

# **Technology Management in Lund: A Multi-disciplinary Master's Program**

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## **Abstract**

The management and development of high-technological industries demand skills in engineering as well as management. A new academic Master's program - Technology Management in Lund - is described, in which Technology and Management are integrated in three dimensions: curricula, students and teachers. The program has been developed in cooperation between The School of Management and Economics and The Lund Institute of Technology, both part of Lund University. The Technology Management program is unique in several ways; it involves not merely the question of teaching engineers business skills and vice versa, but integrating these fields of knowledge into a single entity in a Master's program. The purpose of the Technology Management program is to provide students with knowledge and skills in management and the development of high-technology industries, high technology bearing upon the product itself or the production process. The program started in 1997 and the first intake of 27 students graduated in June 1999. In this paper the experiences of the students, teachers and companies involved in the program are described and analyzed. Conclusions and suggestions for other universities interested in implementing similar programs are presented.

## **Keywords:**

Technology Management, Multi-disciplinary, Education, Project Management, Teamwork, Leadership, Live Case

## **Introduction**

In industry the connection between management and technology is natural. A high-tech business needs both kinds of competence and individuals who master both are of special interest. Why is it so difficult to bridge the gap between technology and management at universities?

In this paper, a novel academic Master's program - Technology Management (TM) - is described. The TM program bridges the gap by integrating not only the curricula of technology and management, but also students and teachers in an integrated Master's program developed in cooperation between The School of Management and Economics (EHL) and The Lund Institute of Technology (LTH). An integrated program is quite interesting from an industrial perspective and it has been easy to find partners among suitable companies. This kind of cooperation opens the way for some

novel pedagogical ideas, which are discussed in the paper. Some light is also shed on the question of why true integration comes hard to universities.

Taylor's thoughts presented in *The Principles of Scientific Management* (Taylor, 1911) originally concerned industrial and manufacturing establishments, but have spread and taken root in other parts of society, including universities. In traditional education, typical Tayloristic ideas, such as "organizing and planning is a task for managers", functional divisibility, individual tasks and rewards, to mention a few, are common practice. However, when a growing number of companies are taking steps away from Tayloristic ideas, the educational system should not continue to foster students according to these principles. Instead schools and universities should practice what they preach and organize their work according to new organizational ideas, based on concepts as empowered students, process thinking and multi-functionality.

The design of the TM program is based on such new organizational ideas. For instance, a common feature is teamwork, with the teacher acting as a coach and not as a person giving instructions. Students with different educational backgrounds work together, which inevitably brings multi-functional teams to mind. Furthermore the educational concept as such is designed with a process perspective.

## **Purpose**

The purpose of this paper is to describe the fundamental idea behind the TM program and to discuss the experiences of the first intake of students, the teachers and the partner companies.

## **The Technology Management program**

### **The purpose of the program**

The purpose of the TM program is to provide students with knowledge and skills in the management and development of high-technology industries. The program answers the demands made by industry for highly trained staff with a wide frame of reference, a well-developed capacity to learn, holistic thinking and the ability to analyze so-called "ill-defined problems" (Reich, 1991).

### **A program in three phases**

The TM program can be divided into three phases, in accordance with Figure 1. Phase I covers the first 2.5 years of each engineering student's or 2 years of each business administration student's program. Phase II prepares the engineering students with rudimentary knowledge of business administration and management and the MBA (Master of Business Administration) students with a basic knowledge of technology and engineering. Phase III is the fully integrated conclusion of the TM program with one year of courses and a 20-credit<sup>1</sup> Master's dissertation.

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<sup>1</sup> The Swedish academic year has 2 terms, 20 weeks long. 1 credit is equivalent to 40 hours of work and one academic year is equivalent to 40 credits.

In phase II, the engineering students acquire their specialist engineering competence based on the program chosen (mechanical, electrical, civil engineering, etc.) and their individual preferences; in essence what they would have chosen had they not been accepted onto the TM program. Their status as engineers is thereby ensured. During phase II, the engineering students also acquire some basic knowledge of business administration and management through condensed courses. Phase II for the business students provides, in addition to advanced courses in business administration, an introduction to technology and engineering by integration of business students into existing courses at The Lund Institute of Technology. The engineering students and business students both attend a course in teamwork and leadership, which deals with individual experience based learning and group dynamics.

Phase III is the final phase of the program, consisting of one year of joint education in Technology Management, Project Management, Teamwork and Leadership and one elective course. The program is concluded with a joint 6-month Master's dissertation written in teams of at least one business student and at least one engineering student. After concluding the program the students are awarded a Master's degrees in Engineering or Business Administration.

