12th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

EDUCATION IN MANUFACTURING – YOUTH PERCEPTION, COMPETENCES, CURRICULUM DEVELEPOMENTED, INTEGRATION OF EDUCATION WITH THE INDUSTRY

Slavko Dolinsek
slavko.dolinsek@guest.arnes.si
Institute for Innovation and Development
of University of Ljubljana
University of Primorska, Faculty of management. Koper
Slovenia

ABSTRACT
Many new challenges have arisen for Slovenia as a full member of the EU from May 2004, and also many opportunities. On the one hand we have some successful economic players who can definitely gain from the new opportunities. On the other hand some structural changes still have to be accomplished. Among all of them one of the most demanding tasks is related to the higher educational system related to the harmonization of the EU and global educational systems. In relation to that, we can also observe a significant increase in the number of students enrolled in social sciences and, consequently, a relative decrease of the number of students enrolled in natural and technical sciences and engineering, where the number of students in the last ten years remained the same.

In the paper results of international framework for a Master degree curriculum in manufacturing strategy is presented and also an example of integration of competences in technology and business. Approach is a good example of meeting Bologna goals - to establish a system of easily reckonable and comparable educational degrees and to accelerate employment of EU citizens and competitiveness of the European higher educational system. In order to gain insight into the values of the youth a parallel analysis has also been preformed showing that perception of the youths related to the science and technology is similar as at the EU developed countries.
Keywords: manufacturing, competences, education, enrolment, science, technology

1. INTRODUCTION
Few years ago Ridderstråle and Nordström published his bestseller about business, Funky business [1] where they said: *with the introduction of the plantation we moved from the hunting and gathering society into the agricultural one, and, with the coming electricity, we entered the industrial era. Some call our world the knowledge society and others the brain one. The only certain thing is that the critical skills and answers of tomorrow will not be those of today. The future cannot be predicted – it has to be created. Either you see things happen or you make them happen.*

Therefore, the European countries are in the stage of renewing the concepts of engineering education. There are two reasons for that: technological development and globalization [2] (Dolinšek at all. 2006):
Technological development has at least two key effects: obsolescence of knowledge and the development of society. The fact is that the pace of technological development is so extensive that theoretical and professional engineering knowledge is fast becoming obsolete. With the usual practice of renewal, as commonly accepted by academia, at every 10 – 15 years, it is very difficult to meet all the needs for engineering knowledge and skills which are demanded by industry. Technological

development also has an influence on other areas of a society and contributes towards its development in the sense of knowledge or information society, which intensifies the problem of knowledge obsolescence not only in the technological field, but also in all other areas.

Globalisation has a big influence on the technological development and consequently on theoretical and professional knowledge of engineers. Technological development is on increase in countries with high quality engineering knowledge, where there is a lot of quality cooperation between the industry, developmental laboratories in companies or the academy. Production is being moved to countries with a cheaper work force, cheaper energy or fewer environmental concerns. These processes have a great influence on the type of engineering knowledge in a certain society, which consequently depends on the economic structure of a society.

Quite obviously, technological development and globalisation has a huge influence on the requirements of the economy to have a different kind of engineers, which cannot be provided by the exiting natural science and technical study programmes.

It is therefore obvious that a lot of criticism, debates and projects are continuously going on, with the aim of modernising the existing educational practice and curricula offered by the universities; we can ascertain:

- Technological development and globalisation require a different type of engineers
- The young prefer more "attractive" jobs and studies, which additionally supports negative trends of globalisation (outsourcing production in countries with a cheaper work force, energy, etc.), which is yet another disadvantage for Europe's position on the world market.
- European and national policies– with the Lisbon declaration – are aware of this problem se and emphasise the importance of increasing the enrolment in technical studies.
- In Slovenia, the Government tried to deal this problem by decreasing the number of enrolment places in social sciences and increasing the number of enrolment places in natural sciences and technical studies (indirect financial mechanisms)
- What is needed is a more comprehensive approach: transfer of knowledge from the economy and universities and laboratories, the production of state-of-the-art products, and the development of suitable study programmes, etc.
- And, from the industrial point of view, manufacturing is a subject that cannot be handled efficiently inside a university classroom alone.

Therefore a real challenge for academia, government and industry [3] (Rolstadas, 2005) is: how to provide industry with the human capital that will develop the future manufacturing strategies. To do that, universities need to develop a ***new generation of manufacturing curriculum*** with professors, who understand the future industry and we need to ***attract youth with an interest in technology and natural sciences.***

Considering the changes of the industrial development it has been written [4] (Moseng, Rolstadås, 2002): *the industry has over the last decade undergone a significant change. It is no longer home-based; it operates in a global market. Digital business has become a strategy to survive. The extended enterprise is being implemented. Parts are made where conditions are most favorable. Non-core activities are out-sourced. These service companies then become part of the supply chain that also spans suppliers and distributors. They all comprise and international co-operative network to provide manufactured goods and support services for a world market just in time, at low prices and with quality surpassing customer's expectations.*

And also [5] (Rolstadås, 2004): *in order to meet the challenge of the future way of business operation for the manufacturing industry, a new type of curriculum in manufacturing strategy is needed. For this reason the IMS project "Global Education in Manufacturing" (GEM) has been launched. The main objective of GEM is to develop a new curriculum covering both manufacturing technology and manufacturing business – a Master degree in Manufacturing Strategy.*

Thinking about the dilemma: is this approach and are these curricula also appropriate for the specific needs of the Slovenian manufacturing industry, and about the necessary skills and knowledge of Slovenian engineers in relation to the GEM approach, we also stated [6] (Dolinsek, 2003): *in respect of the other NAS (Nearly Associated States) Slovenia has a relatively highly developed industry, which also largely contributes to the whole export from the country. To a large extend the main competitive advantage of this industry is based on the professional skills and knowledge of the engineers and the extensive investment of the companies in the education of the workforce.*

We can establish that in that sense the needs for skills and knowledge of many Slovenian manufacturing companies are far ahead from what the academic institutions can provide. Therefore links and benefits, such as those provided through the GEM project can be an excellent support for Slovenian educational institutions to become part of the global education system.

