Report 39

Gender and Diversity in Engineering and Science

1st European Conference

Editor:

VDI - The Association of German Engineers
Tatjana Belovenceva
Fib Women in Engineering
Duesseldorf

By order of VDI
published by Prof. Dr. Susanne Ihsen, Johannes Klumpers, Dipl.-Ing. (FH) Sylke Pageler, Dr.-Ing. Roya Ulrich, Prof. Dr.-Ing. Burghilde Wieneke-Toutaoui

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Duesseldorf 2009

ISBN-Nr. 978-3-931384-65-4

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Content

Content 3

Foreword 5

Career Courses, Career Orientations and Career Planning of Female and Male Chemists and Political Scientists in the Transition to the Post-doc-Phase 7

Reconciliation strategies and career-perspectives in Austria's non-university research institutions 21

Housework and Childcare alongside Academic Work in the Lives of Engineering and Basic Sciences Turkish Female Academics 35

Paying the price: the impact of maternity on career progression of women scientists and engineers in Europe 47

Technology and Masculinity - reconsidered - New perspectives on an apparently simple question 57

Engendering Knowledge Networks: Empowering Women through ICT 71

Obstacles and stimuli in the scientific careers of men and women in photonics 83

Gender Issues in Environmental Engineering and Research: a Matter of Translation between Gender Studies and Engineering 85

Gender and Diversity in Innovation Processes 95

Female Engineers: what kind of job? 111

Women's Underrepresentation in Technological Disciplines within Western Cultures: Issues and Possible Interventions 119

Investigation of the causes for the low attraction of female students in engineering careers 135

International Mentoring – A Model of Best Practice of Gender-Equal Human Resources Development 149

Staff development and the reform of the German higher education system – A chance for a more diverse workforce!? 161

- Spirit –A Life-Cycle Based Gender Mainstreaming Concept at the University of Stuttgart 175

Gender and Diversity as an Organisational Development Strategy at Technical University Aachen 189

Gender equality in study courses at Swiss technical colleges: The path to change in elec-trical engineering, business IT and biotechnology 201

Motivating Factors and Barriers to Study Engineering - Gender Differences and Possible Consequences 215

Educational Gender and Diversity Projects at RWTH Aachen University: Interdisciplinary Strategies to establish Gender Mainstreaming in various Teaching Scenarios 231

How to achieve Competence in Issues of Gender and Diversity Studies? 241

Gender and Diversity in Engineering Education – Fit for a Career 255

Work-Life Balance on the way to the top 263

Munich's gender-sensitive education – extend girls' world to the fascinating field of engineering 273

National Joint Initiative for Women in MINT-Professions "Go, MINT." 305

Authors 315

Foreword

"Gender and Diversity in Engineering and Science" is the motto of the first European Conference organized by the division 'Women in the Engineering Profession' (fib – Frauen im Ingenieurberuf) of the Association of German Engineers (VDI). As one of the top exporting nations with a specific focus on high technology and engineering services, Germany and German industry are putting the diversity argument into practice more and more: only if teams are made up of members with different backgrounds, ages and sexes it will be possible to achieve the results that satisfy customers, employees and employers. In the international competition for the best engineers and scientists no business can afford to abstain from the half of all talents.

The idea of gender in engineering and sciences has been widely discussed outside the areas where it should be applied: research and development in industry and research institutions. Although the last few years have seen a growing acceptance of gender issues in Germany, there are still many steps to go.

The conference's core objective is to bring the gender and diversity argument from the gender sciences to industry and to those people who want to make a change. Therefore the conference will turn the spotlight on best practices all over the world, results of studies showing the benefits of diversity and gender conscious management and information on world-wide work-life balance concepts in engineering and science. Besides insights into strategies to a successful career, the conference addresses cross-cultural success factors, women leadership, the changing professional image of the engineering profession and gender relevance in engineering education.

Since business-related contacts are nowadays no longer limited to one's own country, but are rather spread all over the world – particularly in engineering and science – networking is taking place globally. The conference aims to encourage the European networking of female engineers. Be invited to use this conference to extend your network, gain inspiring insights and exchange motivating ideas.

11th – 13th September 2009, Duesseldorf

Dipl.-Ing. (FH) Sylke Pageler
Chairwoman of fib

Career Courses, Career Orientations and Career Planning of Female and Male Chemists and Political Scientists in the Transition to the Post-doc-Phase

Keywords: academic career, gender differences, post-doc-phase, career orientation and planning, comparison of chemistry and political science

Abstract:

Various studies show that one reason for the underrepresentation of women in leadership positions can be found in gender differences in career orientations and career planning. In our article we want to point out the inconsistent results on gender differences in career orientations and career planning of male and female chemists and political scientists in the transition to the post-doc-phase. We discuss the structural and cultural conditions in chemistry and political science and try to show how they affect the career courses and decisions of men and women. Both subjects have a high amount of women who graduate from university, but at the same time only a small number of female professors. The comparison of the subjects therefore shows on the one hand the differences of the respective subject cultures and on the other hand the general mechanisms, which lead to fact that more women than men leave the academic career path after their doctorate.