## **The fundamental ideas**

### ***Integration of Technology and Management***

Academia traditionally offers people with a deep knowledge of management but lacking an understanding of the underlying technologies and, engineers with no deep understanding of management. The aim of the TM program is to provide business students with an understanding of engineering and the engineers' way of thinking, and vice versa - engineering students with an understanding of management. Integration, therefore, is a key word in the TM program where technology and management are integrated in curricula as well as through students and teaching staff.

The integration of the subjects Technology and Management starts in phase II of the program, where the business students attend courses in technology and engineering students in management. In phase III the courses are designed to include both engineering and management aspects and thus the integration is extended from concerning the students' knowledge portfolios to the curriculum itself. For example, Product Development is studied from a technical as well as a management point of view.

Students with different educational backgrounds work together throughout the TM program. The integration of students starts "part-time" in phase II and is extended to "full-time" in phase III. Spontaneous transfer of knowledge between the students is encouraged through this intensive and long-standing interaction. Furthermore, the students are provided with the valuable opportunity of understanding each other's way of thinking and to learn to turn the differences into advantages instead of being obstacles for co-operation.

In the TM program teachers from both fields of knowledge are involved in teaching and tutoring. What makes the TM program one of its kind in Sweden is that the teaching staff (as well as the students) who originate from different faculties. Teachers from the engineering school normally give the management courses for the engineers, which is not the case in the TM program. Instead, teachers from the School of Economics and Management teach the engineering students management, which is natural

in order to ensure the necessary depth and breadth of the subjects. In the joint courses of the TM program, teachers from both schools work together, which gives them too the opportunity to interact and learn from each other to develop as teachers.

### ***Process perspective***

In traditional academic education, a program is divided into separate courses, which are developed and improved separately, by each department. The design of the TM program, however, is based on a process perspective to avoid sub-optimization. Three main characteristics support this idea of developing a program that crosses functionally borders:

Firstly, the program is designed as a unity<sup>2</sup>, with a holistic perspective and the courses at the program are chosen to complement each other.

Secondly, teachers from different departments, as well as different schools, cooperate in teaching the program, which supports the complementary characteristic of the courses. A key characteristic of the program is that the teachers come to the students in the educational process, as opposed to the common academic process in which the students come to the teachers and their individual courses.

Thirdly, teaching is focused on the output; what knowledge and capabilities do the students need to be successful in their working life? After completing the program, the students should be well suited for the management and development of high-technology industries, project management and management consulting. The ability to analyze ill-defined problems (problems with highly complex interrelations that do not lend themselves to simplification and numerical problem solving), work in and lead teams, write reports and give talks are therefore skills considered important and these are reflected in the design of the program and the courses. Owing to the holistic characteristic of the program and the coordination between different courses, it is possible to plan and carry out these ideas all the way.

### ***New pedagogical concepts***

Academic education is part of a life-long learning process. The TM program is aimed at providing students with a distinctive ability to learn. Organizational learning, including individual and group learning, was originally discussed by Argyris and Schön (1974), with double-loop learning as a key concept. In the TM program the students are encouraged to step back, reflect over and question the information given, according to the double-loop principle. Furthermore analysis and discussions are emphasized to a great extent, which is often not a pronounced feature in traditional academic education, particularly not in traditional engineering programs.

According to Problem-Based Learning (PBL) principles, problem solving is promoted rather than the memorizing of facts. Throughout the TM program students work together in teams to solve various kinds of problems including both engineering and business aspects. Most of the work is

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<sup>2</sup> The students' freedom to choose courses on their own is hereby limited. Instead, the choice lies in choosing to join the program in the first place.

structured in projects, and the vast majority of them are performed in conjunction with companies. In the course in project management, the students initially study a company and how it works in projects, and then the students take part in a project at the company. Thus, the students, according to PBL ideas, not only learn by reading about project management, but learn by studying it and practicing the techniques as well.

A resemblance between the working conditions of the students on the TM program and self-directed teams in industry is evident; a goal is set but the students/workers are free to choose their own way of achieving it. Sometimes, students also participate in formulating the problem. The teachers are there to support and assist the students when needed, but without interfering too much. It is therefore appropriate to talk about the teacher as a coach rather than an authority. The students are treated as creative and intellectual individuals - not only as an audience, and are empowered and given a great amount of freedom and possibilities to influence their work situation.

## **Experiences**

How can a new educational program be evaluated properly? It is a complex question without simple answers. What signifies success in education in the first place? And are such factors measurable?