On the basis of response from the Slovenian industry, these tasks was completed within the GEM project, we also published the results and concluded [7] (Dolinsek 2004): *one of the most important demands in developing the new curriculum is therefore firstly to define and understand the needs of the manufacturing industry for training and education on a global basis. The approach presented forms part of the international GEM project (Global Education in Manufacturing), a project in which Slovenia is also involved as a partner, and some experiences obtained in the GEM project and research of the needs in the education of the manufacturing strategist are also presented.*

At the GEM workshop organized within the international IMS Forum 2004, where we presented our efforts and results in introduction of GEM curricula into Slovenian educational practice we also said [8] (Dolinsek, Starcic, Kopac, 2004): *among different structural changes, which have to be accomplished, one of the most demanding tasks is related to the higher educational system related to the harmonization of the EU and global educational systems. Particular emphasis is on the needs of Slovenian industry, particularly those related to the competencies, as a contrast to the discipline-based education practice, mainly offered by the Slovenian universities. Links and benefits, such as those provided through the GEM project, can be an excellent support for Slovenian educational institutions to become part of the global education system.*

Actions followed were focused into the implementation of GEM curricula in relation to the changes of educational programs due to the Bologna declaration and Slovenian low for higher education (Slovenian GEM industrial workshop), the last achievements of the GEM project and possibilities of introduction of GEM results into the Slovenian universities and also the GEM industrial training model is the aim of this paper.

In order to identify different values of the youth several analyses have been carried out. One of them has been developed within the framework of the ROSE project (Relevance Of Science Education), which has been managed by the University of Oslo. In Slovenia, similar researches have not been carried out yet. The initiative for the research was proposed in 2005 within the final meeting of the international GEM project (Global education in manufacturing, project 5 FP EU).

The ROSE project (Perceptions, values and priorities of young people in relation to science and technology education) is based on the belief, that science and technology form an important area in all countries, apart from their culture and economical development. The science and technology curriculum should be adjusted to learners' needs, which can differ among countries and among certain groups of learners in each country. Other countries as well have been invited to participate in the ROSE project with the aid of the international research institutions (IOSTE, ESERA and NARST). UNESCO has been also acquainted with the ROSE project.

In the "ROSE – Slovenia research" we were interested in different interests of the eight grade primary school learners in science and technology curricula. Furthermore we took in consideration other primary school grades, final grades of gymnasium, the difference in opinions among different regions, the opinion of the economy etc. The research development and the inquiry in different schools began in

2005 (therefore the first publication was made). The work continued in 2006 (an international science and research project between Norway and Slovenia has been also approved on the basis of first results). In 2007 the international conference of partners was organized within the framework of the KRIM project (Gender, Recruitment, Interest and Motivation in Science and Technology Education).

2. YOUTH PERCEPTION RELATED TO THE SCIENCE EDUCATION

In Slovenia, the increase in the number of students enrolled in social sciences and, consequently, a relative decrease of the number of students enrolled in natural and technical sciences and engineering, where the number of students in the last ten years remained the same. The number of graduates in mathematical, scientific and engineering programs (2000-2002) increased by 4.3, which is reflected in the share that is, in comparison with other countries, positive and can be placed in the middle of EU-25 (4.6). A decrease in the number of graduates was noticed in Germany (-2.1), Spain (-2.9) and in Ireland (-5.1).

The share of these graduates has also been decreasing in Slovenia (2000 22.8%, 2001 20.3% and 2002 19.9%) and is lower than in the EU-25 (2000 24.8% and 2001 24.4%). (Progress towards the Lisbon objectives in education and training (SEC (2005) 419, 22 March, 2005). Of course, the unfavorable demographic changes reflected in rapid decrease in the number of live births, will soon strongly interfere with school system.

In Slovenia the majority of schools are public and free of charge. There are few private schools (catholic and schools based on alternative pedagogical approaches). Children start school aged six and usually finish compulsory schooling at 14. Compulsory schooling is divided into three triads, each lasting three years. Natural science subjects are taught in all grades. From the first to third grade the subject environmental studies is taught. In the fourth and fifth grade natural and technical science are taught, in the sixth and seventh grade natural sciences and in the eighth and ninth grade chemistry, biology and physics.

Science is taught throughout all grades. In the first triad the content is taken mainly from biology but also from chemistry and physics. In the second triad there is a subject Science and Technology. In the third triad pupils have Physics, Chemistry, Biology, Technology and they can have one or two subjects from the field of science and technology (e. g. electrical engineering, astronomy …) according to their choice.

ROSE methodology [10] (Schreiner 2006) was used in the study and the original questionnaire was recapitulated in its entirety. It was not necessary to obtain special permission for undertaking the study, as only data on sex and age were collected from pupils. The target population was the final grade of elementary school, where the children were usually 14 years old. For ROSE project methodology the inclusion of at least 1,000 pupils in the study is adequate. According to ministry data 20,716 pupils attend the ninth grade. The pupils are divided into 1,004 departments with the average number of pupils per department being 20.6. Schools were selected for the survey according to the principle of random sampling.

The original version of the questionnaire was in English and finalized in 2002. At the end of the year 2005 a group of translators and school teachers translated the questionnaire. The aim was to keep the questions and statements as simple and clear as possible. A group of teachers had to form the questions in order to be understood by the pupils. Before the final version was done, the ROSE team proof-read it and after a few meetings we agreed on the final version.

The study began on February 20th and all questionnaires were returned to March 15th, 2006. The pupils showed interest in completing the questionnaires, which took 20 to 40 minutes to complete. After undertaking the survey it was found that 1,187 pupils or 96.03% of the anticipated sample were included or 20.46 pupils per department. 537 boys and 547 girls took part in the study, their ages ranging from 13 to 16 years. 14 questionnaires (1.17%) were excluded as invalid (inadequately completed or pupils left an entire page blank), meaning 1,084 pupils or 91.32% of questionnaires from the total sample were valid according to the methodology used in the ROSE study.

