Women as Engineering Students in Slovakia[1]

Oto Hudec – Iveta Orbánová – Felizitas Sagebiel – Nataša Urbančíková[2]

Women as Engineering Students in Slovakia. In spite of the fact that in the last decades the number of women who have decided to study in higher education institutions has been continuously increasing in all European countries, in engineering studies on the contrary, there are only 20 per cent of female students.

Even though the percentage of the female and male students at engineering faculties in Slovakia was almost equal before 1989, the present situation is getting more and more similar to other European countries and number of female students in engineering studies has dropped significantly.

The described facts led to the research, which is focused on the clarification of factors that contribute to the creation of the culture for women engineers that would positively influence the female decision regarding engineering as a profession. The following hypothesis has been tested: a friendly and warm atmosphere and culture, and non-existence of institutional barriers for female students could lead to the growth in the percentage of female students in engineering courses.

The study is focused on clearer identification of the key stages of loss of women in engineering studies in Slovakia, and the different influencing factors operating and gives an overview on identified supporting and hindering factors for female students in engineering studies. The single parts of the study describe the qualitative research undertaken within the project. The aim of the qualitative research was to gain knowledge not only about the content of degree courses and studies, but also about the culture of degree courses and institutional barriers for female engineering students.
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Introduction

In the last decades the number of women who have decided to study in higher education institutions has been continuously increasing in all European countries. While more than 50 per cent of female students are opting to work in so-called "women professions", such as social workers, teachers, etc., at the same time, a much smaller percentage of women is choosing to study engineering or applied sciences. In engineering, manufacturing and construction studies generally, there are only 20.9 per cent of female students in EU15 (Eurostat, year 2001), whereas in electrical engineering, the percentage of female students is even lower. Society should be interested in finding solutions to the question of insufficient enrolment of female students in engineering studies. The ETAN report considers the low number of women in engineering in Europe as a "particular cause for concern" (2000, p. 58). Not only the numbers of women engineering students are gradually decreasing, but the numbers of women students and engineers who drop out the engineering study are far higher than those of men. Foster, Lister and Cronin (1999) in their survey of Scottish undergraduates in the academic year 1996-1997 showed that only 14% of engineering and computing students were female.

There are several reasons why it is important to attract more women into engineering and the commercial and financial arguments have been well rehearsed many times. Throughout the European Union the number of young men undertaking engineering studies is falling in part due to the demographic trends of falling birth rates. Balanced against that, engineers are one of the mainstays of the economy required for wealth creation and for the maintenance of economic competitiveness in world markets, and for the maintenance and development of infrastructures. This has led to many initiatives to attract more girls and women into engineering. Apart from this, personal level jobs in engineering, in general, are prestigious, well paid, offer a career structure and are interesting and demanding. If young women ignore jobs in science and engineering, they strongly reduce the scope of professions among which to choose from, plus they also refrain from active participation in the efforts of shaping our society and future via shaping technology. Educational institutions and companies that mainly recruit male employees leave out an enormous pool of gifted women.

Clearly, lots of young women have the capability and the talent to become engineers, to participate in technological innovation, and to contribute to sustainable development. Engineering, in general, can only profit from harnessing 50 per cent of its potential, both as consumers and as engineers (Ellis, V., 1997, p. 25).

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[2] Address: Doc. Dr. Oto Hudec, PhD., Faculty of Economics, Technical University of Košice, Letná 9, 040 01 Košice, Slovak Republic. Tel: +421 556330983, fax: +421 556330983, e-mail: oto.hudec@tuke.sk

MSc. Iveta Orbánová, Faculty of Public Administration, P. J. Šafárik University, Popradská 66, 040 01 Košice, Slovak Republic. Tel: +421 55 788 3639, fax: +421 557883665, e-mail: orbanova@fvs.upjs.sk

Dr. Felizitas Sagebiel, PhD., Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany. Tel: +49 202 439-2165, fax: +49 202 439-2431, e-mail: sagebiel@uni-wuppertal.de

MSc. Nataša Urbančíková, PhD., Faculty of Economics, Technical University of Košice, Letná 9, 040 01 Košice, Slovak Republic. Tel: +42155 6023294, fax: +421 55 6330983, e-mail: natasa.urbancikova@tuke.sk

Women in Engineering – State of Art

European and non-European research demonstrates what barriers and what promoters influence the number of women in engineering degree courses. Cronin (Cronin, C. – Cooper, M. – Roger, A., 1997, Cronin, C. – Roger, A., 1999) stated that progressive loss of women to higher engineering education is represented as a multi-layered funnel, where barriers to women's recruitment and retention act as a series of filters at key stages.

