CREATING CULTURES OF SUCCESS FOR WOMEN ENGINEERS

5th FP, Specific Programme "Improving the Human Research Potential and the Socio Economic Knowledge Base"

A Project Funded by the European Commission, 5th FP, HPSE-CT-2002-00109
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Synthesis Report

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Introduction

Throughout the European Union both the proportion and the number of young people undertaking engineering studies are falling, due in part to demographic trends of declining birth rate. Balanced against that, engineers are one of the mainstays of the economy required for wealth creation and to maintain economic competitiveness in world markets. The education of young men and women is a key issue in terms of quality of education and quantity of persons involved. It is in the interest of the whole society to find solutions to the question of insufficient enrolment in engineering studies.

Usually and traditionally women are not attracted by technology. However lots of young women have the capability and the talent to become highly skilled engineers, to participate in technological innovation, and by doing so, to contribute to the general welfare. Despite many initiatives devoted to the recruitment and the retention of girls and women in engineering over the last couple of decades, they are still dramatically under-represented in this field.

This under-representation has become a key preoccupying factor in Europe, in particular with regard to the fact that up to half the potential talent for the European engineering workforce is missing.

But beyond raw facts and figures, there are other reasons to justify the increase of women's participation in engineering studies and careers.

Many studies have shown that women engineers can bring different views, diversify the mono cultural engineering workforce and broaden the impact engineering has on society.

Women are particularly attracted to and interested in the societal aspects of technology and science. By becoming engineers, women will be able to reach a high level of responsibility and finally to play a significant role in influencing company policy, in relation to social and environmental responsibility and improved quality of life.

Attracting more women into engineering studies and careers can also contribute to the modernization of the European social model by fighting the gender gap. Today, it is socially unacceptable regarding equality to have so few women in engineering, which offers interesting, well-paid careers, the possibility of personal development and at senior level the opportunity to participate actively in the efforts of shaping our society and future via shaping technology.

The main objective of the WOMENG research work conducted from 2002 through 2005 by seven academic partners within the 5th Framework Programme of the European Commission[1], is to understand the reasons why women are not attracted by technology in general and by engineering in particular and to propose efficient tools that could be used to correct this situation.

The numbers of women engineers can be augmented by increasing the numbers studying engineering and by stemming the loss of women from engineering studies and careers. But to achieve this on a European level it is necessary to understand how to become and engineer in each country. Only once we understand this can we make effective recommendations to increase the numbers of women choosing to make a successful career in engineering. The path to becoming an engineer requires a young girl to make a series of decisions at key stages in her life. A positive decision will take her closer to becoming an engineer. The opposite choice will take her further away. Who and what influence her choice at each stage of her path?

To answer these questions we have organised the research into three interlinked themes. The first, **"Reasons for Choices"** aims at understanding the internal and external influences on women's choices towards engineering. Why, when and how do young women decide to choose or not to choose engineering careers. Who influences their choices, parents, friends, teachers? Why did they choose engineering?

[1] Womeng RTD Programme is funded by the European Commission in the 5th FP, Specific Prpogramme "Improving the Human Research Potential and the Socio Economic Knowledge Base"

In some countries the first key stage for choice can be when the girl is only 13 or 14. If at this stage she chooses not to study physics it is not possible to become an engineer. The next important time is to choose a course at University. Then of course, she must decide to pursue an engineering career so we also look at the first job. How easy was it to get this job? How much training does the company give its engineers? How easy is it to become promoted?

Cross cultural aspects of the phenomenon have been investigated so that the key stages for intervention and a set of recommendations on when interventions are most likely to succeed have been prepared taking into account the national differences.

Not all women who choose to study engineering are successful; so the second theme, **"Success and Non-Persistence"** has aimed to identify internal factors (like self-confidence) and external factors (such as poor advising, lack of faculty support) that may influence success in completing the degree and developing an engineering career or that may cause a woman to drop out of her studies or her career. Our research has led to a deeper theoretical understanding of the mechanisms leading to success and non-persistence in engineering careers. The key factors are presented here along with a set of recommendations to enhance success and persistence of women engineers.

It is evident that activities that only focus on young women, trying to influence their career choice, (like information days, booklets, exhibitions for girls) have not been particularly effective in encouraging more girls to enter the masculine culture of engineering. Our third interlinked theme, **"Organisational Culture and Social Change"** has aimed to identify gendered institutional cultures and structures in higher education and in the professional sphere and to analyse their influence on women's studies and careers. The key findings are presented here along with a set of recommendations to change gendered organisational culture in ways that will enhance their effectiveness.

We have developed techniques, or tools, to allow us to make cross cultural comparisons between the different countries involved. These are outlined in part 1, **"Methodology"** and presented in greater detail in our scientific report.

The key findings are organised in three different parts corresponding to those three interlinked themes. In each part facts relating to engineering studies are presented separately from facts

relating to engineering careers.These parts are subdivided and organised so that readers who wish to focus on one particular aspect, such as the factors that influence choice of course and associated specific recommendations, may find this easily.

A further part, **“Recommended Steps for Action,** is given for policy makers and agents for change who wish a wider overview of what might be effective.

Part 1 Methodology

Introduction

From the beginning of the interdisciplinary and international WOMENG project, comparison was chosen as a research strategy, assuming that a comparative approach would provide more than national results and would represent an opportunity to reveal new hypotheses, as expressed for example by Lallement and Spurk (Lallement and Spurk, 2003). This part presents the methodological toolbox developed by the WOMENG consortium, combining qualitative and quantitative methodology. This toolbox is presented thoroughly in a specific publication (Pourrat, 2005) and will be available on the project website www.womeng.net from November 2005.

Designing research methodology for large-scale international cross-comparisons implies dealing with 1) the specific issues of cross-comparisons, either a variable-oriented approach, or a case-oriented approach; 2) the standard problems of research design in human and social sciences, first of all the choice of qualitative, quantitative or mixed methodology, according to the needs of the research topic; 3) the large-scale issue, generating a huge amount of data.

1.1. Cross-comparison: methodological issues

1.1.1. Ensuring comparability

First of all, a cross-comparative research project has to ensure **comparability** through the definition of **common research objects**, common classification, and common scales of evaluation. This is particularly obvious when dealing with a notion as vague as that referred to by the term “engineer”, which corresponds to various levels of qualifications and various areas of expertise across Europe. The WOMENG project decided to concentrate on the common characteristics of engineering in all countries. “Engineer” is defined here as an academic degree confirmed by an accreditation board, at master’s level, in all scientific and technical areas, excluding agronomy, business and architecture, which are not considered as

engineering disciplines in all European countries. As far as possible, existing ISCED and ISCO[2] international classifications were used to enable the use of existing data and facilitate further comparisons. In the quantitative questionnaires, approval and disapproval were measured on a scale of 5, "1" meaning "strongly disagree" and "5" meaning "strongly agree". Ambiguous translations and cultural variations were tracked down by the collaborative work of all partners.

Even if the participating countries differ by the size of their population, the same number of questionnaires was handed out in all countries. The **sampling philosophy** was based on **three assumptions**: 1) The same methodology and sampling have to be used to compare the situation of women and men. 2) The sampling has to be larger where women are a minority, because their situation is supposed to be more diverse. 3) To understand why people choose engineering or not, it is important to study also the reasons for not having chosen engineering.

Because engineering is a very diverse field, the sampling needs also to take into account the various areas of speciality and the ranking of the diverse faculties and schools[3]. In the professional sphere, three criteria were selected for an exploratory study of two companies in each country. The sampling includes at least one company in the energy sector[4], one with "good practice" to attract and retain women engineers, and, if possible, one in the manufacturing sector.

1.1.2. Beyond case-oriented and variable-oriented approach

When using cross-comparisons in social studies, two main traditions may be identified (Ragin, 1987):

> On the one hand, a vague and abstract variable-oriented approach, based on quantitative data from many countries. That methodology misses the connections to

[2] ISCED = "International Standard Classification of Education" (1997 – UNESCO); ISCO = "International Standard Classification of Occupations"(1988, used by EUROSTAT).

[3] A detailed view of sampling is given below. 200 questionnaires were handed out in each country, as follows : 50 female and 50 male engineering students, 50 female and 50 male students who could have become engineers, but chose another speciality. Compared to the national average proportion of women students in engineering, 50% of questionnaires were handed out in settings where the percentage of women students is low, 20% where it is the average, 30% where it is high. Sampling of non-engineering students is composed of 40% of students in Natural Sciences, 20% in Human and Social Sciences, 40% in Economics.

[4] The energy sector was chosen because all countries have at least one company in this sector.

actual empirical process, social bases, specific phenomena, but enables comparisons to be made between many different countries, thus broadening the scope. However, few general conclusions may be drawn from that kind of study.

On the other hand, a case-oriented approach, sensitive to complexity and specificity, which treats each case as a whole. The drawback of such a method is the difficulty of extending it to a large number of cases because an attention to complexity across large numbers of cases is very difficult. Another sensitive issue is the possibility of generalizing conclusions from a few cases.

From that statement Ragin proposes 'to formalize qualitative comparative methods without departing from the general logic of case-oriented approach' (Ragin, 1987,) and recommends '*examination of constellations, configurations and conjunctures'* that will describe the causal complexity of the phenomenon. From Ragin's conclusions we tried to go beyond a quantitative approach and to develop mixed methodologies.

1.1.3. An iterative mixed methodological framework

Mixed methodologies are still emerging, they have been thoroughly described by Cresswell, who reviews different mixed methodologies and points out their advantages and drawbacks (Cresswell, 2003). In our field, a mixed methodology offered the opportunity to use all the available data, both qualitative and quantitative, with heterogeneity due to the different countries. In addition, the concurrent progress of qualitative and quantitative strategies enables the use of iterative approaches, and therefore the emergence of common cross-national research questions.

The WOMENG methodology is iterative and uses three levels of data collection:

- I: An overall statistical framework, built from existing gendered national data, expressed in international classifications. When it was possible, this type of data was collected directly from EUROSTAT. These data were used as a reference and were a first source of correlation hypotheses.
- II: Specific quantitative data collected by the project on specific questions. The aim was to check hypotheses in a comparative context and to identify significant factors related to choosing engineering. These data were provided by WOMENG-designed questionnaires applied to specific samples in higher education, and by the collection of information about chosen companies for the professional sphere.

- III: Qualitative data from interviews, focus groups, participant observation and document analysis. The aim was to understand why and how specific situations may be explained from the inside, and to find reasons and explanations for results observed in data I and II. Common issues were addressed in the different sets of data.

Quantitative and qualitative methodologies were designed to allow mixed and iterative methodologies: some questions are common to questionnaires and interviews or focus groups.

1.1.4 The large-scale issue

The sets of data in seven different countries form a rich database offering possibilities of testing a number of associations, correlations, etc. For each set of data, the results are so numerous that browsing the database becomes a challenge: cross-cultural analysis means mastering seven hundred to one thousand pages of qualitative data, that must be added to the enormous volume of quantitative data. This situation means that direct access to the data, which is the usual research situation, is no longer achievable. Moreover, the data may be made more difficult to analyse by translation problems, by reports and summaries made by national researchers, and by our sometimes poor or unequal knowledge of national situations. This linguistic difficulty must be kept under control through various procedures in order to report in the same way and to provide information for analysis on a basis of mutual trust among the different researchers.

A second difficulty arises from the way of consulting the database. For some data, transversal reading always remains possible. When the amount of data increases, it becomes time-consuming for sometimes ineffective results. Our process in reporting and classifying results insisted on the linear process of the interview, which is useful for getting at the inner logic of each interview, but is not very convenient for addressing the same question in different settings.

1.1.5. Specific practical problems during the progress of research

Because of the extent of the project, we encountered practical problems. Even if they have nothing to do with the epistemological problems raised by cross-comparisons, it may be very useful to mention the most important ones, as they can be underestimated and cause delay and management difficulties for the consortium.

In WOMENG, a crucial issue was the timing for handing out the questionnaire or doing interviews, which can be different from one country to another. The same problem exists with companies; they are not available for questioning at any time of the year. Another problem was in finding equivalent settings for handing out questionnaires or carrying out interviews.

The questionnaires tended to be too long, so some students or colleagues were afraid of filling them in or answering them because a whole hour was required. This may be the price to pay for the collegial design of common instruments. This collegiality limited the number of different research instruments, which was a good thing in itself, but lengthened each one that was designed. The design process could be improved in order to be less cumulative and more integrated.

The technical process of collecting and reporting must be defined very carefully to avoid missing or mixing up data and the huge amount of data to be analysed must be considered from the beginning.

Another effect of the extent of the research is the fact that for a long time, we had no immediate access to the results. Statistical treatment of the data was long and not so easy due to the large number of questions. After basic processing of the data, all the items were tested from the country and gender points of view according to the nature of the variables: Kendall's tau-b, Somers' D, Spearman's rho, Mann-Whitney test, Analysis of Variance, etc. However, it is essential to combine those quantitative results with qualitative results in order to work on an interpretation.

1.2. WOMENG methodological framework

Finally, through research experience, a methodological toolbox emerged from the WOMENG project. Four steps may be identified:

1.2.1. Step 1: Designing research tools

The WOMENG project was structured in two parts: engineering education and the engineering profession and three main “Work Packages”: “Reasons for Choices” (WP2), “Success and Non-

Persistence" (WP3), and "Organisational Culture and Social Change" (WP4). WP1 "Methodology" was responsible for designing common research tools and ensuring comparability. Each Work Package proposed specific questions in relation to its hypotheses; those questions were gathered and reviewed to ensure coordination, relevance and exactness in all national contexts. Several versions were produced and improved until a final version of methodological guidelines was reached. Then the final version of guidelines was translated into national languages. Major translation problems were avoided thanks to the collaborative design, but some irrelevant questions in certain contexts remain.

1.2.2. Step 2: Fieldwork

Due to the number of different actors and contexts, fieldwork procedures must be described very clearly and cultural differences must be taken into account. (cultural bias, socially desirable answers, etc.). A crucial element is an accurate documentation of the research context through biographical data, identification of relevant samples, etc.

1.2.3. Step 3: Reporting

The idea was to work as closely as possible with the original data, even if they were necessarily filtered by the translation into English, the summaries and the national reports. Complete transcription and translation of qualitative results would have taken too long, but, on the other hand, relying on national reports without any access to original data would have reduced the benefits of cross-comparisons with the risk of juxtaposing national studies without comparing them. So an intermediate methodology was implemented: each interview or focus group was summarized in English, question by question. The authors of the summaries were asked to quote important sentences, to identify general patterns and to stress national specificities. In the margin, a column was added for comments and first interpretation. To help interpretation, short national reports were written for first interpretation at national level and explanation of the specific contexts. All this data will soon be available to all researchers on the WOMENG website.

1.2.4. Step 4: Analysing and interpreting

Through this methodology, relevant and comparable material has been produced, with appropriate documentation. Analysis and interpretation represent a challenge due to the huge amount of data we have. The main difficulties must be mentioned:

- Technical difficulties in consulting the results and lack of immediate, intuitive perspective due to the amount of results. Designing appropriate software could solve this.
- Epistemological difficulties in choosing meaningful comparisons and conceiving qualitative data comparison.
- Methodological difficulties for qualitative data comparison. A more or less intuitive identification of recurrent ideas was attempted, but it may be possible to try coding or mapping the main concepts and their links as Ragin suggested (Ragin, 1987).

Conclusion on the benefits of cross-cultural mixed methodology

From a methodological point of view it must be stressed that an iterative cross-cultural mixed methodology allows a fruitful comparison that goes far beyond the usual statistical comparisons, within logical limits: never forget you are comparing grapefruits with tangerines.

As far as we are able to consider the results of the project, the methodology for research design, fieldwork and reporting may be considered as well-known and our toolbox ensures comparability and commensurability. But if we consider the methodology for consulting the data, we still lack efficient technical tools, and our methodology for qualitative comparative analysis needs further research and development.

It appears crucial to keep in mind that these steps are connected, and that only a collegial process can ensure comparability. A mono-national approach would reveal itself to be completely inappropriate when doing fieldwork or interpretation in other countries. Only through collaborative work are similar categories emerging, similar configurations that enable new hypotheses to be formulated, but do not deny the diversity of each specific setting. "*In varietate concordia*" as the European Union says.

Summary of qualitative and quantitative methodological tools

I. HIGHER EDUCATION

A. Quantitative methodology

Questionnaires sampling by country (set 2)		
Country	Q1: 100 questionnaires to engineering students (goal: 50 men and 50 women)	Q2: 100 questionnaires to students who could have chosen engineering, but did not (goal: 50 men and 50 women)
Austria	- Graz University of Technology: Electrical Engineering, Chemical Engineering - Vienna University of Technology: Electrical Engineering, Chemical Engineering - University of Linz: Informatics	- University of Graz: Natural Sciences, Social and Human Sciences, Economics - University of Vienna: Natural Sciences, Social and Human Sciences - University of Linz: Economics
Finland	- University of Oulu - University of Helsinki - University of Tampere, - University of Jyväskylä Students from environmental eng., mechanical eng., process eng., electrical eng., industrial and management eng., information and knowledge management, chemical technology.	- University of Oulu: Humanities, education, Science, Medicine, Economics, Business Administration - University of Tampere: Municipal government, languages, Social Science, Medicine, Information - University of Jyväskylä: history, media, communication
France	- ENSAM in Paris: generalist training in engineering with emphasis on mechanics, Paris - Centrale-Lyon: generalist training in engineering - INSA-Lyon: electrical eng., civil eng. - Université de Technologie de Troyes: various specialities in engineering - ENSCP in Paris: chemical engineering	- students in social sciences (prep. class. Lycée du Parc, Lyon) - students in business and management (prep. class. Lycée du Parc, Lyon) - University of medicine (Lyon 1)
Germany	- Technical university of Berlin, mechanical eng., civil eng. - Technical University of Aachen, mechanical eng., civil eng. - University of Wuppertal: civil eng. - Technical university of Applied Sciences, Berlin: mechanical eng. - University of Applied Sciences, Stralsund: industrial eng. (co-ed. And mono-ed.)	- Technical university of Berlin, sociology - Technical University of Aachen, chemistry - University of Wuppertal: Economics, social sciences, physics - Technical university of Applied Sciences, Berlin: Economics
Greece	- National technical university of Athens: chemical eng., civil eng., mechanical, electrical and computer eng. - Technical university of Patras: chemical eng., civil eng., mechanical, electrical and computer eng.	- Pantheion university: human and social sciences - Athens University of Economics and Business, University of Piraeus: Economics - National and Kapodistrian University of Athens: Natural Sciences
Slovakia	- Technical university of Kosice: electrical eng., informatics, civil eng., mining, ecology, process control, geotechnologies - Slovak University of Technology in Bratislava: electrical eng. And information technology - Technical university of Zilina, civil eng.	- Technical university of Kosice: Economics - Matej Bel University in Banska Bystrica: Economics, natural sciences, education - Safarik University in Kosice: natural sciences - University of Presov, education
United Kingdom	- Glasgow University: mechanical, civil - Strathclyde University: mechanical, electrical, chemical, civil, interdisciplinary mechanical - Napier University Edinburgh: computing engineering - Heriot-Watt University: mechanical, electrical, chemical, civil	- Glasgow University: computing science, physics, business - Strathclyde University: computing science, physics, business - Napier University Edinburgh: computing science - Heriot-Watt University

Number of distributed questionnaires in all partner countries:

Country	Q1 from which:			Q2 from which:		
	males	females	total	males	Females	total
Austria	45	34	79	55	58	113
Finland	71	59	130	28	86	114
France	53	53	106	33	40	73
Germany	50	50	100	51	49	100
Greece	40	40	80	32	32	64
Slovakia	49	49	98	51	49	100
United Kingdom	56	50	106	32	41	73
Total	364	335	699	282	355	637

B. Summary qualitative methodological tools (set 3)[5]

	Interviews				Focus Groups		Other	
	Persistent Students (IPS)	Non-Persistent students (ISNP)	Female Expert: faculty of officer (EIF)	Male Expert: faculty or officer (EIM)	5 Female students (FGF)	5 Male Students (FGM)	Participant Observation (PO)	Webpage analysis (WPA)
Austria	5	5	4	5	1	1	4	5
Finland	4	5	4	2	-	-	-	2
France	6	6	3	5	2	1	2	4
Germany	7	7	2	7	3	3	5	8
Slovakia	5	5	5	3	-	-	-	-
United Kingdom	5	-	4	4	1	1	-	10

[5] The number of interviews is high but unequal from one country to another. It is partly explained by the fact that, according to the WOMENG contract, some partners had more qualitative work than others. Because Finnish and Greek partners are women engineers' associations, they had more opportunities to do research on the professional sphere. Interviews and analyses were conducted in the institutions where questionnaires were handed out, except concerning non-persistent students.

II. PROFESSIONAL SPHERE

A. Summary of quantitative methodology:

Set 1: National data collected from Eurostat	
Data 0	women and men as wage-earners
Data I	women and men as engineers
Data II	women and men as top managers
Data III	women and men as middle managers
Data IV	women and men as employers
Data V	women and men in entrepreneurship

B. Monographic surveys in companies (set 2)

Because of confidentiality restrictions, company names are not mentioned.
Sample: 2 companies, among the 2, at least:

- one in the energy sector
- one with "good practice" to attract and retain women engineers
- optional: one in the manufacturing sector.

Presentation of the two companies chosen for the study:

Name of the company
Date of creation
Type of activity
Recent history if relevant (in case of merging and acquisition for example)
Annual "budget"
Number of persons working
Number of women
Number of men
Number of highly qualified[6] people:
Number of highly qualified men:
Number of highly qualified women
Total number of engineers:
Total number of men engineers:
Total number of women engineers:
Among engineers, number of engineers, with an engineering degree:
Among engineers, number of men engineers with an engineering degree:
Among engineers, number of women engineers with an engineering degree:
Among engineers, number of engineers trained in the company without academic degree:
Among engineers, number of men engineers trained in the company without academic degree:
Among engineers, number of women engineers trained in the company without academic degree:
How successful are they in their career ?
Age bracket (?) of the men engineers:
with academic degree
without academic degree
Age bracket (?) of the women engineers:
with academic degree
without academic degree
Departments they work in:
Position they occupy
Description of the specific policy/program for women executives and non executives

[6] Holding a master's degree or more (5 years after baccalaureate, according to new European classification)

If any, what policy regarding recruitment of women ? Why such a policy ?
Effects of such a policy
Difficulties regarding such a policy
If no specific policy regarding women, why ?

C. Summary of qualitative methodology for each country (set 3):

Company A: Energy	Company B
1 focus group female engineers (3 to 6 people in different departments). If FG not possible, interviews with 3 fem. Engineers	1 focus group female engineers (3 to 6 people in different departments). If FG not possible, interviews with 3 fem. engineers
1 qualitative interview with a reliable person/union representative/member of work council	1 qualitative interview with a reliable person/union representative/member of work council
1 qualitative interview with the HR manager	1 qualitative interview with the HR manager
2 to 4 qualitative interviews with women engineers managers (at least 2, from middle management, if possible 2 from top management)	2 to 4 qualitative interviews with women engineers managers (at least 2, from middle management if possible 2 from top management)
Web pages Analysis (WPA PS)	Web pages Analysis (WPA PS)
4 qualitative interviews with female engineers who quit	
1 optional focus group “Confrontation” with: female engineers, Union representatives, chamber of engineers, association of Women engineers, human resources manager, etc. (1 per country, optional, 4 to 8 people from different companies, choice of companies is independent of interviews and Focus Group “Exploration”)	
optional: 1 qualitative interview with a representative of women engineers association	

Overview of realised fieldwork, by country:

	Austria	Finland	France	Germany	Greece	Slovakia	United Kingdom
Focus group female engineers	1 + 1*	3*	1	2	-	2	1
Interview Human resource manager	2	2	2	2	2	1	-
Interview women engineers managers	3 + 2**	6	6	7	4	4	6
Interview Union representative	2	1	1	2	2	3	-
Focus Group “confrontation”	-	-	1	1	-	-	-
Interview with women engineers who quit	4	4	3	4	3	4	3
Web page analysis	2	2	2	2	2	-	2

* No focus group, individual interview with focus group guidelines
** non engineers

Part 2 Reasons for Choices

The aim of this part is to identify and understand the different factors likely to influence young women's decision to go into engineering careers. It will first concentrate on key moments identified as such in their engineering studies then on critical turning points during their personal and professional lives .

