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Designing an Industrial Management Curriculum, Overcoming Obstacles

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Abstract

The degrees in Industrial Management are often so called combination degrees linking business and management to engineering. They aim to bring out the best of both worlds: to combine the logical, engineering mindset with economical and managerial awareness. Including the essentials and advanced knowledge of several fields in one degree program is a clear challenge. How to choose the essential knowledge and link it in a useful way? There is also a risk that the combination degree would produce just superficial engineers who would not be able to find their place in the world of work. This fear seems to be wrong according to a survey conducted for the graduates of 1995-2002 in Industrial Management at Lappeenranta University of Technology. One of the main reasons for the top-level employment of the graduates may be the smooth slide to the world of work through the master's thesis. The master's thesis reflects the whole curriculum and exposes the graduate's knowledge and skills, both in the academy and the world of work.

Key words: curriculum design, education, industrial management

1. INTRODUCTION

Combination degrees aim to provide a wide perspective with solid understanding about several fields. In the case of Industrial Management, the fields are engineering and management. This is clearly a challenge, because normally students concentrate on just one field instead of two. The students of Industrial Management should have an engineering mindset and knowledge, but they should also be capable to evaluate the economical and managerial influences of a decision. The Industrial Management (IM) degree program at Lappeenranta University of Technology (LUT) aims to provide its graduates tools for success in challenging positions. This sets major challenges for the curriculum as well. How to balance the amount of technology and management education? How should the basics of engineering professions be taken into account? How to teach also soft skills and subjects like communication and foreign languages?

LUT Industrial Management is the biggest university-level educator in IM in Finland. In 2011, there were 95 Bachelor of Science (Technology) graduates and 146 Master of Science (Technology) graduates in the department. There are 15 professors in the department, and the number of the whole personnel is about 90. The way the education is delivered is developed

continuously, and this has been noted also by several external organizations: the department has a rare triple-nomination as a Centre of Excellence in University Education (awarded by the Finnish Higher Education Evaluation Council) and ASIIN –accreditation. This paper analyzes one way of creating a combination degree, which combines studies in engineering and management successfully. The good results are supported by alumni survey data, master's thesis commissioners' surveys, and employment surveys. The collected data contributes to the knowledge of the employability of IM graduates, and it also supports the conclusions about the advances of a combination degree.

The paper answers to the following questions:

- How should we design an interdisciplinary curriculum, where much information is included in one programme?
- How do the graduates get employed?
- How can the master's thesis help in finding employment?

2. BACKGROUND OF THE STUDY

Industrial Management is a combination curriculum. The educational aim of the department is to train experts for planning and executing demanding organizational and business development actions which require interdisciplinary know-how. The staff members of the department conduct high-level research on complex and dynamic business problems. The aim of the research is to produce new methods, models and tools for the performance of business processes and networks. However, linking the versatile curriculum and research activities conducted in the department is not always completely trouble-free. The aim of the present study is to present some of the best practices of the accredited and awarded department of LUT Industrial Management: namely its curriculum design and the master's thesis project. The achieved results are demonstrated with survey results. The current state of the satisfaction of masters' theses commissioners' (persons in companies, which commission the thesis) has been examined first since 2011.

The difference between engineering students and professionals is defined as following: After graduation engineers are practitioners [1]. This fits also with the aims of the degree programme in Industrial Management: in the world of work, the graduates form teams for different aims, such as developing new products, solving problems and working on new innovations. For many students, the differences between business and educational environments are harsh. The step from the university to the world of work may be a big, once-in-a-lifetime experience for the graduates. Internships, relevant work experience and active participation in student organizations help graduates in this, however.

Life-long jobs are more and more scarce. The career path may include several lateral and not so many vertical steps. On the other hand, many engineering curriculums aim to educate engineers with a very specific skill set. [2]

Work experience related to career goals is the only certain way to forecast one's employment success [3]. Thus, even this factor can be called self-explanatory: people who have found a job related to their studies already during them, may have also other personal advantages. Working during studies may also develop other skills.