The interdisciplinary character of study has been identified in the European project INDECS (Beraud, A., 2003, p. 8; Sagebiel, F. – Hoeborn, G., 2004) as one of the key players (if sufficiently developed under certain conditions) in attracting women to engineering courses, although to distinguish and isolate this factor from some other factors, such as teaching methods, specific organisational structures (Sagebiel, F., 2003) (ex. mono educational courses, tutoring etc. ...) is not always possible. Moore and Holford (1995) concluded that engineering education would be improved if programmes of study had far more practical examples.

Cronin and Roger (1991) developed a conceptual framework against which initiatives and strategies might be assessed, and which demonstrates that the initiatives that are most likely to be successful are those which recognise the gendered and socially constructed nature of engineering and the need to change the curriculum, the structure and culture of engineering in order to attract more women (and men).

Engineering can be considered as gendered in three ways. First, gendered structures are visible in gender differences in terms of the division of labour and work styles of women and men. Second, the symbols and images of engineering knowledge and practice (artefacts, institutions) are gendered through cultural associations between masculinity and technology. And third, individual engineers have gendered personal and professional identities and experiences (Faulkner, W., 2000; Harding, S., 1986).

All three phenomena, gendered identities, symbols and structures, are pervasive. Research work on gender in engineering has to address the interactions between gender identity, symbols and structures and thus try to destabilise the equation of masculinity and engineering (Faulkner, W., 2000; Haraway, D., 1986). Etzkowitz et al. "have found that 'critical mass' is meaningless when women are isolated and unknown to each other, when affiliation with other women is too stigmatising, or the female faculty model available reflects an archaic, male stereotype impossible to emulate or incorporate into a contemporary professional identity" (Etzkowitz, H., et al. 2000, p. 245).

From critical men's studies you can learn how masculinities are embedded and perpetuated in society (Connell, R. W., 1999), not only in engineering. Feminist technology studies focus on the binary thinking, which is deeply rooted in persons and society (Wajcman, J., 1991, 1996). So research on women in engineering must bear in mind societal changes and surrounding social changes towards less gender segregation in educational and professional choices and careers.

In Slovakia the attitudes towards engineering come from a different background. The founding fathers of communism advocated that women should take part, as much as possible, in what was the man's world in terms of capitalism? (Ferber, M. A., 1994, p. 32). Newell, and Reilly (2000, p. 2) stated that historically, in many centrally planned economies, women's labour market participation was high and gender pay gaps low in comparison to many Western economies. Employment policies in Eastern Europe were based on a belief in both the duty and the right of women to work. In the former Soviet Union (and in the centrally planned economies of Central and Eastern Europe as well), female participation rates were regularly over 70 per cent, while in the West, the rates as high as this have only been observed recently in some Scandinavian countries. A noteworthy fact is that in the current transition period the participation of women in the labour market has dropped in most of the transitional economies, including Slovakia (74.2 % in 1990, 62.6 in 1999 - ILO, Bureau of Statistics).

Hence, the present situation in Slovakia is getting more and more similar to other European countries. Following research of Piscová (2003) in the academic environment, both horizontal and vertical segregations in academic careers are evident not only at universities, but also in research institutions (Piscová, M., 2003, p. 596).