2.1 Key Moments in Engineering Studies

The research conducted in this section concerning engineering studies, dealt with discovering and identifying the key stages of choice for entry into higher education. What is the impact of different factors identified? What can be done to improve the situation? What might influence those students, male or female, to choose engineering or not? What are the stages they may go through? Why, when, and how do students choose engineering or not?

2.1.1. How to become an engineer: key decision moments across Europe

At first sight there appear to be considerable differences across the systems in the seven highlighted countries, but closer examination reveals some common features, once the predictable differences in nomenclature have been identified. For example, in all countries students typically make the transition to higher education at age 17 or 19 and people qualify as "engineers" around the age of 22 – 26. Within each country there are several different ways to become an engineer and this adds to the confusion. Indeed, the differences within a country, especially a large one like Germany with a considerable amount of local autonomy, may mean that there is greater diversity within a country than between this country and its neighbours. However, to identify 'key moments' we must return to the start of schooling.

- **Early choices**

Children in all seven countries attend some form of common primary schooling from age 4½-7, and then continue through to the minimum school leaving age. In some countries they continue through in comprehensive, all-inclusive schools (for example in Scotland[7] and

[7] It should be noted that the school system in Scotland is different from that in other parts of the UK.

Finland) while in other countries the choice of a particular type of secondary school is made somewhere between age 10 (Germany) and 14 (Slovakia, Austria)[8]. The type of secondary school attended can have a significant impact on a student's final career options. Parents are involved in this important decision affecting their offspring's future life chances and one wonders how well informed they are about the consequences of making the different choices.
In those countries where comprehensive secondary education prevails, students select subjects for more in-depth study after perhaps two years of secondary schooling at age 13-15 and stop studying others. This can also be a key decision moment because students who fail to study the necessary mathematics and science subjects beyond this point find it extremely difficult to pick up these subjects later and consequently do not have the entry qualifications for degree courses in engineering. Again, parents are likely to be involved in the choice of subjects. However, the later these choices are made, the greater the influence of teachers and peers may become.

- **End of compulsory schooling**

The end of compulsory schooling occurs everywhere around the age of 15 or 16 and in some countries there are national examinations at this stage (for example in Greece, UK). Some students leave school at this point and begin to work, possibly gaining vocational qualifications in the process as in Finland or UK. Around this time choices need to be made between different institutions, as in Austria (technical or vocational colleges and secondary school) or between different programmes in the same schools, as in France or UK. So by the age of 16, in all countries, young people are setting off on well-defined educational tracks (academic, vocational, technical...), some of which will equip them for a future in engineering but many of which will not.

In some countries such as Scotland or the rest of the UK, the choice of educational track limits the available choices of degree options as each degree specifies particular prerequisite subjects and grades in the national examinations. Clearly it is important to target pupils and those who have a key influence on them, such as parents and careers teachers, at an early enough stage with information about potential careers so that they can make informed decisions about the choice of subjects for the national examinations. In other countries such as Austria the choice of degree appears to be far less restricted. However, different types of

2 We are considering state educational provision in the school sector and not any additional private provision.

schools have different proportions of sciences and technical subjects on the one hand and non technical subjects on the other, so that it may be possible to start an engineering degree without having done sufficient maths and physics beforehand. This may cause problems for students once they embark on an engineering degree.

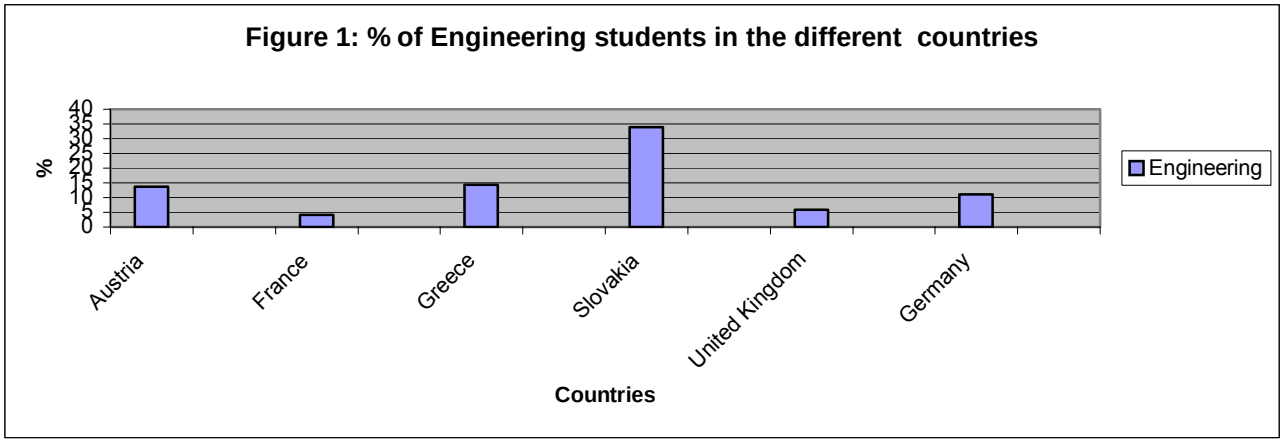
- **Transition to further and higher education**

In all countries this generally occurs at ages 17-19 although there is scope for more mature entry in some places. There are different routes into engineering at this stage. In all countries there is an academic route where well-qualified students follow a fairly theoretical degree course in engineering or sciences for three or four years. Additionally, in some countries, for example Austria and Germany, there are more practically orientated degree courses in technical universities. Elsewhere, for example in the UK or Austria, less well-qualified or more practically oriented students may choose to follow a technical college route which allows them to follow a practical engineering type of career or to go on to higher education later. In France one can leave school at 18 having completed the "terminale technologique" and after working for ten years as an engineer, gain professional status.

- **Post first degree**

Gaining a first degree in engineering is insufficient in most countries to gain professional recognition as an engineer. In some countries (e.g. Slovakia, UK, France, Germany) a master's degree is required. Others follow set programmes laid out by engineering institutes. People who do not receive immediate professional recognition as a result of their academic qualifications may obtain it after a period of professional employment possibly including a period of study laid out by the professional institute.

The engineer's status is not the same in the seven countries: As we can see, the percentages of engineering students, male plus female, vary across the seven countries:



2.1.2. Students' reasons for choosing engineering

- **Reasons for choices**

The first important element which has to be underlined is the fact that most of the students in Austria, France, the UK, Germany and Slovakia had decided to study engineering before they started higher education. If they had not specifically chosen engineering, they declare they liked sciences and maths in secondary school and sometimes even before. It was a positive choice for almost all of them.

There are some exceptions, of course, like a young Austrian woman who wanted to study interior design but it was not offered in Graz, and her parents could not support her financially in another city, or a female student from Finland who chose her course because it was the only one that still had spaces.

For most of the students, the reasons for their choice (if positive) were the following ones:

- Interest in technical (mechanics, aerospace, biomedical technology) and scientific fields (mathematics, physics and chemistry).
- Promising job prospects, good salary promises and social status.

This is particularly true in countries where engineering is socially highly valued and where engineers can expect good salaries, interesting jobs and stable positions.

In some countries engineering is so highly considered that it is a natural choice when you are a bright student and there can be pressure on students to study engineering because they are

clever enough rather than because they are interested in the subject. Engineering studies also leave a lot of options open as is the case in France:

"When you are a very good student in sciences in secondary school there are three possible careers: Medical Doctor, University Professor or Engineer. I chose the last one because it was the most open for later choice". (French student)

- **Other influences**

Choosing engineering is not always an individual choice. Very often students admit that others have influenced their choices and that their families and friends have influenced them more than their teachers or pedagogical advisors. The level of education of the two parents has an important influence.

Each of the following charts shows the % of engineer parents for our samples, the % of parents who have completed Higher Education (University Degree) and the third column shows the total.

Fig. 2 Education of the parents for men engineering students: Fathers

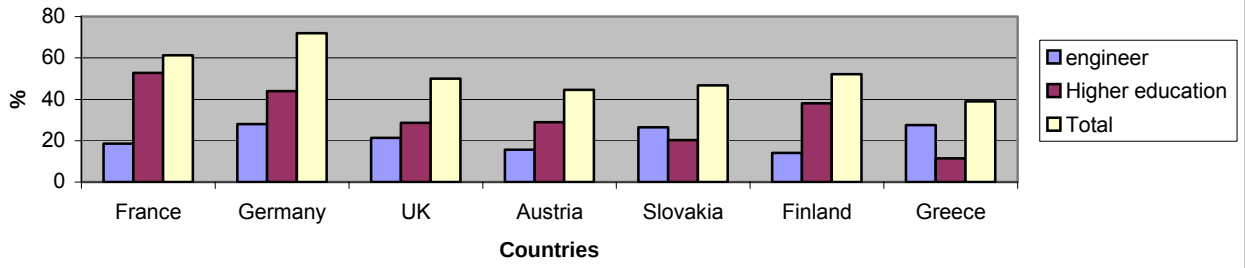


Fig. 3 Education of the parents for women engineering students: Fathers

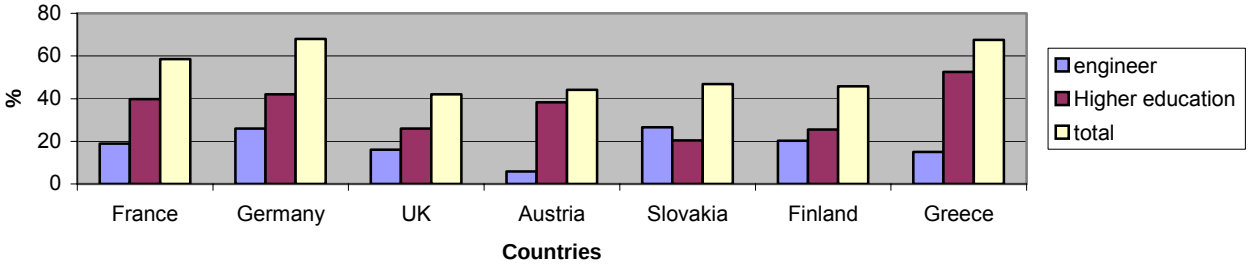


Fig. 4 Education of the parents for men engineering students:: Mothers

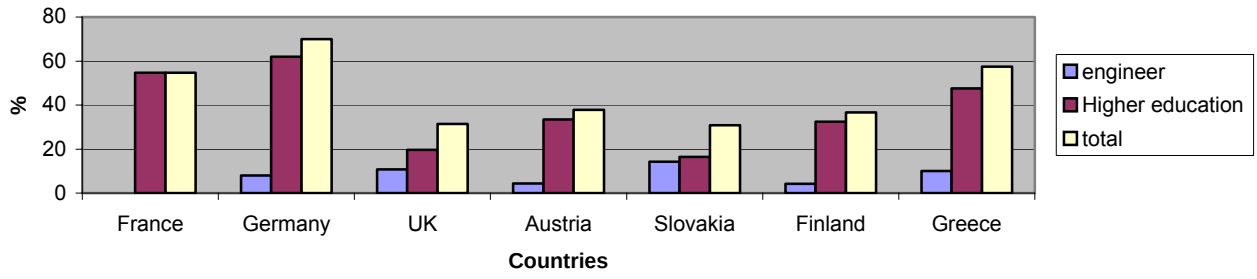
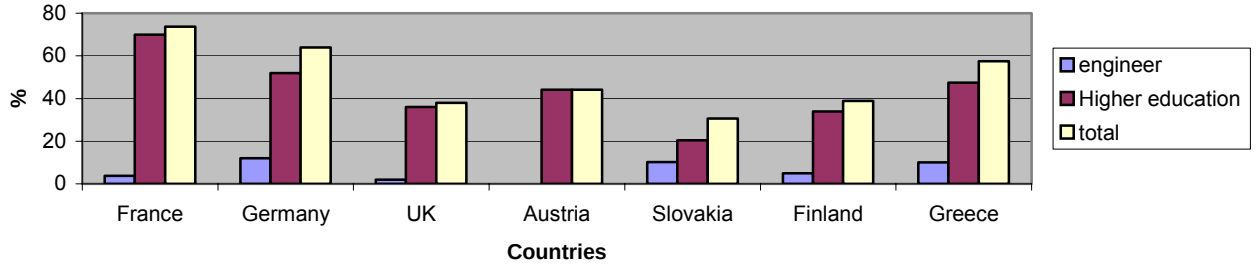


Fig. 5 Education of the parents for women engineering students: mothers



Globally, the level of education in our samples is extremely high, particularly in France and in Germany, compared to the average level of education of the population in the different countries. In France, Germany and Finland more than half of the fathers of engineering sons have completed Higher Education and in other countries it ranges from 40% to 50%.

If we compare figures 2 and 3 we can see that in several countries, France, UK, Finland, the fathers of engineering daughters are less likely to have completed university education than the fathers of engineering sons. Slovakia, Germany and Austria make another group where the fathers are equally educated while Greek fathers of engineering daughters are more highly educated than of engineering sons.

If we look at the situation for women engineering students, we find that in Germany, UK, Slovakia, Finland and Greece the fathers of engineering students daughters are more likely to have completed university education than the mothers, while parents of Austrian engineering daughters are equally likely to have university degrees. In this group the striking result is that in France the mothers of engineering daughters are much more likely to have a university education than the fathers.

In each of France (20%), Germany (25%) and Slovakia (25%) male and female students are equally likely to have an engineering father. In the other countries there are more sons than daughters of engineering fathers, especially in Austria and Greece. Overall, with the exception of fathers of Austrian daughters, a high proportion of fathers of engineering students are engineers showing a positive influence on the children's choice of study and career. Many students surveyed indicated other family members were engineers, for example grandfathers, uncles, brothers and occasionally sisters indicating a wider influence than these charts suggest.

Without taking individual national situations into account it is difficult to interpret these results more fully. Where the education level of parents is high, it could reflect that engineering is a high status profession and that professional parents encourage their children to follow engineering studies. Where the education level of parents is lower it could reflect the lower status of engineering, or it could reflect the lower access to Higher Education in many countries of a generation ago.

All the students declare they had discussions with their families, who were most of the time strongly supportive. Most of them had at least some idea of what engineering is because they have one or several engineers in their family or close environment. Most of them admitted having been influenced in their choices by a parent, a family member or a close friend. When they do not mention a role model in their family (German focus group), the students always underline the importance of the support from family, relatives and friends. This support is essential for successful studies in engineering and probably in every kind of demanding studies. Several female students mention that their families and their friends are proud of them: being a woman and being successful in engineering is obviously considered as something worth noticing!

Among the other influential factors concerning the students' decision to attend an Engineering School or Faculty, personal contact seems to be a decisive one. The most effective opportunity for personal contact is certainly Open Days which are mentioned in almost all the countries. Interestingly, counselling by a professional counsellor does not seem to be highly valued and booklets or other kinds of printed information are never mentioned. Information collected from Web sites is mentioned only once.

- **Interest in sciences**

An **early** interest in scientific subjects appears to be a decisive factor too: it is very often mentioned by students that they have always enjoyed physics, maths and chemistry and technological subjects. The fact that, at a certain point in one's studies, a combination of subjects was possible, is mentioned several times. This point is emphasised in Germany, Austria and Slovakia where engineering can be combined with other subjects: technology and economics, IT and economics in Germany, electronic research and music in Austria.

In France about half of the students declared they decided to study engineering because they liked sciences, the other half decided because of the school and social influence in favour of engineering. They knew at the end of the 5th year in secondary school that they would study sciences, not because they liked them but because they *"had to do it, considering they were good students"*. It means that the real and personal choice was made at the baccalaureate level (end of secondary school).

- **Lack of information**

Nevertheless, one thing is striking: none of the students interviewed had any precise information about the job itself, about the actual activities of an engineer; none of them seemed to have a clear vision of their future career when they started engineering. There seems to be a general lack of information combined at the same time with a total lack of curiosity from the students, even from a young Austrian woman whose two parents are engineers, and who received very little information about jobs for engineers.

2.1.3. Dropping out

- **Countries with a high drop out rate: Austria, Finland, Germany, Slovakia**

Why did they drop out? This question is central for our study because students' answers should hold the key to understanding the situation and consequently to defining paths of action. In general the experts agree to say the drop-out rate is high but they cannot quote precise figures. Figures are available but they do not know them.

In Austria it is difficult to gather data but drop out is estimated at between 20% and 50%. Wrong expectations linked to poor information about course content is the most common explanation for the high drop-out rate. An example is the Audio Control Engineering Degree where students expect lots of art and music. Some experts estimate that more boys drop out than girls during the degree course. They suggest girls tend to finish their studies and then leave the University, have children, raise a family and never return to their profession. Drop out usually takes place during the first cycle (or at the end of it says someone in Germany).

❖ Expert Opinion

Possible 'expert' reasons for drop out are given below:

- **Competition**

According to our experts there are some specific reasons for girls not going into engineering: the studies are seen as **highly competitive**, which "*girls do not like as much as boys*".

- **Lack of Information**

Another possible explanation is related to jobs and vision of the future: "*The basic problem is that pupils do not know about engineering jobs, professions and careers . . . Girls are more mature than boys, they want precise answers to their questions concerning jobs, professions and careers.* ***We should explain what engineers do***", a point emphasised by all the people interviewed. A lot of efforts have been made so far to explain what the studies entail.

In secondary schools, a lot of information can be collected about engineering studies from information officers. Schools of engineering have developed an intensive information policy to inform potential students about their courses but it does not seem to be the main point:
"*They know about the studies but they do not know about the jobs*".

- **Attitude towards studies**

The experts agree that **girls have a different attitude toward studies**. They seem more mature than boys, less impatient about their jobs. They have a precise idea of what they want after their studies, what sort of professional position they want to have, about their family life, about their couple. They expect a balanced life-style.

The point is that girls do as well as boys (in fact they usually do better at school at every level and in any subject). There is no difference according to French experts, but they have a different attitude toward life. Studies are not the only centre of interest they have, they have a large vision of their life, of what they want and what they do not want. That explains why they make more positive choices than boys who trust counsellors and advice more easily.

❖ Students' Reasons

From questionnaires and focus group interviews we gathered information about what reasons students thought are important for drop out:

- **Work load & knock-out exams:**

Regarding the students, the first reason given by all of them is the **quantity of work**: "*a very heavy work load*", "*a huge amount of work*", very often connected to the difficulty of technical subjects. **Knock-out exams** when they exist (Germany, Austria), are seen as *"psycho terror"* (a German student).

- **Lack of knowledge:**

In Germany, Austria and Finland, female students explain some of their difficulties by the **lack of previous knowledge**. They say it is different for the men who, very often, have already acquired this kind of knowledge. In Finland, for example, they insist on the fact that young men already had previous experience with electricity, construction or electronics. Such a situation leads some women to declare that men can cope better with technology or technical subjects. One of them goes as far as saying: *"women cannot understand technology very well, this is why there are so few women in engineering".*

But explanations for failure can vary significantly from one country to another and sometimes from one person to another. In Finland, the women interviewed explain their problems by the lack of previous knowledge and competence in using tools and machines. In Germany, by contrast, they complain about the lack of practical work; "*it is too abstract*", they say.

- **Pedagogy**:

The pedagogical system is very often questioned or criticized more or less heavily. Austrian and German women are very critical of the lack of attention from staff, poor course organisation, lack of information and the poor quality of the pedagogy (use of old material), no dialogue with professors, no will to introduce examples more suited to female students. In Finland and Slovakia, students are not so critical; they do not blame the institution for their failure but rather the subjects and their own lack of previous knowledge.

The choice to drop out can be **positive** in a way because some of the women interviewed explain that they want to **study broader subjects**, not limited to the field of "hard technology". In particular German and Austrian women ask for other fields, for non technical subjects to be included in the degrees.

- **Countries with a low drop out rate: Scotland and France**

Engineering in France, an elite subject

The French situation is very special because the prestige of engineering is very high. Engineering studies have always been seen as difficult, prestigious, elitist and leading to high social positions (respect, money and power, to put it briefly). The school system and families consider it as "normal" to go into engineering when you can be admitted, not necessarily to get a job in engineering after your studies but to get the diploma. Consequently, the pressure from the school system, from teachers and from families is strong on students who are doing well in sciences in high school to choose engineering and, if possible, "preparatory classes" (*Classes Préparatoires aux Grandes Ecoles*) which lead to the most prestigious *Ecoles*[9].

All the French women interviewed made a **positive choice** meaning they could choose engineering from among lots of different fields. They are bright students with several possibilities. They all confirmed they **had pressure put on them to enter a *class préparatoire***: *"When you are good at sciences it is considered as normal and compulsory to go into engineering"* .They said they **did not receive any useful information** about engineering careers or other possibilities:

[9] Today around 48% (in 2000) of engineers go to preparatory classes before entering a school of engineering

Engineering in Scotland, a low prestige subject

By contrast, in Scotland engineering has **low prestige** and students who are clever at sciences and maths at school are encouraged to go into medicine, law or accountancy. The proportion of **girls** choosing engineering is low but those who do choose engineering make a **positive choice** and are generally considered by the experts interviewed to be very focussed and determined. Very few drop out and non-persistence is a greater problem with the men.

Drop out in Scotland

One Scottish Head of Department indicated that the number of students who dropped out in his first year engineering course was around 10 % usually because the students decided they were not suited for engineering studies, in which case they might transfer to another degree such as Maths or Physics, or they were not ready for University studies at all in which case they would take a year or two off and return to their studies often at a different University. A few more students would leave because they failed their exams – first year maths is usually the most difficult subject. A few students might leave after 2 years; then there is the possibility of graduating with an ordinary degree after 3 years. Out of a first year class of 140 students, 90 to 100 would reach the fourth year (BEng) and around 60 of them would continue to the fifth year (MEng). Figures are not precise but it is clear that more young men than young women quit as the percentage of women increases in the later years of the course.

Some of the experts interviewed expressed the opinion that because they were entering a non-traditional subject where the numbers were low, the women had made a positive choice. By contrast, many of the young men had apparently drifted into engineering studies, often because they did not get into the course they would have liked to do.

Drop out in France

The situation is specific in the sense that dropping out is almost unknown at least when students have been admitted to a school of engineering. A Professor at one institution indicated that in computer sciences 1 student out of 120 drops out every other year. More students drop out in preparatory classes. We do not have a precise idea about how widespread this is because those preparatory classes are in lycées (Secondary schools) and no national figures exist. Very recently it seems that drop-out figures for the first year have been increasing and some colleagues in charge of the first cycle are starting to worry about it but

again we do not have precise data. Traditionally it was estimated at around 10% and was considered as a minor problem. A specific study should be conducted on the phenomenon in order to know, firstly, if it is increasing or not and if so, why.

Students' reasons not to study engineering

French students gave three common reasons for not studying engineering:

- it is seen as competitive
- it is seen as too specialised, too narrow
- ignorance about jobs

One non-engineering student declared: *"Engineering studies are OK but jobs for engineers are boring".*

2.1.4. Representation of engineering careers

What is amazing and linked to the lack of information denounced by students concerning engineering jobs and studies is the fact that most students from all seven countries have no idea about their future jobs and specific careers. As they cannot really imagine what their future job as an engineer will be, they do not describe it; they simply refer to it very vaguely.