Heike Kahlert, Marieke Gonschior, Katharina Nieter

1. Introduction

Although women and men nowadays have the same access to means of education, most of the leading positions are still occupied by men. This situation can also be noticed for universities. The number of women in the upper levels of science is much lower than the number of men. The highest decrease of women in science can be seen after the doctorate. In relation to the doctorate only half the number of women qualifies as a university lecturer. Since the postdoctoral lecturing qualification (*Habilitation*) in the German academic system is a condition for the appointment to a professorship[1] at university level, the available amount of

[1] In the German university system, since 2002 a so-called limited junior professorship of 3 + 3 years has been established as an alternative way of qualification after the promotion, but this new personnel category is not generally accepted yet for different reasons.

female scientists for scientific top positions – although with subject-specific differences – is still low. With higher career stages the participation of women in science continues to stay ever behind the available potential.

The fact *that* many scientific careers in the German academic system once begun by women are not continued is empirically obvious. *Why* fewer women than men aim to write a postdoctoral thesis or/and pursue the career orientation of becoming a university professor, is hardly examined for the German system of higher education so far. The state of research for individual motives for dropping out of the scientific career after the doctorate and for the connection of personal decisions as well as structural conditions for this career step is still insufficient, as Inken Lind (2004: 85-87) already stated in 2004. The career orientation and -planning process of young scientists in the transition to the post-doc-phase have so far not been examined for the German science system with a comparison between the genders and the subjects.

In the research project "Academic careers in political science and chemistry: orientation, planning and consulting in transition to the post-doc-phase"[2] we examine this question for the German university system. In the following we present first results of this empirical project comparing two subjects and genders. Therefore we initially take a closer look at chemistry and political science (2). Secondly we illustrate the situation of young scientists in both subjects by analysing statistical data (3). Thirdly we display the state of research for this topic (4). In conclusion we summarise the results on career courses, career orientations and -planning of the generation of young scientists with regard to our empirical study (5).

[2] The project is funded by the German Federal Ministry of Education and Research (BMBF) and the European Social Fund (ESF) of the European Union from march 2008 until may 2010. It is located at the institute of sociology and demography of the University of Rostock. It was initiated by the Executive Board and Advisory Board of the German Association for Political Science (DVPW) and is supported by the Executive Board of the German Chemical Society (GDCh). For more information see: http://www.wiwi.uni-rostock.de/soziologie/wissenschaftskarrieren.

2. The subjects political science and chemistry in comparison

The comparison of political science and chemistry firstly appears unusual, since political science as part of the humanities and chemistry as a natural science seems to have little in common. Regarding our research question, the comparison can show to what extent the mechanisms, which cause continuing or dropping out of the academic career are typical for the respective subject culture or typical for the German science system in general. The comparison of the genders again makes it possible to work out whether there are gender-based characteristics in career decisions of young scientists in both subjects. In order to understand the development of the two subjects, a look at the respective history and the role of women is helpful.

There are different opinions about the age of the political science. Some see its origin already with Aristotle and the sophists, but here it was a component of philosophy. In Germany the modern political science was established as a science of democracy in terms of re-educating the population after the Second World War by the American occupying forces. In the 1970's the subject experienced a major gain in importance due to the educational expansion. When exactly women entered the subject cannot sufficiently be answered, due to the lacking portrayal of women's history in political science in German-speaking countries. This shows how little importance was attached to the participation of women in this discipline. Only since the 1980's the numbers of the graduations, promotions and postdoctoral theses were documented in political science and hence the participation of women in this subject became noticeable. At the beginning of the 1980's the amount of women of all graduates was only scarcely more than one quarter (see Ostendorf 2009: 154). Additionally there are still less formalised fields of work available for graduates of the political science. Political scientists do not have a certain field of work like chemists have, who must purposefully decide between industry and science.

Chemistry is however clearly an old, scientific-technical subject, which roots lies in the alchemy. The academic education of chemistry was established and systemised in the mid-19th century. In the Middle Ages women were systematically displaced out of chemistry and could only slowly enter this field in Germany at the beginning of the 20th century. They obtained the access to study chemistry and also the permission to qualify as a university

lecturer in 1920. Given the fact that women were excluded from the subject such a long time, chemistry has become a male dominated work field.