In order to increase the number of women in engineering fields to explore the reasons why they are too often not attracted to engineering becomes necessary. It should aims (besides others) at:

- identifying the best practices, ideas and solutions to react to the present problem of the labour market (not enough graduates in the engineering area),
- providing data and its analysis for developing political strategies in European society in order to manage social changes driven by technical innovations,
- producing recommendations to make the engineering degrees more attractive to women,
- strengthening equal opportunities in the education system and the labour market for men and women in the European Union
- participating, in the long run, in the build up of a harmonised European training system which considers the needs of the labour market in Europe as well as the well being of its citizens and their equality as far as learning is concerned.

The above stated reasons has led to the research undertaken within the frames of the 5th Framework Programme funded by the European Union, covered by the project named "Creating Cultures of Success for Women

Engineers“ (Research and technological development project: Knowledge-based Society and Economy, HPSE-CT-2002-00109). The research project is focused on the clarification of factors that contribute to the creation of the culture for women engineers that would positively influence the female decision regarding engineering as a profession.

One purpose for this project is to identify more clearly the key stages of loss of women, and the different influencing factors operating. This will allow us to specify more clearly what strategies and interventions are likely to be effective, and to make recommendations based on these findings.

Methodology and fieldwork

In order to explain the culture of engineering degree courses at universities, it was essential to show both the examples of best practice and the institutional barriers at universities for women engineering students. It means overall environment and practices applied by universities generally that should, even if unintentionally and unconsciously, influence the attitudes of the women to engineering studies. Therefore, it was necessary to describe the culture and the atmosphere in engineering degree courses. As it is difficult to describe and measure it by quantitative methods only, qualitative methods were used.

The aim of the qualitative research was to gain knowledge not only about the content of degree courses and studies, but also about the culture of degree courses and institutional barriers for female engineering students. The hypothesis has been tested that a friendly and warm atmosphere and culture, and non-existence of institutional barriers for female students could lead to the growth in the percentage of female students in engineering courses.
The qualitative methodology included the following measures:

1) *The interview with successful female students* that included five participants. Two of them were chosen from such a faculty where the number of female students is higher than expected (in comparison to the average percentage of women at the engineering faculties in EU countries). The Faculty of Mining, Ecology, Process Control and Geotechnology at the Technical University of Košice fulfilled this requirement because the number of female students at this faculty is 57 per cent. The other three participants were chosen from a faculty with a low percentage of female students. That was The Faculty of Electrical Engineering and Informatics at the Technical University of Košice where the number of female students is only 5 per cent. Both faculties were chosen as they belong to the same Technical University of Košice, which creates the excellent base for the comparison of institutional culture within the same university, but different faculties, as far as participation of female students is concerned.
2) *The interview with non-persistence female students* that included five female students who started their study in the engineering courses; however, after several semesters decided to abandon it. They studied at the faculties with low and average percentages of female students (Faculty of Electrical Engineering and Informatics – 5 per cent of female students only, Faculty of Mechanical Engineering – 30 per cent of female students, Faculty of Metallurgy – 36 per cent of female students). All the above-mentioned faculties belong to the Technical University of Košice.
3) *The interview with faculty academic staff members* that included six participants. Two male staff members and two female academic staff members were from the Faculty of Electrical Engineering and Informatics (a low percentage of female students – 5 per cent), and one male academic staff member and one female academic staff member from a faculty with a higher percentage of female students - the Faculty of Mining, Ecology, Process Control and Geotechnology (a high percentage of female students – 57 per cent). As the participants from the successful female student group and faculty academic member staff were from the same faculties, the different attitudes and opinions can be investigated. All representatives were not in charge of the degree courses so that social desirability reactions could be avoided.
4) *The expert interview* with the steering committee member has been carried out at the Technical university of Košice in which the Vice-Rector responsible for education took part.

The selection of interview participants was aimed at obtaining a comprehensive overview of the problem at the same university from selected groups (successful female students, non-persistence female students, faculty academic staff members and the steering committee member).

The research team has prepared the scenario of interviews before the commencement of the interviews. All interviews were held in the faculty meeting room and usually two persons from the project research team (interviewer plus one person) were present and followed this scenario:

- The introduction of the research project, a short description of the project and its tasks – done either by the local project co-ordinator or interviewer;
- The short description of the interview and the explanation of its purpose and function within the project;
- The interview itself.