They cannot imagine their future professional life or job: they only talk about their present studies, their present difficulties or successes… They might enjoy the varied aspects of technological studies but have no clear idea what to expect from an engineering degree. getting a job, even if they admit that they are career-oriented. Finnish, Scottish, German, Slovak and French engineering students describe only their present studies when asked about their future job. It is certainly linked to a lack of information or a lack of global view of their studies and perhaps to the fact that in the final year of their courses the students are focussed on their exams…

Conclusion

Even if dissimilarity and heterogeneity are the two terms that best describe engineering studies, engineering students, institutions, teachers and pedagogical systems in the seven countries under review, we can see that some aspects of the phenomenon we want to understand are similar:

- There is a real and serious lack of information concerning engineering studies.

- Everywhere women seem more concerned by a long-term vision of their life than men

- They are more preoccupied by the question of balancing professional and personal life, they want precise answers about actual working conditions, actual conditions of mobility.

- Salary does not seem to be the main concern for women in particular. That point will be cross-analyzed with expectations for a professional career.

- Many students ask for more classes based on dialogue, exchange and direct contact with other students and teachers (a typical concern of women).

- Personal contacts such as Open Days are obviously more important than any other source of information: students mention massively the influence of their family, their friends etc. . . .

- The first cycle (the first two years) is obviously the decisive time for students everywhere, in every country. If action is decided on, it has to take place in the last year of secondary schools and/or (depending on the countries) during the first two years of higher education. In countries where subjects are selected in the early years of secondary education, action may be required even earlier.

2.2 Key Moments in Women's Engineering Careers

The aim of this section concerning engineering careers is to understand how women engineers deal with their professional and personal life at key moments in their careers. We know from research carried out in different European countries and in North America that women with the same level of training and the same academic background do not have the same job opportunities nor the same careers and salaries as men.[10] Our intention is to understand how women engineers live four key moments that we have identified in our study. Those key moments which seem to be critical turning points during a professional life correspond to four different steps : first job, motherhood, dual career choices, promotion and mobility.

Our work here is based on interviews with women and on focus groups, what women actually say, how they analyse their life, their experience. In order to have other points of view we interviewed Human Resource Managers and Union Representatives. Because we wanted to have comparable material from the different countries, we established precise guidelines for interviews and focus groups, we analysed web sites of companies, we interviewed members of work councils, union representatives and Human Resource managers of the same companies. We chose two companies in each country, one " good practice " company and a " normal " company.[11] One of the two companies had to be in the energy sector.

Before analysing interviews of women engineers it seems necessary to start with an overview of what women students in engineering expect from their future professional life. The idea is to compare expectations of students and the reality of professional life for women engineers.

Another starting point is the presentation of some data in order to have an overview of the general situation of women in the professional sphere in Europe in terms of salary, career, access to managerial positions and access to top positions.

[10] The literature concerning this question is enormous. We will refer to some data in Part 2. We must remark that it has been impossible to obtain precise data concerning women engineers in particular. We know from other sources that their situation (with differences between countries) as far as careers are concerned, is not different from other jobs.

[11] "Good practice" means, in this case, a company which uses good employment practice which may include a policy for recruitment of women, for their integration and promotion

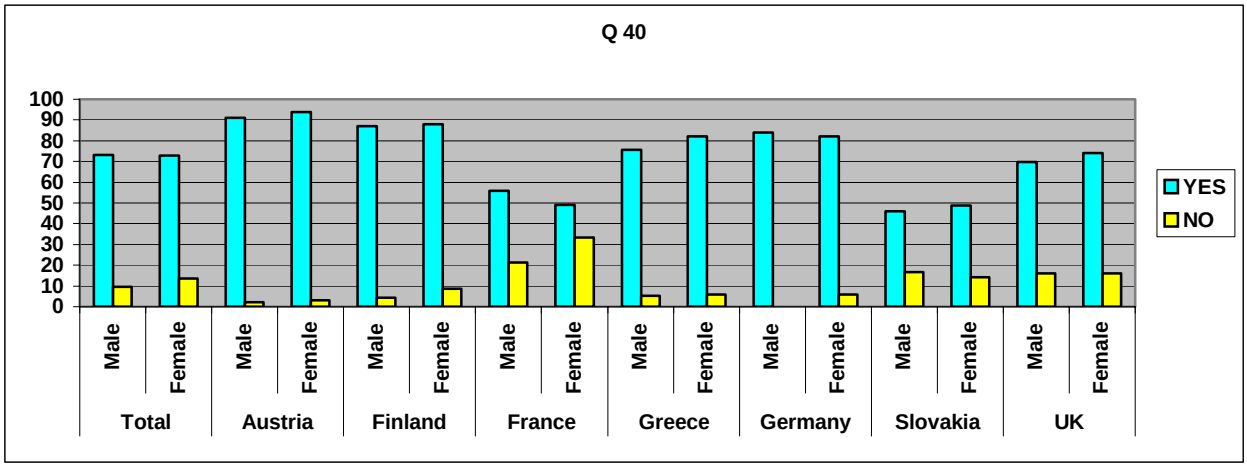
Then, and it will be the core of this part we will analyse how women engineers speak about their jobs, and what they say in particular about four particular key moments : the first job, maternity, promotions, choices which have to be made when there is a dual career couple

Finally we will present recommendations: policies exist for the recruitment of women, solutions exist to the work life balance problem women engineers experience, examples of good practice can be presented and analysed, which show that women can have equal opportunity.

2.2.1. Students' vision of the future:

When asked about their future seven years from now, average differences between men and women are not very great either. Men and women have basically and globally the same vision of their professional life for the future. But there are important differences between countries. A striking fact: in two countries – France and Slovakia – there are less than 50% of students who say they **will be working as engineers in 7 years.** In Slovakia 37% of students do not know (they answer neither *No* nor *Yes*) ; in France 21% of men and 33.4% of women clearly say, they will not work as engineers. When we compare with Germany (84% of men say *yes*, 0% of men *No*, 82% of women say *Yes* and 6% *No*) or with Austria (91% say *Yes* and 2.2% *No*), the interpretation of such data seems difficult but it probably means that within Europe, students have obviously very different reasons for studying engineering.

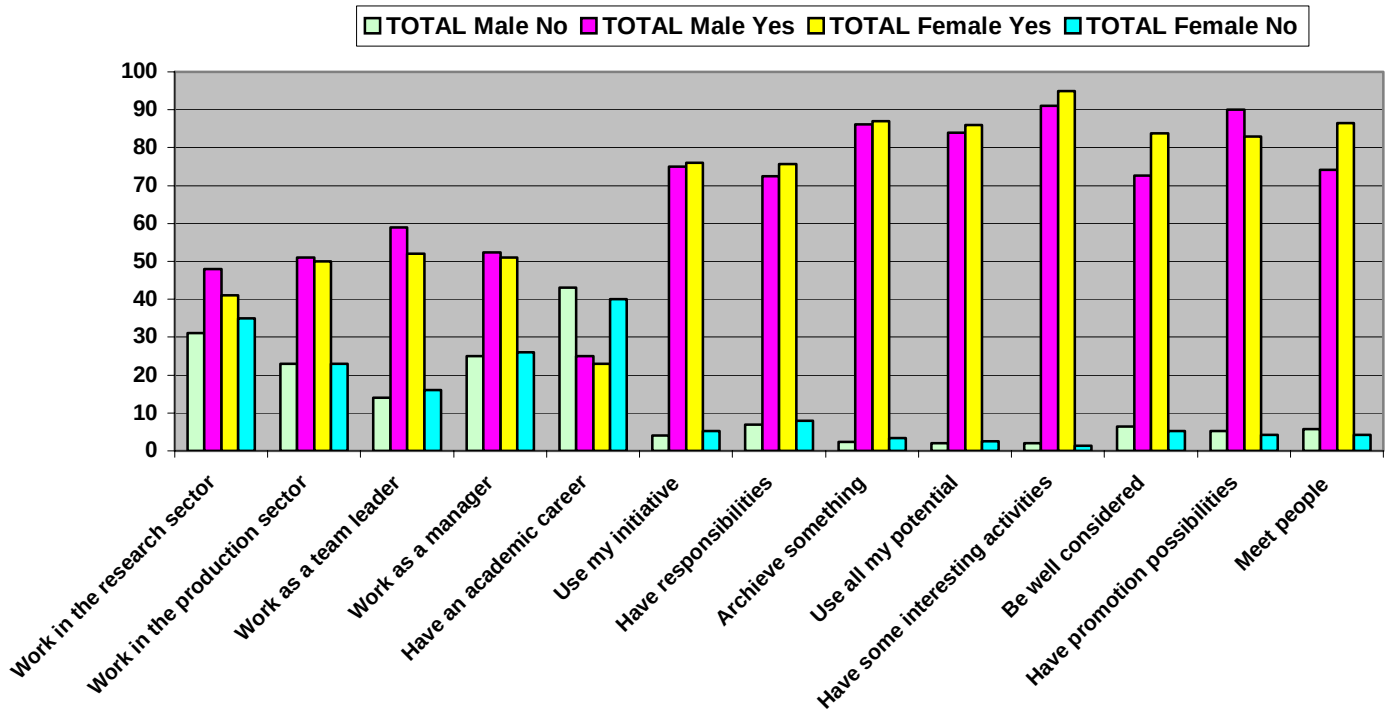
Perhaps it is not too surprising that in France a relatively large proportion of students believe they will not be working as engineers in 7 years as in this country engineering studies are considered to be 'The Royal Path', which brings many diverse opportunities. Relatively few Slovak students expect to be working as engineers in 7 years, but this is probably because here engineering is a low status profession and it seems that once they qualify students will try to find a different profession. By contrast in countries like Germany where engineering is a high prestige profession, or in countries where students choose to study engineering because of interest in maths and physical sciences at school it is to be expected a high proportion of students would wish to continue to work as engineers.



Question 40: Is it likely that you will be working in a technological related field in seven years from now?

We asked students about their expectations of their future job as an engineer and the results are shown in figure Q38. Differences between men and women are very slim, when they exist. **Expectations are almost identical** with small differences : on two items the difference is higher than 10%. More women want to *meet people* (the difference is 12%) and *to be well considered* (the difference is 11%). One point can be underlined : **students do not expect power but personal, social and intellectual satisfaction.**

Question 38: -As an engineer you would like to:



The vision of the work is the same: long hours, managerial responsibilities, heavy work load are part of the job. But there are differences when it comes down to family life and personal life : women are more worried than men, especially about bringing up children (38% compared with 27%. We can add that differences - when they exist - are not that deep ! The most noticeable is the fact that men do not answer the question of "*bringing up children*": 47% of them answer neither *Yes* nor *No*! which probably means they have not thought about it or do not want to think about it. Women have thought about it : 82.9% answer the question and although 38% are worried about combining family and work, reassuringly 44% are not.!

The strong support students have received to pursue an engineering career suggests that the image of an engineering career in Europe is positive both for men and women. The exception is Slovakia where results shows exactly the opposite : the image is negative. One point is underlined: **information received by students about engineering jobs has to be rethought, clarified and improved** especially in the countries where students in engineering declare they do not have enough information about jobs.

It appears that globally speaking, women and men do not have significantly different expectations about their career as engineers. They have the same motivations but there are profound differences between countries which are worth considering because they show that situations could be changed, they do not have to be the way they are (information about jobs being an example). Families support their children's choices to study engineering everywhere except Slovakia. The image of engineering in terms of a career is globally positive.

2.2.2. Women's careers in Europe

Many studies have been released in recent years and a lot of data is now available. All the studies prove that women are discriminated against in terms of careers. Women engineers are no exception. We know that they have more difficulties finding a job[12]:

Unemployment Rate

European Union	Men in 2004	Women in 2004
15 Countries	7.1 %	9.3 %
25 Countries	8.1 %	10.2 %

Source Eurostat

Source Eurostat

their salaries are lower:

Gender pay gap

Countries	2000
Austria	20
Finland	17
France	13
Germany	21
Greece	15
Slovakia	22
United Kingdom	21

Source Eurostat

[12] We give only the most basic data concerning each item, for more details see Eurostat, EPWN (European Board Women Monitor), European Union DG EMPL, data base on Women and Men in decision making.

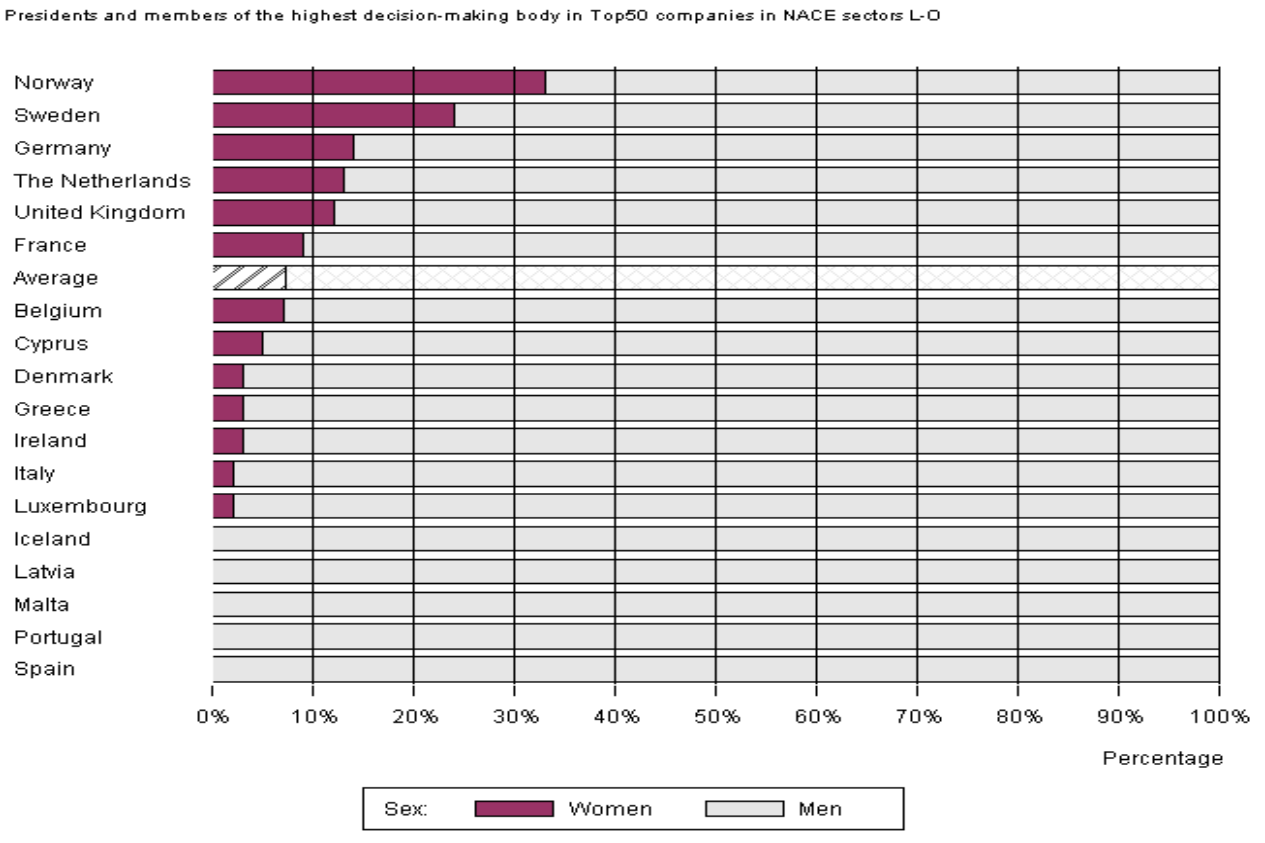
women work more often part time:

Part-time employment as percent of the total employment of a given sex (%)

Countries	Total 2000	Women 2000
Austria	17,0	33,0
Finland	12,7	17,5
France	16,9	31,0
Germany		
Greece	4,7	8,1
Slovakia	2,1	3,1
United Kingdom	24,8	44,4

Source Eurostat

and they very rarely get to top position:



Source: European Commission, DG EMPL, Database on women and men in decision-making

If we compare expectations and hopes of women engineers - which are the same as men engineers - we can see from all the available data that careers are very different. Students start with the same potential, the same desire, the same expectations, the same idea about what they want and what they do not want but real corporate life makes a big difference.

Against this background we will try to understand how this difference becomes reality. When does it first appear? Is it brought about in the first job or is it felt later, perhaps when women have children? Is it just a consequence of restricted mobility because of children or because of dual careers?

2.2.3. The First Job

In creating a successful career as a woman engineer, one of the most important steps must surely be obtaining the first job as an engineer and this is what we focus on in this section of the report.

To build up a comprehensive picture we have examined the 'first job' from the perspective of:

- the company (Interviews with HR and, where they exist, union representatives and works council members)
- the experience of (young) women engineers without a management role
- the recollections of women engineer managers looking back at their own first experiences as engineers
- women engineers who quit engineering.

➢ The approach we took to analysing 'the first job'

The key factors for the first job are being recruited to the position and settling into the job. Do companies have particular initiatives to attract women or to promote the company to them? What do companies do to help new recruits to settle into the job, such as assigning a mentor, giving training in soft skills like running meetings or negotiation? Is there anything just for women? In other words, do companies have a framework to assist the development of their career? The presence or lack of such initiatives could have a bigger effect on women's careers than men's, especially where there are few women.

It was also important to look for evidence of access to training, especially training for promotion, and whether there might be gendered differences. Who decides access to training? "*Creating cultures of success*" involves achieving promotion; are the criteria for promotion transparent and objective? Who decides on promotion? Are there different expectations for women engineers? Work atmosphere and the reality of working relationships between men and women could influence the decision to stay and develop a career in engineering or alternatively to give it up. We hear many stories of sexism and discrimination and marginalisation in the work place, all of which would make it more difficult for women to develop successful careers. What is the reality now as experienced by young women engineers?

What of the expectations of women engineers compared to male engineers? And what is the reality of all this compared to the company rhetoric? Do women engineers find the transition to the workplace easy? Do they perceive equal access to training and promotion or equal expectations of their performance compared to men? Are women judged equally or do they *'have to perform twice as well to be thought half as good?'* What expectations do young women engineers have? What about older women managers, how did they achieve their career progression? And what about older women engineers who have not received promotion? Does it matter to them or have they a different definition of 'a career'?

- **Recruitment**

There exists a wide range of strategies for recruiting engineers and reasons for targeting (or not) women engineers. In our context best practice in recruitment comes when a company recognises the business case for employing women engineers. It may come because the company makes products that men and women can buy, or because it recognises that women have qualities such as good project management that will strengthen company performance. The drive may be that the company wants to be the best and so it wants the best thinkers to take on board environmental and sustainability issues.

A best practice company will have well-designed web pages which include a recruitment section. This will provide information such as job profiles and technical requirements as well as person specifications for each job, for example ability to work in teams, to show initiative, the need for interdisciplinary cooperation. Any necessary or desirable 'soft skills' such as

communication skills will also be indicated in this section. The company will practise diversity and gender sensitive language will be used throughout the web pages. The company's policy will be to 'groom' its employees through excellent training opportunities and by promoting life long learning and work/life balance. It will also have returner schemes after career breaks and flexible work arrangements, particularly for people with childcare or other caring responsibilities.

This will be combined with images and recruitment materials that encourage applications from women and women may be targeted through links with high schools or through recruitment fairs. There are likely to be strong links with schools and universities that allow young women to have summer placements or internships and the company will support activity days or weeks to allow pupils to gain experience of what it is like to be an engineer. Job advertisements will use non-discriminatory language.

In general, the women interviewed chose engineering because of interest in the field or in maths and physics at school, and because of role models in their family. This is especially true in France where all the women interviewed have an engineer in the family. Many women in Slovakia were directed to engineering in communist times. Engineering was promoted to them at that time even if it was not the career they would have chosen for themselves.

- **The transition from studies to work**

A *'best practice'* company will have an excellent induction program for all new recruits to familiarise them with company policies and values. There may be particular emphasis on inducting and supporting graduate engineers. The company will have longer induction programs linked to training and familiarisation with different sectors of the company through a number of placements lasting 3-6 months before the engineers specialise in the area to which they are best suited and interested. New recruits will be assigned a mentor who is not too senior to be accessible, from a different department in the company and not a line manager.

- **Ease of access to training**

In a best practice company there will be equal and open access to extensive training. Especially in the early years there may be a well laid out menu of training opportunities from which the new recruit selects suitable and useful items in collaboration with a boss, such as

the line manager, project leader or mentor. This menu will be agreed with a professional institution if there is the requirement for the young engineer to become chartered. Once the engineer has completed initial training, further training should be agreed at least annually at the regular performance reviews. There will be training in technical aspects of the job and in soft skills, such as training for personal development and how to run a meeting. Diversity issues such as gender will be incorporated into mainstream training so everyone will benefit and be influenced. Ideally there will be a dedicated training budget and training will be linked to promotion. Completion of certain training programmes, such as team building, conflict resolution, equal opportunities in selection and interviewing would be requirements for promotion. The line manager will not have the power to veto a request for training if the engineer can make a good business case for taking the course.

There are some indications that there is a correlation between the presence or absence of an induction scheme, or training programs and developing a successful career for women engineers. In Germany, Greece and the UK where extensive training is equally available regardless of gender it seems that promotion prospects increase because of this.

- **Criteria for promotion**

In a best practice company, criteria for promotion will be objective and transparent (performance can be measured against a published list) and widely known. Ideally there will be a section of the web site, perhaps an internal section, dealing with promotion criteria. They will be gender transparent. Part-time or flexi working will not be a bar to promotion and it will be possible for someone who has taken a career break to return to a career track position. If promotion is into a specific new job it will be the match of skills to the job and person specification that will decide who is promoted. Line managers will not have the power to block or veto promotion.

Reading and reflecting on the material collected it is evident that stereotypes and discrimination are starting to kick in and it is here that women's careers start to diverge from men's. We start to see a big difference between what the companies say about career expectations and the reality for women. In several countries two types of career progression are recognised – one leads to being an expert in a technical specialisation, a 'techie' and the other leads to a management position. Companies often have a perception that women will wish to be technical experts rather than go into management roles. These companies tend not

to prepare women for management roles. Some women have been warned that ‘techies’ can rarely make the transition to a management post, which will reduce their earning potential over their working life.

Some of the companies we surveyed, which are close to best practice, have an emphasis on ‘grooming people’ and they provide extensive training with promotion based on criteria for the position. In some of the other companies it is possible for women to reach middle management. The women believe that men do not automatically make better managers but the reality is that men will be promoted and paid more. In other companies there is a management perception that women want to be technical experts and that they have good skills to be project leaders but that they do not want to become top managers. The women are frustrated because they see that they have no possibility to go beyond middle management regardless of their desires and skills. In these companies women have to be better qualified to obtain a job with less responsibility and less pay than men. The companies do not recognise the financial cost to them of not utilising all of the available talent. Other companies have less transparent criteria or procedures; for example it can depend on an individual department head identifying potential and recommending someone for projects or for promotion. Promoted jobs are not circulated widely and a department manager has the power of veto, so it is a system of patronage which can work against women. Women engineers are not encouraged to put themselves forward for promotion

A major challenge is accepting that part-time work does not mean diminished commitment. A woman engineer working in Scotland pointed out she has worked part-time since her eldest child was born. She believes she shows more commitment to the company than full-time workers whose partners take care of family responsibilities, that it is not time spent in the building that is a measure of a person’s effectiveness. Several women talked of a culture of ‘presenteeism’, of people staying later than the manager and perhaps sending some e-mails just before they leave to prove how diligent they are.

However, we should be careful not to assume that the only definition of a successful career is to reach the top. Many women choose to have an interesting, reasonably well-paid job that satisfies them and a job in engineering meets those criteria.

