [6]. The general approach at Aalborg University is to apply project-based and problem-based learning in teams of 3 to 8 persons [7]. However, in the MMT Program the projects are carried out individually by the participants focusing on problems in their own company.

When applying the theories to their own companies the participants are encouraged to adopt a broader view and to have their interpretations presented to and tested by their colleagues. For example, the basic theoretical idea behind 'Strategy' is easy to communicate and makes intuitive sense. However, when the different schools of theories are presented it becomes clear that 'Strategy' is an ambiguous multidisciplinary concept [8]. And, furthermore, the ease of initial communication is often overshadowed by the high complexity when the concept is to be finally designed and implemented.

The intended interplay between theory and practice encourages the participants to experience the four elements of the Kolb Learning Circle [9]: concrete experience, observation and reflection, the formation of abstract concepts, and testing in new situations. Kolb argues that the learning cycle can begin at any one of the four points, and that it should really be approached as a continuous spiral. However, it is suggested that the learning process often begins with a person carrying out a particular action and then seeing the effect of the action in this situation. Following this, the second step is to understand these effects in the particular instance so that if the same action was taken in the same circumstances it would be possible to anticipate what would follow from the action. In this pattern the third step would be to understand the general principle under which the particular instance falls. When the general principle is understood, the last step, according to Kolb, is its application through action in a new circumstance within the range of generalization.

Kolb's model suggests emphasis on reflection, as a means of identifying patterns in past experience, and on experimentation, as a way of learning new things. Although Kolb's model primarily was developed for individual learning, we have successfully used reflection and experimentation in collective learning.

Change agent in own company

The two first semesters of the program focus on analyses in the participants own company with the

aim to obtain a comprehensive understanding of the functioning of complex organizations. The analyses cover technologies, organization, and strategy from a multidisciplinary perspective. While conducting and communicating these analyses the participants gain important insights into their organizations and provide the company with innovative approaches and input to risk and opportunity assessments.

During the third and fourth semesters the focus of the projects will change toward implementation and the role of the participants will be change agents in their respective companies. The success criteria for the projects are captured in five bullet points:

- strategic importance and relevance
- implementation has been initiated
- holistic perspective and communication
- theoretical understanding
- explicit reflection

In addition to having an M.Sc. or a B.Sc. degree, the participants must possess a minimum of three years of work experience to be admitted to the MMT program. Most participants have more than three years of experience and this has proven to be an important success factor. In cases where the participants have longer work experience they are able to position themselves more favorably and to use their projects to promote their careers.

In cases when younger participants have been admitted to the program they generally have had trouble when attempting to implement changes. Some participants have chosen to step out of the program to gain more experience. This is in line with recommendations from other MBA programs. Mintzberg argues that conventional MBA programs are mostly for young people with little or no experience. He recommends a different approach where practicing managers learn from their own experience [10]: 'No one can create a manager in a classroom. But existing managers can significantly improve their practice in a thoughtful classroom that makes use of that experience'.

Often to their surprise, during the third and fourth semesters the participants become much more aware of the political reality in their companies and realize that this is important in their reflections about how to get their ideas implemented [11–14]. Often the final project will be an important part of their agenda for the next three to five years.

The companies will also benefit

Accepting a participant into the MMT Program often involves an interview at the company with participation of the superior managers of the participant. The purpose is to make sure that the participant has the right back-up from the company.

During these sessions it becomes clear to the company that they can make the participant address any complex and strategically important issues. This can either lead to a specific solution or to a broad understanding in the company that may eventually lead to a development initiative.

During the studies the participant has access to the research community and the wider network associated with this community. In cases where the project will exceed the capacity of the participant, additional resources in the form of student teams or Ph.D. students can be supplemented.

THE PRACTICAL SET-UP OF THE PROGRAM

In each of the four semesters the students attend five intensive seminars starting on Thursday afternoon at 4 pm and concluding on Saturday afternoon at 2 pm. The seminars are organized around a theme and include overview lectures, exercises, industry guest lectures, and discussions.

In-between seminars the students will work with their individual semester project, discuss and meet with their advisor, discuss and meet with fellow participants, as well as study the suggested literature.

Originally the program was intended to make substantial use of computerized distance learning tools. However, it has proven that the face-to-face communication is considered as an important or even exclusive feature about the program. The computerized tools, e.g. a dedicated website for participants and teachers, have a supportive role of organizing and distributing teaching materials.

The contents of the program

The themes of the semesters and seminars are as follows:

- *Strategy and Business Processes*—the 1st semester theme

The themes of the seminars are:

- Strategy, technology, and organizational change
- Development of products and services
- Operations Management
- Supply Chain Management
- Integrated Solutions—conceptual design

The intention of the 1st semester project is to create a comprehensive picture of the strategic challenges and practice of the company. This includes product-market strategies, operations strategies, supply chain strategies, etc. At this stage of the program focus is on analysis and understanding, and the participants are encouraged to take multiple approaches in their analyses.

Since most participants have not written more comprehensive reports for a number of years the project assignment is divided in four parts.

Although carrying out individual projects, the students are organized in smaller groups of 4–5 persons. This provides an opportunity to gain a rich insight into the other group members' challenges, and, furthermore, the group shares one

facilitator who is an experienced faculty member. In between the seminars the group will typically gather once at one of the associated companies.

