Engineering Education Development Modelling in STELLA Environment

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Abstract: - The lack of specialists of engineering and precise sciences already for quite a long time causes problems to the development of economy in some countries. The lack of engineers hinders the introduction of science capacious technologies and the production with high added value. The EngiMod model described in the article serves the analysis of education system using system dynamics and simulation in STELLA environment. Special attention is devoted to influencing factors that affect the choice to study engineering sciences. STELLA allows easily manipulating with the weight of the significant factors and interactively acquiring the necessary predictions. According to the primary conditions and statistical data, it is possible to model and predict the development of the situation in any time period. EngiMod multilevel model can be adapted to the needs of other sectors.

Key-Words: - Engineering Education, Simulation, System Dynamics, STELLA

1 Introduction

The lack of specialists of engineering and precise sciences is no longer a surprise, but already for quite a long time it causes problems to the development of economy in some countries.

On 25 May 2007 the Education Council adopted conclusions on a coherent framework of 16 core indicators for monitoring progress towards the Lisbon objectives in education and training. The important indicators are literacy in reading, mathematics and science, and ICT skills [1].

Regular monitoring of performance and progress using indicators and benchmarks is an essential part of the Lisbon process, allowing strengths and weaknesses to be identified with a view to providing strategic guidance for the Education and Training 2010 work programme.

By adopting five European benchmarks in May 2003, the Council set measurable objectives indicating the policy areas in which, in particular, it expected to see clear progress. The benchmark related with the indicators nominated above to be achieved by 2010 were: increase of at least 15% in the number of graduates in Mathematics, Science and Technology (MST). MST cover the following fields: life sciences, physical sciences, mathematics and statistics, computing, engineering and engineering trades, manufacturing and processing, architecture and building.

In 2005 Estonia, Greece, Poland, Austria and Italy showed the strongest growth in the numbers of MST graduates (>10%). Despite the general positive trend, some countries Spain, Cyprus, Belgium, Hungary, Malta, Sweden, Iceland, and Norway showed a considerable decrease in numbers in 2005. Other problem is total growth of MST graduates, which majority of countries as Bulgaria, Czech Republic, Germany, Greece, Cyprus, Latvia, Hungary, Malta, Netherlands, Austria, Slovenia, Croatia, FYR Macedonia, Turkey and Norway are bellow average EU-27 level [1].

The lack of specialists limits the possibilities to develop and produce science-capacious production with high added value. There are difficulties with introducing technologically complicated systems of management and control whose exploitation requires specific knowledge obtainable in a longer period of time. But the representatives of social sciences, humanities and management sciences often lack the knowledge and skills necessary to take well-grounded decisions which in the information and knowledge society are not possible without the knowledge of mathematics and modelling skills, and not based only on intuitive assumptions.

Not only the lack of new specialists causes problems, but also the necessity to regularly update the technical engineering skills and knowledge in accordance with the rapid changes in the development of technologies.

It must be noted that the solving of the above mentioned problems still is rather unsuccessful because it requires considerable capital investments in the development of material supply and introduction of new training methods.

In order to develop a well-considered state education policy, it is necessary to perform the analysis of affecting factors and create a full cycle model that would allow predicting the development of the situation in a longer time period. It can be done by using the system dynamics approach which gives the possibility to describe the set of significant factors and check the possible results in different conditions and development scenarios.

There exist a number of mathematical methods that can be used for solving differential equations. However, in order to reach the model transparency and sufficiently high level of abstraction, to ensure the possibilities of model usage by people without IT knowledge who should take decisions regarding state policy in the field of education and science, as well as to promote the interactivity of modelling process, the decision was taken to use the possibilities offered by *simulation*.

Today there is no problem to choose any of the system dynamics modelling tools like Vensim, Powersim, Dynamo, Dymola, STELLA, iThink etc., but it is preferable to have the best possible compliance with the previously defined criteria.

2 STELLA and EngiMod – environment for changes management in engineering education

To describe the structure and functioning of continuous system in 80'ies, Barry Richmond created STELLA software [2, 3, 4, 5]. STELLA introduced and integrated graphical interface using icons to develop stock-and-flow diagrams, and tying these icons to the underlying equations. STELLA window is divided into four tabbed pages: *Interface, Map, Model*, and *Equation*. Each tab represents a distinct layer in the model and each provides a different way of designing and presenting a model. Most important are Map and Model layers. Map layer is used for designing a visual model by using the alphabet provided by STELLA. In order to describe the processes of dynamics, the following basic elements are being used in STELLA environment: *stock, flow* and *converter*. Model layer is used for transformation the maps into models that can be simulated, but Equation level gives the presentation about all the equations that make up the model [2]. The results of modelling are usually acquired by means of several iterations. It can be presented both in a graphic and table forms.

The most significant advantage of STELLA [6, 7] is the possibility to specify very complicated models with minimum alphabet and offer different abstraction levels. In turn, the tools of graphic visualisation provide sufficiently comfortable model verification, validation and control of modelling process.

EngiMod [8] can be used to simulate the study processes and also changes in number of engineering specialists in a particular territory or country. In this particular case it is based on Latvian education system [9]. For Latvia [10] is typical an insufficient number of students in natural sciences, engineering sciences and information technologies. Traditionally this problem are solved increasing the number of State budget places in the study programmes of engineering sciences (mechanical engineering, engineering technology, mechanics and machine building etc.). It means that financial factor for study choice has observed as most important. Despite of it the situation practically is changeless. But maybe financial factors are not so critical?