All the interviews were recorded with the prior permission of the interviewees. In order to create a relaxed and friendly atmosphere, small refreshments were served. However, the reactions of single interviewees were different and can be sorted out with regard to their memberships in single interviewed groups as follows:

- Female academic faculty staff:

All interviewed female faculty staff were pleasantly surprised by the fact that such a research activity ever existed. They were very co-operative and communicative. They said that they were very much interested in the project outputs and welcomed the chance to compare the situation in engineering studies in various countries.

- Male academic faculty staff:

It took a lot of effort and time to make the interviewees from this group speak. Within this group there was an extreme but not a rare opinion on female students in engineering courses presented by one of the male faculty staff from the faculty with a low percentage of female students He said that he thought that the engineering field was naturally male dominated, as logical thinking is a male domain. This faculty member in particular was quite communicative and it was not as difficult to make him speak as it was with the rest of this group. The rest of male interviewees were quite hesitant and ambivalent.

- Female students from non-persistence group:

These students were in general very much interested in the research and its mission; almost all of them said that they were glad somebody finally paid some attention to their problems and was interested in the reason why they had dropped out of university. They had no problems to express their opinions and they were quite open and communicative. The interviews went quite smoothly with them as they were already "out of game" and, in their own words, were able to express their opinions freely without any fear or worries.

- Female students from persistence group:

Students from this group were quite surprised that there was the kind of research that dealt with the problem. They were quite hesitant in expressing their opinions. It took much more time to make them speak. From the very beginning it seemed that they were afraid to talk as they were not sure who would have a chance to read the final written materials from the interview (even though it was explained at the very beginning of the interview how the interview materials would be processed and treated). Once it was repeated that all interview materials were highly confidential, the atmosphere became more relaxed and students were more open. However, they were rather surprised by some questions, e.g. the questions about special recruitment programmes for girls, or single sex courses.

- The steering Committee member:

This interview took the highest effort. After the research project, its goals and the aim of the interview were introduced, the interviewee was quite surprised that such a topic was ever to be solved within some project. It took quite a long time to "break the ice" and make him speak. Some questions needed more explanation because the interviewee was convinced that there were quite a lot of female students in some engineering courses and there was no need to pay special attention to this topic. However, he was quite hesitant with his answers.

Results and interpretation

The structured interviews covered several topics and the findings on the most interesting issues are analysed below. The views of different groups (persistence and non-persistence female students; faculty academic staff members and the steering committee member) of the same topic provide a basis for comparisons in terms of various aspects.

Topic 1: Attractiveness of engineering degree courses and recruitment programmes.

The interviewees from the faculties with a lower percentage of female students agreed on the following facts: the new coming era of information society, according to two male interviewees, will bring more professional approaches, so universities will have to establish a professional team that will take care of all marketing issues. Students are becoming our customers, so we should treat them like that, they said. The more professional approaches to marketing are necessary, including a wider and more intensive information campaign, the web portal and better public relations activities. The following activities should be organised regularly: an information campaign for high schools, open-door days, special programmes, and the web portal designed to attract new prospective students.

On the other hand, the representatives of the faculty that has a relatively higher percentage of female students and in general a much higher interest among prospective students said that the faculty representatives had visited high schools, distributed the information materials, such as leaflets and brochures among students and that they had a quite attractive website. According to their opinions, the degree programme they offer is attractive enough to all students, therefore there is no feeling or need to do more or even to act differently at their departments in order to make the faculty more attractive to students.

None of the interviewed faculty members had any knowledge or information of any special advertising events for girls and they thought these were unnecessary. They all agreed that faculties organised the sufficient number of self-advertising events and these were quite well perceived by prospective students. The shortcomings described by the faculty members were discovered in the lack of long-term and regular co-operation between the university and educational advisors at high schools and in the irregular supplies of information materials. None of the interviewed faculty members thought that there should be any different recruitment programmes for male and female students. All faculty members agreed that the recruitment campaigns were sufficient.