Thus it can be stated that in both subjects women were almost irrelevant in the process of professionalisation. They had to struggle for their place in the respective subject. The increasing participation of women in the respective professional associations, however, indicates the gradual establishment of women in chemistry and political science. In the largest German professional association of political science, the German Association for Political Science (DVPW), women are even disproportionately high represented in the executive committee according to their proportion of memberships. Especially the working group "Politics and Gender", created in 1991, and the "Standing Committee on Questions for the Promotion of Women" (StAFF), which was established in 1995, contribute to increasing the amount of women in academia. In the German Chemical Society (GDCh) the "Working Group for Equal Opportunities in Chemistry" (AKCC) was established in 2000 in order to reduce the discrimination of women.

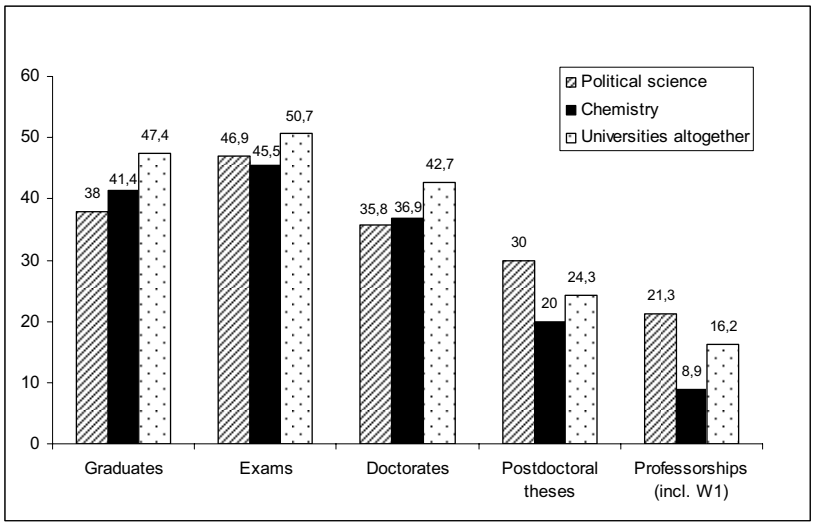
3. Career courses of young scientists in political science and chemistry

Asking young scientists for their opinion about the unequal treatment of men and women in academia, only few refer to specific situations in which they personally felt treated unequally. Nevertheless it seems that there is a vague feeling for the disappearance of the female competitors.

With 50.7%, the majority of the 286.391 graduates of the year 2007 who accomplished a university degree, with a slight overage, is female. But as shown in figure 1, the scissor opens more and more with the increasing status of qualification. Focussing the 20.344 promotions, women are already slightly under the average, with 42.7%. On the level of postdoctoral theses the number of women halves to 24.3%. That means that men still write a postdoctoral thesis more often and also are appointed more often to a professorship than women (see Statistisches Bundesamt 2008b: 18, 2008a: 42-43, 2008c: 479). Particularly striking is the drastic decrease

of the proportion of women in promotion in comparison to those who write a postdoctoral thesis. This turns out very different for political science and chemistry.

Figure 1: Overall proportion of women in 2007 according to status groups and qualifications at German universities in percentage



Sources: Statistisches Bundesamt 2008b: 18, 22-23, 2008a: 42-43, 50-51, 120, 2008c: 420, 438, 479, 2009b

In 2007, the proportion of female students in both subjects was under the average compared to all subjects. In chemistry the female under-representation persists until the allocation of professorships. In political science, however, the proportion of women who get a postdoctoral lecturing qualification and become professors is, in comparison to the total proportion of women with postdoctoral lecturing qualifications and professorships at all universities, above the average.

In terms of the intensity of promotions[3] and the value of promotion there are significant differences between political science and chemistry.

In 2007 the intensity of promotions[4] of political science was at 16.4% and chemistry at 86.8%. The high intensity of promotions in chemistry is due to the fact that the promotion, unlike in political science, represents the first academic degree, which is, of highest

[3] Intensity of promotion means the ratio of exam and finished promotion three years later. It is a simulation, since longitudinal data are not available.

[4] Sources for all figures on the intensity of promotions: Statistisches Bundesamt 2008d, 2009a and own calculations.

importance for both career paths – inside and outside the university. In political science, however, a promotion is merely mandatory for an academic career.

Maybe because of the promotion being considered in chemistry as mandatory, there are no gender differences concerning the intensity of promotion. In 2007 86.2% of women and 87.1% of men finished their doctorates. For political science however gender differences in the intensity of promotions can be identified for the year 2007. The percentage of the intensity of promotions of male political scientists (17.9%) was higher than the percentage of female political scientists (14.1%). All in all the intensity of promotions in both subjects is higher for men than for women.