The quality and the functionality of every model, also EngiMod results depend on the quality of the initial data. During the model development and testing, a set of hypothetical initial data is used.

EngiMod consists of seven layers:

- Prediction of the increase in the number of potential engineering students;
- Training of college level specialists;
- Analysis of the increase of engineering bachelor degree holders;
- Engineers training model;
- Training of master's level specialists;
- Prediction of the increase in the number of Ph.D. holders;
- Tendencies of change of the total number of engineering specialists.

3 First step – forecasting the number of potential engineering student's

The first level of EngiMod is the source of data for the rest of model layers. On the first level the process of the potential engineering student's number changes is described based on the data on the change of the number of grammar school graduates (Grammar_School_Absolvents) or $S(i)$.

$S(i) =< S_i >$, where $i = \{year_1,..., year_n\}$, but n-the length of the forecast (years). S_i - the number of grammar school graduates in $i-$year.

$$S_i = S_{i-1} + deltaS_i \qquad (1)$$

The initial requirements determine S_0 - the number of grammar school graduates in the beginning of first run, and $deltaS_i$ - changes of the number of school graduates in i -year (see Fig.1).

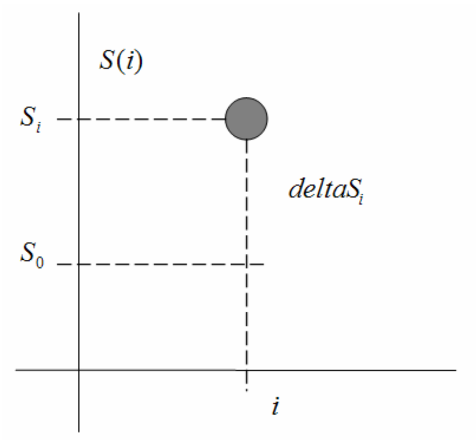

Fig. 1. $S(i)$ changes definition

STELLA environment provides the entering of numeral initial data not only in the form of a table, but also by using a visual graph (see Fig. 2).

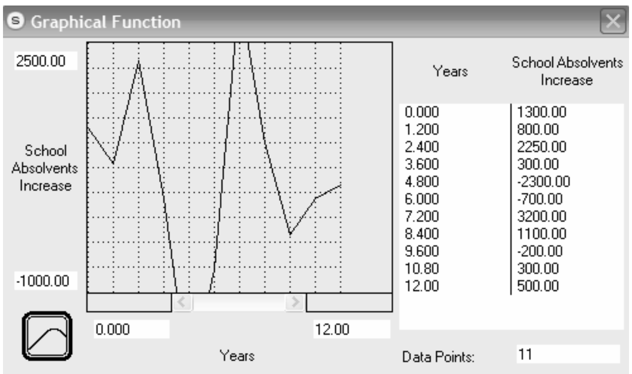

Fig.2. Graphical function (Grammar_School_ Absolvents) or $S(i)$

The number of students that will begin engineering studies (Engineering_Students_Started) is determined by a set of factors.

One of the most complicated tasks during the model preparation is an extensive and versatile analysis of the information in order to find out the significant set of factors that influence the choice of engineering and exact science studies. The analysis of the sources that included information on the last ten years was carried out. The evaluation of the material allows answering affirmatively to two points of view:

- The affecting factors are basically analogous for all countries even though almost every country refers to its experience and situation as something unique. The results show that the answers given by prospective students, graduates and post graduates in different countries are similar enough, thus endless repetition of the investigations will not lead to a success;

- There is a lack of an independent and objective analysis of influencing factors. Unfortunately such research is mainly done in countries that have a problem of insufficient number of engineering students and specialists. That in its turn means that the country does not know how to solve this problem, and therefore the results of the research are not very useful. But in countries where the quality and number of engineering specialists is satisfactory such investigations are carried out very rarely as they are not topical. For example, in India 57% of the total number of students study engineering sciences and natural sciences [11], but only 13% study humanities.

Typical case is Sweden that has always had a highly developed science capacious industry. However it should be noted that in the last decade the number of students in engineering sciences in Sweden has decreased by approximately 40%!!![12], and it creates a threat to further development of the country. Respecting the above mentioned considerations, interesting is the research by Nationellt ämnesdidaktiskt Centrum för Teknikutbildning i Studenternas Sammanhang Project (CeTUSS)[13]. CeTUSS is an engineering education center established by the Swedish Council for Renewal of Higher Education in 2004.

Engineering education in Sweden, as in the rest of the world, is experiencing a decline in student interest. CeTUSS research deal with the ways in which students think about engineering education, why they join an academic programme in engineering, and why they persist in their studies. In this context one of the aims of CeTUSS is to investigate the Swedish student experience and to identify and support a continuing programme of research leading to changes in higher education for engineers.

During 2006/2007 CeTUSS funded multiphase initiative "Stepping Stones" at Swedish Universities. The research is special with joint consortium where participated eight Swedish universities, research centres and representatives from universities of the USA and UK. The aim was to build a community of engineering educators and to increase their familiarity with evaluation and research approaches. The Project consisted of three phases. The first phase was aimed to examining relevant theory and empirical study design in engineering education research. During phase two the participants gathered data in their own classrooms. During the data collection process participants administered and validated a variety of instruments; surveys and interviews and concept map collection using tools developed by the CeTUSS centre. The final phase was a week-long workshop where participants analyzed the aggregated data.