The questionnaire comprised seven areas, marked from A to J. Under letters A, C and E were questions on what interested the pupils and about what they wanted to know more. Under letter B were questions on what is important for choosing a vocation, under letter D questions on environmental challenges, under letter F questions covering the field of natural science subjects studied at school, under letter G questions covering the field of science and technology and under letter H questions on extracurricular activities. Under letter I was an open question asking pupils what they would do as scientists and why and under letter J they were asked how many books they have at home.

The analysis undertaken compared mean values and standard deviations of each question and each area and a comparison was made of responses with the highest values and those with the lowest. Figure 1 shows the comparison of mean values and standard deviations of answers to questions from area ACE.

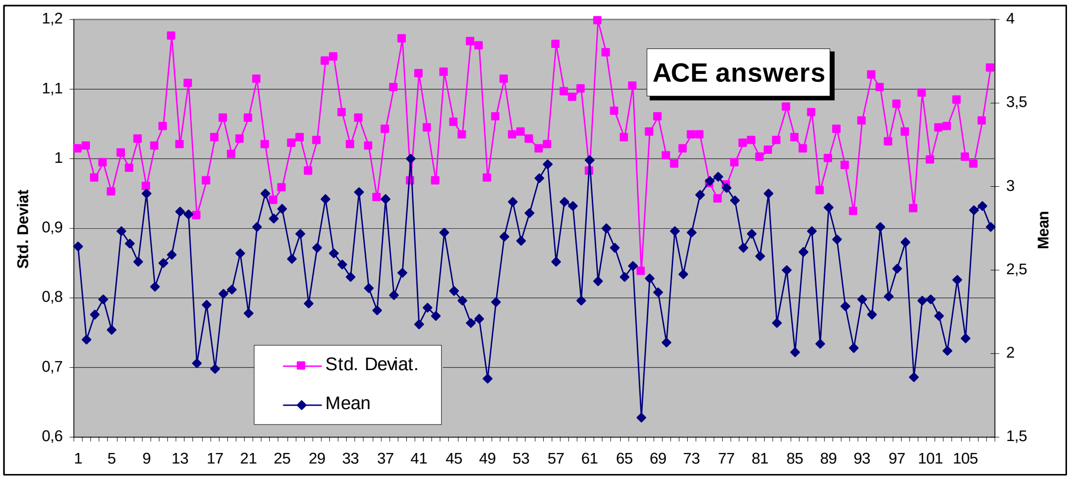

Figure1. Mean values and standard deviations for answers from area ACE

Most values ranged within the interval 2.2 and 2.8. Values deviating upwards from 2.8 indicated things the pupils wished to know more about and represented things they were more than average interested in. Marks under 2.2 indicated things pupils were less interested in or not interested in at all. From the values of standard deviation it was found that the trend was similar to that with mean values, the values ranging between 0.83 and 1.197.

With respect to the area of questions ACE ("How interested are you in learning about the following?" an attempt was made based on an analysis of these questions to find a link between the pupils' interests in the area of natural science and their deciding on future vocations. On the basis of responses obtained it was concluded that pupils were very interested in areas linked to preserving physical activity, space and illnesses. They were not interested in areas linked to technologies connected with chemistry or agriculture.

Area B appertained to responses important in choosing a vocation. Questions covered various areas including the natural sciences. In table 1 are shown the highest and lowest mean values of responses, most lying within a range of 2.5 to 3.3 (only a few answers deviated from this average). In girls using their talents, monitoring their decisions and doing something useful were important in choosing a vocation whereas in boys earning more money was important. Marks to questions appertaining to achieving importance in vocations were low (e.g. the question to become famous obtained an average mark of 2.43).

The gap between boys and girls was very significant in the question "building and repairing objects with their own hands" and "work with machines and tools". Girls were not interested in either but boys had a positive attitude to work with machines and tools. The distribution of responses was significantly bi-modular with the scatter of answers small (the standard deviation for the answers B7 was only 0.75 for girls).

Table 1. Questions B (My future job)

Q. No.	*Question*	*Sum.*	*Girls*	*Boys*
B 15	Working with something I find important and meaningful	3,55	3,71	3,40
B17	Having lots of time for my family	3,46	3,42	3,50
B20	Earning lots of money	3,44	3,33	3,54
……				
B4	Working in the area of environmental protection	2,28	2,32	2,24
B6	Building or repairing objects using my hands	2,08	1,63	2,50
B7	Working with machines or tools	2,03	1,41	2,64

Area F appertained to responses linked to learning content from natural sciences at school. Most mean values calculated ranged from 2.2 to 2.8 (the average value for all answers was 2.5). This means that natural science was not a subject pupils enjoyed when compared to other subjects. Equally important was the response to the question on employment in the area of technology (pupils were not interested in such vocations). Here was significant difference between boys and girls, whereas other responses more or less corresponded (table 2).

Table 2: Questions F (My science classes)

Q. No.	*Question*	*Sum.*	*Girls*	*Boys*
F 07	The things that I learn in science at school will be…..	2,89	2,99	2,79
F 02	School science is interesting	2,86	2,99	2,73
F 13	School science has taught me how to take better care…..	2,71	2,83	2,58
……				
F 15	I would like to have as much science as possible at school	1,90	1,92	1,86
F 09	School science has made me more critical and sceptical	1,86	1,81	1,89
F 14	I would like to become a scientist	1,84	1,66	2,03

With regard to this, the answers to typical questions are interesting (see figure 2). The points at the bottom of the diagrams, where the results obtained in Slovenia can be seen, it can be noticed that the perception of the young related to science and technology is similar as ascertained by the developed EU countries. So, we presented some aspects, which stress the importance of teaching science and technology pupils in the last grades of primary school.