Also with view to the intensity of postdoctoral theses[5] a clear difference between the subjects can be recognised. In 2007, the intensity of postdoctoral theses in political science (9.5%) was higher compared to that intensity in chemistry (2.7%). Only every tenth doctorate in political science is followed by a postdoctoral thesis. This suggests that the Ph.D. in political science is seen more as a basis for a scientific career than in chemistry. However, a promotion in political science is no guarantee for continuing a scientific career, as a view on gender differences of the intensity of postdoctoral theses shows. In 2007 considerably more men (11.5%) than women (6.3%) qualified as university lecturers in political science. Also in chemistry, the proportion of men (2.9%) who qualified as university lectures was bigger than the proportion of women (1.9%).[6]

It also seems possible that the different career alternatives of the respective disciplines have an impact on the career development of Ph.D. students. In chemistry the Ph.D. graduates have to decide between two major pillars at the end of the doctoral phase: on the one hand the university career, which in Germany shall and must culminate to a professorship, and which is characterised by writing a postdoctoral thesis, and on the other hand, industry is a very interesting field of work for a Ph.D. graduate in chemistry. Occupational alternatives and work places for political scientists are less formalised: Career opportunities can be found in the media industry, industry, government, associations, and finally also in academia.

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5 Intensity of postdoctoral thesis means the ratio of postdoctoral theses to three years earlier completed doctorates.

6 Statistisches Bundesamt 2008d, 2009a and own calculations.

The brief overview of the statistical data shows that fewer women than men continue their academic careers after final exams (e.g., diploma, master, doctorate): In a cross-sectional perspective often discontinuities at certain stages of careers can be found. The questions why more women than men drop out of scientific careers and why especially female chemists are underrepresented in academic leadership positions cannot be answered with the statistical data.

4. Career orientations and career planning of young academics

With regard to these questions we want to take a brief look at the state of research of career orientations und career motives as well as of the institutional and structural conditions, which contribute to continuing or dropping out women of an academic career after completing their promotion. Before starting we want to emphasise, that the current state of research with regard to these questions – even beyond the comparison of the two disciplines – is deficient.

We assume that the decision for or against an academic career path is linked to the occupational conditions and options, to the existing non-academic job alternatives and to the social environment of academia. We suppose that the process of decision-making is influenced by individual experiences, collected during the time of studying and in the promotion phase with the predominating structures and basic conditions in the two subjects compared.

Lorenz summarises, that the organisational structures regarding the perception of career opportunities, the job contents and job satisfaction are therefore of substantial relevance. Young academic careers in Germany are characterised by social and financial insecurity, long qualification phases, a lack of structure and a strong dependency on the professor (see Lorenz 2004: 49-50).

After the promotion the question arises whether one would like to get involved in the uncertainties of an academic career, because it is almost impossible to find a job outside of science as the qualification as a professor is completed and a postdoctoral thesis is not a guarantee for an appointment to a professorship. Nägele emphasises that chemists qualified as

a university lecturer without an appointment have difficulties of getting a job in the industry (Nägele 1998: 56). These are reasons for both women and men to leave science after the promotion. So there have to be other reasons for the withdrawal of women after the promotion.

Reconciliation of family and science as a profession? Especially women have to deal with the decision whether a life with children and science is achievable after the promotion phase. This decision seems to be less acutely for men in this qualification and life phase. A proof for this discrepancy is the high number of female scientists without children, compared to their male colleagues (see Krimmer/Zimmer 2004: 29; see Metz-Göckel et al. 2009). According to Nägele the experiences with the necessary continuous presence in the laboratory and the existing work structures, which are already made during the promotion phase, let the possibility of a reconciliation of children and qualifying as a university professor for many chemists appear difficult or even impossible (see Nägele 1998: 55).

Work culture and professional lifestyle? Particularly in chemistry the full concentration on the job and a high motivation are substantial elements of the work culture. The professional lifestyle of chemists requires support in private relations. “Ideally these are in such a way organised that the man is unburdened of all non-business private concerns by his wife, thus in form of a middle-class lifestyle.” (Könekamp 2007: 151) However women do not live unlike many men in traditional life contexts. Traditional life context here means a relationship with a part-time employed wife, who gives up her professional career – at least temporarily – to concentrate on her role as a mother. Women rather live in dual career partnerships. According to Könekamp female chemists are attributed with less sovereignty and less toughness because of this deviating organisation of their private lives, which can turn into a disadvantage for the evaluation of their efficiency for future employments (see Könekamp 2007: 152).

Appreciation of the scientific achievement? Experiences that are made during the promotion phase in the scientific setting can be important for further career orientations and decisions. Thereby the support and appreciation of the doctoral thesis by the professor and other colleagues should not be underestimated. Women are more often dissatisfied with the support and supervising of their doctoral thesis than their male colleagues. They criticise the lack of subject-specific discussions or the little interest in the topic of their doctoral thesis by their supervisor (see Kantola 2008: 211; see also Nägele 1998: 64). Women in science make more

often than men the experience that they are interrupted in discussions and that their scientific achievements are not taken seriously by other colleagues (see Krais 2000: 32).