During the second phase the students were asked to rank ten different statements about why they chose to study engineering. The alternatives contained the following statements [13]:

- Technology plays an important role in solving society's problems;
- Technology plays an important role in solving society's problems;
- Engineers make more money than most other professionals;
- My parent(s) would disapprove if I chose a degree other than engineering;
- Engineers have contributed greatly to fixing problems in the world;
- Engineers are well paid;
- Engineering is an occupation that is respected by other people;
- My parent(s) want me to be an engineer;
- An engineering degree will guarantee me a job when I graduate;
- Engineers are creative problem solvers;
- A person working at/from a university has encouraged and/or inspired me to study engineering;
- A non-university affiliated mentor has encouraged and/or inspired me to study engineering.

Options for each question were following - "not a reason", "minimal reason" "moderate reason" and "major reason". There were no systematic differences between the male and female responses [12] except in the two statements "My parents want me to be an engineer" and "An engineering degree will guarantee me a job when I graduate". The males did not identify the influence of their parents as a strong motivation for choosing engineering, while the females did. But possibly that was only the wish of males to demonstrate their independence in decision taking. The females indicated, to a larger extent than the males, an expectation that an engineering degree would guarantee them a job after graduation.

Practically the questions asked could possible to split in the following groups [13] (see Table 1):

Table 1. Statistical Analysis of Influencing Constructs

Construct Name	Cronbach Alpha	Rank
Motivation (financial)	0.731	4
Motivation (family influence)	0.776	2
Motivation (social good)	0.616	5
Motivation (mentor influence)	0.507	6
Confidence in math and science skills	0.743	3
Confidence in professional and interpersonal skills	0.785	1

For processing of the results statistical methods were used and Cronbach alpha calculation applied [14]. Cronbach's alpha assesses the reliability of a rating summarizing a group of survey answers which measure some underlying factor. A score is computed from each construct item and the overall rating is defined by the sum of these scores over all the test items. Then reliability is defined to be the square of the correlation between the measured scale and the underlying factor the scale was supposed to measure. Most Cronbach alphas in current survey were 0.60 or higher, which is considered an acceptable level of internal consistency. A higher score indicates a more significant influence of a particular factor.

The particular SeTUSS [13] investigation shows that if we leave out every individual's belief in his or her abilities, the determining factor is the influence of the family which allows predicting the number of potential students on a state level by using multilevel and microanalytical simulation methods. The knowledge and skills in sciences acquired in a grammar school plays an important role, but the influence of career advisers is close to zero, which in its turn gives the country a possibility to reconsider the expedience of the investment of financial sources in maintaining the particular services.

Similar results on the factors influencing studies were acquired in a research done in Turkey [15]. 2459 students from 182 universities located in 17 different provinces participated in the research. The aim of the research was to find out the influence of the family and social status on the career choice. The results showed that parents and relatives had a crucial influence on the choice of career. But the choice of a particular higher education institution was determined mainly by social status and the income level of the family.

Also the analysis done by The Institute for Employment Studies (UK) [16] demonstrates several factors that determine the choice of engineering studies:

- The experience of studying subjects at school;
- Public perceptions of different options and careers;
- Media portrayal of engineering sciences;
- Informal networks composed of parents, friends or work colleagues, etc;
- Formal networks such as careers advisers.

The research carried out in UK [17] emphasizes the influence of the work quality of science subject teachers on the further career choice of grammar school graduates. In similar research it is concluded that „Good quality teachers, with up-to-date knowledge and skills, are the foundation of any system of formal science education. Systems to ensure the recruitment, retention and continuous professional training of such individuals must be a policy priority in Europe [18]". It is recommended to improve the curricula of science subjects at school by joining the theory learning with the surrounding environment and problems, as well as by improving the visualisation of the study process [19, 20]. A conditioned influence of parents, friends and work colleagues in the choice of further studies and profession is recorded. The prospective student is influenced also by the representation of science and technologies on television as well as other electronic mass information sources. Rather conditioned is the influence of career advisers. The sex, ethnicity and social class of the potential students are mentioned as the background factors. However, inclusion of such factors into the model could create ethical problems.

The above mentioned considerations are respected in designing EngiMod model and determining the set of influencing factors (see Fig.3). First of all, it should be taken into account that chiefly only those students that have studied exact subjects and taken exams in them (Exact_Education_Factor), as well as those that have been successful enough (Quality_Factor) can undertake studies in engineering sciences.