- **Job expectation**

Although HR managers generally (with the exception of France) said there is no different expectation for women and men engineers, the women have often reported a different situation. In some companies women said they perceived no difference in expectations for women and men engineers. They are expected to complete the same tasks and receive equal access to training in soft skills. In one company women's better interpersonal skills are often called on to mediate in disagreements (and yet they are not considered to be suitable to be top managers!) Women's skills and strengths are also utilised in one energy company to market the products and the company to the extent that the women engineers believe there are no management tasks available for them.

In some companies women are expected to adapt to the masculine work culture. There is a particular challenge for the women in one company which introduced quotas to increase the proportion of women because they feel "*judged and criticised*" as quota women and they feel they need to prove themselves even more than if there was no quota. Women in several countries said they constantly felt they had to prove themselves more to their bosses and their colleagues than men did. In other countries there seems to be a measure of acceptance once women have proved their competence.

Although some women experience considerable sexism and discrimination, one thought there would be no problem if the woman is self-confident and assertive. However, an environment of constant criticism creates the feeling that you (and all other women engineers) are being condemned any time you make a minor mistake (while men are judged to belong to a world where "*these things happen*") and is likely to erode confidence and self-esteem.

- **Work atmosphere**

As you would expect, most of the company representatives thought the working atmosphere was good with well-integrated staff and high job satisfaction. There are some mixed responses from the interviewees. The atmosphere is believed to be influenced by the bosses, by the stability (economic situation) of the company, by the people themselves or by the workload or the threat of redundancy. Where there is a threat of redundancy or restructuring or if the workload is persistently high, it is understandable that employees might find the working atmosphere difficult.

Most women did report a good work atmosphere although some said it was:

-Unsupportive: difficult to have ideas accepted; unequal access to training, to interesting jobs; lack of company back-up for one engineer when she had problems with subcontractors on site,

-Male-dominated but women should adapt and make allowances for men! (Austrian woman engineer),

-Lower paid (for more responsibility even if better qualified; may not be able to afford the woman in a few years time if she is paid more now),

-Sexist: advantageous to work in such a company "*As we are less numerous, we are pampered*" (French women engineers). Women perceived as less competent due to quota system; equal expectations on paper but *'women have to be able to work as well as men'*; different reactions to mistakes,

-Competitive: women competing to show they are as well-qualified and as able as the men; warrior-style management with harsh language,

-Competence questioned due to inherent sexism; but once competence shown it is no longer questioned in some countries, in others it continues to be questioned

-Commitment questioned if women work part-time, especially in a prevailing culture of presenteeism. Also they have to prove their competence over again each time there is a change of line manager.

One Austrian engineer suggested that it is unassertive women who tend to leave engineering. A French HR manager commented that a bad atmosphere might deter women from engineering but we need to ask ourselves if these are acceptable working conditions for male engineers

This brief analysis shows that work culture can have a significant effect on women engineers' career development. However, good on-the-job technical training, especially if it is combined with training in soft skills which includes some gender sensitisation, is leading to change. Having objective criteria for measuring performance and assessing for promotion is another key aspect that will improve the situation for women in the engineering work-place.

- **Working relationships with men and women**

The key thing here is that the general approach to the problems or failures caused by women and men is different in some countries. If a woman *'spoils something'* the reaction is usually

"Well, she's just a woman, what else could we expect from her" (male engineers of female engineers in Slovakia when something goes wrong).

and if it's a problem caused by a man,

"It could happen to anybody" (male engineers of male engineers in Slovakia when something goes wrong).

Several women reported having problems with older men (dinosaurs) who could not accept that young women could be better qualified than they were, although women in Austria also found difficulties with male engineers of the same level. In general they find it easier to work with male colleagues of lower ranks. Others commented that the expectations of women are higher and the mistakes made by women are not overlooked. *"Her mistakes were always presented more openly than the men's mistakes"*

Lack of respect (which can be 'institutional' or individual) can also cause problems in work relations and job expectations. Some Slovak engineers found women were tolerated but not accepted at the company. The company management did not expect much from women and they had no chance for further education whatsoever. They were generally given simple, unchallenging jobs. Men were those who were supposed to climb the career ladder and women were there to finish those great jobs that were started by men. Others found they were patronised by male colleagues.

"Okay my dear, you say whatever you like and then we solve the problem in our way" from the male colleagues.

Women engineers in several countries have reported being mistaken for a secretary and one (UK) said she was often treated with more respect when they found out she was an engineer.

It is encouraging to see that most women in most countries have spoken of experiencing good working relationships and a good work atmosphere. However, we must bear in mind what the President of the Women's Engineering Society said: in the UK about 80% of engineers are employed in small to medium-sized companies. The reality of their work relationships and their work culture might be very different from the situation in large companies, particularly in multinationals. In other words, the overall picture in each country may be worse than the picture we are painting. This does not prevent us from drawing conclusions and making recommendations based on the information we have received, and this should be able to make a positive difference in any company where these recommendations are applied.

2.2.4. Having children as a key moment in women's engineering careers

Having a child can be a key moment in a woman's career. For women engineers, maternity is seen as a problem and correlated with professional difficulties (Discourses of Women engineers), and companies use it to put pressure on mothers. Maternity seems to be only a woman's problem: women talk about their arrangements concerning children, as if it concerned only mothers, and the companies observed adopt the same discourse: maternity and its consequences only concern women as mothers. Companies would propose to mothers teleworking and part time solutions, flexible working hours, *"but working part time is not career promoting at all levels"* (Germany) and *"they could not be taken into consideration"* (Greece), and very often women would be the first to leave in case of economic lay off: *"the easiest victim"* (Slovakia). In brief, maternity is still a woman's affair, and represents an *"eternal dilemma"* (Slovakia).

Even if taking maternity leave is not a problem in itself, it seems that motherhood is considered by most of the women we talked to as an obstacle to promotion and mobility. Even if most of the women declare that they do not drop out of their job as engineers directly because of having children, they may drop out because of problems linked to dual careers, difficulties in handling both work life and private life. As we can see in Germany, none of the interviewed managers knows a woman engineer who dropped out because of having children, but some of them assumed it as a hidden reason for dropping out.

- **Maternity and professional career:**

Comparing the different maternity social systems which exist among our seven partner countries can give a deeper understanding of what women engineers, human resource managers and other persons interviewed have to say about maternity. In the seven partner countries maternity, paternity and parental leave exist but they do not seem to have the same impact. Laws and regulations - even if they are based on the same principles - are somehow different: for example in Greece or Slovakia maternity leave is not as favourable as it is in Finland or in France. In the seven countries maternity leave ranges from 15 to 28 weeks. One point is still a problem: fathers are very reluctant to use the paternity leave right they are entitled to. It is a deep and fundamental problem. But few of the women engineers interviewed thought that paternity leave should become compulsory as it is in Sweden.

Another important issue emerged. Everywhere mothers and/or fathers can take parental leave (between one and three years with different financial compensation) but when they come back from it, can they find their former job and their salary ? In Austria, for example, women can benefit from parental leave for 2.5 years (3 years, if the father also takes half a year) but they only maintain the right to come back to their former company (not the same job!) for 2 years!

Good childcare is crucial for when parents (= mothers!) return to work. France and Finland have good public childcare as opposed to Germany and Slovakia, for example, where such structures rarely exist. It can be explained by the lack of financing, of course, but more important seems to be the low social acceptance of working middle class or professional mothers who allegedly cannot take care of their children "decently".

Regarding the attitude/culture of companies many situations exist. Naturally all the companies involved in the survey comply with the national laws and regulations but they put them into practice in very different ways. In the same country very diverse situations can be observed. The "good practice companies" we surveyed take into consideration the fact that many of the women have children and want to take care of them, so they have a specific policy and they plan maternities, parental leave, sometimes child-care facilities, part time, flexibility etc.[13] However, some of the companies – and/or society at large –consider it is a personal problem so that mothers have to find solutions by themselves.

Some societies still consider that mothers should take care of their children before they can think of having a professional career. According to the women we interviewed, some companies in Austria, and Germany and the society at large in Greece and Slovakia are examples of such an attitude.[14] What seems obvious is that laws and regulations are necessary but they are not enough to solve the problem; companies must become proactive and recognise it is partly their responsibility as well. Key to this shift in attitude will be developing the business case for retaining staff, both in terms of money saved in recruitment and training replacements and in terms of building a loyal work-force who will stay with the company and help it grow. The relation which exists in the couple can another important aspect. As long as it is considered that parenthood is only the problem and responsibility of

[13] We will develop examples of good practices and solutions in the last section of the report

[14] The situation of Slovakia is specific because the restructuration which followed the radical political changes after 1989 was particularly hard on women: many women lost their jobs (fired after maternity leave). They were very often considered as the " adjustment variable".

the mother, not of both parents, difficulties will exist for women, engineers or not. Indeed difficulties will exist for women whether they are mothers or not, in developing successful careers until societal attitudes change and this represents an increasingly unacceptable loss of talent and potential the European Community can not afford.

- **Fecundity Rate**

It is very tempting to compare the situations we describe here with the fecundity rate[15] and the level of employment of women country per country.

Fecundity rate	
Europe (25) : average in 2003	1,48_
Austria	1,39
France	1,89
Finland	1,76
Germany	1,34
Greece	1,27
Slovakia	1,17
UK	1,71
USA	2,07

The fecundity rate here is expressed for all the women in each country of our project and not only engineers; separate figures for engineers do not seem to exist. However as an example in Finland where the average fertility rate is relatively high at 1.76, for professional women it is only 1.3. So even in a country with good public childcare facilities professional women are limiting the size of their families. We are aware that the background to such statistics is a very complex one, however, we can assume there is a correlation between such a rate and the fact that women have children or refuse to be mothers because it is more or less difficult to have children and have a career as an engineer or "simply" to have a job.

2.2.5 Dual careers

Dual careers seems to be a gigantic problem among couples; in fact, it seems to be really difficult to manage, and it responds and correlates itself to different factors which are more or less strong and vivid among the countries studied. Even if certain chosen companies try to

[15] Eurostat ; year 2003. For the definition of the fecundity rate see Eurostat web site

help women, proposing part-time hours, teleworking, shortening the working day, dual career is a strong brake to women's careers, penalizing women in different ways (problems in the couple and inside the family, the social pressure of the taking care of the children, traditionally devoted to women, difficulties of organization… These problems can end in divorce, which of course would make it even more important for the engineering mother to have a career to support her family. Dual-career problems are commonly evoked by the women engineers questioned in the seven countries: it is more or less emphasized, according to the strength of the traditions concerning women.

One key element is the attitude of the husband/partner. It seems that there are strong differences between countries and between generations. In countries where the image of the "caring mother" is very strong and alive (for example Germany, Greece, Slovakia, Austria) the dual career is very difficult to handle. In the case of some "good practice companies" there are possibilities which allow the two partners to have a career; such companies consider dual careers as something the company has to deal with. But obviously such possibilities exist only with the support of the partner. If the husband/partner still upholds the traditional culture which considers as "normal" to give priority to his career and consequently to leave the mother to take care of the children, this puts women in an impossible situation, sometimes leading to divorce, to the woman dropping out of her engineering career etc.

It seems that young generations have a different way of handling dual careers. Several young women interviewed insisted on the fact that they can have a career because of the support of their partner and we found that many women who become managers seem to have had support from their partner. But even in that case the situation is not equal between men and women*: "a woman never has the same support from her husband as the other way around. Men always get compliments for doing housework, things which are normal for women."* (Interview with Women Engineer Manager in Austria). Again we must sound a note of caution. Not all women are married or in a long term relationship. Not all women can be or choose to be mothers but even childfree, single women do not progress as they should compared to male colleagues. For as long as we continue to see childcare (beyond the biologically determined necessity for maternity leave) as women's problem it penalises all women, and society suffers from the failure to utilise all available talent.

2.2.6 Promotion and mobility

Some women engineers mention the question of mobility, others do not. Do we have to suppose that women who do not talk about mobility are not asked to be as mobile as men? It is just possible. Nevertheless, in some countries, mobility appears as a hidden but real factor of promotion, in others, mobility is not present, but the issue of achievement at work is questioned. These mobility and promotions questions clearly appear, to women engineers from the seven countries, as closely linked to the family question.

Greek, Slovak (and German women to a lesser extent) do not talk about mobility: is it because they stay away from mobility and so from promotion intentionally ? Do they limit themselves, because of the lack of kindergartens? Are they not asked to be mobile, or do they consider that, as women and mothers, they cannot be mobile (social pressure)? Austrian female engineers evoke the subject and relate it strongly to family, French female engineers refer to mobility as a key factor in promotion.

In some companies "*Mobility promotes promotions. And when you reach a specific age, offers correspond less to your competence and experience: there is a stagnation of the careers of women who have reached a certain age. You have to play the mobility game"* (Interview with Women Engineer Managers in France*).*But in other countries the situation seems different; in Greece and Slovakia the women interviewed do not seem to be concerned about this mobility question being a promotion criterion for women engineers. Women engineers do not evoke this problem of mobility at all.

The picture is almost the same for promotion. A lot depends on the company policy and on the partner's support or opposition to it. There again stereotypes seem present and sometimes very strong, including in the family: "*My husband thought that I was crazy to take that job as a project manager in Graz (because she was the first female in this position), but it was no problem*". Interview with Women Engineer Managers). The idea that women very often do not want to be promoted because the weight of responsibilities is supposed to be too heavy for them has been expressed by some people interviewed. Of course some others refuse such an idea and insist on the fact that such a stereotype has to be proven wrong by showing successful examples.

Perhaps we have to question the assumption that people can only achieve promotion if they are prepared to move around. Perhaps they can achieve promotion by building different kinds of experience within one section of a company as some of the women engineers in France reported.

Conclusion

Women students in engineering are in no way different from men, they basically expect the same things from their professional life, they have the same degree of involvement in their studies, they have the same ambition, the same objectives, the same interest for the jobs and the careers offered by their diploma. They are just a little more aware that the balance between personal and professional life may be difficult to achieve! The key moments in their career are the same in the seven countries: the first job is not a problem but having children and taking care of them is experienced differently according to the laws and regulations of the different countries. Another key point is the “culture” of the company and of the country; it is not accepted everywhere that a woman can work and can decently take care of her children even if examples of success and good practice exist. Stereotypes are stronger than reality! Another unsolved problem is the question of promotion, very often connected with the question of mobility. It is obvious that the glass ceiling exists for women engineers.

Part 3 Success and Non-Persistence

This part aims at identifying the internal and external factors that may influence success or non-persistence in either completing a degree or developing an engineering career.

The first section, focussing on engineering studies, will analyse the situation from the point of view of women engineering students. The second section, devoted to engineering careers, will investigate the reasons why women engineers leave their jobs and what factors can lead to successful engineering careers for women.

3.1. Success and Non-Persistence in Engineering Degrees

Over the last 30 years, a variety of initiatives have been set up to involve more women in the study of engineering. Early attempts focused primarily on young women and making them more informed. More recently, stronger emphasis has been put on changing and improving degree courses and the cultures of engineering institutions. It is in this context that the WomEng project is situated. The main question we are trying to answer in this section is the following: *"Once women have enrolled in engineering degree courses what factors affect their decisions to either persist or drop out ?"*

It has been observed that dropping out, rather than being a result of a lack of intellectual ability, is dictated fundamentally by the discouraging climates found in the various departments, courses, and schools of engineering. For these women, contributing factors such as lack of practical experience, an alienating atmosphere, and weak to non-existent or non-specific faculty support play decisive roles in their decisions to leave, all of which is highlighted by European and North American research such as Engler 1999, Heublein 2000, Lewin 1995, Lewin et al. 1995, Minks 2000, Robst/Keil/Russo 1998, Adelman 1998, Crawford/MacLeod 1990, Rayman/Brett 1995, Sandler/Hall 1984, Seymour/Hewitt 1997, or Goodman et al. 2002.

It is vital for women to feel part of a larger engineering community. A sense of belonging is strongly linked to a student's self-confidence, especially for female students in a minority and in male-dominated degree courses. It can be promoted and increased when they experience that their peers, professors, family, and friends believe in their engineering abilities and genuinely want them to be part of the engineering community.

3.1.1. Dropping out

Generally, in the seven countries covered in this study, there is no specific data available. Drop-out data is not gathered centrally, not monitored, not evaluated. Some interview partners state that they think data is collected but they do not know where and what the exact figures are. Estimates vary between a range as wide as 10 to 60 percent.

According to our research, one third of engineering students have thought about dropping out at least once. Female engineering students (except in Finland) think more often about it than their male colleagues. 70.1% of the students know of at least one colleague who dropped out of an engineering degree course.

The most difficult phase for a student is at the outset of the studies. Among other factors, students have to organise themselves, learn how to learn and handle the new freedom. Most of the dropping out happens in the first two years. During this period, the academic subjects, though basic and important, are very "dry", as one interviewed expert put it.

- **Reasons for Dropping out**

More than 10% of all engineering students of both genders questioned thought of dropping out because of the heavy workload, the different course expectations, or exam failures, or because they were considering changing to another course.

The heavy workload dominates in Austria, whereas it is the course change in Finland. In France and in Great Britain it has more to do with the different expectations about the degree course, and in Germany and Slovakia most thoughts of dropping out are connected to poor exam performance.

More than three quarters of the students of both genders think that poor exam performance is the main reason for dropping out of an engineering degree course. More than two thirds also say that different expectations about the course and the heavy workload are further reasons for dropping out. A little less than two thirds of the students think that a dislike of the subject could be a reason and more than one half believe that students who dropped out from engineering had changed to another course.

More women say that the dislike of the subject is very often a reason for dropping out of an engineering degree course. On the other hand fewer women than men think that the heavy workload is a reason. The change to another course is slightly more often mentioned by women. The main difference compared to the female perspective is that males agree more with the heavy workload but not so much with the different expectations as main reasons for dropping out.

In Austria there is a high percentage of agreement with the statement "*I did not feel comfortable*", followed by the German sample. In France there is no agreement at all. The feeling of isolation is also a bigger reason for dropping out in Austria, again followed by Germany, than in other countries. On the other hand the "low number of female students and teachers" is a relatively bigger reason in Great Britain for thinking about dropping out than in other countries.

- **Self Description and Thoughts of Dropping Out**

More than two thirds of all students see themselves as co-operative, logical, caring, and clever while three quarters of the engineering students agree they are co-operative and logical. Three quarters of the non-engineering students agree with caring and co-operative. All female students describe themselves to be more co-operative and caring while males see themselves more as logical and rational. Nevertheless more than two thirds of the male students also say that they are caring. Generally the self-image of the student fits the image that others have of them. Male students are considered to be more competent in engineering relevant tasks, while female students are regarded as harder working and more socially competent.

A look at the correlations between self description and thinking about dropping out shows some interesting country and gender differences. No thoughts of dropping out occur among:

Austrian female engineering students who describe themselves as rational and analytical and believe in their leadership qualities;
Austrian male engineering students who see themselves as only slightly or not co-operative;
Finnish female engineering students who describe themselves as team players;
Finnish male engineering students who see themselves as creative;
French female engineering students who describe themselves as machine oriented;
French male engineering students who see themselves as clever and logical and having a high degree of self-confidence;
Greek female engineering students who describe themselves as determined, rational and competitive;
Greek male engineering students who see themselves as intuitive and risk taking;
Slovak female engineering students who describe themselves as very co-operative;
British female engineering students who describe themselves as very ambitious, very logical, very analytical, and very determined;
British male engineering students who see themselves as very rational, very co-operative and very hardworking.

In Germany, there are no significant correlations between self descriptions, gender, and thoughts of dropping out.

- **Competitive Exams**

Over a quarter of the students reported on competitive exams. About 60% of the students think competitive exams are conducive to dropping out. Almost 60% say passing competitive exams increases their self-confidence. But only 15.6% females and 26.3% males feel comfortable with those exams.

- **Gender Differences**

Generally, interview partners say that fewer women drop out than men. That could be true considering their assessments of the motivation of female students to study. It could also be a biased conception. Since no data exists this is difficult to evaluate.

In general experts and students interviewed say there are no gender specific differences for dropping out. However, one gender difference mentioned in the expert interviews by both

faculty and students is that female engineering students always have to justify their degree choice as it is perceived as not normal for a woman to study engineering. This can subsequently lead to a decrease in self-confidence. Students report that they have to justify their decision, that they have to perform better, that they constantly have to prove technical competence. Often they are also addressed as “the secretary”.

They are also confronted with subtle but persistent discrimination in the form of jokes, remarks, and even different exam standards. Some students also report discrimination through wrongly understood politeness, for example some professors give women easier exam questions and better grades. But this is not what female students want and it does not help them at all. Sexist jokes and remarks were mentioned by Austrian and Slovak students.

Women engineering students require their needs be given equal consideration to those of the men. They are very sensitive towards promotions of women because they think that could be seen as a privilege. Females need to be treated without bias and to not always have their engineering competence unduly questioned. Female students are often treated as if they can have no technical competence. Women's problems are treated as individual problems, they are not seen as gender problems. Gender neutral language is not used and is made fun of. Women have to get used to common male-dominated language. But if someone is talking to them as an individual they want to hear terms that refer to them as females.

- **Coping Strategies**

The most often mentioned coping strategy is talking problems over with friends or family members, or with colleagues. Only a few students consult counselling services offered by the university or student organization/union and seek professional advice. Non-persistent students often reported that they did not talk about their problems with others but were brooding and tried to settle their inner conflicts by themselves. Doubts remain unspoken, partly because of fear of giving the impression of, or actually being a failure.

It is more common in France to turn to advisors or talk to professors. which appears to be particularly difficult in Slovakia. Several students talk about not being treated like adults and not liking the demeaning behaviour of their university teachers. Support from the department, including the secretaries, is very important for the students. Measures should aim at increasing communication, and stimulating and supporting bonding between staff and students.

Austrian experts mention several times that dropping out should not be seen as something negative, as a failure, but as a re-orientation that helps students find a better solution for their careers.

3.1.2. Supportive People

While more than half of the engineering students agree that their parents were encouraging for their pursuit of an engineering career, only about one third of the non-engineering students see their parents as encouraging for the choice of their degree course. The most important supporting persons for engineering students are friends and family, colleagues, room mates in dormitories, and members of the department. Study groups and tutorials are also very important. The support of family and peer group is vital for the pursuit of an engineering career. Females think that both parents influence them in equal measure and males think that the influence of their father is larger. Role models are equally important for both sexes. Teachers have a stronger influence on women than on men.

3.1.3. Supportive Factors

More than two thirds of the students agree that interest in the subject matter of engineering, salary potential and employment opportunities were the most encouraging factors for their pursuit of an engineering career. Salary potential and employment opportunities are more important for male students than for females.

- **Self-confidence**

Over two thirds of all students think their ability to think analytically and critically and their communication skills increased during their studies. Two thirds of the engineering students say they also improved their engineering and team working abilities, while more than one half of the non-engineering students say their team working skills are better now.

- **Atmosphere**

The atmosphere of the engineering department is of relatively high importance for all students (40.3%), and is more important for females than males (46.3% vs. 34.9%). The atmosphere of engineering courses is a more encouraging factor for females (41.9%) than for males (37.1%) while just less than half agree they have a healthy combination of private and academic life

and the atmosphere in their department is supportive for their individual development and their personal concerns are valued. About one half of the engineering students describe the atmosphere in their degree course as a healthy atmosphere of telling stories and jokes.

Over half the students want a more co-operative department atmosphere. 40.1% of the males and 46.2% of the females want more personal concern too. More than half of the males but only one third of the female engineering students want more women students. Over one third of the engineering students (more females than males) want more women staff. Interestingly the number of women in the major and the number of the women teachers are more discouraging for males (42.9% and 46.6%) than for females (29.0% and 34.7%). A few more females (39.5%) than males (33.5%) think competition in engineering classes is discouraging.