Both the content of the program and the teaching concept are significant when evaluating the program. The content must be supported by a sound pedagogical concept, vice versa.

In the following discussion and analysis, the experiences of the students, teachers and companies involved, constituting the main interested parties in the program, are regarded. Since the program is new, all those involved have had insufficient experience of other traditional courses and programs to be able to make a comparison. An indication of the significance of the educational content can be given by considering how well companies in industry receive the Technology Management concept. Furthermore, the program must attract the right type of students, teachers and sponsoring companies to prosper, and thus issues such as the reputation of the program are also discussed and considered.

## **Challenges**

The novel educational ideas based on empowered students, multi-disciplinary and a process perspective, in contrast to the traditional authoritarian and functionally divided system, entail challenges for the teachers as well as the students, since neither are used to this form of working.

### ***Collaboration across borders***

The high level of integration in the TM program requires another approach to the teaching task than the traditional one. It is no longer a question of the teacher optimizing a course he/she is running on his/her own; it is about coordinating the work with that of other teachers to make the joint outcome as good as possible. Industrial experience shows that adopting a process way of thinking in the organization instead of focusing on functions may be difficult, since it requires a total change in mindset.

In most cases, integration in the TM program has worked out well; the teaching staff as well as the heads of the program have been aware of the potential pitfalls but determined to make it work. However, there have also been cases where the different subjects in a course were considered separate by the students and more integration and cooperation between teachers was desired. The teachers, in turn, expected the students themselves to tie the subjects together to a greater extent. This experience emphasizes the importance of making the rules clear at an early stage, for the students as well as for the teachers. Integration may occur spontaneously when the opportunity is given, but it should not be taken for granted that it will occur.

### ***Few, but clear guidelines***

Managing self-directed teams or empowered students is far from “letting go”. Some guidelines and rules are *even more* important in this situation than in the traditional management/teaching system. The few remaining guidelines must, however, be clearly stated at an early stage - it is about setting the direction without specifying the way.

Many of the students in the first intake have complained about ambiguity, especially initially, and demanded more specific rules and direction at an early stage. According to the discussion above it is important to consider the criticism considering the foresight aspect; the right information at the right time is a prerequisite for this kind of work setting. It is, however, difficult to evaluate to what extent the rest of the criticism is warranted, since it is not desirable to remove all the uncertainties on the part of the students. Learning to handle ambiguous situations is a goal in itself.

### ***Coping with uncertainty***

The students on the TM program are supposed to work independently and have a great amount of freedom. Often, they are given the opportunity to decide for themselves how to perform their work. However, with freedom comes responsibility, which may be unusual or even difficult to deal with.

Since most academic education is based on a Tayloristic system where the teachers tell the students what to do, check they have done it and evaluate the result, it is understandable that students become confused when they are asked to make their own decisions about the educational process. A logical question is whether the students can be prepared for this ahead of time, to avoid complaints and negative feelings. The experience of the first intake however, indicates something else.

A gradual change in the students’ opinion of the Technology Management concept during the course of the program has been noticed. The main trend shows initial excitement and belief in the fundamental ideas of the program, changing to doubt and demands for greater structure and guidelines (we want the old, “secure” system back), resulting in a deeper understanding and enthusiasm for the Technology Management concept. It may be difficult to explain and prepare the students for the changeover to this new way of reasoning ahead of time. Instead, appears that this is a process that the students have to go through. A process ranging from knowledge that self-direction and process orientation is important but with a basic (and subconscious) belief in Tayloristic principles, to a stage

where the students realize the benefits of the novel ideas of the program through their own experience of the advantages.

### **Technology Management's reputation**

The TM program has a good reputation among the students at both the School of Management and Economics and The Lund Institute of Technology, and the number of applicants is constantly increasing as the program becomes better known. Over the three years the program has been available an average of more than twice as many students have applied, as have been accepted, in spite of the fact that the admission standards are considered high, which deters some students from applying in the first place.

Teachers find it professionally challenging and interesting to teach Technology Management students. Normally, one only teaches students within the same knowledge area as one's own and thus with the same type of "blind spots". Teaching students of subjects other than your own leads to a learning experience for the teacher as well. Furthermore, in the Technology Management courses, teachers from both schools teach together and hence get to know each other, which has already led to joint applications for research grants. One problem with such applications is, however, the lack of understanding of multi-disciplinary research projects. In Sweden the bodies providing such grants are typically divided into subject areas such as Engineering *or* Social Sciences.