Below are two specific descriptions of projects:

1. Strategy content and challenges at a bank (Company A), and the analyses focused on the challenges of combining traditional banking operation with internet-banking. The analyses revealed that the existing strategy perception and strategies had several contradictions. While the original strategy was founded on assumptions of predictability [15] the new strategies had to include elements of less predictable emerging possibilities and a high degree of networking [16]. Based on the results of the project, the strategic process was adjusted according to the requirements as stipulated during the analyses.
2. Strategy content and challenges at an entrepreneurial start-up company (B) that develops and produces high-end sports equipment. The project focused on the process of initiating a strategic process and in particular the product-market strategy. During analysis of the different emergent strategies it became clear that there were several inconsistencies. This formed a basis for proposing a more professional strategic process.

• *Integration Processes and Mechanisms*—the 2nd semester theme

The themes of the seminars are:

– Organizational structures and systems
– Organizational processes and systems
– Organizational learning and development of competencies
– Innovation and technology management
– Strategy

The intention of the 2nd semester project is to make more specific analyses of the operations and development systems of the company. These analyses must include in particular organizational perspectives.

During the 2nd semester the groups and the faculty facilitators are changed. This is to ensure that the participants gain detailed insight into the challenges of more companies.

Below are two specific descriptions of projects:

1. Organization and process integration at an old television broadcasting company (C) that faced challenges of adjusting their processes and organization to the emerging strategic challenges. A very rapid development of technology combined with an old and rather stiff organizational structure forced a new way of defining the business processes and of empowering the organization. Based on a thorough integrated analysis of technology and organization new directions were defined.
2. Organization and process integration at a large traditional company within the mechanical industry (D). Increasingly the share of electronics had grown to be the main part of the products. This change required new approaches in both operations and product development. The analyses proved that the traditional mechanical approach was not applicable regarding the new electronic production and the development issue. Based on the analyses new directions were developed.

• *Organizational Change Processes*—the 3rd semester theme

The themes of the seminars are:

– Initiating and planning organizational change processes
– Corporate culture, power and conflicts
– The manager as a change agent
– Workshop on change management

Based on the experiences gained on the two prior semesters, the 3rd semester is focusing on analysis and definition of a development initiative.

Below are two specific descriptions of projects:

1. Organizational change at a large global company (E) within the semi-conductor industry. The technology and product development activities took place at four geographical sites in USA, Europe, and Asia. By and large, the knowledge structure was a mirror of the product structure, and there was a need for a thorough integration across the geographical sites. Though a number of workshops organized by the MMT student a new geographical and technological division of tasks were developed. This led to a proposal for a change project that eventually became the problem of the 4th semester.
2. Organizational change at an international, highly branded company (F) within a niche of the consumer electronics industry. Increasingly large companies provided solutions that were applicable within the particular niche of Company F. This put a pressure on the company to increase the innovation capacity. The diversity of the emerging technologies and the dynamics of the market required that the use of external partners in the technology and product development process. This led to a proposal for a change project that eventually became the problem of the 4th semester

• *Future Challenges and Company Scenarios*—the 4th semester theme

The themes of the seminars are:

– Future conditions for business and industry
– Corporate scenarios
– Workshop on the thesis projects

During the 4th semester the participants are expected to develop innovative and comprehensive projects and to plan and initiate the implementation process. Most often the project is a continuation of the 3rd semester projects.

Below are two specific descriptions of projects:

1. Development project at a large global company (G) within the consumer goods industry. The analyses of the 3rd semester project had indicated a number of problems related to the product development process. This was explained partly by the dynamics of the fashion like market and partly by the current performance of the product development department. One radical change to the process was developed and a framework for continuous improvements was adapted. The implementation was initiated.
2. Development project at a software company (H). The analyses of the 3rd semester had indicated that the organization structure and culture were increasingly getting obsolete according to the changes in the market. A proposal for at new product structure (platform) and a proposal for a matching organizational setup were developed. With the purpose to change the culture and to introduce new ways of working a training program was developed. The implementation was initiated.

EXAMINATION

Emphasis at the individual examination is on the written report submitted by the student. At the examination, the student makes a presentation of the project. A discussion and evaluation of the project follow the presentation. The purpose of the examination is to examine the knowledge possessed by the individual student and to evaluate the realism of the proposals. During the examination 2–3 student peers participate in the discussion. The external examiners are experienced industrial managers.

The supervisor conducts the examination and the whole process normally lasts between 1 and 2 hours.

CONTINUING EDUCATION

The students have access to the MMT intranet after graduation. Since the structure of the program changes every 2–3 year the content of seminars changes as well. Therefore alumni are invited to participate in renewed seminars or in seminars with high profile international speakers.

Once a year in August the university arranges a 'Lifelong Education' week. During this week updated research results are presented. Participation is free of charge for alumni.

Besides these formal activities an active alumni club, MMT3000, has been established. The club provides a network between candidates and arranges one yearly conference with international speakers. Additionally, 2–4 smaller events are organized each year.

CONCLUSION

The MMT program at Aalborg University has been active for 9 years with more than 150 graduates. It has been a gratifying experience to see how the program has triggered a marked personal development, in addition to strengthening their professional proficiencies. The problem-based learning approach, in the form of individual projects in own company, has been a major driver for this development providing relevance and motivation to learn. Coaching, thus, has a key role and will be an important focal point for the further development of the MMT Program.

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