The transition from the university to the world of work may be also difficult because of the limitless-seeming options there are at the moment of graduation. There may be too many choices available for the graduate, and he/she may not be sure what he/she really wants. [4].

The above statements support the practice of business-commissioned master's theses: working while studying (or writing one's master's thesis) gives a chance for the potential employer and employee to get to know each other and the corporate culture. This period ties the parties for just six months. A six-month contract is a relatively low-risk way for the potential employer to get a good idea of the student's capabilities. The

employment percentages have been excellent among IM graduates: in 2010, 78 %, in 2009 78 % and in 2008 82 % of the graduates were employed at the moment of graduation.

Industrial Management graduates are often expected to be leaders in the future. Good leaders are emotionally available and inspiring [5]. Managers who score high in logical ability may have strong leadership motivation, but motivation does not predict high scores from subordinates. Instead, optimism and emotive communication ability correlate with positive subordinate perceptions.

3. DESIGN OF A DEGREE CURRICULUM

3.1 Formal design of the curriculum

There is definitely not just one specific correct way to create an Industrial Management curriculum. There are some basic differences already in Europe. Güven [6] presents an Industrial Engineering and Management curriculum at Middle East Technical University, Turkey, but exact comparison is difficult because of the different sizes of the bachelor's degrees.

The department of Industrial Management at LUT has found a way to overcome the obstacles, avoiding superficial knowledge about several fields, by providing the major subjects as integrative industrial management subjects. The minor, 30 ECTS in the Bachelor's degree and an additional 20 ECTS in the Master's degree, is one of the six engineering or technology subjects taught at LUT. The general studies consist of basic competencies for technology studies, like mathematics, physics, as well as language and communication studies.

The designs of the Bachelor's and Master's degree curriculums in LUT industrial management are presented in tables 1 and 2. As shown in table 1, the bachelor's curriculum courses are divided into four different areas: general studies, major studies in IM, minor studies in engineering/technology, and optional studies. A student can accomplish the Bachelor's degree in three years, and the Master's degree in two years. All students are encouraged to complete also the Master's degree, and when a potential student is accepted to study for the Bachelor's degree, he/she is accepted also for the consecutive Master's degree.

The students start their first year with basic competencies for studies in technology, for example mathematics and physics. The students are instructed to choose their minor immediately, so that they can fit a part of its studies in their freshman schedule. Also the basic competencies in industrial management, like basics in logistics and marketing, are taught already during the first year. These form basic knowledge providing competence for taking part in the major courses in industrial management. IM courses are by nature interdisciplinary. Students choose their major during the fourth semester and start its studies during the last bachelor year (fifth and sixth semesters).

Despite of four different options for majors on the bachelor level, most of the courses are the same for all

majors. The Bachelor's thesis is always written for the chosen major.

The students have a wide range of options when considering their own major and minor -combination. This creates unique combinations, and the freedom to choose is likely to enhance the motivation of an individual student.

During the master's studies, the student continues his/her studies in the same major and minor he/she chose on the bachelor level. On the master level, the majors are more differentiated than on the bachelor level. The majors do not share as many courses as on the bachelor level, and the amount of general studies is just 10 ECTS, consisting of optional studies in technology and/or mathematics, as well as work internship. The emphasis on the master level is clearly to become an expert in the field of one's chosen major and to attain advanced knowledge in technology/engineering issues.

The goal of the versatile curriculum is to equip the graduates with skill sets which enable them to work in versatile positions. The objective of the technology/engineering minor is not just to train oneself as an engineer, but also to provide the vital interdisciplinary skills. One major point of the versatile curriculum is also to enable graduates to develop processes: they should be able to form effective teams for different purposes.

3.2 Development activities for the curriculum design

To keep the curriculum up-to-date and a coherent entity, a lot of coordination is needed. This helps avoiding overlapping courses and enables wise use of resources.

To achieve the goals of the curriculum and to develop it even further, a curriculum committee has been nominated for the degree program. The curriculum committee meets several times per year and prepares the curriculum for the faculty council, which approves the curriculum. Representation of all major subjects, the head of studies, the head of the department, and students enable thorough preparation of the curriculum.