The program has also gained a good reputation in industry, especially among consulting firms, which explicitly seek out students with both technology and management skills. The first graduates of the program have had no problem getting employment - rather the opposite; many companies have taken the initiative and contacted the students initially. A respected and well-known consulting firm in Copenhagen has, for example, proclaimed Technology Management students as their prime target group for recruitment. The good reputation of the program is also reflected in the ease of finding and maintaining suitable Technology Management partner companies.

Technology Management students have, on average, been offered higher salaries than their former fellow students. In Sweden it is appropriate to describe students' starting salary in different levels. The MBA students obtain salaries at one level, engineers at a slightly higher level and those having a degree in both subjects at the highest. The Technology Management students have increased their salaries by at least one level.

### **Discussion and conclusion**

To summarize the experiences of the students, teachers and companies involved, the program has succeeded beyond expectation. The program has experienced some obstacles, and it has suffered from teething problems, but there are no obstacles in sight that can not be managed.

Since the TM program is designed with a holistic perspective and has interrelated parts, the courses are dependent upon each other to succeed. The best example of this is the course in Teamwork and Leadership where the students become familiar with team-building theories, but the opportunity to

experience real team-building processes can not be given within the framework of the course. Instead, the students are exposed to long, intensive interaction in groups in the two courses, parallel to Teamwork and Leadership. The group dynamics are analyzed and discussed in the course in Teamwork and Leadership at the end of the semester. Although the experience of the first intake of students shows some initial confusion among students not used to interrelated courses, the synergy is there; the two complementary courses were tough enough to put the groups under the pressure needed to push the team processes forward.

The concept of integrating students and teachers from different schools has been favorably received; the teachers as well as the students involved in the TM program have been enthusiastic concerning the opportunity to meet and interact with people with an other educational background than their own. Above all, the opportunity of learning completely new things and of getting new perspectives in various topics has been emphasized.

In a way, teachers may face contradictory demands when, on the one hand, they are supposed to let the students, as far as possible, decide for themselves in work-related issues - with the assumption that the self-directing processes and what they includes in terms of thinking and reflecting contribute to the students' development - and on the other hand, the teachers are supposed to make sure that a certain level of knowledge is passed on to the students. If the students are not able to cope with the freedom given them and the responsibility for their own learning is forsaken, the teacher does not fulfill his/her second mission; to pass on knowledge. In the TM program the students' own powers of motivation are of special importance; because of the high level of interaction not only the single student's results are affected, other students' learning is affected as well. A potential pitfall for the teachers is to tighten their control at an early stage if they consider the efforts of the students to be inadequate. It is, in other words, important that the teachers have the right attitude, are committed to the pedagogical concept and stick to the main guidelines. The students also need to reach a certain standard to make the Technology Management concept work. The challenge in handling and giving freedom has been discussed earlier, but to summarize, both the teachers and the students have lived up to expectations to make the pedagogical ideas successful.

## **Looking ahead**

### ***Further development of the program***

The TM program is not a terminal point in it self. Rather the opposite and the program is constantly developing, with students and teachers taking an active part in the improvement process. The program has also been a source of inspiration and a basis for other educational and business activities.

### ***Technology Management as inspiration***

The close interaction between students and companies in the TM program has been further refined by the second intake of students themselves, who have started a joint project with industry, called Technology Management Advisory. The idea is to bring students and business leaders together in a mutual mentor-like relationship, where the business leader provides insight and guidance based on his/her industrial experience while the students brings the latest academic findings to the company. This

creates a channel for interaction and learning and establishes and supports future business-academia relationships.

The joint courses given by teachers from different schools have proven to be of great value. Valuable to the extent that some of the teachers involved in the TM program joined in an extended multi-disciplinary research project in order to pursue research in the field of Technology Management (Technology Management Research Program). The Ph.D. students of the program have supervisors from both the Institute of Technology and School of Management and Economics. The research program also serves the purpose of securing a supply of new knowledge, thereby constantly keeping university education up to date.

The fundamental ideas of the TM program, such as multi-disciplinary, self-directed teams and process orientation, are becoming increasingly important in industry. Other universities in Sweden are realizing the importance of offering a program like Technology Management, to live up to the demands of industry, and are therefore imitating the concept. From a Technology Management perspective, this imitation is welcomed since the advantages outweigh the disadvantages of the competitive aspect; if the program is spreading, the concept is becoming better known and the program and the students are paid greater attention. Furthermore, it serves as confirmation of the importance and need of such an integrated program - it is obvious that Technology Management is a concept for the future.

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## **Bio-sketch of authors**

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**Title**

Technology Management in Lund - a Multi-disciplinary Master's Program

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