Integration into the scientific community? Important for an academic career, besides the professional qualification, is the integration into networks and the position within the scientific community. Mostly women are not as good integrated into the scientific community as men (see Lind 2004: 110). Thus their informal access to important contacts and information, which can be relevant for their future career, is distinctly more difficult.

Do women plan their career to a lesser extent than men? A study of the participation of female scientists, who apply for research projects, at the German Research Foundation (DFG), one of the central institutions of the national research funding, shows that many women are not sure about continuing their academic career after the doctorate. They asked female and male research assistants, whether they intended to qualify as a university lecturer. This question only was affirmed by 26% of the women, but by 40% of the men (see Güdler/Reinhardt 2007: 5). According to Macha women set rather small aims, which can be attained faster and simpler, rather than to determine for example the career aim professorship (see Macha 2000: 171).

Gender-based career motivations? The research results of gender-based differences in career motivations of scientists are very contrary. Geenen (1994) and Strehmel (1999) maintain that the career motivations of men and women differ. According to Abele no differences concerning career motivations and power motivations can be found out between men and women (see Abele 1994: 28). Finally it can however be noted that gender roles seem to have a strong influence on the career motivation. Women seem to be more interested in content-related topics and evaluate their success differently than men. Men are more driven by a positional motivation (see Lind 2004: 88).

These highlights show: The state of research of career orientation and career planning of female and male scientists is inconsistent and leaves many questions open. Nearly all the empirical studies concerning career courses and orientations focus on institutional or structural aspects. The individual decision-making processes for or against an academic career are neglected.

5. Discussion and conclusion

Our analysis shows that the examination of the career processes, career orientations and career planning of the young generation of chemical and political scientists is a very complex task. Overall, with view on the structural influences, it is obvious that women have to fight harder in the science system and have to increase their job performance to achieve the same goals as their male competitors. Which individual orientations, plans and decisions on the basis of these experiences follow cannot be clarified here in an empirically satisfying manner.

On the basis of the qualitative interviews with young scientists at the transition to the post-doc-phase, implemented in our research project, only first theses can be stated at the time of this contribution.[7]

The uncertainty of a scientific career in German academia is one of the aspects that were brought up for discussion in many interviews with chemical and political scientists. We like to emphasise that this is an influential factor with the decision for or against a scientific career. That can be seen however as a reason for men and women, who attain a doctorate, not to continue their scientific careers after the doctorate.

The reconciliation of family and scientific career is a very important matter for young scientists of both genders, too. In our interviews both genders often brought up the fact that they see the reconciliation of science and family as problematic or even not as possible.

In the first place there are probably the experiences that are made during the qualification phase keeping or displacing young scientists in academia. Concerning this matter women seem to have different expectations than men, particularly concerning the subject-specific and psychosocial support during the qualification phase and the socially compatible work setting. The interviewed male scientists seem to handle more freedom and missing support better than their female colleagues. They also seem to be integrated more into the scientific community.

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[7] 30 junior scientists of both subjects, political science and chemistry, were interviewed at the transition from promotion to the post-doc-phase. 30 of them were female and 30 male. The composition of the sample consists criteria such as the professional affiliation and gender as well as life form (with or without child/ren), social background, geographical origin (West or East Germany, migration background) and promotion model. Since the interview phase was just completed at the time of writing this article in spring 2009, only first theses can be introduced here. Systematic results of our research cannot be given yet.

The female interviewees however still describe themselves as outsiders in the scientific system, whereby the position as an outsider makes it more difficult to opt for an academic career. Based on these impressions we assume that the reason leading to the withdrawal of women from science after the post-doc-phase does not express a different manner of career orientation and career planning process compared to men, but rather subtle maybe gendered mechanisms in combination with the structural uncertainties of the science system.

Following the US-American researcher on higher education Burton Clark (1960) we speak of "cooling out" effects. It seems, as if women in the promotion phase make different experiences than men. They are already underrepresented at this stage of the academic career, they are not as integrated into informal networks as their male colleagues, they have to fight against a "male dominated society" and their needs for a good supervising situation and work setting are not satisfied. All these "cooling out" factors may lead to the fact that a lot of women – due to these experiences – finally decide against a further career path in(to) science.

Besides that fact the interviews show that some Ph.D. students seem much more motivated by personal wishes and goals than other interviewees. They emphasise the desire for the freedom of research much more than the uncertainties of a scientific career. Thus it can also be possible that the stronger the intrinsic motivation to work as a researcher is the less is the awareness for the uncertainty of a scientific career. Or they tolerate the uncertainties more because of their high intrinsic motivation to work as a researcher.

How these aspects mentioned above work together by "cooling" more women then men "out" of the scientific career path after the doctorate, will be discussed by our research in the future.