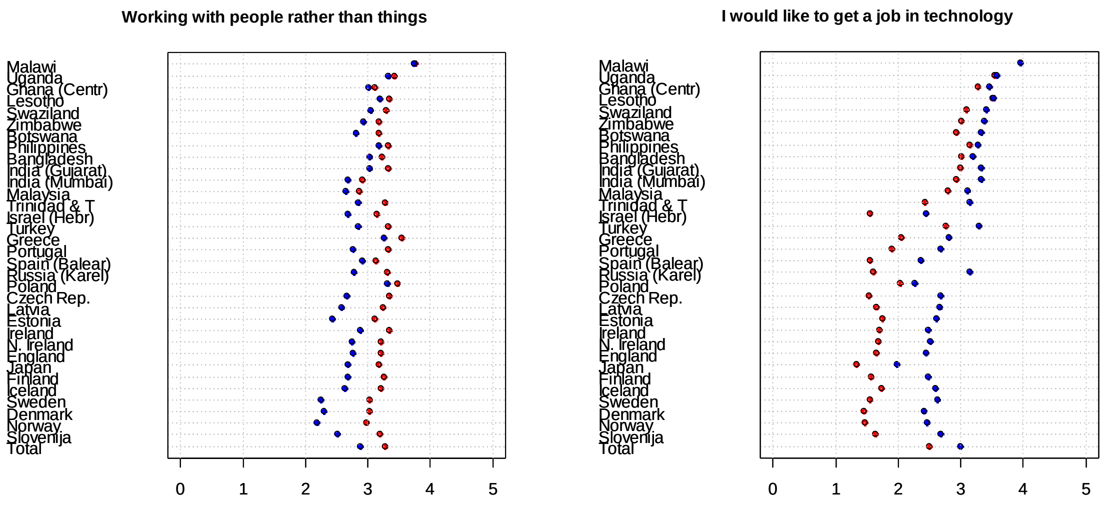

Figure 2. ROSE results and youth perception in Slovenia.

Results indicated some interesting finding as following:

- Perception of the youths related to the science and technology is similar as ascertained in the EU developed countries.
- However higher values in standard deviation of the results in relation to the Norwegian results can indicate some transitional influence probably related to the scatter of the values or differences in school subjects.
- Even the youths indicated the importance of the science and technology, but they would not like to get a job within the technology.
- There are significant differences between the perception of boys and girls and some results are opposite to those within the ROSE (e.g. girls like science more than boys).

3. COMPETENCES NEEDED IN MODERN MANUFACTURING

In the most general sense, manufacturing is central to existence or survival and the manufacturing industry is a key industry. The activity of manufacturing is much more than machining metals: manufacturing is an extended social enterprise. Within the manufacturing industry a challenging activities influencing competitiveness are therefore connected to radical new way of operation (digital business) and to new products (extended products).

Digital business involves advanced use of information and communication technology in every link of the supply chain to simultaneously reduce cost and lead times and increase profit. Interesting problems are connected to e-commerce within manufacturing systems design and production management and e-commerce within design and product development. In this context, manufacturing should not be understood in the traditional sense, but as the new way of working as digital business with extended products. Extended products mean taking a lifetime product support perspective and thus include all services to support the product in addition to the manufacturing of the product itself.

This will require that intelligence is embedded in the product. It includes both tangible and intangible products and services. The main challenge is within the support services for the product. Digital business significantly accelerates the flow of information within the extended enterprise. The creation of extended products through digital business is in figure 3.

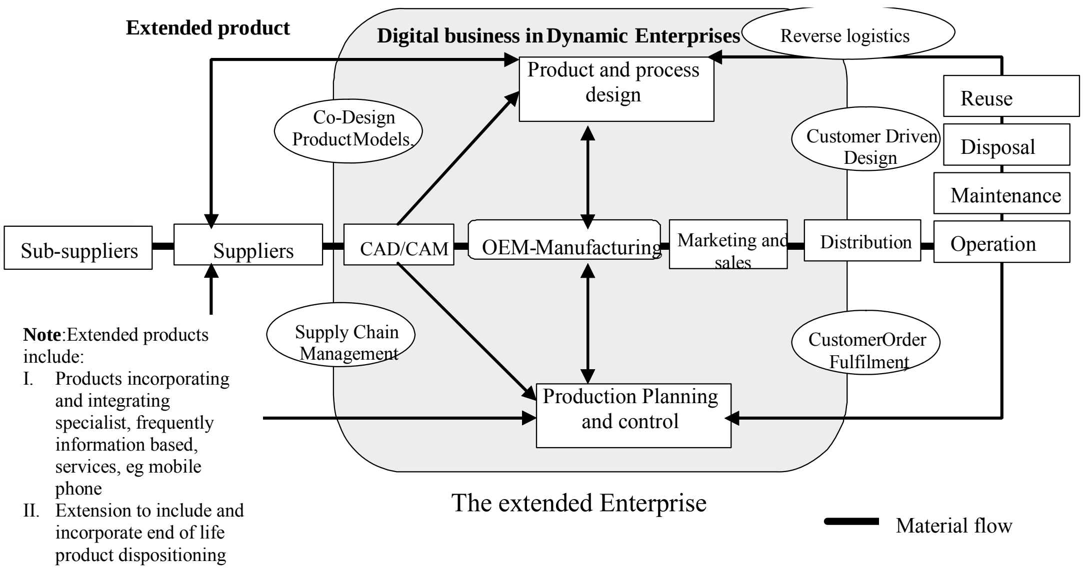

Figure 3. The concept of digital business and extended products [5].

For manufacturing companies required knowledge, skills and engineering competences are provided by mechanical engineers, industrial engineers and electrical, electronic and computer engineers. Their basic education is discipline oriented with focus on mechanics, operation research, cybernetics, electronics, etc.

To a limited extends this education reflects the real needs of the industry that faces problems of integrative nature across the traditional disciplines, such as:

- working with digital tools for communication;
- working in a multicultural environment;
- working in interdisciplinary, multi-skill teams;
- sharing of tasks on a global and around the clock basis;
- working in an virtual environment.

Existing curricula for Masters in manufacturing are directed more towards manufacturing engineers rather than manufacturing strategy. They have often tended to emphasize theory over process and have failed to meet the needs of the manufacturing enterprises operating as future extended and virtual enterprises.

To propose a master program that will meet the needs of the industry a survey that defined industrial needs was made. The questionnaire was divided into to parts. The first part covered the general demographical information to be used as classification variables for the analysis. The second part of the questionnaire covered the competence areas.

3.1 Competence areas

The competence areas have been divided in three main areas (figure 4):

- technological competence (Product related topics, Production related topics, Business operation related topics),
- humanistic competence (Individual related topics, Company related topics),
- business competence (Business and economic related topics, Management related topics).