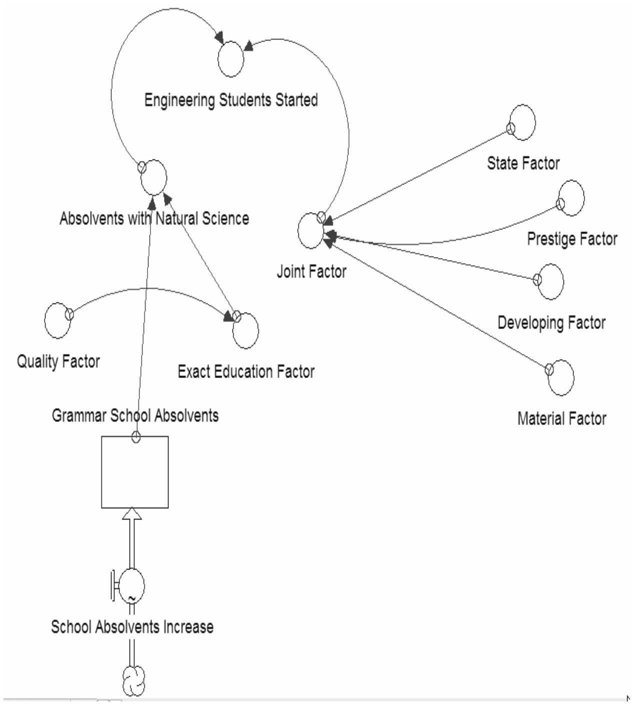

Fig. 3. The growth of potential engineering students

However, there are a number of factors that determine whether the potential student (Absolvents_with_Natural_Science) will choose engineering science as his or her profession (Engineering_Students_Started). The potential student is concerned with the salary in the future profession (Material_Factor), the possibilities for development and career (Developing_Factor), as well as the prestige of the profession (Prestige_Factor).

A significant factor in the choice to study exactly engineering is career possibilities that simultaneously are linked to a considerable improvement in financial situation.

It is the most common undergraduate degree among Fortune 500 CEOs (20%), has the highest average starting salary of any undergraduate major ($51k for mechanical, $53k for electrical, and $56k for chemical per year), and on average earns ~ 65% more than a degree in other sciences. Also the incomparably easier retraining possibilities are pointed out, i.e. it is incomparably easier to go from engineering to business than vice versa [21]. By the way, the change of profession from mechanical engineer to surgeon is not considered here.

One of the important influencing factors is state support (State_Factor) in providing study loans, state funded studies and other benefits.

4 Simulation the changes at college, graduates and engineers level

On the second level of EngiMod the training of first level higher education specialists in engineering sciences is described (see Fig.4).

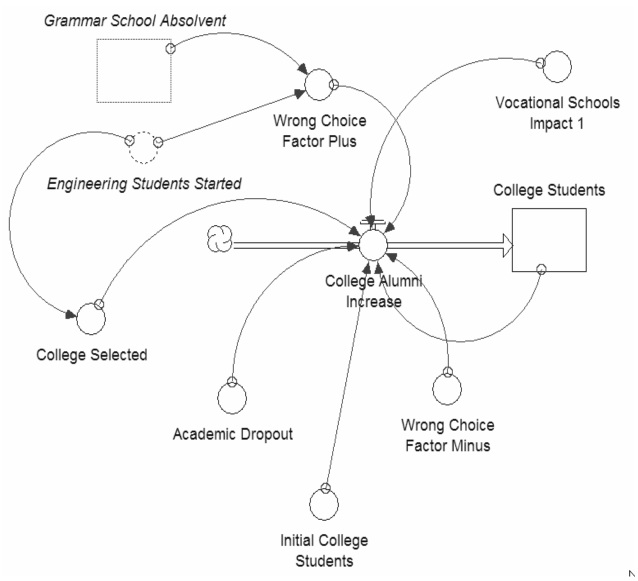

Fig. 4. Training of college level specialists

In the particular model the influence of vocational schools is taken into account (Vocational_Schools_Impact_1), as well as the possibility that a small number of grammar school graduates without formal knowledge in exact sciences will nevertheless risk and choose engineering science studies (Wrong_Choice_Factor_Plus). It must be noted that only part of Engineering_Students_Started choose college level studies (College_Selected), but the majority go to universities. The increase of the number of specialists is affected by academic dropout (Academic_Dropout) that results from the failure to complete study debts, as well as the realisation of the wrong choice of the profession (Wrong_Choice_Factor_Minus). Academic drop-out factors more detailed will be analyzed later.

Third level model of EngiMod (see Fig.5) considers the condition that bachelor studies (Bachelors_Input) are undertaken not only by students that have planned studies for a long time (University_Selected), but also those grammar school students that have not considered that before (Wrong_Choice_Factor_Plus_2). Also part of the specialists who finish college level studies can continue with bachelor's level studies (Continuing_College). Small part of vocational secondary education graduates (Vocational_Schools_Impact_2) prefers bachelor's studies instead of college level studies.

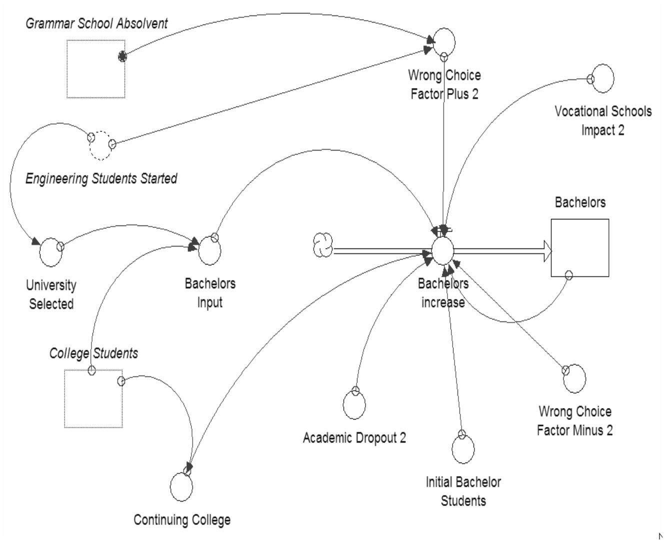

Fig. 5. The increase of engineering bachelor degree holders

The considerable student dropout should be taken into account (Academic_Dropout_2), resulting from the complicated character and the specific study process of engineering science studies (laboratory works, high costs of individual study process). Academic drop-out is a problem for specific discussion.