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Reconciliation strategies and career-perspectives in Austria's non-university research institutions

Keywords: career, career motivation, reconciliation

Abstract:

This paper considers gender specific career aspects in science and technology, based on gender-theoretical career concepts that see 'career' in a broader sense, integrating professional and private life aspects. As women's career perspectives have become politically more important in Austria, more knowledge about women's individual career images, career patterns and strategies is needed. So empirical results from two Austrian surveys in the non-university-research sector are discussed, focussing one on career images and career motivation and one on the reconciliation of research and care work. The findings show that while female researchers show a wide range of career orientations, role stereotypes just change slowly; male and female researchers with children still practice traditional gender roles with classical distribution of work and care.

Helene Schiffbaenker

1. Introduction

Recently, career aspects have become increasingly relevant when talking about gender issues in science and technology (S&T). Because of the Lisbon Strategy, the participation of women in S&T has become an important political goal. Policymakers at both the European and national level intend to promote women in science and technology in a quantitative (more women) and qualitative way (more women in leading positions and better frameworks for their career advancement).

To make the field more attractive and to get a greater number of women into S&T, more women are needed at all levels of the innovation system. In Austria, industrial research in particular and also non-university research institutions attract few women. More research is needed on factors influencing the choice of discipline at school and university level and on barriers when starting and continuing a research career. Doing this from a gender-theoretical position, we need to look at both genus groups, women and men, as well as at structural dimensions.

There is a general insufficiency of empirical research on women in S&T in Austria, but in particular there is a lack of data on female and male researchers in non-university research institutions and in industrial research. In the first section of this chapter, the Austrian S&T sector in general and the non-university-research sector are described, focusing on different career steps.

The second part illustrates some of my own empirical research, located at the interface between research work and the private sphere. In Austria, the difficulty in reconciling childcare and research work is seen as the main factor in the less successful careers of female scientists compared to their male counterparts. So we have asked female and male researchers with children who are active in the field for their reconciliation pattern and how they combine work and childcare, and what their coping strategies are. Possible differences between male and female researchers with children are then analysed.

2. Women in science and technology in Austria

In Austria, women are still marginalised in S&T. Only 25%[8] of all R&D personnel are women. However, there are considerable differences between different sectors. The private non-profit sector and the government sector employ the highest percentage of female researchers, but the total number employed in these sectors in Austria is marginal.

8 Headcounts are used because women more often work part-time.

Table 1: Male and female scientific personnel by sector 1998-2006[9]

	Research and development (R&D) 2006				
	Higher education sector HES	Government sector GOV	Private non-profit sector PNP	Business enterprise sector BES	Total
Total	23,609	2,789	284	22,915	49,597
Women	8,190	1,095	147	3,109	12,541
Men	15,419	1,694	137	19,806	37,056
Share of women	35%	39%	52%	14%	25%

Source: Statistics Austria

The two sectors with the most significant employment numbers are more sex segregated in their employment structure. 35% of all researchers in the higher education sector are women, which makes university the most important employment field for female researchers (in terms of absolute numbers) in Austria. But in the largest sector, the business enterprise sector with its increasing employment potential, just 14% of all researchers are female. This is of specific relevance, as in terms of the Lisbon goals this sector will be in particular need of more highly qualified human resources. From the cross-national perspective, the share of female researchers in Austria is below the EU average. In the business enterprise sector, Austria is at the bottom end (EC, 2006).

In this paper the focus is on the non-university research sector, which in Austria is part of the business enterprise sector.

Table 2: Employment structure in non-university research institutions in Austria

Total	2,391
Women	430
Men	1,961
Share of women	18%

Source: BMVIT (2006)

Looking at the "career ladder", it can be seen how male dominated the management level is in the field, as only 7% of all management positions in non-university research institutions are held by women. On management and executive boards, less than 6% of the positions are held by women, while on scientific boards, only one out of ten members is a female researcher.

9 Based on headcounts.

Table 3: Male and female scientific personnel 2006

	Women	Men
Management	7.1%	92.9%
Management/executive boards	5.7%	94.3%
Scientific boards	9.8%	90.2%

Source: BMVIT (2006)

Before looking for reasons at the empirical level, a few theoretical remarks on the notion of "career" seem necessary to clear up what we are examining.

3. Career – lifestyle – reconciliation

What do we mean when we talk about "career", in general and from a gender-perspective? In everyday language, at least in a German-speaking context, the term "career" is related to hierarchical advancement or leading positions. A career is visible, meaning a better job, more income or a special position. "Career" is a common term. We read about careers in newspapers, and career prospects are already important when children or their parents choose a certain educational institution, as they are already thinking of specific career options. However, at the individual level the significance of the term may differ considerably from the common definition, with the concept being based on personal decisions, and individual preferences, priorities and goals in professional and private development.