The companies have been asked to rate the importance of the topics today, in five years and the needs for education and training for the future.

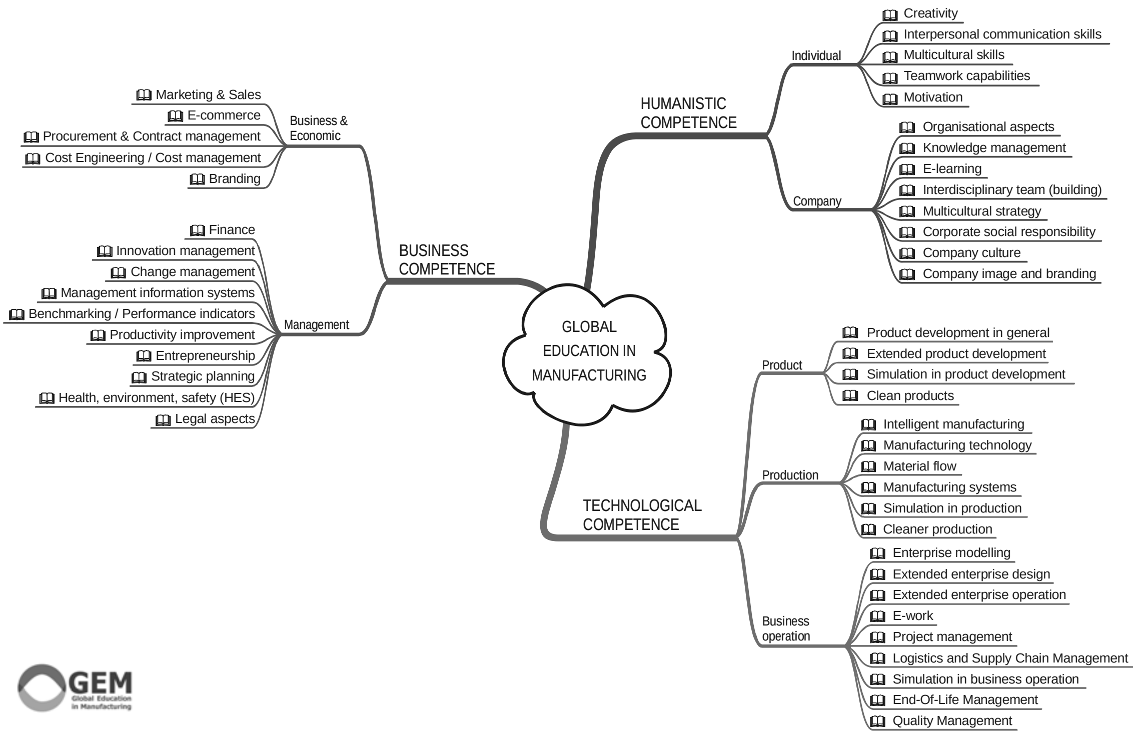

Figure 4: The skills and knowledge required for the production strategist

3.2 Survey results

Survey results among all IMS regions compared by survey results from Slovenian companies are shown on figure 5. We can see that there are similarities between results from Slovenian companies and results from all IMS regions. If we compare those results with importance of competence in 5 years we can see that:

- topics which are important today also need education in the future;

- less important topics today (remanufacturing of products, simulation in production, sustainable manufacturing, simulation in business operations, multicultural skills, e-learning…) seems to be more important in the future;
- all proposed topics need a focus in a new curriculum.