In order to find out why the studies are often not completed, there is a number of investigations, but in most cases nobody is surprised if at the end of the first study year the academic dropout in engineering studies reaches almost one third of the enrolled students, but the bachelor degree after three or four years is in the best case received by approximately half of those that commenced the studies. If taken into account that most students study for tax-payer money, the situation is rather unpleasant.

The reason of academic drop-out can of course be wrong choice of studies, financial problems, as well as the incorrect assessment of one's intellectual capabilities, but as in every life situation an another point of view can tell a lot. Therefore it is useful to take into consideration the opinion of foreign students that go to study in Europe [11]. The report observes the perception of European higher education in third (non-European) countries. It sets out the results of a project conducted between November 2004 and December 2005 by the Academic Cooperation Association (ACA) in response to a call for tender issued by the European Commission's Directorate for Education and Culture. Four member organisations of ACA, the British Council, EduFrance, the German Academic Exchange Service (DAAD) and the Netherlands Organization for International Cooperation in Higher Education (NUFFIC) conducted 'fieldwork' by acting as "country coordinators" for information gathering activities in Brazil, China, India, Mexico, Russia and Thailand. The Institute of International Education (IIE) in New York City, an associate member of ACA, played a similar role for activities in the United States of America. Participation in the surveys was remarkable. More than 15000 students were involved.

In conformity with this report [11] Europe was clearly perceived as the destination with the most interesting tradition and cultural heritage and with the most attractive arts, music and cultural offer. On the other hand, Europe lacks innovation and tolerance in the view of respondents, reinforcing the picture of a "traditional" Europe that lacks dynamism.

Survey participants from the Asian countries rank the US above Europe in most academic and labour-market related issues. In current survey some opinions of foreign students about European studies were evaluated [11]:

- Best quality of higher education (only 60% were agree with this declaration);
- Best student support, orientation and academic guidance (only 37%);
- Highest flexibility of study and research (only 33%);
- Best research environment (only 41%).

The survey results still suggest that Europe is "modern". Otherwise, when asked for Europe's attributes, a substantial share of respondents from all target countries characterised Europe as "modern" - but not as "innovative". In the words of a Brazilian interviewee: "tradition can also mean inertia" [11].

The same results were obtained from the first Bulgarian Students Professional Orientation and Motivation Survey [22] was published in February 2008. The survey involved a sample of 12,477 students from 37 universities and 71 faculties or courses. This represents 10% of all students in Bulgaria and the survey is nationally representative in terms of universities and regarding students by year of education, course, region and sex. They considered the university programmes in engineering and IT especially is extremely outdated compared with the increasingly dynamic business practice in these areas. The survey findings confirm the criticism of many companies regarding the gap between higher education and labour market demands.

On the whole speaking about the European study programmes in engineering and natural science, it can be concluded that they are too wide and traditional, but with a low level of innovations. There is a lack of modern laboratory and research equipment. The training methods are little based on modern technologies that could make studies more exciting and better to perceive. The traditional training methodologies do not respect the different perception ways of different people.

However, if it is unpleasant to listen to the true reasons of drop-out or troublesome to improve the study process, then, of course, the Bologna process can be used as a means in decreasing the academic drop-out [23].

The data from the research by the Higher Education Information System (HIS) shows that in Germany the drop-out rate decreased in some sciences. Education minister Annette Schavan said, "This positive development shows that the Bologna process supports us in an important aim in university politics: the significant reduction of the university drop-out rate. The introduction of bachelor degrees at universities contributes to a higher rate of student success." But what is the benefit of the Bologna process in this case? The answer is following [23]: „...the average length of time that a student takes to complete a degree has been shortened with the introduction of the bachelor degree..." Of course, since the length of studies is diminished, the student simply cannot manage to drop out. Whether better specialists are obtained this question is doubtful.

Influenced by the above mentioned factors, a number of students can make a conclusion that bachelor studies in engineering sciences is not their true call (Wrong_Choice_Factor_Minus_2).

Bachelor studies provide second level higher education; nevertheless, it is possible to continue studies (Engineer_Speciality_Selected) in order to obtain the professional qualification of an engineer (see Fig. 6) or study on a master's level.

The fourth level of EngiMod takes into account the condition that part of the students that begin engineering studies, will leave it (Academic_Dropout_3), but the experience shows that for the time being this factor is not an important model component.

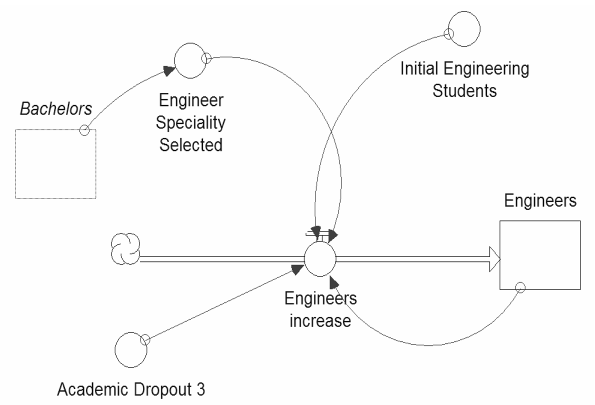

Fig. 6. Engineers training model

Modelling results can be represented in a graphic form. For example, three curved lines can be seen in Fig. 7 characterising the changes of the prepared engineering specialists (college, bachelor level specialists and engineers) during 12 years.