- **Infrastructure**

Most students feel comfortable with using computer facilities, the library, and laboratory equipment. Females feel a little more comfortable with the workplace than males and equally comfortable with the workload. However, there is a big gender difference in using workshop equipment (41.4% females, 52.6% males) and asking questions in class (34.6% females, 45.4% males) with women less happy than men.

- **Interdisciplinarity**

On average there is only a slight gender difference between the 34.6% of male and 37.9% of female engineering students who want more interdisciplinarity in their degree courses. What is interesting is that over one quarter of non-engineering students say they would have chosen an engineering degree course if more subjects from human and social sciences were included. Within this 58.2% of Austrian students want non-engineering subjects, (average over seven countries = 36.3%). More Austrian females (64.7%) would like to have non-engineering subjects than Austrian males (53.3%), but most males want more too. The gender difference is not as big as in other countries (for instance Finland, where 35.0% females but only 16.7% male students want more non-engineering subjects). One explanation could be that the wish for more interdisciplinarity is so big in Austria that the country difference is much higher than the gender difference. French students also say that more subjects from human and social sciences would have influenced their decision to study engineering (38.9%), with a huge difference between males (28.2%) and females (47.5%). Consequently, more human and social sciences in engineering studies will attract more women (and will attract more men.)

3.2. **Success and Non-Persistence in Engineering Careers**

Whenever women enter a “male domain” they encounter similar mechanisms related to their minority status, be it as a science or engineering student, as a professor at a Technical College or University, or as an engineer in a company. The ongoing practice of “doing gender” enforces this experience of “otherness”. Historically evolved and culturally attributed values, connotations, and prejudices that link technological competence with masculinity are extremely persistent and change only very slowly.

Various studies have shown that what drives most women away from technology is not women’s deficit in, for example, abstract thinking but the content and climate of teaching and working prevalent in technical institutions, – institutions that are still formatively influenced by a culture of “dominant masculinity” (Connell 1995).

Women are hardly ever visible as actors in engineering contexts. At the same time the “realities” of women are not given equal consideration in technology design and development. Different social, cultural, biological experiences, needs, and demands of women, their various interests, their knowledge and skills, their differing values are not considered valuable in a technological civilisation that is formed and dominated by basic male-centred knowledge.

Since both engineering and women fundamentally play key roles in our technological civilisation, it is important that more women get involved in science and engineering if only to diversify the participation in shaping our future. A retreat from this field would not only assign women the status of mere technology users but would, furthermore, minimise their chances of actively participating in designing the world according to their demands (Wächter 2002). Engineering might provide women with more knowledge and skills, and thus with more influence and power. And last but not least, jobs in engineering, in general, are prestigious, well paid, offer career paths, and are interesting and demanding.

3.2.1. Women's Engineering Careers as a hurdle race

In the companies studied, a frequent message was*, "We would employ women but they do not apply for vacancies."* The economic profit of mixed teams is meanwhile unquestioned in organisational development. The Human Resources managers interviewed agreed that women improve the social climate within teams as well as with regard to customer contact. They contribute a broader and more holistic view and integrate isolated singular problems in a wider context.

Women in non-traditional professions are confronted with a variety of barriers. This is true for engineers, scientists and technical professionals in a broader sense. After having successfully negotiated the cliffs of technical training and education they are confronted with heavy storms on the sea of the job market. The interview partners no longer used the pseudo-argument "*A woman could become pregnant.*" However, the so-called "clonal effect" (Josefowitz 1983) and the "*pressure to reproduce homo-social and homo-sexual structures of management*" (Kanter 1977) are still prevalent in company hiring practices. Decisions in favour of a woman will still only be made hesitantly even if she is better qualified than the men who apply. Whoever chooses a woman has to justify his or her decision even more strongly. Female Human Resources managers are in a similar situation to their male colleagues and sometimes it is even more stressful. They may react even more severely since they are observed more closely and face higher pressure to legitimise their decisions.

The statements of the women engineers confirmed findings in previous studies (Collmer 1997, Janshen/Rudolph 1987). They described their professional lives in science and engineering as an ongoing hurdle race. They feel trapped in a status of "permanent beginners" They have to prove anew their competence every day. Whereas male engineers are perceived as competent from the start, such confidence is not placed in women in advance. Even highly qualified women engineers feel they have to work harder than their male colleagues to get the same recognition and appreciation. They have to convince their colleagues that "being female" and "being technically competent" is not an oxymoron or a contradiction in terms.

Various women engineers stated that one reason they chose to go into this non-traditional field was their rejection of the traditional female gender role. But even women engineers cannot escape the socially attributed expectations put forward towards women in a hierarchical, gender-segregated society (Harding 1986). They have to combine professional

duties and chores of the reproductive sphere like all other working women, a mechanism Regina Becker-Schmidt (2000:57) calls “double socialisation” (“doppelte Vergesellschaftung”).

Probably every woman has had the experience that statements from men are valued more highly. This communicative asymmetry was confirmed in the interviews and focus groups as well.

As long as women engineers are a minority the gender aspect will dominate the professional aspect since the gender role spills over into professional competence. Individual, singular women engineers are more visible than the majority of their male colleagues and are seen as token women. Much of their energy goes into rituals of adapting to the male environment and culture. Only if they can reach a critical mass of at least 15%, or better 30%, can they assert themselves, contribute with their qualities and express their requests and demands as a social group (Kanter 1977).

As in engineering, women in leadership positions are also often seen ambivalently. On the one hand, women are accused of not wanting to take charge and of not being confident enough to take on executive functions in management. On the other hand, women who do want the responsibility are at the same time not seen as competent or as possessing the leadership qualities desired and do not receive the necessary acceptance. Things might not work out properly if a woman was responsible and the person who entrusted the woman with that job could be criticised along the lines of, “*Why did you give a woman that responsibility?!*” (Leyendecker 1993).

Women engineers, generally, are more loyal to their company and for a very practical reason: once they have achieved a certain level of recognition and appreciation of their work, they do not change to a new company where they would have to start all over again from the bottom.

3.2.2 Having a career

The definition of a career depends on the individual woman. The women engineers emphasized that success in their career depends on themselves. Also one’s own point of view on success matters. One can think that she has succeeded in her career when she has been

given responsibility for many employees, created new things, or achieved minor successes in her everyday working life.

The word *satisfied* came up surprisingly often in different interviews. If you are satisfied with yourself, job and career, then you are successful although an outsider might not see it that way. Also the word *disappointment* came up rather often. Disappointment in yourself and your creations and guilt because of the family, etc. When this satisfaction and disappointment is put onto a chart – then internal feelings of satisfaction grow alongside one's happiness. The situations that have added to the feelings of disappointment are connected to accepting compromises in order to succeed, meaning that although through outsiders' eyes the woman seems successful, inside she feels that she has not succeeded or has made too many sacrifices.

Some women engineers report that they do not want to have a career in management. They like engineering and want to work as engineers and not as non-technical managers. They aim at a horizontal career, making the most of their engineering competence, e.g. as team leaders or project managers.

Dual careers, work-life balance, peer pressure, and feeling guilty for not living up to the company's and society's expectations are common problems evoked by women engineers. Maternity still puts pressure on women engineers, even in some good practice companies. Not surprisingly, taking a part-time job is more a woman's choice than a man's, and having a part-time job in most companies is still looked down upon. Women who take a part-time job are considered as assistants and lacking in commitment. Going part-time usually means losing out on promotion.

Quitting engineering or moving into other professions was partly based on the irreconcilability of working full time as an engineer and also having or wanting to have a family life. The crucial moment was when children came onto the scene. More or less subtle discrimination, like lack of support from hierarchical superiors, male colleagues being promoted and receiving higher salaries and better equipment and more staff, amongst other things, led to a change in women's career plans and made them leave either the companies or engineering for good. This should not be interpreted as rejecting a career, but rather as a readjustment of personal plans to better fit a desired work-life balance. At the same time the

long term impact on society of the loss of 'investment' in training and the loss of talent needs to be recognised.

Most women engineers who moved into new fields away from their former engineering job, e.g. to go into teaching, or set up their own business, or who quit completely, considered this to be a positive move.

3.2.3. Experiencing discrimination

The majority of women engineers reported that they have not experienced serious, open discrimination. On the contrary, they stressed very good co-operation with their male colleagues and some of them seemed to be totally unaware of the unapproachable male networks which exist. Occasional examples of discrimination were usually attributed to personality differences rather than to gender. However, looking back to their days at university makes it easier for them to see and admit having been the victim of gender-based discrimination. This is also the case for women engineers who quit or changed jobs. In retrospect they see more clearly.

Those who are still working as engineers mentioned being excluded from "old boys' networks" or that their male colleagues had much higher salaries. But surprisingly enough, they do not qualify this as discrimination. In the professional sphere, not having access to information that is necessary for career progress is discrimination. During the interviews, when discussing networks, the women agreed this kind of discrimination existed but many of them had not hitherto been aware of this career hindering factor. It is obvious that women face discrimination.

One of the main reasons women gave for not wanting to work in such a male-dominated field any more is that an unreasonable amount of their time had to be spent not on furthering their careers but rather on fighting stereotypes and discrimination, an entirely different line of work altogether from engineering and something that most people generally of all backgrounds have little or no expert experience in dealing effectively with, especially when it is institutionalised discrimination. More subtle discrimination is either not recognised as such, or simply put up with and belittled by women engineers. Paying little attention to and putting little emphasis on gender discriminatory treatment may be an unconscious coping strategy.

Almost all women engineers report sexist jokes and other macho, discriminatory behaviour. Discrimination can also come from other women. Occasions were mentioned when secretaries openly favoured junior male engineers or it seemed women engineers had to wait longer for tasks to be finished. One possible explanation for this is the perceived threat that women in traditional jobs experience when confronted by women in non-traditional jobs, like women engineers. The concept of what it means to be a “real woman” is strongly questioned.

Women engineers have to show consideration for males, they have to be the socially competent ones and act as conflict moderators. They talked about not being taken seriously, and the difficulty of building a career, and being judged negatively on the fact that they would want to work part time. Often they are seen as a secretary. A man with the same training would never be employed as or mistaken for the secretary in this company. Women engineers were accused of being too emotional when they argue in a meeting.

More than once it was reported that, on paper, women and men have equal access to further education and training. In some cases, however, at the end of the year “the budget” did not allow women engineers to attend courses selected and agreed upon with their superiors earlier on in the year. The women engineers have had to get used to being in a minority and have the self-reliance and self-confidence to carry themselves through, provided there is no significant institutionalised sexism or discrimination that erodes these qualities. Young engineers are often not aware of any sexism, or choose not to see it.

Women also have to face traditional stereotypes. They are seen as the ones responsible for housework. It is assumed that every woman will have babies and stay 2 or 3 years at home. It is also perceived as “the woman’s” problem how to combine family and work. Men who want to go on paternity leave are ridiculed. However, not having children is also held against women engineers, as they have failed to be “real women”.

3.2.4 Balancing private and professional life

It comes as no surprise that the problem of how to combine job and private life was a topic for women engineers. Most of them think of having a family in the future or already have one but at the same time do not want to stop their career. They have gone through a long and intense

training and education process and do not want to end up as "*highly qualified mothers and housekeepers"*. Many of the women engineers interviewed mentioned the difficulties that they face in the reconciliation of family and work life and the importance of this combination when fighting for promotion and recognition.

There is no doubt about the fact that flexible working hours make life easier for both women and men who have children. But to combine career and family life, women – and men – also need appropriate child care facilities and ideally a partner who shares the responsibilities and work of both child care and household chores. In many companies there still is a high demand for regulations and programs that go beyond individually negotiated agreements. A phase of especially crucial importance is re-entry after parental or other long term leave since to stay away from the job for too long would have negative effects on progression and career options. Measures should not only focus on women but on men as well since "*father*-friendly companies" are more "family friendly" and would really make a difference.

There are several male and female employees who work partly at home. But this is arranged on an individual basis and not as a comprehensive programme. In many companies a culture of permanent availability is prevalent. This culture of 24/7 (twenty four hours a day, seven days a week), which means no private life, meetings in the evenings and on weekends, makes a work-life balance difficult for everybody, not only for women.

It is important that companies recognize that their employees have a life outside their professional life and do not automatically expect long hours. Obviously there are times when it will be necessary to work longer hours to meet deadlines and such, but as long as this does not interfere irreconcilably with their other objectives or for an unreasonable length of time people will give this commitment willingly."Good practice" companies certainly show what can be done to support women by providing excellent parental leave schemes, by creating a supportive culture for everyone, and by having fair, open and transparent criteria for performance assessments and promotion decisions.

3.2.5. Supportive factors

- **External and organisational / institutional supportive factors**

- An interest in the subject and a motivation for an engineering career that has been fostered and supported by family and friends, especially parents and partners.
- Role models also help.
- A friendly, non-sexist work atmosphere.
- Flexible job models and working hours, teleworking, part-time jobs, as well as child-care facilities in the company are supportive factors.
- Mentoring[16] and networking are crucial, not only to have access to informal information but also to work on personal coping strategies and to learn from others.
- An active top-down management strategy to increase the diversity in the company.

➢ **Internal, subjective / personal supportive factors**

- Strong self-confidence, based on an interest and motivation for the field.
- A dedicated commitment to achieving realistic goals and a high degree of self-discipline.
- Communication skills and a good sense of humour are also vital for persisting.

3.2.6. Hindering Factors

➢ **External and organisation / institutional hindering factors**

- A sexist work environment (sexual harassment, pictures of nude women in the production line, male colleagues taking clients to strip bars, etc.) – often hidden "in" jokes –, with strong gender segregation, creates a basis that is not supportive for women's engineering careers.
- Women engineers are underestimated and get low respect.

[16] Mentoring is a career-supporting factor for all women engineers. The mentor has to be several levels higher so as not to build up any competition with the direct hierarchical superior of the women engineers. Mentoring would reduce discrimination due to not having access. Mentoring would help to get access to networks and would help women to become top managers.

- Not being taken seriously as an engineer (constantly having to prove their competence, being addressed as “the secretary” or being treated as “the assistant” or like a child in a father-daughter relationship, to name a few examples), few or no career opportunities and lack of promotion are further discouraging factors.
- Men are better paid for the same or similar work. Their skills are more highly valued. Women’s skills are not recognized and not valued.
- Presenteeism, expectations of permanent availability, meetings in evening hours or on weekends, expectations to be mobile – all these are big barriers, especially for parents, for women even more so because they are in most cases the ones responsible for organising and managing family and household in addition to their professional lives and careers. Balancing career and family is generally perceived as a female problem.
- Lack of mentors and networks. As far as women’s networks are concerned, they are mostly “networks of the powerless”.
- Frustration from witnessing male colleagues being supported, pushed into careers, groomed for success, getting promoted faster, receiving preferential treatment, while women have to fight for their careers.
- Part-time jobs are a career-hindering factor as well. They lead to fewer social contacts in the company which also results in lack of information and are often viewed as part-commitment.
- Inefficient or insufficient information flow about and a lack of encouragement to apply for vacancies in the company.
- Stereotypes like, “*Women do not want to commit and have a career*.”, “*Women will get pregnant and stay away for two or three years*.”, “*Women as mothers are not good at work.*”, “*Women have no leadership qualities*.”, *“Women are not good at engineering*.”
- A dominant male culture and bias in the make-up of teams is a further reason for dropping out. Its effects include such uncooperative and unproductive behaviour as the arbitrary dismissal of ideas and suggestions coming from women engineers, which can be seen as an attempt to reinforce the stereotype that women do not have such expertise to offer, and which amounts to harassment. In these terms where women are the minority and treated as subordinates they rightfully feel excluded.

- Discriminatory processes that arbitrarily favour men for further training.
- Women are judged more harshly than men if they make mistakes.
- To expect women to have better social skills, simply because they are women, is discriminating as well. Not only does it put pressure on women engineers, but that "*extra bonus*" of social competence that is understood to be the *"most natural thing in the world"* paradoxically is not recognized as an additional skill, not valued, and does not result in a higher salary or in promotion.
- Difficulties for dual career couples have been reported by many interviewees. Women are still expected to subordinate their careers and follow their husbands / partners. Some partnerships / marriages have broken up because of the pressures caused by irreconcilable professional and family demands.

  - **Internal, subjective / personal hindering factors**

- Perfectionism.

3.2.7. Country specific situations

A broad variety of programs at all levels of education and the professional sphere is needed to overcome historically evolved patterns and resistances.

What is particularly true for **Austria** can also apply to the other countries.
Better work-life balancing opportunities, such as more child-care facilities, consciousness-raising for fathers about taking parental leave, part-time leadership, role models, are some examples of measures that can help create a culture of success for women engineers.

Gender-sensitivity training should become a compulsory module in further training programs, for both men and women. It also stands to reason that being a woman does not automatically lead to gender awareness, sensitivity, or behaviour that fosters equal opportunities and reduces or abandons discriminatory structures or patterns. It is vital to obtain the support and co-operation of gender-sensitive men on all hierarchical levels.

In **Finland,** gender equality has reached a high level. There, women in engineering as well as in many other fields and hierarchies can be found in greater numbers than in many other European countries. However, measures have to be continuously implemented so that in the future, having a reasonable work-life balance does not interfere with the career plans of women engineers and vice versa.

In **France**, diversity programs can make a company stronger, but a strong commitment from top management is necessary to implement voluntary measures. One company has introduced a quota system which only works if there are also consequences for not fulfilling it. However, a quota system also has disadvantages like branding women as "*quota woman*" and thus degrading their competence.

Support structures to ensure the mobility of women engineers are also necessary. Specific help has been proposed for dual career couples. The web based tool www.partnerjob.com helps employees to find a job for their spouse / partner in the new country they are moving to. The family situation of both male and female engineers, and employees in general, has to be taken into account.

For **Germany**, the broad variety of programs recruiting women seems to be successful and should be continued. Women managers combining family and career in a balanced way should participate in those programs as role models to show the broad field of possibilities for finding one's own priorities. Young women engineering students should be strongly advised to do internships or project work in big companies to get used to the work atmosphere and to become part of the company network. Such internships can make it easier to obtain a permanent job with a company.

Networking is another important area of attention. Female engineering students should be aware of networks and the way they work. Women engineering managers should tell female engineering students about networking. Further personal training concerning networks, career planning, and career paths should be set up and organized by consultants outside the company.

Most of the people interviewed in **Greece** were of the opinion that stereotypes should be combated and the state should support the family, especially in the process of raising children. Companies should promote and implement equal-opportunity policies and women should focus on constant vocational training. In addition to this general training, education on managerial issues is very important for the empowerment of women, the development of their skills, and their promotion to management positions. They should also attend workshops working on psychological elements to strengthen their self-assertiveness.

In **Slovak** companies, even the most basic steps still have to be taken to raise awareness about gender equality issues. Gender stereotypes are still very prevalent. In addition to measures within companies, consciousness-raising programs have to address the stereotypical representation of women, and in our case women engineers, in school textbooks, in the print media, on TV, etc. The engineering skills of women have to be made public. Professional life has to be structured in such a way as to enable women engineers to have a life outside their job commitment as well. This means that responsibilities for household and family chores have to be shared more evenly between men and women.

For the **United Kingdom** it was suggested that a key thing to consider would be to improve child-care schemes. The provision of longer paid paternity leave to be taken at a different time from the mother, similar to Scandinavian models, is seen as a good idea. Where both parents worked for the same company this would mean at any time one of them would be present and they could also alternate periods of unpaid leave. Other key interventions could include relatively simple measures like assertiveness training for everyone – it could tone down aggressive behaviour while encouraging women and unassertive men to be more assertive. Senior women interviewed think that even having one woman present can make a difference to the culture, for example men are less likely to swear in meetings. Junior women thought that this should be part of company 'etiquette' and that men were perhaps making a point if they excused themselves for something because there was a woman present.

Part 4

Organisational Culture and Social Change

This part aims at identifying gendered institutional cultures and structures and analysing their influence on women's studies and careers from a gendered perspective. Focussing both on engineering degrees and engineering careers, the key findings are presented here and will serve as a basis for a set of recommendations (Part 5) to change gendered organisational culture in ways that will enhance success and persistence of women engineers.

4.1. Gendered Institutional Cultures in Higher Education

4.1.1. The need to widen the image of engineering and build the self-confidence of women students

The ETAN report points out that in all EU Member States women are under-represented in mathematics, computer science, engineering and architecture (except Germany). Girls seem to prefer sciences linked to nature, human and social matters (ETAN 2000:58). But it is not women's deficit in abstract thinking, etc. that drives them away from technology, but content and climate in technical institutions, referred to as an atmosphere of 'dominant masculinity' (Sagebiel/Dahmen 2005; Sagebiel 2005b). The results from the former European project CuWaT (1998) show that cross-disciplinary courses and significant elements of group work and project work are effective for retaining women in engineering.

US research has shown the low number of females in engineering can be largely explained by the lack of self-confidence in intellectual abilities based on low self-esteem with this being due to the female students' minority status and their feelings of isolation. Moreover men are less affected by poor teaching, poor organisation of the course material and by dull course content. 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 available female faculty model reflects an archaic male stereotype, impossible to emulate or incorporate into a contemporary professional identity*' (Etzkowitz et al. 2000: 245).

A one year European project INDECS, preliminary to WomEng, proved the attractiveness and acceptability of interdisciplinary degree courses [17]. Case studies in the different countries in four different technical fields, together with interviews with academics and employers, confirmed the hypotheses. Interdisciplinary degree courses together with innovative teaching methods appear to be more attractive to women than the traditional single degree courses, especially if the interdisciplinary subjects start as early as possible in the curriculum and information on the interdisciplinary degrees and career opportunities reach female students.

Experts interviewed shared the opinion that good communication and language skills have priority, followed by conflict management and experience of team working. The employers asked for interdisciplinary engineering degree courses to be more attractive to both men and women, which will better satisfy the social and industrial needs of a changing society. In addition INDECS showed that in some countries single-sex degree courses seem to be successful in increasing the number of female students, who otherwise would not have chosen engineering or IT (Sagebiel 2005b). Several recommendations were given on the basis of INDECS (Beraud 2003), which should be implemented in the design and realization of degree courses and their organisational characteristics.

4.1.2. Questions of genderedness in engineering education

To measure organisational culture in engineering departments and degree courses, several research questions were examined:

- Is advertising degree courses in a woman friendly way in combination with recruitment measures a first step towards attracting schoolgirls to engineering? Interdisciplinary degree courses and innovative teaching methods seem to support this enhancement strategy.
- Can single-sex education motivate new groups of female students for engineering education? Experiencing marginality depends on how minority status is perceived, if

[17] INDECS was carried out as an Accompanying Measure of the 5th IHP Framework Program of the European Union. INDECS is short for **In**terdisciplinary **D**egree Courses in **E**ngineering, Information, Technology, Natural and Socio-Economic Sciences in a **C**hanging **S**ociety, lasting from August 1st 2001 till July 31st 2002. Eight European countries were involved in the project: Austria, France, Finland, Greece, Germany, Slovakia, Switzerland and the United Kingdom. Further information on the project is given in the Final Report which can be downloaded at www.INDECS.uni-wuppertal.de.

females feel isolation or even discrimination, for example if hostile attitudes from their male colleagues and/or from teachers exist and if stories and jokes reflect the masculine image of engineering.

- Does the study atmosphere with its environment, social relations, masculine jokes and stories lead to feelings of isolation and marginalisation or do young female students feel comfortable and integrated in organisational culture? The emphasis here is on the coping strategies of female students.