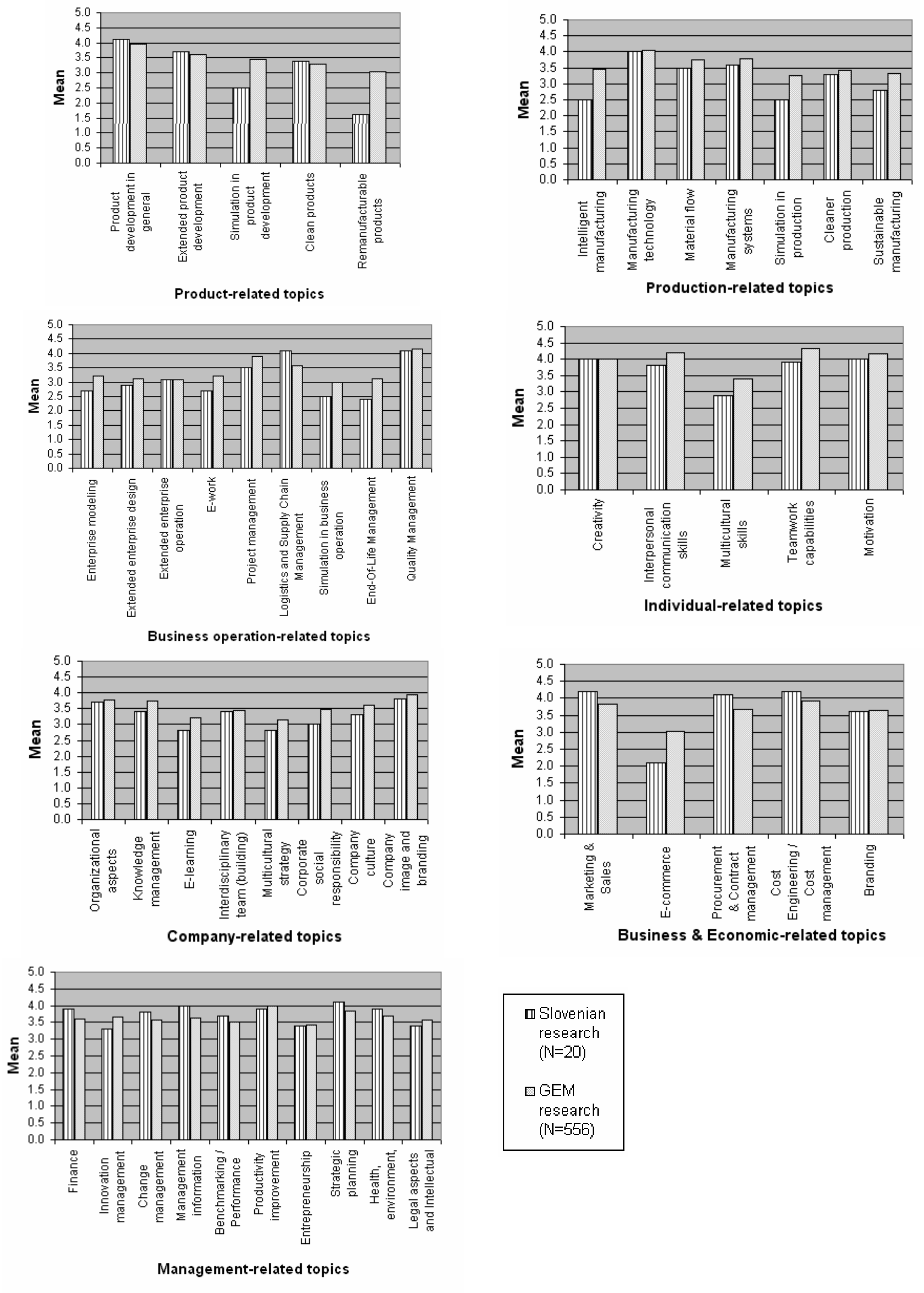

Figure 5. Today's importance of competences in industry [11] (Dolinsek, Prodan, 2004)

Survey results shows that the industry rated all competences almost equally important (figure 6). The most important competences are Product related (in GEM and also in Slovenian research).

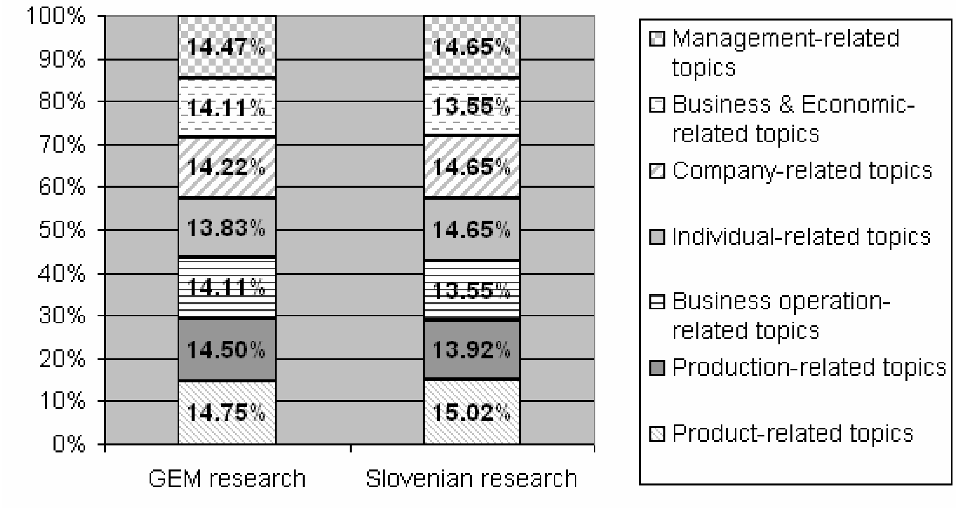

Figure 6. Importance of different competences

If we compare need for further education, all competences are almost equally important (figure 7). For further education the most important are Management-related topics.

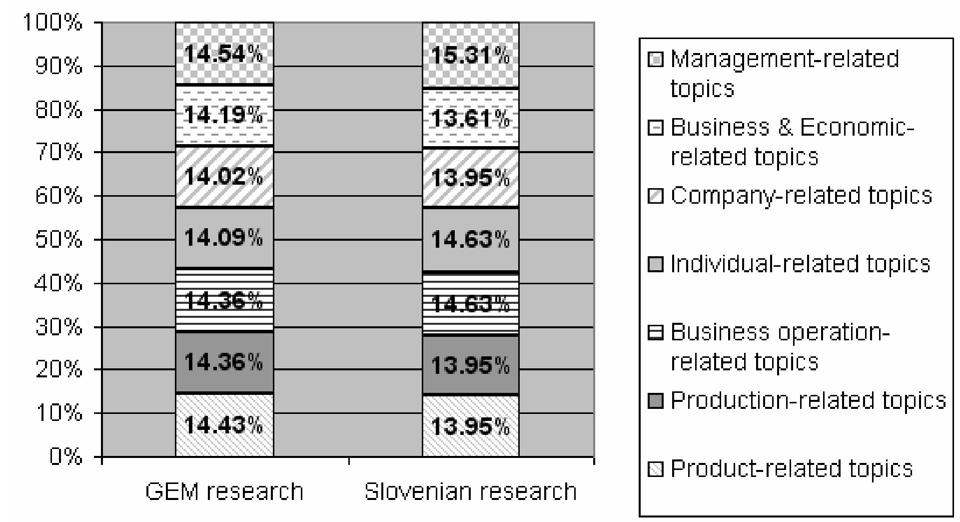

Figure 7. Need for further education

Survey that defined industrial needs together with reports describing cases and best practices in industry and pedagogic approaches give the main requirements for the new curriculum in Manufacturing Strategy.

4. CURRICULUM IN MANUFACTURING STRATEGY

A Curriculum in Manufacturing Strategy will be for a Masters program. It will be based on traditional engineering Bachelor degrees. However, it will deviate from the traditional education by focusing tomorrow's industrial situation requiring enterprise architects and products architects. The future education in manufacturing strategy must built industrial competence by providing a learning atmosphere in the company in co-operation between academia and industry.

The GEM framework identifies seven core knowledge areas within any new manufacturing curriculum and all of which reflect the current and future needs of the manufacturing industry. Table 3 shows an overview of the knowledge areas.