There are also groups which concentrate on deeper issues: for example an advisory steering committee meets twice a year to discuss long-term development needs. Also in this group, different major subjects and students are well represented.

The degree program has also a development day, which gathers about 60 % of the personnel of the unit and a group of students together. In this one-day session many significant issues, like renewal of the Bachelor's curriculum, application as a National Centre of Excellence and accreditation have been under examination.

The development activities are not separate themes, but a permanent part of daily work in the department.

3.3 Individual courses: student-centred learning

Not only curriculum design, but also the quality of individual courses is considered to be of great importance. The teachers are encouraged to learn and

use new methods, especially on the master level courses where the group sizes allow more flexibility in the choice of teaching style. The university provides pedagogical training for the teachers.

Interactive and collaborative learning methods are preferred. Small and medium-sized course groups call for teaching methods that promote the skills and knowledge needed in real-life situations in the work life. This is achieved through assignments that require practical problem solving, decision making and development of activities through extensive true-to-life material, as well as high-pace interactive team work. The advanced courses also include assignments and extensive special projects commissioned by businesses, in which the students solve practical problems for the company. The "traditional" lectures and exam -combination is rather rare. Despite of the academic nature of university education, practical solutions are integrated with the theory. The students have to be able to use and apply the theory they have learned.

The courses have typically more than one instructor. Pair and team work among the teachers enhance the possibilities for study guidance. In large-scale courses, the students are usually assessed by the responsible lecturer, but in small and medium-sized courses also the assessment duties are divided between the teachers. Teacher cooperation is also supported by the Blackboard online learning environment. Blackboard is a platform for either blended learning courses or material banks, as the aim is to produce courses that combine web-based and contact teaching instead of pure online courses.

The way of assessment often controls the whole learning process. That is why the ways of assessment are also carefully considered to fit the aim of the particular course. The assessment methods are versatile: it is not common to grade the student's knowledge just with an exam. Project-based work has often its own percentage in the final assessment. There are also several courses where there is no final exam, but the students' grades are given on the basis of their performance during the course.

The student-centred approach enables the students to gain real know-how instead of just pure theoretical knowledge, already during their studies. Larger assignments are often accomplished in student groups. Team work does not only help students learn social and team-work skills, but also enhance the spirit of the whole community. The teachers coach the students to solve problems and the students work together in teams, not competing against each other. The team work methods are also activating and versatile and selected considering the nature of the particular course. All in all: the degree program finds the alignment of objectives and teaching and assessment methods extremely important.

3.4 Interdisciplinary curriculum content

Building an interdisciplinary degree is not easy. The aim is ambitious: the graduates should be capable in problem solving in a wide range of issues, they should have knowledge of different tools and frameworks in

practice, they should not be afraid of a practical approach, they should be able to communicate, and be active and initiative. Their approach must be truly genuinely multidisciplinary: in addition to substance in several fields, they should have also social know-how.

LUT Industrial Management does not create interdisciplinarity just by combining traditional fields. Instead of that, the way is to combine traditional engineering and technology fields with multidisciplinary industrial management majors. The four majors in the Bachelor's and Master's degrees are Cost Management, Innovation and Technology Management, Industrial Marketing and International Business, and Supply Chain and Operations Management. The core competence is still on the engineering background, and mathematics and physics are considered essential for logical thinking and problem-solving skills.

All majors share the same idea of creating innovations and business opportunities with technology. Also the management and exploitation of resources in a focused and sustainable way is common for all majors. The combination of the majors and minors teach the graduates to help individuals, teams, functions and companies to enhance collaboration in order to create value within business processes and networks. They learn also methods, models and tools to improve collaboration, coordination and control between actors within business and networks.

Despite of the academic ambitions of the department, most of the graduates are employed in industries, public organisations etc. outside the academia. The department encourages its soon-to-be-graduates to take their first steps in the world of work by conducting their research for the master's thesis – a six-month project – in a company, commissioned by a company which exploits the work of the student. This practice may raise a question about the scientific relevance of the work, but well-formed pieces of advice have resulted in satisfaction of academic instructors, as well as the commissioners and the graduating students. The plain project plan is presented in figure 1. Students as well as their instructors in firms and at the university have access to the Thesis Roadmap. It describes in-depth the process and steps required at different stages of the thesis process. This public web-site saves the energy and time of the instructing professors, because the students can find answers to the most common questions by themselves.