On the other hand, all interviewed students agreed that their knowledge about the university was limited; they basically did not have any relevant information on the corresponding faculties. All of them observed that the information about the content of study at any of the faculties was not spread sufficiently; so young people did not know what to expect. The majority of young people rely on their friends and relatives for some advice. Some of them were not satisfied with the work of career advisors at high schools and were convinced that if the co-operation with universities was more consistent and systematic, and the information flow smoother, young people could have a better chance to make reasonable decisions about their future careers. They also did not think that the recruitment programmes should differentiate between female and male students.

Topic 2: Welcome events

At all faculties there are special welcome events organised for new students. They are organised in co-operation with the faculty Dean's Office and senior students. The events are divided into two parts – official ones, with the official speeches, and more informal ones – parties. Both play an important role in integrating new students according to the interviewees. These activities have quite an old tradition and a very good reputation among both students and teachers. They are very popular and many students and teachers usually participate in them. Based on all interview groups' opinions, the welcome events are very important socialising events, as they can give the new students a feeling of togetherness and belonging to the faculty. However, there are no special welcome events for female students.

Topic 3: Single sex courses

The opinions obtained from the interviews with the faculty members demonstrated that none of the interviewed faculty members agreed that single sex courses would be good or even bring more benefit than mixed courses. The female interviewees felt that it would be a kind of positive discrimination and could even reinforce the underestimation of female students, which might open the gap between male and female students. All interviewees agreed on the fact that female students were generally more diligent and responsible.

The male interviewed faculty staff did not like the idea about the single sex degree courses at all and strongly disagreed with the opinion that this could be more pleasant or beneficial for female students.

Topic 4: Study experience

In general, the non-persistence students had quite bad study experience. Particularly, the first semester was quite difficult for them because of some knockout exams, such as mathematics, physics, and some other technical subjects. The most difficult part in the adaptation process was to learn how to manage time and how to study independently. The exams were very difficult not only because of the intensity of study, but particularly because of the fact that the teachers tried to show off, and to prove the students that they did not know enough or were not good enough. There was a great barrier between the students and teachers. Almost all teachers underestimated all students regardless of the fact whether they were male or female: the students got the feeling that too many students were admitted to the faculty the first year and the faculty wanted to reduce the number of students by all means. The interviewed students also thought that a more sensitive and supportive attitude from the teachers' side would help them to overcome the difficulties.

The views of the interviewees from the persistence group showed that according to their present experience, the position of female students, particularly within the specialised electrical engineering subjects, was slightly different. The female students had to invest much more effort so that they could prove they knew as much as their male counterparts.

Topic 5: Mentoring

The interviewees from among the faculty staff thought that supportive actions in small groups were useful. However, they need to be organised very carefully and students must not be pushed into them. The friendly and supportive atmosphere is very important. At the faculty (the one with a low percentage of female students) the teachers started considering the possibility of getting back to the previous system of the ´80s in which each study group had its own mentor and the students studying in one study year and study branch had a "head mentor". The group mentor worked with the students of one particular study group, whereas the "head mentor" would help solve

problems of the whole group of students studying in one study year. Nevertheless, the faculty top management did not approve of such proposal. Mentoring is not obligatory at the majority of departments.

Topic 6: Atmosphere and social network at the department

The opinions on the working atmosphere at the interviewees' departments varied a lot and there did not seem to be any links to the fact whether the interviewee was male or female. The interviewees´ descriptions ranked from apathetic, with quite gloomy moods mainly due to their financial problems, and the low social status of universities and university teachers in general (one interviewee), through average and comparable to other departments they knew (3 interviewees), to quite good descriptions of the atmosphere (one interviewee). One interviewee did not want to compare, he told he did not feel to be competent to do so.

According to the interviewees, there is no real chance to establish closer contacts within single departments. Although there is an effort, coming especially from the final year students, to organise some activities (football matches) and invite their teachers so that they could build a social network that would include the students too, it is not consistent and lasting long. Some other activities include special occasions, such as semester parties organised usually by the first and final year students where professors are invited to join. The majority of the interviewees thought that there was virtually no real social network and that it was considered to be unimportant.