4.1.3. Winning or losing in a minority situation – attracting or frustrating women by curricula, teaching methods and atmosphere

➢ The first impression: Homepages

It is increasingly important to promote an interesting and modern degree course in times of shrinking numbers of engineering students. Advertising universities and degree courses in combination with woman-friendly elements like recruitment programs and welcome events is becoming more popular. Taking a deeper and more analytical look at 35 homepages of degree courses and departments which were selected for investigation in WomEng partner countries, what can be said about their marketing ?

Overall the web pages create an image of engineering that does not seem to be very attractive for women! Highly text-oriented web pages, with few pictures or very masculine image ones predominate. The most frequent images presented are of machines or technical equipment without any people around them. If people are pictured, men play the more active parts in the situations, e.g. men are explaining or doing something and women are listening or just sitting around. Only four websites advertise special programs for women, even though these are very popular in Germany and Austria. When looking at gender of faculty around four times more males can be found than women. ‘Old fashioned’ teaching methods (lectures, seminars) are found in nearly every department, new teaching methods like project work are also offered but it depends mostly on teachers’ preferences.

To conclude it can be said that the atmosphere and the culture which are shown through the homepages are very male-oriented. It seems that homepages are made by men for men and that the presence and the needs of women are not sufficiently taken into consideration.

However, the importance of homepages for the moment seems to be relatively low. In our questionnaire surveys less than 50% of students thought homepages were important. The Austrian female students gave the highest value (41.7%) for the websites, but this will probably change in future if universities and faculty start to market courses more effectively.

➢ Women and the male image of engineering

The male image of engineering seems to be a factor which very much influences the decision of girls and young women not to follow a technical or engineering degree course. And as the homepage surveys have shown in 6 countries the image of engineering in society is still a masculine one, especially in the view of female students (Germany, France, Austria and Slovakia). It is:

- machine oriented,
- with less communication,
- rational but not creative,
- not positive, but combined with earning a lot of money.

Two German female focus groups had quite negative views: "*the image of engineers is not a nice one*" and *"the image of an engineer is a crude one and a masculine one*".

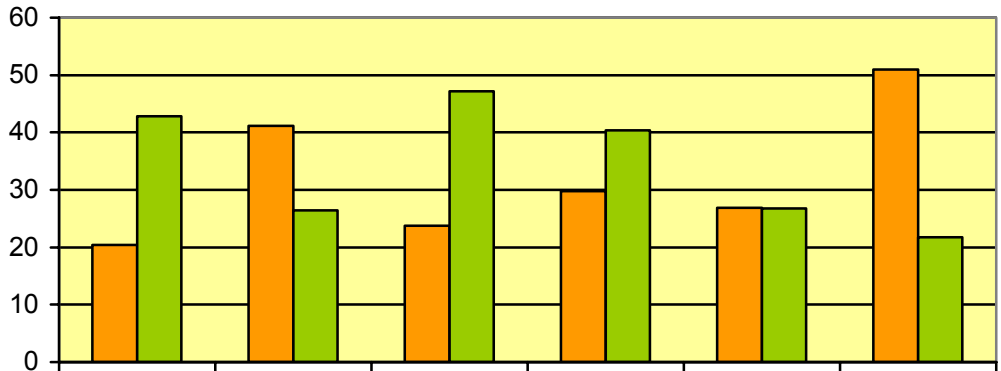
Departments of engineering degree courses reflect this masculine image. Female faculty comment: "*It is often impossible to admit mistakes; perfectionism and tidiness are still important values*". For mechanical engineers traditions are very important (female faculty in a German technical university).

Many female students especially in Germany and France see a conflict between the image of engineering and femininity, most of all in the eyes of other women. "*Women want to be feminine, so maybe that is a reason why not many women study engineering*" (German female student). Women in France, Germany and Austria thought this conflict could discourage other women from studying engineering. A similar result was found in the Athena project (Etzkowitz 2000: 58).

We explored the image of femininity and the compatibility with the image of a female engineer in our questionnaire surveys. The results show old-fashioned images prevail

especially if the answers of male students are considered (see figure 1). 51% of Scottish male students indicated that their own image of femininity does not fit with the image of a female engineer, followed by 41.2% of Greek male engineering students. This result is not so different from the answers of Greek female non-engineering students, who also answered (37,5%) that femininity and engineering do not go together.

Figure 1: Image of femininity fitting with the image of a female engineer – answers of male engineering students (in %)



	SK	GR	F	G	A	UK
1+2 rejection	20,4	41,2	23,8	29,8	26,9	51
4+5 consent	42,8	26,4	47,2	40,4	26,8	21,7

Female students explain their low numbers by different socialisation processes: ”It is still a question of education, which is different for girls and boys”, and refer to the influence of peer groups: “*Women are pressed into typical female subjects or they may choose those typical female subjects themselves. And peer groups are very important, too*”. Austrian females argue that if a woman is interested in technical matters and wants to take engineering courses then she really needs to insist on it and be interested in it; whereas it is enough for a man to say he’s studying mechanical engineering because he will earn a lot of money one day.

- **Recruitment programs**

Recruitment programs can be a supporting factor to get in contact with engineering fields especially for those pupils who do not have knowledge from school or from relatives who work in an engineering/technical related sphere. Also girls who might have some kind of ‘fear’ of getting to grips with technical things can be given the possibility of diminishing this through practical exercises.

Special recruitment measures for women like open days, school visits by university teachers and engineers, communication campaigns only for girls/women like information events, summer universities, girls' day etc. are practised in Germany, Austria and the UK, these measures are not used in France and Slovakia, where they are even seen as not being legitimate: "*This should not be"* (Slovakia), "*We don't want to be looked upon as assisted people or treated like children*" (France).

On the other hand students in almost every country underline the fact that they did not have enough information about engineers' professions and their actual activities; not only when deciding on which university to go to, but also during their current studies. Even in countries where the prestige of such studies is high, students know very little about engineers' jobs. Better and more complete information about engineering courses available to all high schools would make students' choices easier and they would know what to expect from university study – content, extent, form and requirements. Additionally, in countries like Austria and Germany where different University types exist, the specialities of those institutions must be taken into consideration in advising individuals. Better specific counselling of pupils who want to enter university could help to reduce or avoid or diminish drop-out rates.

- **Welcome activities**

Activities in freshers' week can provide important icebreakers for new students, encouraging them to get to know others on the course. Tutorials for beginners are also very helpful for new students. Student engineering societies have a significant role to play here. Welcome events or activities are estimated as helpful in all countries by the students consulted through questionnaires and interviews. With the exception of Scotland, men do not rate the importance of welcome events as highly as women do. These events provide opportunities to meet others on the course, an important step towards integration of new students. For minority women in particular it is a chance to meet other females and to build up something like a social network to cope with the 'special' status they have as a minority in a male domain. In Germany there are special welcome events for women only.

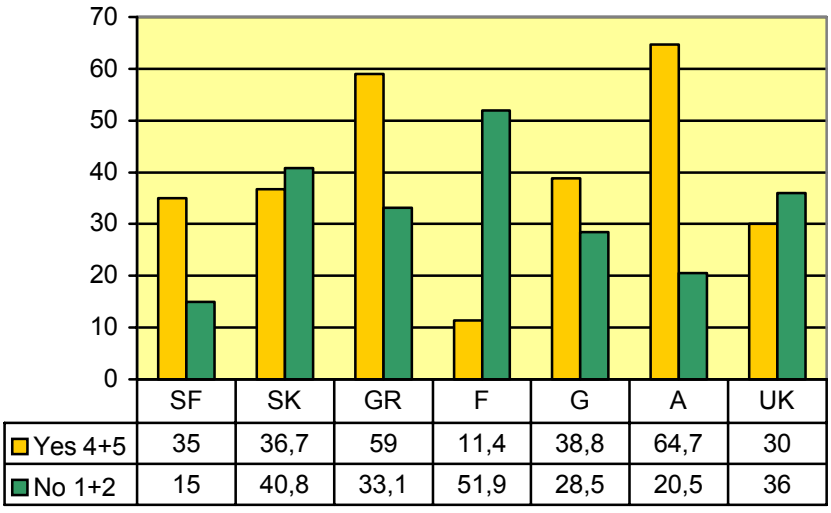
- **Interdisciplinary curricula**

It is largely accepted among experts we talked to that a larger choice of subjects with more non-technical/scientific courses would be more attractive for female students who are usually looking for less specialised studies which include more social and human sciences. Our earlier

INDECS survey indicated men would also value a greater range of subjects and women in particular systematically ask for this. Most faculty think that interdisciplinary subjects cannot be included because otherwise indispensable technical subjects would have to be cut.

Austrian female students show the highest desire for more interdisciplinary subjects 64,7%, followed by Greek women at 59%, in contrast to France (11,4%) where the curricula had already included a greater proportion of non-technical issues (see picture 2). Significantly men would also appreciate more non-technical subjects, again students from Austria show the highest demand with 53,3%, followed by the Germans with 42,0% and the Greek men with 40.0%. More German, British and French males would prefer a higher percentage of non technical subjects than their female counterparts. All the answers must be interpreted in the context of the curriculum of each degree course, otherwise we get incongruous conclusions.

Figure 2: Request for non-technical subjects - answers of female engineering students.



	SF	SK	GR	F	G	A	UK
Yes 4+5	35	36,7	59	11,4	38,8	64,7	30
No 1+2	15	40,8	33,1	51,9	28,5	20,5	36

Over 50,0% of all students would like more languages while 77.5% of French women would like more soft skills, as would well over 50% of Austrian, German and Slovak engineering students. Maybe for these subjects the connection and value for later professional life seems to be clear to the students.

By contrast female students in Finland, Greece and the UK do not see the need for soft skills; instead they would prefer to have more technical subjects, which students in France, Germany and Austria would not appreciate at all (ratings below 20%).

- **Teaching methods**

In evaluating teaching methods all female students – excluding the single-sex degree course with a small total number of students – ask for more dialogue, more discussion and more projects, fewer lectures, which are not appreciated and are presented as 'boring" and without enough practical links. Except for Austrian students there is a high desire for all kinds of practical work (see figure 3), e.g. industrial placements. So project-oriented and practical work is wanted and liked by female students, maybe because they can link theoretical knowledge with practical application here. Also the importance of being well prepared for professional life should not be underestimated. To conclude, we recommend that curricula should be thought over regarding a higher amount of practice, in combination with interdisciplinarity.

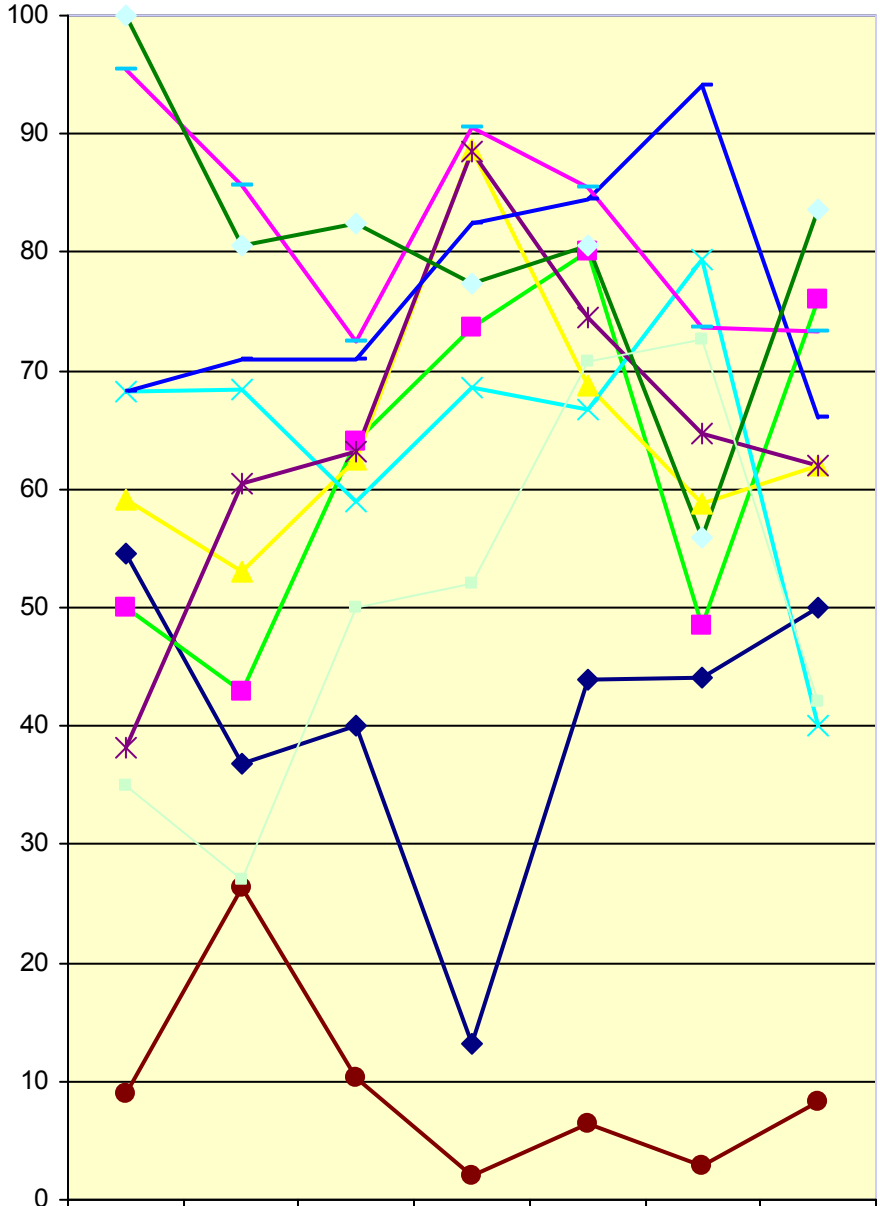
The importance, indeed the necessity, of self-organised study groups is greater for the students of German speaking countries in this investigation than anywhere else; Austrian women (72,7%) and German students (70,8%) said that their preference is for this kind of teaching/learning method. Maybe this result correlates with the existence of so-called competitive exams, which is also a speciality of both countries.

- **Single-sex teaching and degree courses**

In Germany several engineering single-sex degree courses are implemented especially at universities of applied sciences. The women only environment should allow a prejudice-free study time without male competition structures. Through this possibility also young women should be attracted who would have been deterred by co-educational degree courses.

Members of the single-sex degree course investigated in Stralsund/Germany believe that 'single sex teaching increases self-esteem and self-confidence' in female students. At the same time the model can be an agent for change, as it shows that a traditional department culture of mechanical engineering could be changed. Old structures were thought over and more and more given up.

Figure 3: Preference of teaching methods according to female engineering students



	SF	SK	GR	F	G	A	UK
Lectures	54.5	36.8	40	13.2	44	44.1	50
Tutorials / Seminars	50	42.9	64	73.6	80	48.5	76
Project work	59.1	53	62.5	88.7	68.8	58.8	62
Laboratory work	68.2	68.4	58.9	68.6	66.7	79.4	40
Group / Team work	38.2	60.4	63.1	88.5	74.5	64.7	62
Single sex teams pro	9	26.4	10.3	2	6.4	2.9	8.2
Mixed sex teams	68.2	70.9	71	82.4	84.5	94.1	66
Internships	95.4	85.7	72.5	90.6	85.4	73.6	73.3
Practical work	100	80.5	82.5	77.4	80.5	55.9	83.6
Self organized study groups	35	27.1	50	52	70.8	72.7	42

However, few of the students questioned wanted single-sex classes with the notable exception of Slovakia where 77.1% agreed that female students would feel more relaxed without male students. For the whole question a high number of ‘I don’t know’ answers is obvious, so for the students it was hard to judge or imagine what changes single-sex classes/degree courses would offer. Here it becomes clear that information is necessary to free single-sex teaching from prejudices.

On the other hand, opponents of mono-education, both faculty and students, think that ‘it is an artificial world’ and that women who want to study engineering must have self-confidence right from the beginning, otherwise they will not succeed. Without discussing the potentials of single-sex teaching, French faculty members totally disclaim mono-education by seeing it as sexist and unnecessary. Male faculty members in Slovakia and Austria are particularly against single-sex teaching whereas female faculty see some positive potential in those models but fear a kind of ‘positive discrimination’ (Slovakia). Women working together would be more uninhibited, could develop ideas more easily and deepen their knowledge without competing with men.

- **Minority situation and marginalisation**

Being a male domain, engineering studies are less attractive most of all because young females fear being lonely among a vast majority of young men. Female-friendly universities are aware of this. A female member of a steering committee of a technical university of applied sciences, being a Professor of mechanical engineering at the same time, stated: "*It is important to show the women that they are not 'alone' and to welcome them. Also it is very good to present to the young women early the woman-friendly university structure e.g. that every department has its own equal opportunity officer*".

UK female students felt no marginalisation by academic staff although occasionally workshop technicians treated them differently, sometimes underestimating what they were capable of when equipment was being demonstrated. This was interpreted to be paternalism rather than discrimination or marginalisation. Some commented they also found it was easier to get assistance from technicians but thought it was because they were friendly to the technicians. Only a few students interpret their high visibility and attention to them in the long run as a form of discrimination. One woman, who studies mechanical engineering at university in Germany, suggested some professors have fewer expectations in the knowledge of the women

and so they invest more time in explaining something to them. Although there are some examples of 'positive' discrimination, one equal opportunity officer indicated female students "*are marked off very subtly; discrimination is becoming more subtle nowadays*".

French and German females feel acceptance overall. Some women even appreciate their exotic status and say that because of the open atmosphere with their male colleagues, they do not feel any isolation and don't long for more female students. One German female engineering student was very astonished to experience difficulties with her male peers because she never expected to be treated unequally by her colleagues. Elite students from a very prestigious technical university in Germany even like the anonymity at the beginning of their studies.

- **Aversive attitudes and discrimination**

Some of the UK, Austrian and Slovak female students complain about feelings of loneliness and have experienced negative attitudes towards them. In Slovakia and Austria they feel open discrimination, not being attractive to their colleagues, seen as masculine women (Austria) and getting male remarks about their 'female logic' (Slovakia). Additionally, 38.8% of Slovak female students report discriminatory remarks from professors or instructors, like 21.2% of Austrian and 20.0% of Scottish female students (see figure 4 below). More open discrimination in Austria is shown by having partly sexist professors as teachers, being not taken seriously, often taken as a secretary instead of an engineering student, excluded from men's groups (reported in a male focus group), being discriminated against by their boyfriends. Students characterize the atmosphere as 'no mistakes are allowed' and see a big distance between faculty staff and students: it is a punishment to talk to a professor. Male rituals are hardly practicable for women (e.g. giving a pat on the back), as the line between acceptance and harassment is a very thin and subjective one. The climate is not open to questions: "… *you cannot ask a question because you are then regarded as being stupid*" (Austria).

As a result, around 50% of Austrian female students want more female fellow students and Austrian and Scottish female students would also prefer more female teachers/professors. The participants in the Austrian female focus group agreed that they wished for a higher number of women studying engineering; "*if there were female role models, female students wouldn't*

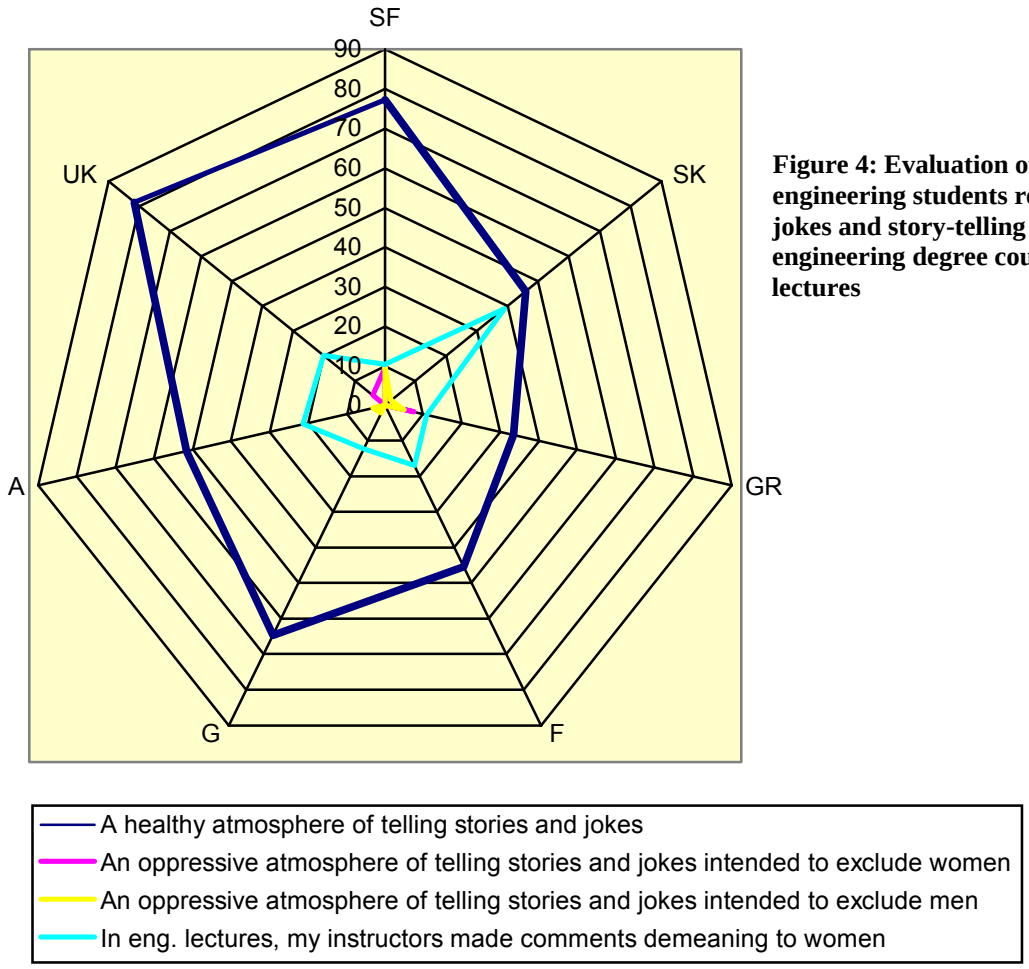


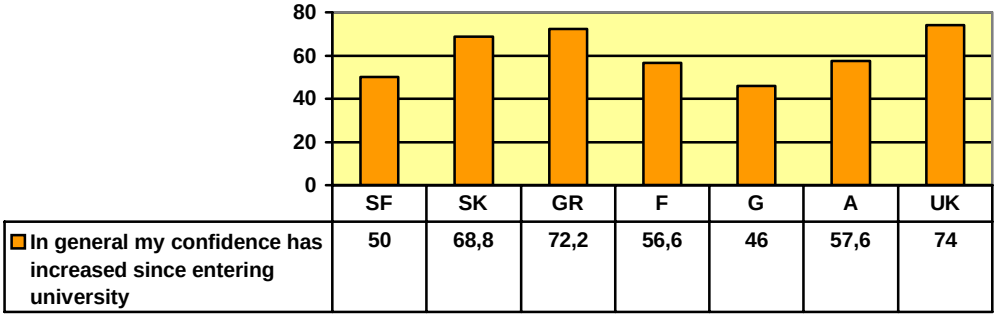
Figure 4: Evaluation of female engineering students regarding jokes and story-telling in engineering degree courses / lectures

attract so much attention. It is important to meet women at the beginning to provide confidence. It is very exhausting to be among men all the time".

- **Self-confidence**

Self-confidence is seen by most of the faculty as a prominent factor for females to be successful in engineering studies. As an Austrian female lecturer said, female students need high self-confidence in their competence, support from family and friends and self-esteem, and sometimes they have to defend themselves, mirrored by a female interviewee (civil engineer) who sees "*a good base of self-confidence*" as a necessity right from the beginning of study, "*otherwise it makes no sense to start an engineering degree course*". Figure 5 shows that in all investigated countries the female students state that their confidence has *increased since the beginning* of study, so this means that looking back at the start of their university life, between half and three quarters of the women would asses their confidence then as lower than today.