4. RESEARCH DESIGN

LUT organized a large research for its stakeholders in 2011. Part of the research was a survey for the university alumni, which gave interesting information about the career paths of graduates. A survey for master's thesis commissioners has been a continuing survey since 2010. Its aim is to study the satisfaction of the master's thesis instructors in organizations outside LUT.

4.1 Survey of alumni

The survey of the alumni was limited to Industrial Management graduates from the years 1995-2002. This survey was conducted between the 12th April – 16th May 2011. 174 responses were received from the Industrial Management alumni.

4.2 Survey of Master's thesis students

Since 2010, LUT has carried out a survey of Master's thesis students, answered by the commissioners. The organizations are asked to give 1-7 points in each question for the person in question (1=poor 7=excellent). The web-based survey is sent to the Master's thesis commissioners. The mentors in enterprises and other organizations respond to 14 statements related to three major themes: the substantial knowledge of the Master's thesis writer, project management and co-operation, and communication know-how.

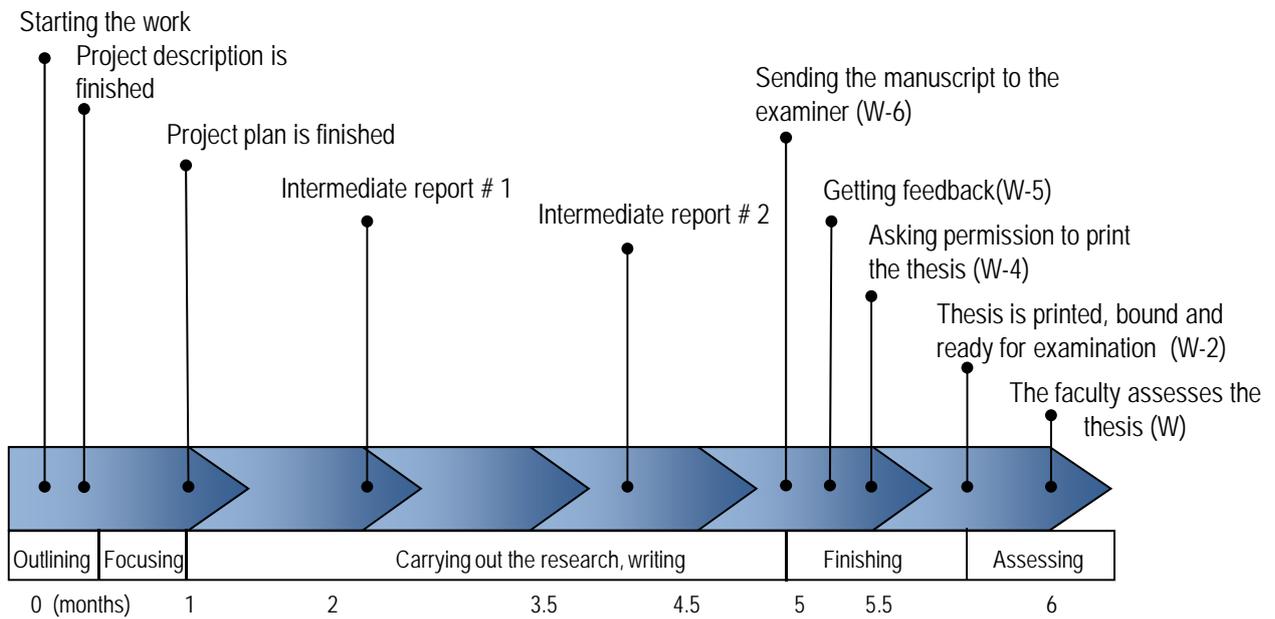
In 2010 there were 56 respondents, and in 2011 48 respondents. In 2011 there were 146 master level graduates in the department of Industrial Management. The answering percentage was 33.