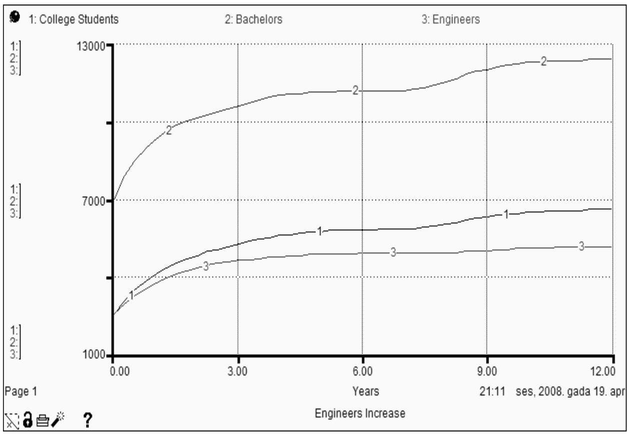

Fig. 7. Graphical presentation of the simulation results

5 Master level – step to the PhD?

It must be noted that a considerable part of bachelor graduates choose to continue studies on a master's level (Master_Studies_Selected) (see Fig.8). Academic dropout (Academic_Dropout_Masters) is almost equal to bachelor's studies, and also the wrong choice of study programme has some effect (Wrong_Choice_Factor_Minus_3).

However, the number of engineering and precise science master's students can be increased by one very important way – interdisciplinary study programmes (Interdisciplinary_Programmes), which is a perspective in order to change a rather hopeless situation in specialist training in precise sciences.

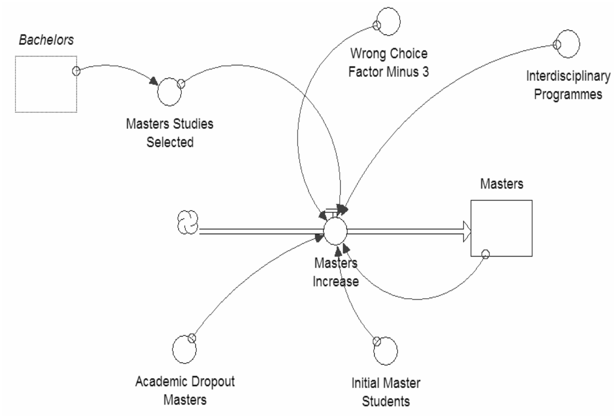

Fig. 8. Training of master's level specialists

Although it is not possible to achieve it in a democratic way that grammar school graduates study engineering sciences, it turns out, however, that in the following years the mood of the social science supporters can change significantly and some social science specialists are willing to study exact subjects with pleasure acquiring lots of things previously ignored or not understood by way of self-instruction. These conclusions were made due to EU SocSimNet (2004 – 2006) project [24, 25] that was devoted to developing an interdisciplinary master's study programme in Sociotechnical Systems Modelling.

After the preliminary testing, studies in this programme were undertaken by IT, business and humanities bachelor graduates with acquired professional qualification. The new knowledge and skills in knowledge management, simulation and modern technologies allow new master's not only to work in their specialities more successfully, but also ensure higher mobility in the labour market.

Much of the current concern about science education, expressed in reports such as *Europe Needs More Scientists* [26], concentrates solely on the supply of future scientists and engineers and rarely examines the demand. There are mentioned that the percentage of graduates studying for a PhD and obtaining the degree practically has dropped in all European countries.

The sixth level of EngiMod (see Fig.9) describes the study process of potential Ph.D. It must be noted that the doctoral studies are undertaken not only by the local students, but also by students that have acquired their master's degree abroad (Masters_Abroad). It is possible that the doctoral dissertation is prepared individually without attending doctoral studies (External_Doctors).

Academic drop-out (Academic_Dropout_ Doctors) in PhD programmes also is specific question. Traditionally the influence of the financial factor is glorified. Thus, the state searches for funds to create state financed study places and award special high scholarships, but nothing happens. Why? Supposedly that the managers of the education systems of several countries will find the answer in this very short comment: „To gain a PhD degree a student has to do two things: master a single, or *narrow* subject field completely and significantly extend the body of knowledge of that subject [27].

The problem is that European master study programmes in most cases are too wide, burdened with various and completely unnecessary requirements for different subjects and do not prepare the prospective student for the research work in the doctoral studies. As a result of master's studies the student has received extensive, but fragmented knowledge in a particular subject field, slightly widening the skills obtained previously in the bachelor study programmes.

As a result, master's studies do not reach its goal – to prepare the becoming scientist for the work on the doctoral level, but create a kind of upgraded bachelor.

More than that, in several countries there is a practice to award a professional qualification during master's studies which in its terms is nonsense. The profession should be obtained during bachelor studies, but master's study is a way that leads to doctoral studies. Thus, one of the most significant factors that determine the doctoral studies is the curriculum quality of master's studies.