Table 3: GEM knowledge areas [5]

Knowledge Area		Description
A	Development of extended products	The development of a combination of a physical product and associated services/enhancements that improve marketability.
B	Digital business along the supply chain	Information on how a business can use e-commerce and related technologies and processes to develop, expand or enhance its business activities along the facilities and functions involved in producing and delivering a product or service.
C	End of life planning and operation	Techniques on how to develop methodologies and tools to support the end-of-life routing/processing decision based on economic, environmental and societal criteria.
D	Business operation and competitive strategy	Explanation of how organizations function and interact with competitors and their market place, and deliver performance over time.
E	Intelligent manufacturing processes	Elaboration of techniques applicable for handling complex production working in an uncertain, changing environment, with special emphasis on artificial intelligence and machine learning approaches.
F	Intelligent manufacturing systems design	Tools on how to model the skills and knowledge of manufacturing experts so that intelligent equipment and machines can produce products with little or no human intervention.
G	Enterprise and product modeling and simulation	Information on how to develop and use computational representations of the structure, activities, processes, information, resources, people, behaviour, goals and constraints of a business or a product.

A skeletal framework is illustrated in figure 8. The framework has a number of elements. Students will enter a particular program with a bachelor's degree and may or may not be induced into the program or university through a series of induction, bridging or capstone courses or workshops.

The details of these activities are solely the responsibility of the university concerned. Students will then have available to them, a number of courses. It is not anticipated that a particular university will offer all defined courses. On the contrary, universities will develop courses based on their core competencies on campus. However, the GEM framework will be available to help educators to identify and specify courses of interest.

5. INTEGRATION OF EDUCATION AND INDUSTRY

During the 1990s, universities were faced with significant pressure to produce innovative results that could be exploited more effectively by industry. This was mostly due to the fact that the European innovation gap was deemed to result from insufficient and inefficient scientific and technological transfer. In this context, universities and technical schools around Europe have been trying hard to adapt themselves to the new manufacturing reality of the 21st century. The modern university is distinctly different from that of 30 or even 15 years ago, see [12].

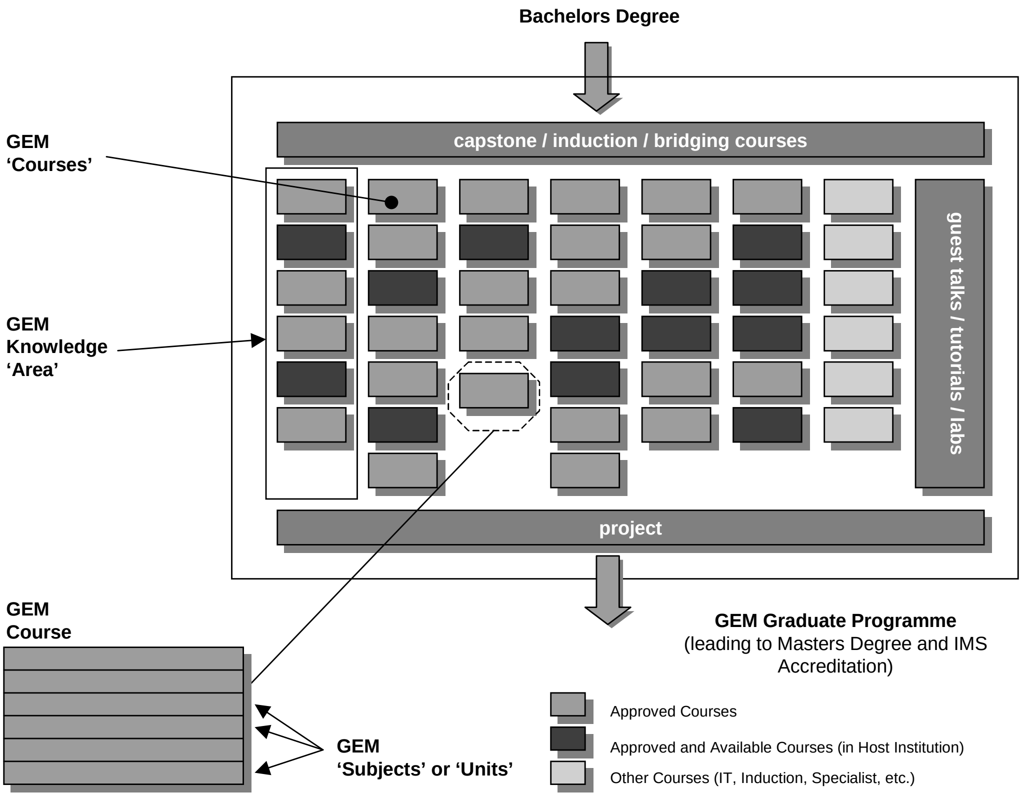

Figure 8. The GEM framework skeleton [5]

Development of educational curricula has nevertheless failed to keep pace with either the growing complexity of industry or the economy, and even less with the rapid development of new technologies. Studies are often too lengthy and too general. Furthermore, it can be argued that manufacturing is a subject that cannot be handled efficiently inside a university classroom alone. New forms of basic and life-long training, moving beyond the traditional disciplinary boundaries, with world-class targeted interdisciplinary teaching at university level, should also be envisaged (e.g. academic start ups, 'venture capital universities').

In general, an average engineering education and training last longer than is the case in other studies, as economy or social sciences (see figure 9). It is believed that in process of engineering education and training the first two stages are mainly carried out in school, while the last one is accomplished in industries [13]. In fact it is difficult to complete the engineering taste by relying solely on schools because universities fail to offer the real engineering environment for students to experience practical works, while industries pay little attention to this as they consider it is responsibility of the universities.

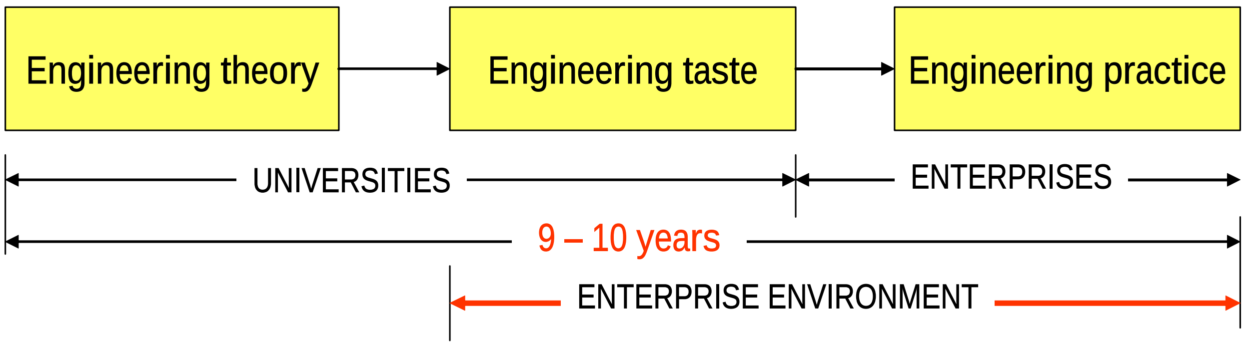

Figure 9. General process of engineering education and training

A highly promising approach would be to integrate the factory environment with the classroom, to create the ‘teaching factory’, in which academic study learning is combined with practical work experience and exposure to the needs of industry [12] (according to the Manufuture SRA).