The first statements in the survey about the Master's thesis student focus on the substantial knowledge of the soon-to-graduate student. The statements are: "The student has large knowledge in his/her specialist field", "The student can apply his/her knowledge to the problem given by the company", "The student can analyze the results and make conclusions about them", "The student has shown an ability to learn new things", and "The student has shown in his/her work an ability to handle large entities".

The second set of statements focuses on project management and co-operation. The five statements are: "The work of the student has been systematic", "The student has the needed team working skills", "The student has shown an ability to work independently", "According to his/her abilities, the student could be a new employee in our company", and "Co-operation with the instructor at the university went well".

The third set of statements focuses on communication potential. The four statements are: "The student is convincing in presenting situations", "The student's spoken communication in a foreign language is fluent", "The student's written reporting in Finnish is easy to read", and "The student's written reporting in a foreign language is on a good level".

Master's thesis project



Department of Industrial Management

Figure 1. Master's thesis project. Describing the project clearly for all parties is a vital element of success.

Table 1. Bachelor of Science (Technology) in Industrial Management 180 ECTS

<p>General studies (88 ECTS cr)</p> <p>Basic competencies in industrial management (42 ECTS cr).</p> <p>Basic competencies for studies in technology (46 ECTS cr), e.g. mathematics, physics, language and communications studies.</p> <p>Compulsory studies 88 ECTS cr.</p>	<p>Major studies in industrial management (50 ECTS cr)</p> <p>Options (the student chooses from):</p> <ul style="list-style-type: none"> - Cost Management - Industrial Marketing and International Business - Innovation and Technology Management - Supply Chain and Operations Management <p>Compulsory studies 45 ECTS cr, incl. Bachelor's thesis (10 ECTS cr). Alternative studies 5 ECTS cr.</p>
	<p>Minor studies in technology (30 ECTS cr)</p> <p>Options (the student chooses from):</p> <ul style="list-style-type: none"> - Chemical Engineering - Electrical Engineering - Energy Technology - Environmental Engineering - Information Technology - Mechanical Engineering <p>Compulsory studies 6-14 ECTS cr, alternative studies 24-16 ECTS cr (depending on the subject).</p>
	<p>Optional studies (12 ECTS cr)</p> <p>University level courses (from LUT or another university).</p>

Table 2. Master of Science (Technology) in Industrial Management 120 ECTS

<p>Major Studies in Industrial Management (70 ECTS cr)</p> <p>Options:</p> <ul style="list-style-type: none"> - Cost Management - Industrial Marketing and International Business - Innovation and Technology Management - Supply Chain and Operations Management <p>Compulsory studies 50-52 ECTS cr, incl. Master's thesis (30 ECTS cr). Alternative studies 20-18 ECTS cr.</p> <p>Major subjects in non-consecutive Master's degree programs:</p> <ul style="list-style-type: none"> - Global Management of Innovation and Technology - Knowledge Management - Technology Entrepreneurship 	<p>General studies (10 ECTS cr)</p> <ul style="list-style-type: none"> - Optional studies in technology or in mathematics - Work internship
	<p>Minor studies in technology (20 ECTS cr):</p> <p>Advanced studies in technology – a separate continuation of the minor subject chosen in the B.Sc. degree.</p>
	<p>Optional studies (20 ECTS cr)</p> <p>University level courses (from LUT or another university), e.g. for additional minor subject or studies abroad.</p>

5. DATA ANALYSIS

5.1 Results of the survey of alumni

The survey was conducted to 174 Industrial Management graduates from the years 1995-2002. 91 % were employed three months after graduation, 5 % were unemployed but looking for a position. 6 months after graduation, 95 % were employed and only 2 % unemployed and looking for a position. At the moment of the survey only 1 % were unemployed and looking for a position.

In 2010, 36 % of the IM graduates (graduated in 1995-2002) worked in managerial or leadership positions. 31 % worked in planning, development or administrative positions. 10 % worked in consultancy, training or education, and 9 % in marketing and selling. The rest worked for example as researchers, in customer relations or in communication and media.