Nonetheless, the interviewees agreed that common activities with both students' and teachers' participations can be supportive and might help create a friendlier atmosphere at the faculty and could provide a solid basis for the social network, if taken seriously. However, as many as five out of six departments do not make any active efforts according to the interviewees´ opinions.

Topic 7: Attitudes in society – outside engineering departments

All female academic faculty staff members' interviewees said that the typical picture of an engineer in general public is that he is supposed to be a man. This image of an engineer is gradually changing for better, i.e. it is becoming less important whether an engineer is a man or a woman, as five out of six interviewees agreed. All interviewees agreed on the fact that in society the university degree of "an engineer" has a lower status in comparison with other degrees, such as a doctor of medicine or law; the social status of engineers being slightly lower than that of other university educated people.

One of the male interviewees said that the typical picture of an engineer in the public mind was that only a man could be an engineer and that he would agree with that. He also mentioned that engineering jobs were typically male jobs and added that many men would certainly agree with him.

The interviewees from the non-persistence group thought that the social position of engineers was very weak as there were quite a number of engineers, and nobody could tell what kind of engineer was being spoken about. Slovak society does not appreciate engineers well enough. Their positions in society are worse than they should be in comparison with what they contribute to society and what they deserve. The original prevailing picture was that an engineer was a man. However, according to the interviewees´ experience the picture has been changing lately. Men are in a much better position in Slovak society; much higher respect is paid to them than to women. There are quite big differences in the positions and chances of female and male engineers.

The interviewees from the persistence group thought that the part engineers play in society is very important, but the life of engineers as specialists in their fields is not easy at all. It is not enough to graduate from university, everybody agreed, because the real training starts after graduation. An engineer has to pay a lot of attention to lifelong education. Based on what these students said, the picture of an engineer is very traditional in Slovakia: an engineer is a man, as all think that men are technically oriented. They thought that female engineers are underestimated in society and the general picture of an engineer in society is the picture of a strong male. However, they observed that it would gradually change thanks to a younger generation.

Topic 8: Attitudes towards women in engineering degree courses and masculinity

Based on the answers from the faculty academic staff members, the majority of them did not observe that the female students felt disturbed by the reactions of their male counterparts, but all the interviewed observed several times that the female students were unsettled because of the behaviour of the male students and they could not describe any typical reactions of the male students during the lessons while female students were asking or being asked questions. Only one male interviewee mentioned that the female students were unsettled because of the behaviour of the male students, since the way of female thinking is somewhat different; for example, the female logic is worse. Yet, he thought that the atmosphere in mixed study groups was good. All interviewees from this group said that female and male students were treated equally and there were no differences.

On the other hand, the views of the interviewees from the non-persistence group demonstrated that there were very radical opinions about the engineering studies at the university: that was exclusively meant for male students. They agreed it was changing slowly; still, if somebody says "an engineer", they mostly mean a man. Almost all of the interviewees in this group felt discriminated at the faculty. Two of them were told a few times that their results

were quite good for a woman; occasionally they witnessed a situation in which their female schoolmate was told by her teachers that they would not ask her "such a difficult question" as she was a woman. They agreed that there was not a problem among students, but the teachers approached male and female students differently and the assessment of male and female students was also different. Female students had to prove that they were good enough, while male students were good enough just because they were male. One of the interviewee said that from the very first moment she felt that female students were not very much in favour with some of the teachers, especially with those teaching technical subjects. The message she thought she received from those teachers was "welcome boys, and you, girls go home, to the kitchen - that is the right place for you."

As far as the views of interviewees from the persistence group are concerned, the students from this group thought that female students were more diligent and more responsible; therefore they usually succeeded better in their studies. On the contrary, it is different in real life because of the traditional view on engineering as a typically male field of interest. According to the students, some of the teachers use gender-sensitive language, but the majority of teachers do not pay any attention to this issue at all and they tend to ignore it or even ridicule it.