Gender in this context is a dimension of inequality. Today, women are better educated and better integrated in the labour market, yet they still do not succeed in their careers, at the level of income and leading positions, in the same way that men do. Their investments in their careers are not equally rewarding. A typical female life course, with more employment interruptions, more part-time work, and thus less professional advancement, does not correspond to this life course concept as well as the male one, which is strongly employment-oriented. Feminist researchers have already formulated critiques of this "male" employment concept in classical career theory. The dominance of the male life course ignores the differences in female life orientation both in terms of career path as well as family. Feminist theorists argue for new theoretical approaches that better integrate female career aspects in

career theory by paying more attention to female life specifics such as the private sphere, female values or female ways of acting. Gallos (1996) focuses on differences in female personal development. These differences illustrate the need for a new career theory that concerns not only the professional sphere, but that equally integrates aspects of private/family life. The often used definition of "career" as the "success of a person in his (!) self selected profession"[10] is not broad enough to describe diverse (female) career paths that could also be attractive for men.

These differences have to be recognised in order to avoid the general use of male career concepts as the norm, making women's careers seem like deviant exceptions. Gallos argues that typical female career management is not accepted as "female", but is always compared to the male model and thus characterised by deviation. It is described in terms of shortcomings, career-backlash or quitting the one and only (male) career path. It could also be described as involving less job commitment and less career ambition, and being less career focused. At the same time (as Gallos shows empirically), some women in successful organisational positions quit in favour of better life quality. They "opt-out" to "gain back their sovereignty over life-time".

But talking in terms of the careers of women and men may re-establish gender stereotypes and also career stereotypes. Therefore, theoretical concepts based on the social construction of gender roles, such as doing and undoing gender, could help insights to be obtained more efficiently and the structural dimension to be better integrated.

For my own empirical work, this basically means that in analysing the career aspects of female and male researchers, not only does pubic sphere retrospectively paid work have to be integrated, but also unpaid work. Dimensions more relevant for women (in traditional gender roles), such as the reconciliation of work and family, have to be integrated. They may in fact have an important impact on career orientations and career trajectories. At the same time, it is necessary to integrate men into the analysis to be better able to deconstruct traditional gender roles.

[10] Merrian-Webster (1974).

4. Reconciliation of childcare and research

As mentioned above, the reconciliation of (research) work and childcare is important when looking at gender specific career aspects. In public, politics and also in enterprises it is said to be the main reason for a woman's "career slump" and less successful career advancement. This argument is based on two opposite positions. The first mentions the lack of childcare facilities as the main barrier to the better career advancement of women, while the other refers to the freedom of choice to care for children at home and re-enter a career at a later time. Nevertheless there is strong evidence that political regulation[11] has had a hindering effect on career advancement (Riesenfelder et al., 2006). At the same time, in Austria it is highly valued socially for mothers to stay at home and care for their children themselves. Other factors that make reconciliation an important gender specific career aspect include ongoing employment patterns like job interruptions, part-time work or a woman's orientation towards her partner's/husband's career.

In addition, an internal career, defined in terms of personal motivation aspects, plays a crucial role in choosing an individual reconciliation pattern. The same can be said about the division between paid and unpaid work, as both are greatly influenced by personal values incorporated in role models. Reconciliation is related to both the employment and private sphere. The decision on how long a woman stays at home after maternity leave and to what extent she re-enters the labour-market is of great relevance to her career prospects. This decision depends on her personal preferences and motivation structure and also on institutions and role arrangements. It also depends on the welfare state, which (in combination with the market) offers money and regulations concerning time off as well as public childcare.

Reconciliation is often discussed exclusively as a female matter, but it has to be said that this is not so. Do only women have children and thus something to reconcile, or men too? Why do more and more women neglect personal goals and refrain from having children? And does being childless mean women having the same career options as men? - For gender specific career advancement, the fact that women are biologically able to become pregnant and so

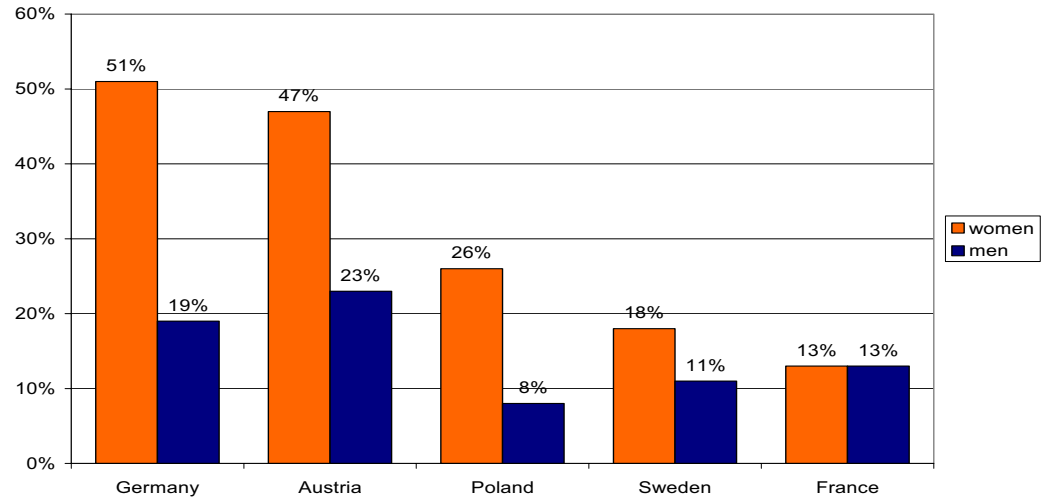
[11] In fact, it is possible for mothers to stay at home on maternity leave for 30 months, while fathers may take another 6 months.