In the current job, the most important knowledge was related to analyzing and systematic thinking, data collection, problem solving, team work, negotiation, coordination, ability to life-long learning, communication in Finnish and foreign languages, and business knowledge. 92 % of the graduates were quite or very satisfied with their degree.

5.2 Results of the master's thesis commissioner survey

In LUT IM, the masters' theses are almost always commissioned by companies. This has caused no problem with the scientific quality of the work. Even if (or normally, when) the theses are commissioned by companies, there is also always a supervising professor

who monitors that the thesis achieves a sufficient academic level. Despite of the company connection, the conclusions are academic and transparent. This is ensured by the examiners. The final thesis is always examined by two professors or researchers. This ensures also the legal protection of students.

The first statements in the survey about the master's thesis student focus on the substantial knowledge of the soon-to-graduate student. The results for 2011 and 2010 (the latter in parenthesis) are presented below. The scale is 1-7 (1=poor, 7= excellent).

In 2011 the average grade for the statements about the "substantial knowledge" was 6. The statements were as follows: "The student has large knowledge in his/her specialist field" 5.583; (5.661), "The student can apply his/her knowledge in the problem given by the company" 6.021; (5.839), "The student can analyze the results and make conclusions about them", 5.958; (5.804), "The student has shown an ability to learn new things" 6.375; (6.179), and "The student has shown in his/her work an ability to handle large entities" 6.064; (5.875).

The second set of statements focuses on project management and co-operation. The average for this part in 2011 was 5.898. The five statements are: "The work of the student has been systematic" 6.104; (5.732), "The student has the needed team working skills" 5.83; (5.732), "The student has shown an ability to work independently" 6.458; (6.071), "According to his/her abilities, the student could be a new employee in our company" 6.277; (6.179), and "Co-operation with the instructor at the university went well" 4.576; (5.875).

The third set of statements focuses on communication ability. The average for these statements was 5.399. The four statements are: "The student is convincing in

presentation situations" 5.521; (5.536), "The student's spoken communication in foreign language is fluent" 5.182; (5.019), "The student's written reporting in Finnish is easy to read" 5.553; (5.875), and "The student's written reporting in a foreign language is on a good level" 5.318; (5.245).

5.3 Interesting findings and cross-check

The findings show very high satisfaction of the master's thesis commissioners. The lowest given grade is "Co-operation with the instructor at the university went well", with 4.576, which is a much lower grade than those in the other sections. Of the three separate entities, the first one, which discusses the substantial knowledge of the person, is the highest, 6. The second part, project management and co-operation, is 5.898, and the third one, communication ability, the lowest, 5.399. It is worth noting that the statement "Co-operation with the instructor at the university went well" with 4.576 drops the average.

The results in the section "substantial knowledge" are very good. From this point of view, the theoretical knowledge-base of the graduates is on a very high level.

When we compare the results of the master's thesis commissioners' survey against the IM alumnus survey, it is especially delightful to note that the graduating students get a high grade for their problem solving ability from the master's thesis commissioners, because this competence is named to be of high importance in the alumnus survey. The same phenomenon can be seen in the area of "learning new things".

At the moment the weakest points seem to be in the area of "soft skills". The alumni rate the importance of negotiation and communication skills very high, but according to the survey of the master's thesis commissioners, they are the weakest points of the graduates. Development of these skills must be fostered in the degree programs.

6. CONCLUSIONS

In general, the results of the master's thesis commissioner's survey are excellent. It looks like there are no major gaps in the knowledge of the graduates, at least from the viewpoint of potential employers.

An interesting finding is that the statements concerning substantial knowledge get the best grades. The importance of "soft skills", including the ability to productive and successful teamwork and communication skills are highlighted in the degree program during the recent years. The conclusions of Lappalainen (2012) suggest that not only substance knowledge and logical thinking, which were formerly appreciated as crucial characteristics of good leaders, are the decisive factors.

All statements (except "co-operation with the university instructor") earned even better grades in 2011 than in 2010. Because this survey is still new, it is interesting to see how the results will develop.