The result of a successful doctoral programme depends not only on material circumstances (Social_Factor), which often serves as a formal reason, but a very significant condition is the lack of qualitative and interested doctoral dissertation advisers (Guidance_Quality).

It is absolutely clear that to enter the doctoral studies, then choose an adviser and the topic, and then only start working on the topic and prepare publications is a totally wrong approach that is a direct way to an unsuccessful doctoral studies concluding without submitting and defending the doctoral theses. The adviser and the topic has to be chosen and the first publications should be prepared during the master's studies which should serve as a transition period from obtaining a profession to generalizing the knowledge by doing a research in a very tiny part of science.

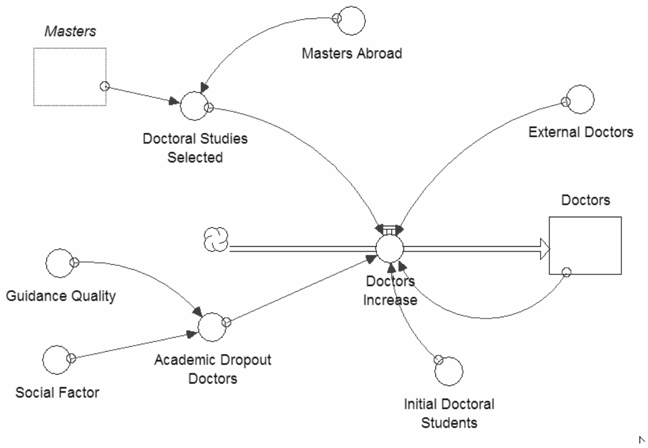

Fig. 9. Prediction of the increase in the number of PhD holders

6 EngiMod for changes management

On the seventh level of EngiMod the total changes in the number of engineering science specialists are described (see Fig.10).

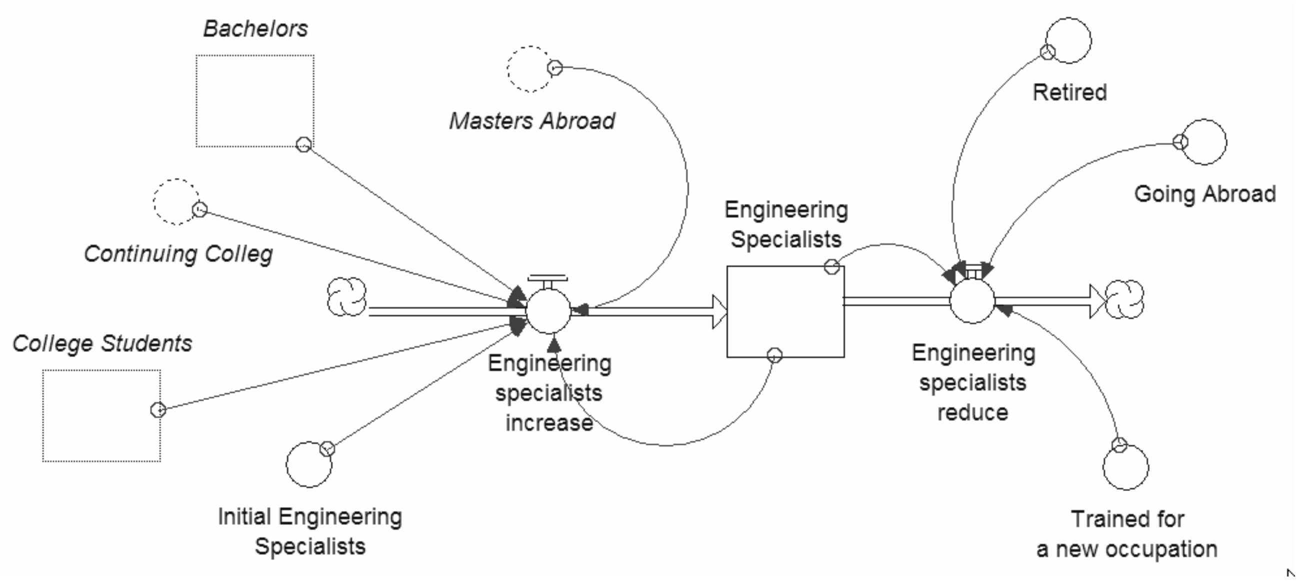

Fig. 10. Tendencies of change of the total number of engineering specialists

Not only the increase of the total number is enumerated (Engineering_Specialists_Increase), but also the decreasing tendencies are analysed caused by processes of aging (Retired) and migration (Going_Abroad), as well as change of profession (Trained_for_a_New_Occupation) if the person has not managed to find a good and suitable job or if there is a lack of willingness to periodically update the knowledge.

4 Conclusion

The EngiMod model described in the article serves the analysis of possible affecting factors using system dynamics possibilities. It allows easily manipulating with the weight of the significant factors and interactively acquiring the necessary predictions. According to the primary conditions and statistical data, it is possible to model and predict the development of the situation in any time period. EngiMod multilevel model can be adapted to the needs of other sectors.

Further development of EngiMod will be related with inclusion of several factors in model construction. In the next version, the sex of the students, as well as parent and environment influence in the choice of studies will be taken into account. The model validation with real data will be performed.