Conclusion and Recommendation

Based on the interview analysis done by the research team, several supporting and hindering factors for women students have been identified. The most important hindering factors are as follows:

- The lack of technical and natural science subjects at high schools, which results in the lack of knowledge in these fields;
- The lack of information about the content of study and single technical subjects;
- Perception of and attitudes towards engineers in society in general, underestimation of female engineers;
- No real support for female students from teachers and departments during their studies;
- Inappropriate behaviour of some teachers – male culture at engineering faculties;
- Unequal treatment – the underestimation of female students.

In order to lower the female student drop-out, the academic faculty staff recommended to cut down on math-oriented subjects, to prepare the entrance examinations more thoroughly, to introduce more open university studies, and finally, to offer alternative ways of study, such as distance education or e-learning. Besides, the improvements of study conditions, including social ones, are also very important factors.

The interviewees from the non-persistence group showed that better and more complete information about the engineering study delivered to all high schools would help students decide on what jobs and professional training might be best for them, as they would know what to expect from the university study: the content, extent, form, and all requirements. They put stress on the fact that better co-operation with professional high schools would attract more female students to study at engineering faculties and also that lower numbers of students admitted to engineering faculties would enable teachers to work with them in a more efficient manner.

The undertaken research revealed only some of the aspects that should increase a percentage of female students and attract them to study engineering.. In order to broaden the picture, making use of both qualitative and quantitative methods is necessary.

Oto Hudec, *he studied at the Komenský University in Bratislava, Pavol Jozef Šafárik University in Košice and Charles University in Prague (Statistics, Systems Theory, Operations Research). Senior lecturer at the Technical University of Košice, the Faculty of Economics. Local coordinator of two projects of 5th Framework Programme, with the issue on women in engineering education and professional sphere – INDECS and WomEng. His research priorities and experience are in the area of public opinion surveying, public needs assessment, regional science, women in engineering. He is currently lecturing courses in Statistical methods and Regional Economics and Policy.*

Iveta Orbánová *graduated in 1984 from the Technical University of Košice, the Faculty of Civil Engineering. She has been active in the field of distance education since 1984. The holder of two diplomas of the University Continuing Education Certification Programme at the Kennesaw State University, Atlanta, USA (1999-2002), the Certificate in Open Learning from Heriot-Watt University, UK (1999). At present, a senior lecturer at the Faculty of Public Administration, Department of Economics, Pavol Jozef Šafárik University in Košice, Slovakia. The main professional areas of interest include open and distance education, e-learning, regional development, project management, and project writing. Extended experience in the area of international programmes, a co-ordinator, contractor and/or member of managerial and research teams of many EU and national funded projects (e.g. 5th Framework Programme, Leonardo da Vinci, Socrates, TEMPUS, PHARE).*

Felizitas Sagebiel *diploma in Social Sciences 1970 (University Erlangen-Nuremberg), PhD in Sociology 1978 (Technical University of Berlin), is a senior lecturer in sociology in the Department of Education (University of*

Wuppertal). She has been the responsible person for the German partner University of Wuppertal in EU-Commission Accompanying Measure INDECS and IHP-project Womeng in 5th Framework Program, with the issue on women in engineering education and professional sphere. Research priorities are: higher education, women in engineering (European Commission projects), gender studies, institutionalisation of innovative degree courses, life long learning, evaluation of senior studies, interpersonal relationships (women friendship) in German transformation process. She has published in criminal sociology, social pedagogy, interpersonal relationships, women and gender studies, gender perspective on senior studies in life long learning, gender and masculinities in engineering. She has given numerous papers on relevant international conferences of different scientific associations (ISA, Gender in Higher Education, ECPR, GASAT, European Feminist Research, Gender and Education) in European and non-European countries (Australia, US, Africa).

***Nataša Urbančíková** as a senior lecturer at the Technical University of Košice, the Faculty of Economics, Department of Management and Marketing teaches subjects focused on marketing. She has extended experience in the area of project management. The holder of the international certificates in the area of Continuing Education Management from the Kennesaw State University, Atlanta, USA and Education Administration from Chicago Loyola University, USA. Her research area is focused on marketing, regional development, open and distance learning and women in engineering.*

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