Figure 5: Self-assessment concerning confidence - answers of female engineering students



	SF	SK	GR	F	G	A	UK
In general my confidence has increased since entering university	50	68,8	72,2	56,6	46	57,6	74

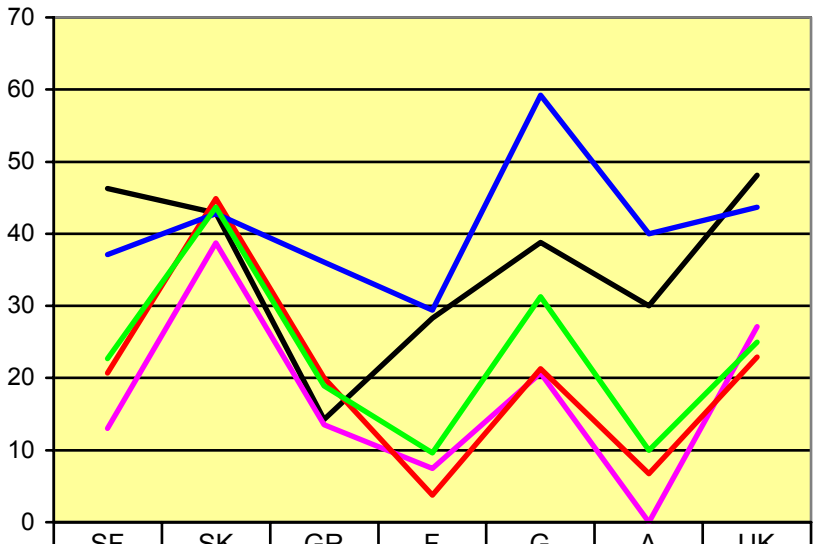
The main reason for single-sex engineering degree courses is to build and further this self-confidence in technical abilities, which promoters of co-educational engineering degree courses see as a pre-condition. In WomEng the existence and necessity of single-sex degree courses or lessons was critically discussed in European partner countries. For most of the interviewees mono-education still has the bad 'flavour' of needing special support or the imputation that females are not able to study engineering in the company of men. The vehement aversion of female students in interviews and focus groups allows us to conclude that women do not want to have a special status and are afraid of being singled out. Scottish students were adamant they didn't want female only classes because they reported more problems from other girls at school, not from boys, and were glad to be away from that.

In this connection looking at the result of the questionnaire, it is interesting how female students evaluate themselves in comparison to male students (see figure 3). Self-assessment of female students in comparison to their male colleagues reflects partly the known phenomenon of the underestimation of their own performances as shown in the quantitative results (see figure 6). In particular, nearly 50% of women engineering students from the UK think that they spend more time and effort on class work than the males do, followed by Finnish (46,3%), Slovak (42,9%) and German (38,8%) students. Here the lowest number comes from the Greek women with 14,3%. However, this item can be positively interpreted if we think that women are more thorough in studying and that is why they appear to spend more time on the mentioned issues than the males.

German female engineering students believe they work better with other people (59,2%). Nearly all countries rated this item highly. The gender-specific prejudice of the socially skilled woman is reflected here. Many Slovak women (44,9%) think that they are better at

solving engineering problems than their male fellow students and that they understand engineering concepts better than males. Overall it seems that Slovak female engineering students have a more self-assured opinion about their engineering abilities than women in other countries.

Figure 6: Self-assessment of female engineering students in comparison to their male fellow students – agreement on statements



	SF	SK	GR	F	G	A	UK
I spend more time and effort on my class work	46.3	42.9	14.3	28.3	38.8	30	48.1
I understand engineering concepts better	13	38.7	13.5	7.5	20.7	0	27.1
I am better at solving engineering problems	20.7	44.9	20	3.8	21.3	6.7	22.9
I work better with other people	37.1	42.8	36.1	29.4	59.2	40	43.7
I have more confidence in my engineering	22.7	43.7	18.9	9.6	31.3	10	25

- **Perception of masculinity and coping strategies**

Female students are conscious of studying in a male domain (Germany, France, Austria and Slovakia) and they see their study contents as male-dominated. But asked in the interviews about changes, they suggest no alternatives. French females sometimes take advantage of their minority situation: "*It's easy to ask questions when we don't know, we pretend we're a little bit stupid and I sometimes say: sorry, I'm a girl, so I can't understand everything, so everybody laughs and I play along with that*". A not so free female German student experienced a similar situation "*I am treated like a child sometimes*" by male colleagues, but overall she said that she is not too disturbed by the behaviour of her colleagues.

Special male-oriented language and humour is used in all countries. Stupid jokes are common (Germany, France, Austria) and women behave in the same way. As this is a crucial element of masculine culture in engineering degree courses and departments, the question is how women's adaptation to this behaviour can be interpreted. Interviews with non-engineering or non-persistent students in France and Slovakia (Hudec et al. 2004), show masculinities, which female engineering students do not mention. So the explicitly mentioned non-existence of discriminating practises in France and Germany must be interpreted cautiously. In questionnaires female students from Austria and Greece, who feel more discriminated against (see above) than females from other partner countries, would prefer more non-technical subjects in comparison to students from other partner countries. It seems that the dichotomy between 'hard' technology and 'soft' women (Austria) is more radical in a more traditional engineering educational culture.

A predominantly competitive and masculine climate in engineering degree courses is one deterring factor preventing women from following a technical degree course. Female students in Greece suffer most from a competitive atmosphere (50.0%), followed by the UK (38.0%) and Slovak female students (25%), while it seems to be no problem in all other partner countries. To cope with this competitive male behaviour 'some women adopt the competitive imperative, and learn how to compete in male terms. Men are often not comfortable with this. It is their game, and there is no place in their prestige system for a woman who competes successfully with them' (Etzkowitz 2000: 55). Generally female students are 'playing with gender prejudices' (see above) (Germany, France) or they are 'making sex invisible' (Austria).

4.2. Gendered Institutional Cultures in Engineering Careers

4.2.1. Does being a minority lead to marginalisation?

The professional engineering sphere can be described as a man's world. This characterization of engineering culture and structures in the professional sphere means that because of the minority status of women, this field is characterized by (dominant) masculinity. This dominant masculinity affects culture during the education stage and the professional engineering sphere alike. Many empirical studies have shown the huge impact of male organisational culture on women, who, to a greater extent than men, are leaving engineering careers because they are unsatisfied and marginalized.

Bagilhole and Goode (2001) have argued recently that women's lack of progress has its roots in an unacknowledged and implicit patriarchal support system that favours and rewards most men and excludes and undervalues most women. They argue that the 'reward of individual merit' is a myth since those who progress do so with the tacit help, support and recognition of their male peers and mentors. Since women exist at the margins, this help and support is generally denied to them. Further, if women complain, ask for support or try to set up their own networks, they are generally made to feel that the fault is somehow with them, that they are in some way 'incapable'.

4.2.2. Questions of genderedness in engineering professions

To measure organisational cultures in the professional engineering sphere, several research questions were examined:

- First, to discover whether the barriers to the careers of women engineers, especially those considered as highly qualified, still exist.
- Second, to see if there are approaches at company level to overcome these hindering factors e.g. through special programs and how these measures are evaluated by their target group
- Third, to analyse how the current professional engineering culture has to be changed in order successfully to create a more woman and employee-friendly working atmosphere. Are there different organisational cultures which lead to different results?

Have any innovative changes in the professional sphere proved to be more successful in increasing persistence than others? Are there European variations in organisational cultures and changes and what can be considered as good practice?

4.2.3. How company culture promotes women engineers and how male networks hinder them

All good practice companies we investigated show vital diversity, with open-minded employees and with superiors harbouring less prejudice about supporting women. It seems that women have everything to gain from this diversity.

- **What homepages tell you about genderedness of companies**

You might expect that the web-site of a good practice company that values diversity, that promotes engineering to young people and that values female employees would reflect these values. You might expect to see gender-balanced images and to find information about diversity programmes, work with schools and young people.

Most of the companies investigated cooperate actively with universities except the two Greek companies and the Austrian energy company. German, British and Finnish companies also cooperate with schools, and the two German companies have special activities for female students and pupils. The companies investigated in Greece and Austria do not yet have either a diversity program or a gender-mainstreaming concept, and neither does the production company in France. All the companies investigated from Germany, Finland and the U.K. have a special diversity program, but only the French good practice company also has a gender-mainstreaming concept in the sense that it has introduced a quota system to increase the number of women engineers. The German companies provide information specifically about women's career advancement and also special information about childcare facilities, about job-sharing possibilities and about flexible working time. Similar models are available at the web-site of the Finnish good practice example.

Mostly (young) men and women feel addressed by the pictures on the websites. The website of the Finnish good practice company is unique in that it seems to refer more to women than men, while the web pages of other companies, particularly in Austria and Greece seem to be more man-centred. Neither of the Greek websites investigated nor the Austrian energy

company site showed gender balance in the images displayed. Men seem to be in a higher position on the websites of many of the companies including the UK and German companies and the Austrian energy company. On the website of the Finnish 'good practice' company the reverse is the case. Special information for women is available only at both Finnish websites and at the French good practice company.

To sum up it can be noticed that both German and Finnish companies present many more programs, concepts, initiatives and information for students and employees on their external web-sites and their websites seem to be addressed more to women than men. Both companies from Greece and both from Austria seem to have not such special initiatives and their websites seem to be mostly addressed to men rather than women which may reflect a historical situation of the workforce.

- **Male overtime culture**

Overtime versus part-time is a central element of masculine versus feminine organisational culture. Most women managers practising their own leadership concept with focus on a good working atmosphere are conscious of the importance of reducing overtime to urgent and necessary cases.

Concerning working hours and overtime there is a big cultural difference in Europe. In Germany, France, Slovakia and Austria and in the U.K. it is quite normal to do overtime and show permanent availability. This working time culture is male dominated. In Finland it is the other way round, doing overtime, being a workaholic is not socially desirable. Nevertheless overtime does not seem to be a big problem for women engineers when they are asked to do it in one Austrian firm. Here in one company the culture of working overtime and late nights leads to strange practices. The women engineers in the focus group tell that some men go on hour-long coffee breaks and work in the evening, sending emails late at night to impress the others. Or some cheat by setting the computer clock ahead of time. All this is for show. It seems the majority of superiors are unable to assess the work of their employees and use the very crude tool of hours at work as an indication of performance and commitment. The fear of the pressure to do overtime when in a management position is very high in Germany and stunts women's career aspirations.

- **The culture of part-time work**

Part-time work does not have the same status all over Europe. In some countries like Germany, Austria, France and Finland, part-time work is quite normal and accepted at all companies, especially for women with young children. But in other countries like the U.K. or Slovakia it is rarely possible and usually leads to loss of promotion prospects. Having no possibility of working part-time leads to quite different decisions concerning family and career and can cause women to drop out.

But as the example at a German company shows, reducing working time can have some negative effects. Working part-time is seen as a way of having a balanced life for women, especially when they have young children. Part-time work can be seen as a career hindering factor, because career progression is closely related to being present and known. Reducing working time means your visibility diminishes and also the intensity of social contacts, which are necessary for networking. A French woman engineer who quit talked about her experience after reducing her weekly working time: *"At the beginning, yes, some people tried to transform me into a secretary, and I said: no, I can't do that. It was the job of his assistant!",* so, if they take a part-time job, women are sometimes considered as an assistant.

The good practice company investigated in the UK has found ways to measure performance so that part-time employees can achieve promotion but some of the women interviewed in the U.K. do not want to have part-time working focussed only on childcare, because not all women have or want to have children and because they think we should promote work-life balance for everyone. Superiors in all nations still assume that women will have children and that it is women's responsibility to look after them. But in reality, some women do not have and do not want to have children. Those women feel the prejudice about all women being seen as child-bearers. And this prejudice causes loss of support for **all** women or more support for men.

- **A balanced working life with children**

Many of the women managers interviewed for our project are living examples of the possibility of combining family and career. They are unknown as role models because women engineers who do not work at this career level normally have no contact with women managers. Especially younger women engineers are still afraid of the detrimental career effects of a break to bring up children. (Germany, Greece). Children are still a point of

discussion concerning their influence on career. Childcare facilities are mostly good in the European partner countries. Women engineers with children themselves want to live a balanced life including the time spent with their children and families. Their main focus is on the compatibility of family and career. Experienced women managers know about the difficulties but found their personal solutions. Reaching a certain management level offers a higher salary so childcare can be organised individually.

German women engineers talked about a company phenomenon which might be transferable to other companies: before getting pregnant most of the women were aspirants to a higher career level, but promotion prospects evaporated during pregnancy and parental leave. There are two possible explanations:

- hierarchical superiors still have the old-fashioned opinion that a combination of career and family is not possible (socially biased) **or**
- hierarchical superiors assume that women don't want to be promoted, because they will concentrate on their child.

The second explanation seems to be partly true, but depends also on the age of the child(ren). As time goes by the possible time commitment for work increases again.

Women in Germany, Austria, Slovakia, France and Finland do not leave their jobs when having children. In France there is a great difference between the good practice company practicing maternity leave as a kind of diversity and finding solutions to support the women and the companies which see pregnancy and maternity just as a problem. Internal company childcare facilities are not offered everywhere; this should be improved to take pressure especially off younger women engineers who fear career breaks or problems as parents.

- **Masculine culture and the minority situation of women**

The organisation of work and work methods are attuned to the male model; men have been developing this for generations according to their own needs without the presence of women. Austrian women clearly stated that they still feel they are considered as a minority and feel dominated by masculinity and they also mentioned the culture of sexist jokes.

Overall the women gave conflicting images about gender problems in Europe. Two explanations are possible: the awareness of masculinity is confirmed, but masculinity is not really a problem, or women engineers have no problems because of their 'tough' image as

mentioned in former literature. On the other hand for some of the women it was a big challenge to work in a male field at all; the women also agreed that women constantly have to prove that they are competent, hard-working, know what they are doing and should be taken seriously (*"I had to fight to convince the company that as a woman I could make it!"* (French woman engineer who quit).

Women agree that it is not easy to assert oneself and gain acceptance if you are a woman. *"It is a man's world and women have to accept that it is a man's world."* (Austrian female engineer). Austrian women see men as having a conservative worldview, so they cannot handle assertive, competent women. Many men are not aware of their old-fashioned gender stereotyping. They want to behave and think modern, but their traditional upbringing manifests itself in macho behaviour.

The women at a Slovak company talked openly about facing completely different problems in comparison to their male colleagues. For the discussion group the explanation lies in traditionally different positions in family and society. Also the general approach to the problems or failures caused by women or men is different: if a woman 'spoils something' the reaction is usually as follows: *"well, she is just a woman, what else could we expect from her (women have a 'hen brain')"* If there is a problem caused by a man the reaction is: *"well, it could happen to anybody."* In Greece some of the women and men interviewed expressed the fact that the typical masculine atmosphere in this field deters women from a career in engineering. The engineers who quit also told about the masculinity and the minority situation of women being one main reason for dropping out, especially in France and Germany.

- **Coping strategies**

How do women engineers cope with their minority situation? None of the interviewed women engineer managers mentioned being expected to be a tough woman. Maybe this is one of the still remaining myths of women engineers being tougher than any other academics. This was not confirmed by any woman all over Europe, but all women engineers had great self-confidence. All women admitted that men show much more self assurance. As one Austrian women pointed out *"Men have gigantic self-assurance. Even if they know nothing they open their mouths. Women open their mouths only if they really know something. That is where we do not match at all".*

A special feature of coping seems to involve dealing with sexist or stupid jokes. According to the statements in the Austrian focus group it is best to find a joking way to react on sexist jokes, that does not turn male colleagues into enemies. Women need a lot of sensitiveness and delicacy but on the other hand men do not need sensitiveness when communicating with women. Nevertheless one younger manager in Germany retaliates by behaving in the same way *"...I send the jokes back, but better!"*, she always tried to be better and straighter than her male colleagues, a woman engineer from Finland said: *"I work like a man!"* and some French women adopt that behaviour too. Austrian women think there is no need to change into a man. *"You should remain a woman. That is okay. But if you are oversensitive then that is of course a problem."*

- **Problems for women engineers**

None of the women engineers have had any problems at work. But all women – with exceptions in Slovakia - are aware of gender differences, masculinity and their minority situation. Difficulties and problems concerning the professional sphere seem to include the impossibility of doing a good job, and not just the feeling of some smaller disadvantages and uneasiness. Looking in more detail at the experiences of women engineers reveals the still male dominated culture in engineering and the fact that women are forced to cope in different ways with their minority situation.

- **Career**

Women do not follow the common career definition, they have found their own career values. In all the samples and nations career is defined by work content, including widening their horizon by following a horizontal career path, and by work atmosphere. These characteristics have a higher importance than vertical career steps. So the idea of a career or 'having a career' appears always with a bias which clearly dominates: the interest of the job. *"A successful career means paying a certain price!"* was a statement stressed in both German discussion groups and women from Austria feel the same: *"You can only have a career if you completely sacrifice yourself. Those who are prepared to have no private life, no hobbies, nothing but the company from dawn till dusk, those are the ones who really have a career…As soon as anybody confesses to a family life, it usually means their work engagement will not be unlimited any longer."*

The German and Austrian women agreed that it is more important for them to have an enjoyable, interesting job than to have a 'successful career', which would mean sacrificing the balanced life. A woman has to do two jobs, being a mother and a good professional; a man does not have this social obligation of a dual career. In Austria and Greece the women engineers also talked about not planning the next career step, *"it just happened*", unlike the U.K. and Finland where a career is considered as important to all of the women engineers. Women interviewed in Slovakia are not personally interested in leading positions, they would have to be supported and urged into leading positions. But they think women who are interested in leading positions have a good chance in the company. And they consider themselves as being competent for their positions.

- **Networks**

The importance and influence of networks on careers was confirmed in all project partner countries. Huge gender differences lie in the access to male networks for women, which is nearly impossible. Women's networks exist but to understand female and male networking, one should distinguish between the private and the professional sphere. The professional sphere is related to having a formal women's network, which could also be implemented with help of the company. The informal network like men have was not mentioned in any discussions.

- **Male networks**

All women engineers are aware of male networks. Women have only restricted access to men's networks, but see these networks as a most prominent career factor. All women are aware of not having any possibility to change things by themselves. The appearance of the network is quite different. It starts with informal meetings while drinking coffee or smoking a cigarette, goes on to so-called informal meetings after work or like in Finland where it was mentioned that men have 'sauna meetings' (but it was mentioned that this is not against women's careers).

Especially for the younger engineers who participated in focus groups in Germany it turned out that it's clear that networking is necessary to achieve the next level, but how to network was not so clear. One recommendation was taking a mentor in a higher position. Only French women engineers in one company see a difference: *"To work in a man's world doesn't disturb me at all! If the company has a reasonable policy, it's advantageous to work in such a*

company because as we are less numerous, we are pampered". The women would also deny the fact that one could stay outside the networks because of his/her sex: *"you enter networks only because of your competence!"*.

To summarize, it is obvious that the 'old boys' network still works very well and is helpful in career building and it was a topic in all partner nations except Finland. The women are aware of not being able to change it by themselves. They need time to build up their own male-female networks including men **and** women in high positions.

- **Women's networks**

Women's networks seem to be more formal in comparison to men's networks. In Germany women engineers are aware of the limits of women's networks *"You need someone to push and you need someone to pull".* Interviewees agreed that it is not enough to be competent and efficient, you have to have connections and be known to important persons. Women cannot change the network factor concerning careers themselves.

The main differences between men's and women's networks lie in their affiliation. Are they company internal (partly informal) or company external (formal) ones? In nearly all partner countries formal women's engineering networks exist, created in an engineering association or especially for entrepreneurships, for example. For instance in the U.K. the government has funded a resource centre for women scientists and engineers which collates and provides information and statistics and manages some mentoring schemes. It is hoped that these will provide women with assistance and support to further their careers or to maintain them during career breaks.

But company internal networks which are necessary and helpful for progression do not exist. Women are simply in too small a minority and don't have the power. In Austria women's networks are just starting to appear, but because of the few women engineers and fewer women engineer managers, they are not so powerful as male networks. In France women's networks already exist, but they are associations, they seem to be more conducive to reflection on subjects like reconciling a family and a career, dual careers… than to helping women to find a job, so they seem to have more of an advisory function than to provide concrete support. By contrast in Finland women engineers think that women's networks are not really needed. Of course women active at work are active outside work. Probably this

means that the word ‘women’s network’ is not understood as concerning the professional sphere.

- **Further training access and possibilities**

In the U.K. and in Germany companies have an internal career advisory structure. In Finland the decision-making process is very democratic at both companies investigated. The tasks and goals of women engineers are defined and discussed as personal development plans in companies of all partner nations at a rhythm of about once a year. This process is democratic and transparent and done in co-operation between employee and superior. In the U.K. this process is dominated by the chartering process which cannot be compared to the other partner countries.

All investigated companies offer good opportunities for personal training and gender discrimination was no reason for limited access to training in Europe. But as the Austrian situation showed, the possibility for vocational training depends on more subtle criteria, e.g. on the relationship with the hierarchical superior or on formal criteria like working part-time, which reduces the chances of access in Germany. An example in the U.K. reveals another aspect: in the U.K. training is necessary to become a chartered engineer so the individual importance increases yet some companies take the view it is the engineers’ own responsibility to organise it themselves and it can be something that individuals have to fight for. This would be an aspect of an unsupportive work environment and it contributed to one engineer deciding to quit engineering. Gender differences are visible in Slovakia where the interviewees stated that it is much simpler and easier for males to participate in training and educational activities, as they do not have so many family duties - and the training takes place on weekends.

- **Diversity**

All companies have their own specific cultures. In particular, good practice companies seem to focus on the social skills and creativity of employees. Diversity is an item in all good practice companies and seems to support women’s careers even if the company implements no diversity program. Diversity seems to include the acceptance and valuing of gender differences while including gendered aspects. This is a woman-supporting factor for all European partner nations, even for Finland which does not have the same social culture as the other partners.

At a German company, strongly practicing a diversity concept, the women managers think that the diversity programs and the experience of diversity decrease the power of the old boys' network. Diversity having a great weight in corporate identity supports women by being in contradiction to the old networks. Diversity is helped by being a global player, and women, like other minorities, seem to gain from diversity.

- **Reasons for glass ceiling**

The explanations why so few women engineers can be found in management positions include historical / societal reasons:

- still existing gender stereotypes
- existing ideas regarding the distribution of work in family and social surroundings
- traditional perception of women : they are responsible for raising children and should not pay any attention to their career,

and company internal ones:

- old boys' networks work quite well
- restricted access to male networks
- long working hours

French women engineers have their own explanation: "*Why are so few women top managers? Well do they really want to be? It involves so many sacrifices, at the personal and family level. Why do top management compel people to spend their lives working? I think that women are not ready to pay such a price!"* The price would be an unbalanced working and private life, avoiding which is a high priority for women. And the opinion of a German female engineer confirms this: *"It's not desirable for women because the female concept of life and relationships is not compatible with management positions, so women cannot identify themselves with being a leader. Much effort would be necessary to create a female work environment."*

- **Possibilities for change**

German engineers focus on the career hindering male networks which have to be widened and they think it is necessary to build up their own networks, not only women's networks, because there are no women in high positions. Role models would help younger women engineers to trust in their career paths and in the possibility of combining family and career. Opinion from

the U.K. insists that to change things requires long-term action, which should start by attracting more girls into engineering in the first place. This requires activity at school level, probably at late primary school level (age 10-12). Additionally, it is necessary to promote positive images of engineering and to dismantle fear of mathematics in girls. Also Finnish women think it is necessary to give more information to girls at the age of 14 to 18 and to organise study visits to companies, for example.