The graduates have been placed well in different positions. 92 % satisfaction with the degree is very good. Also the employment rate is very good.

It looks like the graduates of Industrial Management have a small step from university studies to the world of work. Internship is an essential part of the studies, and the master's thesis work is a bridge-builder from studies to work. It helps graduates to get used to project-based work in practice, and to be responsible for projects of their own.

A problem is that sometimes combination degree engineers do not know exactly what they are actually capable for. The solution is close communication with stakeholders, especially future employers. This knowledge is also utilized by the professors, who can transfer the knowledge in their courses for younger students. Successful careers of alumni may give important ideas and instructions for younger students who are still not sure where to find their position.

The graduates in Industrial Management hold different positions in the corporate world, public sector and academia. The degree seems to lead to versatile positions. Traditionally, education in Industrial Management is associated with managerial and leadership roles. This assumption is not wrong, but a major part of the alumni work in planning, development, consultancy and marketing. Of course also the age profile of the respondents may affect the results, and probably the percentage of alumni working in managerial and leadership roles may increase as they move on in their careers. Still, the wage median is high, at least when compared to that of the average Master of Science.

The results of the surveys show that a combination curriculum can give a good starting point for a successful career. The combination curriculum may not give as specialised a skill set for the graduate as a curriculum which concentrates only on one topic, but this is also an advantage: the graduates are problem solvers, who are always ready and willing to learn new things and find their position also in the turbulent and dynamic world of work. They are not tied to specific industries or branches.

It is encouraging to notice that also the master's thesis commissioners are very satisfied with the capabilities of the soon-to-be-graduates. Still, some weaknesses can be found: especially the communication skills of the graduates should be fostered. The results are not weak, but these skills do not get as good grades from the commissioners as the other skills. Communication skills are also especially required through the career path, according to alumni.

The results of the study should be utilized in developing the curricula, as well as individual courses and their teaching and learning methods. The results should be communicated also to potential students and current students who consider their chances in the world of work.

It may be useful to track the career path of every graduating class more carefully: this is how the different needs at different stages of the career could be noticed better.

The cross-check between the alumnus survey and the master's thesis survey may be not fully reliable, because the curriculum, teaching and learning methods

have naturally developed after the graduation of the alumni.

The master's thesis can help to find employment, because it gives the potential employer a chance to get to know the student's abilities. The percentage of students who have a position already at the moment of graduation indicates that the master's thesis commissioners are a significant employer group.

All in all, the degree program has produced at least knowledge to help graduates find their position and also move on in their careers. The master's thesis commissioners value the skills of the graduating students. The combination curriculum has enabled the alumni to choose work from a wide variety of options.

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Kreiranje studijskog programa za industrijski menadžment, prevazilaženje prepreka

Taija Okkola i Tuomo Kässi

Rezime

Diplome Industrijskog menadžmenta se često nazivaju kombinovane diplome jer povezuju poslovanje i menadžment sa inženjerstvom. Njihov cilj je da iznesu najbolje iz oba sveta: da kombinuju logičko inženjersko stameno mišljenje sa ekonomskom i menadžerskom svešću. Uključivanje osnova i naprednog znanja nekoliko oblasti u jedan univerzitetski program predstavlja jasan izazov. Kako izabrati osnovno znanje i povezati ga na koristan način? Takođe postoji i rizik da će kombinovana diploma proizvesti samo površne inženjere koji neće biti sposobni da pronađu svoje mesto u svetu poslova. Ovaj strah izgleda da je neopravdan prema istraživanju koje je sprovedeno sa studentima koji su diplomirali između 1995-2002. godine na Industrijskom menadžmentu na Lappeenranta univerzitetu za tehnologiju. Jedan od glavnih razloga za veoma uspešno zapošljavanje diplomiranih studenata možda je lagani prelaz u svet poslovanja preko Master rada. Master rad reflektuje celokupan studijski program i otkriva znanje i veštine diplomiranih studenata, kako na akademskom nivou tako i u svetu poslovanja.

Ključne reči: kreiranje studijskog programa, obrazovanje, industrijski menadžment