References:

[1] Commission Staff Working Document, *Progress towards the Lisbon Objectives in Education and Training, Indicators and benchmarks*, (This publication is based on Document SEC (2007) 1284), 2007

[2] Fisher S.M, *Modeling Dynamics Systems: Lessons for a First Course*, Second Edition, ISEE Systems, 2007

[3] Ford A., *Modeling the Environment: An Introduction to System Dynamics Models of Environmental Systems*, Island Press, ISBN 1-55963-600-9, 1999

[4] An Introduction to Systems Thinking: STELLA Software, *ISEEE Systems*, ISBN 0-9704921-1-1, 2004

[5] Papageorgiou G., A. Hadjis, K. Abrosimova, Management Flight Simulators; a New Approach to the Development of Decision Support Systems, *WSEAS Transactions on Systems*, ISSN: 1109-2777, Issue 5, Volume 7, May 2008, pp. 415-424.

[6] Roberts N., *Introduction to Computer Simulation: A System Dynamics Modeling Approach*, Pegasus Communication, ISBN 1-56327-052-8, 2007

[7] Sterman J.D., *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin-McGraw Hill, ISBN 0-07-231135-5, 2007

[8] Ginters E., Systems Dynamics Use in Engineering Education Development Planning, In: *Proceedings of the 5th WSEAS/ IASME International Conference on Engineering Education (EE'08)*, Heraklion, Greece, July 22-24, ISBN 978-960-6766-86-2, 2008, pp.221-226.

[9] The education system in Latvia, http://izm.izm.gov.lv/education/education-system.html. 11.05.2008 18:10
[10] Sumilo E. and I. Sloka, Occupational Mobility of the Labour Force, Nr. VPD1/ESF/NVA/04/NP/3.1.5.1./0001/0003, ESF National Programme „Labour Market Researches", Project „Researches of the Ministry of Welfare", ISBN 978-9984-9930-2-7, University of Latvia, 2007
[11] Muche F., B. Wächter, Perceptions of European Higher Education in Third Countries, Project 2004 – 3924 / 001 – 001 MUN-MUNA31, Brussels, December 2005, 251.
[12] Pears A. N., S. Fincher, R. Adams and M. Daniels, Stepping Stones: Capacity Building in Engineering Education, CeTUSS, May 26, 2008
[13] Adams R., S. Fincher, A. Pears, J. Börstler, J. Boustedt, P. Dalenius, G. Eken, T. Heyer, A. Jacobsson, V. Lindberg, B. Molin, J. E. Moström and M. Wiggberg, What is the Word for.Engineering. in Swedish: Swedish Students Conceptions of their Discipline, Technical report 2007-018, ISSN 1404-3203, Uppsala University, June 2007
[14] Cronbach L. J., Coefficient alpha and the internal structure of tests, *Psychometrika*, 16(3), 1951, 297-334.
[15] Ozdemir H., O. Hacifazlioglu, Influence of Family and Environment on Student's Occupational Choices and Expectations of their Prospective Universities, In: *International Journal Social Behavior and Personality*, ISSN 0301-2212, Vol. 36, Issue 4, May 2008, 433-446.
[16] Pollard E., N. Jagger, S. Perryman, M. Van Gent, K. Mann, Ready SET Go: A Review of SET Study and Careers Choices, The Institute for Employment Studies, 3rd Draft Report, CN: 6098, 2003, 159p.
[17] OFSTED, Science in secondary schools, OFSTED subject report series 2001/02, Report No. HMI 817 (see Section .5.2), 2002
[18] Osborne J., J. Dillon, Education in Europe: Critical Reflections, A Report to the Nuffield Foundation, January 2008
[19] Duggan S., R. Gott, 'What sort of science education do we really need?', *International Journal of Science Education*, Vol. 24, No. 7, 2002, pp. 661–679
[20] Sánchez-Torrubia M. G., M.A. Sastre-Rosa, V.Giménez-Martínez and C. Escribano-Iglesias, Visualization on Learning Mathematics Concepts for Engineering Education, *Proceedings of the the 4th WSEAS / IASME International Conference on Engineering Education (EE'07)*, Crete, Greece, 24–26 July, 2007, pp. 232-236.
[21] Brian Hollar, Why Study Engineering? December 09, 2006, http://thinkingonthemargin.blogspot.com/2006/12/why-study-engineering.html, 13.08.2008 12:10
[22] Daskalova N., Survey looks into employment expectations of students, Institute for Social and Trade Union Research, http://www.eurofound.europa.eu/ewco/2008/03/BG0803039I.htm, 12.07.2008 12:45
[23] Bologna process decreases university drop-out rate, Young Germany, http://www.young-germany.de/news-verwaltung/news-singleview/article/1cb14f93ce/bologna-process-decreases-university-drop-out-rate.html?no_cache=1**,** 07.07.2008 14:15
[24] Project No.LV/04/B/F/PP-172.00 (2004-2006) "Competence Network for Introduction of Modern ICTE Technologies in Vocational Learning in Social Systems Simulation and Research (SocSimNet)", http://www.socsimnet.com, 11.05.2008 19:30
[25] Vidzeme University College: Sociotechnical Systems Engineering, http://www.va.lv/en/node/462, 11.05.2008 19:45
[26] European Commission, Europe needs More Scientists: Report by the High Level Group on Increasing Human Resources for Science and Technology, Brussels, European Commission, 2004
[27] Why Study a PhD? QS Top Grad School, http://www.topuniversities.com/gradschool/grad_school_news/article/why_study_a_phd/, 12.08.2008 10:16