The Austrian perception is that more women would bring about different experiences for the men and consequently a change in their behaviour and in the atmosphere of the work-place. An Austrian union representative stated: *"If I knew what should be done to break the glass ceiling I would have suggested it a long time ago."* His company uses a sentence in their job ads which explicitly encourage women to apply and they explicitly say that they would like to employ more women.

A French woman has a different approach to this topic, *"I don't think that people really distinguish between men and women, they distinguish between person A and person B, sometimes mocking takes place, but women are also guilty of this."*. Slovak women don't see a strong need to make big changes, neither do they feel that their company should do anything more to appeal to more women. Greek women see possibilities of changing something only if they personally try hard, focus on vocational training and combat gender stereotypes. On the other hand companies should try to promote and implement equal opportunities and offer child care possibilities.

- **Advice to female students**

Experienced women engineers would recommend female engineering students already during study time to get work placements in big companies to get the experience of working conditions and to become a member of the internal company network. So the chances of getting a job after graduation would increase, although it is not always easy to get a job. Young employees should be aware of the big influence of networks. Women engineers all over Europe agreed on needing more visible female role models.

Most Slovak interviewees would not recommend engineering as it is not an attractive job for women. But as an Austrian woman stated, *"Being a woman engineer is not easy but it is great!"*.

- **Transition from studies to work**

None of the women engineers in Europe had any problems concerning the transition from study to work. In Germany, Finland and Greece most of the women already worked with the companies as students. In France, women engineers have such a high status and prestige that they may choose their future companies according to their own criteria.

- **Career hindering and supporting factors:**

- **Hindering factors**

❖ Women's priority of successfully reconciling family life and a career
❖ Male networks
❖ Overtime
❖ Fewer company internal childcare possibilities (Greece)

- **Supporting factors**

❖ Part-time work
❖ Flexible working hours and
❖ Tele-working
❖ Excellent maternity leave schemes
❖ Diversity (creating a supportive culture for all employees indifferent of gender or ethnic background)
❖ Transparency of criteria for assessment of performance and promotion

Part 5 Recommended Steps for Action

This part gives an overview of the most important recommendations and issues put forward in the report to enhance success and persistence of women engineers. The recommendations are arranged into categories : Engineering Studies (5.1) and the Professional Sphere (5.2).

Some of the recommendations suggested here are very general and could certainly be implemented in any of the seven partner countries. Some others, on the contrary, may appear totally irrelevant for one particular country whereas they may seem perfectly legitimate for another. This is the consequence of a transnational study where the cultural dimension plays a prominent part.

5.1 Key Issues and Recommendations for Engineering Studies

To increase the numbers of women engineers we need to increase the numbers of young women choosing engineering studies, improve retention and increase the numbers choosing engineering careers. Measures that increase the numbers of women students may also increase the numbers of males. However, in some countries, there are limits on the numbers of students in a course and here increasing numbers of women students may be accompanied by reduction in numbers of men students.

Improving the Image of Engineering

In some countries the image of engineering is very negative – a man in dirty clothes with a rag in his hand who repairs cars, or someone who repairs washing machines. Even in countries where engineering has much higher status, the image of engineering is still negative. It is seen to be a masculine, macho culture where the engineers, usually male, are more interested in machines than people and where ‘warrior’ style management is often used. Although engineering underpins so many aspects of our modern society most people do not appreciate the vital role it plays. Because it is seen as such a macho field, many consider it is

'unfeminine' for women to want to become engineers. Many male engineers assume that women will be less competent engineers, and older men often don't take them seriously. There is need for country specific programmes to be developed to improve the image of engineering.

Companies and professional societies should;

- show that there are caring aspects to engineering that it is responsive to the needs of society
- should present 'softer' images in their web-pages, including pictures of people as well as machines or structures although data protection may limit use of pictures of people.
- use female and male role models who are good communicators to meet the public and schoolchildren to promote engineering.
- build links with local communities, schools, universities.
- introduce mentoring schemes for schoolgirls.

Other possibilities include creating role models in television and radio drama[18].

Better Information about engineering careers

Students in every country underline the fact that they do not have enough information about engineers' professions and the actual activities involved even in countries where the prestige of engineering is high. Young people, their parents and guidance teachers need to know more about the reality of being an engineer so they can make informed choices about the course they will follow and their subsequent career. In many countries young women are already concerned about issues such as work-life balance. The caring and socially responsive aspects of engineering need to be emphasised.

Promoting an Engineering Profession

- .Companies should put on Open Days and make links with primary and secondary schools.
- Engineers should tell pupils about their work.

[18] PAWS exists in UK. It provides funding for scriptwriters to meet scientists and engineers so they can create authentic characters and funding to help scriptwriters produce scripts.

- Engineers (and students) should support Science and Engineering activities in primary and secondary schools.
- Links should be fostered between universities and the professional world.
- Professional women engineers should act as mentors and role models (perhaps via e-mail) for young women at school and university.

Engineering Studies

Many students reported that they would have liked more information about the degree course and particularly for women about the atmosphere of the department. Better designed, women friendly web-pages could play a role in making young women feel they would be welcome. Gender sensitive language should be used. Parents and family are important influences on engineering students' choices, particularly for young women.

Engineering studies: Encouraging applications

- Universities should put on Open Days before students make choices and Departments should put on Applicants' Days for pupils who have applied for their course.
- Technical Universities or Engineering Departments and high schools should co-operate more closely and better inform their students what additional knowledge could be useful for their university education.
- Universities should provide easily accessible information about the degree courses and facilities such as, study groups, counselling services, networks, internships, studying abroad, etc. for high schools. This would make students' choices easier and they would know better what to expect from university studies (content, extent, form, and requirements).
- Universities should introduce more interdisciplinary subjects to encourage more women (and men) to apply.
- Advertising of degree courses and departments should mirror the atmosphere as well as provide study information. Illustrations should show women and men

doing the same things in the same situations. Gender-sensitive language should be used.

Engineering studies: Supporting the school – university transition

Once students have decided to study engineering, the challenge is to hold on to them, to avoid drop out. If sufficient information has been provided they are less likely to drop out because they chose the wrong course. Other key issues for drop out identified by young women are workload, dry abstract lectures, knock-out exams. Most drop out happens in the first two years.

The most difficult phase for a student is at the outset of studies. Among other factors, students have to organise themselves, learn how to learn and to handle the new freedom. Induction courses could be very helpful at the beginning of studies. Ideally students would be introduced to the university, the buildings, the infrastructure, and given advice on how to learn, how to organize their studies and what to expect from their studies. This strategy does not avoid people dropping out but it helps students to find out at an early stage if this degree course is suitable for them and if it will meet their expectations. Students will realize faster if they have chosen the wrong degree course. Tutorials for beginners are helpful but they also need to be enriched with gender issues. Tutorials can also help to overcome loneliness in the early days, particularly if students are living away from home for the first time.

University led actions

Universities should:

- put on Induction Courses to introduce students to the university, the library, student support systems etc.
- provide advice and support for students on study and learning techniques and 'catch up' courses for students who have e.g. weak maths or physics or techniques.
- consider the introduction of a "Common Year" for all first year students (where there are not prerequisite subjects and grades for courses or where drop out is high this would be helpful).
- consider shorter courses (in countries where drop out is high).
- consider longer courses to allow introduction of more non-technical subjects without sacrificing the engineering content.

- ensure that all lecturing and teaching staff are trained and have been trained in gender sensitisation.
- provide accessible and confidential student counselling services to give advice and support on personal problems.
- group students on a course close to each other in student accommodation.
- gather and analyse statistics on drop out annually to inform university planning.
- make exit interviews or questionnaires part of institutional practice.

Department or Faculty led activities

The Engineering Faculty or individual Departments should

- put on social events to welcome students to the course.
- introduce group and team work as soon as possible.
- provide contact staff (e.g. an adviser of studies) who can provide general advice and support for students on academic issues and direct them to university support if required.
- ensure there is more than one female in a group even if other groups have none.
- change the composition of groups periodically.
- consider single sex teaching (e.g. for some practical or techniques classes).
- consider curriculum reform to include more interdisciplinarity and greater emphasis on ethical issues from the start.
- encourage and support study groups.
- use senior students to mentor junior students.
- introduce peer assisted learning – e.g. senior students lead tutorial groups for junior students, junior students read and give feedback on peers' coursework.
- provide social space for students and student notice boards.
- build a positive, supportive atmosphere through field trips, guest lectures, social events (e.g. Christmas Parties).
- encourage student engineering societies to support new students, particularly if they join the course in second or third year.

Student Society activities

Student societies can play an important role in providing informal but effective support for students, particularly if they join the course after the first year. They can:

- help with student orientation.
- provide informal mentoring and support.
- organise programmes of guest lectures, visits and social events.

Engineering studies: The later years

High student numbers and shared classes in the early years can make it difficult to develop the sense of the engineering 'family'. By later years in the course students will spend much more of their time in a specific department. Most drop out is in the first two years but even students who are being successful in their studies would like a more supportive atmosphere, with better communication between staff and students and many would like more interdisciplinary subjects. Many women students commented on feeling isolated and marginalised in early years although they felt more integrated in the department by the final years. Some are aware of overt discrimination with sexist comments.

Department or Faculty led activities

The Engineering Faculty or individual Departments should:

- provide social space to create "communication zones" to increase interaction between students and faculty members.
- provide mentoring for female students, facilitating links with women engineers in industry and with engineering employers.
- provide careers advice.
- ensure women students are integrated into year groups through project work, team building exercises to ensure they are part of the 'family' of engineers.
- change the masculine culture of the department through training of staff in gender sensitisation and gender mainstreaming and other diversity issues.
- change the culture of engineering studies through gender-sensitisation of students, male and female.

- take steps to reduce drop out, e.g. consider implementing programmes that have been successful elsewhere such as the programme for retaining female computing science students at Carnegie Mellon[19]:[20]
- use gender sensitive language in all communications.
- create an environment where sexism and harassment are not tolerated.
- provide more female role models.
- ensure women and men are judged equally e.g. through anonymous marking.

[19] Lenore Blum "Transforming the Culture of Computing at Carnegie Mellon" available at [http://www.cra.org/Activities/craw/reports/nov01.pdf]
[20] Lenore Blum: "Women in Computer Science: The Carnegie Mellon Experience": available at: [http://www2.cs.cmu.edu/~lblum/PAPERS/women_in_computer_science.pdf]

5.2 Key Issues and Recommendations for the Professional Sphere

Work is required at every level to effect lasting change for women engineers. At a general, societal level, there is a need to change the image of engineering to attract more women into engineering and suggestions concerning that particular point are presented in section 5.1. However, more women drop out of engineering careers than men and for those who persist in engineering, their careers do not progress as fast or as far as men's of equal education and ability. There is a need to recognise that this is not women's problem. It is not due to lack of ability or lack of ambition. If we continue to view it as a woman's problem there will be no progress and society will lose out from the benefits that greater diversity in the workforce can bring.

General measures[21]

- acknowledge the reality of gender differences - facts and figures to be published regularly and commented on at every level: European, national, regional, local.
- create at the highest level a task force to monitor the question of gender issues and to propose solutions. A clear definition of such a policy and its aim is essential, along with the means for its evaluation.
- incorporate the concept of occupational equality into all collective bargaining dealing with pay, working conditions, training etc. using legislation if necessary. (see Génisson law in France)[22]
- organise discussions and debates at the national and international level about gender programs in companies.

➢ ***Women engineers should be encouraged to***

- take training opportunities, including gender sensitisation and assertiveness.
- develop a career plan and review it regularly with personnel or a mentor.
- ask for experience.
- keep in touch if on a career break or working part-time.

[21] Not surprisingly, we found some common points with recommendations which can be read in the Eurofound recommendations (see http://www.eurofound.eu.int)

[22] The Genisson Law obliges all companies to have a negotiation on gender equality (if more than 50 people work in the company), to establish data, to negotiate objectives and measures. For more information see the web site : www.eiro.eurofound.eu.int/study

- join professional societies.
- join networks.
- promote a positive image of engineering.
- be role models.
- act as mentors (perhaps via e-mail) for local schoolgirls and students.
- expect a non-sexist work environment with equal access to training and promotion.

➢ ***In general at a level to support individuals, companies should:***

- create an induction programme into the company which should include gender awareness.
- introduce mentoring schemes. These can be company led, which can assist the study-work transition for all engineers, or regional so that women can find mentors outside the company and feel more free to discuss problems.
- facilitate networking schemes. These are vital to help women develop their careers, and to support them if they take time out say for caring responsibilities. They could be subject networks, company networks, or regional, networks.
- introduce or extend training programmes for men and women to include gender-sensitisation, assertiveness, negotiation, communication skills, chairing meetings (to ensure everyone is listened to with respect).
- disseminate vacancies and promotions widely, inside and outside the company as appropriate.
- use gender sensitivity in organisation of social space (restrooms, coffee rooms, meeting places etc).

The Role of the Employers

It is not women's deficits that drive them away from engineering but rather established, patriarchal structures of teaching, and working climate, content, and context in technology fields. Therefore, higher education institutions and companies are challenged to adapt their environment and content of training, and to reflect an equal consideration of the needs of all, to use all the available talent. Measures of effectiveness will include the narrowing of the

gender pay gap, currently averaging 20% in most countries and improvement of company performance[23].

Employers must take on an active role. There needs to be a comprehensive programme of action both to support individuals and, in order to effect permanent long term improvements, to change organisational culture.

- ***In general at a 'culture' level companies should:***

- create a positive image of women engineers, showing them managing large projects, working with machines, in leadership roles.
- make a clear statement that they are 'women friendly' employers who will hire technically qualified women and develop their careers.
- include women engineers in their presentation staff at congresses, recruitment fairs, etc., so that young women can see role models and get in contact with them.
- get inspired by good practice examples in their industrial field.
- implement gender mainstreaming and other diversity issues to profit from a higher number of women engineers and other under-represented groups.
- implement career advancement policies and procedures that are open and transparent and linked to measurable performance outcomes, job descriptions and skills profiles to eliminate unconscious bias against women and other under-represented groups.
- introduce work-life balance to the benefit of all employees.
- introduce flexible working including part-time and teleworking.
- recognise that part-time does not mean part commitment.
- implement a 'code of conduct' that does not allow bullying and harassment or 'macho' behaviour.
- implement standards of conduct that favour the inclusion, or at least minimise the exclusion of women and other minorities.
- use gender-sensitive language in all communications within and outside the company.
- create and maintain a non-sexist working atmosphere.
- appoint an equal opportunities officer.

[23] A recent UK Sunday Times survey of 'The 100 Best Companies to Work Fo' (Sunday Times, March 24th 2002) showed that companies implementing work-life balance policies and improving workplace culture to reduce bullying and harassment have better share and dividend returns over a five year period.

- involve works councils, unions etc with the policies and programs to change the culture and with monitoring progress against agreed targets.
- ensure all members of recruitment, interview and promotion panels are trained in gender and other equality issues.
- train all managers in non-sexist working practices.
- train all managers in gender and diversity issues.
- implement specific training and support programs for women progressing to management.
- monitor working conditions and work-life balance of male and female engineers.
- remove age limits associated with identifying people of high potential.

➢ ***In terms of recruitment companies should:***

- create strong links with universities and students, particularly between women engineers and women students.
- base recruitment on present competence and prospective career potential.
- disseminate widely clear recruitment policies.
- set and monitor targets for increasing the representation of women at every level.
- recognise that career advancement should allow people to stay in the technical field.
- recognise the value of women's 'soft skills' as real and desirable competencies that are equally valuable to technical skills.

Company support for Parenthood

Having a child can be a key moment in a woman's career. For women engineers, maternity is seen as a problem and correlated with professional difficulties, and many companies use it to put pressure on mothers. Maternity is seen to be only a woman's problem: women talk about their arrangements concerning children, as if it concerned only mothers, and the companies surveyed adopt the same discourse: maternity and its consequences only concern women as mothers. Special emphasis has to be put on the fact that women in high position can be good mothers at the same time: One of the main arguments for justifying the glass ceiling is motherhood. Too many people still believe women have to choose between being "real" mothers and "real" engineers and women who can't or don't have children are also affected by this prejudice.

- men and women alike should have the legal right to extended career break for childcare (or other caring) reasons.
- companies should maintain contact with parent(s) on leave; information should be sent, job opportunities should be circulated.
- 'keep in touch' and training programs should be available during parental leave, reentry programs should be designed especially for parents coming back to work (technical training, management training etc.).
- Child care has to be organised by the public sector (public childcare centres) or the company (several companies can organise childcare centres on the basis of geographical proximity), or associations (with the help of public money or company funding), or tax incentives have to be introduced in order to allow parents to hire someone to take care of their children. It is obvious that the problem of child care is central. It has a logistic aspect and a cultural aspect.
- an effort has to be made in order to convince men that the glass ceiling problem is their problem as well, it does not concern only women. A father's leave in order to take care of a child has to be presented as normal behaviour.
- companies should offer flexible ways of working (part time position, teleworking, flexible schedule) after parental leave and, more generally, to every employee.
- The prestige of overtime work should be challenged.
- Improved measures should be introduced to support fathers.
- Improved measures should be introduced to support dual careers couples, particularly where there are children.
- Flexible job models, flexible working hours, teleworking, part-time jobs should be widely available and should be linked to career paths.

Company support for mobility

- create a database common to several companies for job opportunities in case of mobility of a partner (e.g. partnerjob.net).
- consider if it is possible for people to obtain the necessary experience for promotion without relocating.

Conclusion

Throughout the European Union both the proportion and the number of young men undertaking engineering studies are falling. This is due in part to demographic trends of declining birth-rate. Balanced against that, engineers are one of the mainstays of the economy required for wealth creation and to maintain economic competitiveness in world markets. Despite many initiatives devoted to the recruitment and the retention of girls and women in engineering over the last couple of decades, they are still dramatically under-represented in this field. This under-representation has become a key factor in Europe, in particular with regard to the fact that up to half the potential talent for the European engineering workforce is missing.

Many studies have shown that women engineers can bring different views, diversify the engineering workforce and broaden the impact engineering has on society. Attracting more women into engineering studies and careers can also contribute to the modernization of the European community.

The main objective of the WOMENG research work conducted from 2002 through 2005 by seven academic partners within the 5th Framework Programme of the European Commission[24], is to understand the reasons why relatively few women are attracted to engineering and to propose efficient tools that could be used to increase women's participation. The numbers of women engineers can be augmented in two ways, by increasing the numbers studying engineering and by stemming the loss of women from engineering studies and careers.

Most women choose engineering because of interest in maths and sciences at school, or especially where engineering is a high status career, because of good job prospects, salary and social standing.

[24] Womeng RTD Programme is funded by the European Commission in the 5th FP, Specific Prpogramme "Improving the Human Research Potential and the Socio Economic Knowledge Base"

Two main strands of activity are needed at the level of Higher Education to increase the number of women engineers. The first is to attract more girls (and boys) into engineering –

by changing the image to emphasise that engineering **is** a caring subject that is responsive to the needs of society

by providing more information about careers and courses through web pages, information to schools and parents, through Open Days for pupils and increased contact between women engineers in industry and university to act as role models and mentors for young girls.

The second strand of activity is to reduce drop out once students have chosen to study engineering. This could involve relatively simple measures like providing 'top up' classes for students whose maths or physics is weak, or who lack technical experience, perhaps by providing classes before the main course starts. Providing welcome events at the start of semester, increasing group and team work and facilitating study groups will provide institutional and peer support for students and help to integrate female students into the 'family' of engineers. Reducing workload and removing 'competitive', knock-out exams would improve the situation particularly in Germany and Austria.

It was clear from our study that introduction of inter-disciplinary courses such as languages and soft skills would make engineering studies more attractive to students, in particular we found, to students who could have chosen engineering studies but did not. Some German universities run women only engineering degrees and they have found that this can help to develop women's self-confidence away from the competitive culture of traditional engineering courses. However, women students in most of the other countries were completely against the idea of single sex classes and some students commented that group work was more efficient in mixed groups than in all male or all female groups.

We have found that in general engineering students want personal, social and intellectual satisfaction, that salary is not a key factor for women. Some women students are already concerned about work-life balance and about combining family and careers, particularly in France but many others are confident it will not be a problem. Few male students have considered these issues.

Within our samples female and male students have very similar aspirations and motivations. Most of them are ambitious, in Scotland the women are more ambitious than the men and most students (over 90% in Austria) believe they will still be working as engineers seven years after graduation. In France, where engineering is 'The Royal Path' to many other opportunities and in Slovakia with by far the highest percentage of engineering students, up to 50% of the students thought they might have left engineering by then.

Students start with the same potential, the same desire, the same expectations however, despite young women's clearly expressed ambitions and aspirations we confirmed the reality of the engineering workplace usually means women's careers do not progress as quickly or as far as men's. From the interview material we collected it is evident that stereotypes and discrimination start to kick in even in the first job and it is here that women's careers start to diverge from men's. We start to see a big difference between what many companies say about career expectations and the reality for women.

Dual careers, work-life balance, peer pressure, and feeling guilty for not living up to the company's and society's expectations are common problems evoked by women engineers. Maternity still puts pressure on women engineers, even in some good practice companies. Not surprisingly, taking a part-time job is more a woman's choice than a man's, and having a part-time job in most companies is still looked down upon.

It is not women's deficits that drive them away from engineering but rather established, patriarchal structures of teaching, and working climate, content, and context in technology fields. Therefore, higher education institutions and companies are challenged to adapt their environment and content of training, and to reflect an equal consideration of the needs of all.

Companies must take on an active role and make a clear statement that they are not only willing but that they actually will hire technically qualified women. They should include women engineers in their presentation staff at congresses, recruitment fairs, etc., so that young women (and their teachers and parents) can get in contact with them.

Companies should get inspired by good practice examples in their industrial field. Consequently, they should implement gender mainstreaming to profit from a higher number of women engineers, career advancement for women, work-life balance for both women and

men, and, in total, a higher degree of diversity. Good practice companies have a ‘code of conduct’ that does not allow harassment or ‘macho’ behaviour and they expect standards of conduct that favour the inclusion, or at least minimise the exclusion of women and other minorities.

The WomEng project has confirmed that there is still a long way to go until gender equality in science and engineering is achieved. Special emphasis should be put on close co-operation between institutions of training and education and companies, integrating both female and male key actors and decision makers. Activities within the organisations should aim at strengthening the positions and increasing the number of women at all levels. As this project has outlined, networking and mentoring programs are important ways of bringing women in technical fields into contact not only with each other but also with interested young women. Contrary to young men, young women seldom know engineers of the same sex in their environment. Role models, however, are an important source of information, motivation, affirmation, and support.

In summary, consciousness-raising programs could appear to increase young women’s interest and motivation to pursue careers in science or engineering and make their integration less difficult. Quantitative feminisation through increasing the number of women in science and engineering is an important step but not the only one necessary to increase female participation in technology design and development.

Apart from necessary changes in teaching contents and contexts, a stronger focus has to be put on how career paths, professional lives, and job profiles are presented and how these appeal to both sexes as well as to target groups that do not correspond to “traditional male standard biographies”, and through which the “staying on” of women in minority positions can be supported. To ensure qualitative, vertical feminisation, it is necessary to foster the promotion of competent women in bigger numbers on all levels of hierarchy in companies and universities likewise (Glover 2000).

In addition to implementing gender-sensitive recruitment policies, their results have to be scrutinised and evaluated. Governmental affirmative action programs in the USA and the UK have proven successful by means of coupling equal opportunity policies with government contracts or public funding. Annual reports on employment equity and its consequences

should be established as standard procedure. This would contribute to more comprehensive, gender-specific company data which up to now have not been available.

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