The concept of the "Teaching Factory" has its origins in the medical sciences discipline and specifically in the paradigm of the teaching hospitals, namely the medical schools operating in parallel with hospitals. In a similar way, aiming to become a new paradigm in manufacturing technology education and training, the Teaching Factory will “integrate” research, innovation and education activities within a single initiative, so as to promote the future perspectives of knowledge-based, competitive and sustainable European industry.

6. CONCLUSIONS

There is the well-known crisis in the field of engineering education throughout the EU and in Slovenia. The fact is that the world »business« and »management« as a parable of success nowadays attracts the young, and also dissuades them from technical studies as a synonym for hard and less paid work. In Slovenia, the increase in the number of students enrolled in social sciences and, consequently, a relative decrease of the number of students enrolled in natural and technical sciences and engineering, where the number of students in the last ten years remained the same. Also, Slovenia has a relatively highly developed industry that needs professional skills and knowledge of engineers not only on engineering field but also on business field. The basic purpose of the article is therefore to present, how universities need to develop a new generation of manufacturing curriculum and what we need to do to attract youth with an interest in technology and natural sciences.

The first part of the article presents, how to determine the wishes of pupils in the final grade of elementary school with respect to content, linked areas of science, technology and technical science (in accordance with the ROSE project) and to find out what the measures adopted by the state, the teaching content in the area of natural and technical sciences and their comparisons with international trends uncovered within the framework of the ROSE study are. Based on the methodology, developed within the ROSE project, a quantitative research has been performed in order to investigate the learners' wishes regarding learning about science topics within different subject fields. The data was acquired by means of a questionnaire. The findings suggest that in Slovenia the learners' interest in science is low; nevertheless the girls are more interested than boys. The learners would like to learn more about animals, non-scientific phenomena and information technology. However, they are not interested in physics.
The second part of the article presents an example how to prepare new curriculum. One of the most important demands in developing the new curriculum is, therefore, firstly to define and understand the needs of the manufacturing industry for training and education on a global basis. The approach presented forms part of the international GEM project (Global Education in Manufacturing), a project in which Slovenia is also involved as a partner. The paper presents some experiences obtained in the GEM project and research of the needs in educating of the manufacturing strategist.

The goal of the research was to establish the knowledge and skills (competencies) which are the most important to achieve and maintain the competitive position of Slovenian industry in the world market. The research was based on the questionnaire prepared within the GEM project, in which industry was required to give some data related to the company and mark the importance of different competencies needed for the production strategist (his task is to organize, to start and control the production of the extended product). If we summarise the results of the complete analysis we can establish that the industry estimates all the proposed competencies needed for the production strategist as being almost equally important. Slovenian companies - as also the whole group - place the main emphasis on the product related topics (technological competencies). Also the future needs are similar; however, all the companies stress the main importance of the competencies related to the management related topics.

7. ACKNOWLEDGEMENTS

The work has been funded by the European Commission through IST Project GEM Europe- Global Education in Manufacturing, IST 2001-32059. Author would also like to sincerely express thanks to the so-called Slovenian ROSE-group (post-graduate UP FM students) for carrying out the research survey among the Slovenian school.

8. REFERENCES

[1] Ridderstråle, Nordström, 2000. Funky Business, BookHouse Publishing.
[2] Dolinšek, Slavko idr. 2006. Some governmental measures and youth perception related to the engineering education in Slovenia. Proc. of the XII IOSTE Symposium. Penang, Malaysia: str. 431–437.
[3] Rolstadås A., 2005. Product Lifecycle Management – the Industrial User Perspective. Advanced Manufacturing Conference, Nov. 16-17, 2005 at Leuven
[4] Moseng, B., Rolstadås A., 2002. Global Education in Manufacturing – GEM, CIRP International Manufacturing Education Conference, CIMEC 2002 Twente, The Netherlands.
[5] Rolstadås A. 2004. GEM – A Curriculum in Manufacturing Strategy Responding to the Needs of Industry; IMS Forum 2004, Como, Italy
[6] Dolinšek, S. 2003. Skills and Knowledge of Technology Managers Relation to The Approach of Global Education in Manufacturing, IAMOT conference, Nancy, France
[7] Dolinšek, S., Prodan, I., 2004. The needs of the industry for training and education in manufacturing strategy, Journal of Management, Informatics and Human Resources, 37, 2, 90-97, Modern Organization Publishing, Slovenia
[8] Dolinšek, S., Istenič, A., Kopač, J., 2004. Education for manufacturing - from discipline to the competency based approach. International IMS Forum, Cernobbio, Italy,
[9] Schreiner, Camilla, Sjǿberg, Svein. 2004. ROSE, The Relevance of Science Education, University of Oslo, Department of teacher education and school development.
[10] Schreiner, Camilla. 2006. Exploring a ROSE-garden, Norwegian Youths Orientations towards Science – seen as Signs of Late Modern Identities, Doctoral Thesis, University of Oslo, Faculty of Education.
[11] Dolinšek, S., Prodan, I. 2002.: Global education for the industrial requirements – new approach of the education for the engineers, Proceeding of the 3.rd Professional SMK conference, Portorož, Slovenia
[12] Manufuture: The Strategic Research Agenda (SRA) of the Manufuture Technology Platform, October 2006
[13] Wang Huifeng, He Renlong. 2006. Modeling and practice of co-operation education of the late part of undergraduate education in IT, ACEN forum, Gold Coast, Australia.