potentially be absent from the labour market[12] is significant, and thus (potential) reconciliation with childcare becomes an issue.

4.1. Reconciliation and research

Doing research successfully while having children at the same time seems difficult, at least for women. This is argued from the point of view of the "male scientific ethos" that proclaims that science needs one's total presence,[13] which is impossible for people with childcare responsibilities. This is confirmed at the empirical level. Looking at the university system first (where more data are available), we can see that a high proportion of female professors, who can be seen as being at the top of a research career, have no children. Looked at from a cross-national perspective, remarkable differences can be clearly seen. This indicates that national and/or cultural factors are of special relevance in the reconciliation of research work and children.

Figure 2: Share of female professors without children



Source: Majcher (2007)

[12] Potential absence may be anticipated by human resource managers, which creates potential disadvantages for all women (both those with and without children).

[13] Recently, the discussion has focused more on social factors, asking how professional roles in science are socially constructed (Beaufays, 2003).

4.2. Reconciliation in Austrian non-university research institutions

As there were no data available on researchers with children in non-academic research institutions, these data have been collected by FEMtech in the human-resource departments of all Austrian non-university research institutions (Table 5). These provided institutional data on their male and female researchers' children.

Table 4: Researchers in Austrian non-university research institutions

	All	Women	Men
Researchers in Austrian non-university research institutions	2,905	582	2,323
Researchers in Austrian non-university research institutions with children	565	N/A	N/A

Source: BMVIT (2006)

In a second survey, all male and female researchers in non-university research institutions in Austria (with children under 16 years of age) were asked about their personal arrangements for managing care work and research activities.

From the gender perspective, it was crucial to ask both female and male researchers[14] for their reconciliation patterns and barriers in order to avoid gender stereotypes by assuming the widespread understanding of care obligations as a female issue. The survey was carried out in spring 2007 by email. Of the 565 researchers with children, 238 returned the questionnaire. This quite high return rate of 42% may illustrate that the subject is a high priority one and of interest to researchers. Analysing reconciliation in terms of gender specific career aspects means looking at paid work as well as unpaid work for both sexes.

4.3. Employment structure in non-university research institutions

The employment structure of fathers and mothers in research in non-university research institutions is highly segregated in terms of sex. Only 17% of female researchers with children under 16 work full-time (Table 6). Consequently, the dominant employment form for mothers in research is part-time. 83% of all mothers engaged in research work part-time, depending on the children's age (under 3: 91%; 3-6: 83%; 6-16: 72%).

[14] With this definition, we include only people who have children and are actively employed in research (not people on maternity leave or those who have not re-entered the labour-market).

An interesting finding can be observed for part-time men/fathers employed in research: fewer male researchers with children work part-time than male researchers in general. Just 12% of all male researchers with children work part-time, while 15% of all male researchers in non-academic research institutions work part-time. This result illustrates clearly that part-time is not a reconciliation pattern for men, but is used more for other reasons. It also shows that it is not impossible for male researchers to work part-time, as is often argued (see below).

Table 5: Form of employment in non-university research institutions in Austria

	Parents with children under 16 N = 238		All researchers N = 2,888	
	Women	Men	Women	Men
Full-time	17%	88%	65%	85%
Part-time	83%	12%	35%	15%

Source: BMVIT (2006)

This gender-specific employment structure underlines the traditional division of paid labour that makes paid work the domain of men (the male breadwinner) and unpaid work the domain of women. The latter do paid work, mostly part-time, in addition to their household and care obligations.

For career prospects, the integration of the private sphere is of specific relevance when we want to improve women's career chances and look for equal career prospects for female and male researchers. Feminist theorists argue that this is an attempt to improve the classical career concept towards a more female-related life concept. As far as the gender-specific division of unpaid labour is concerned, mothers engaged in research work 58 hours unpaid per week, while fathers do only 35 hours. As fathers do more paid work and have less time for unpaid work, this may mainly be caused by the time required for paid work. To check this, only male and female researchers with part-time work were compared. This revealed a significant difference: mothers employed in research on a part-time basis work another 61.7 hours unpaid per week, while fathers with part-time jobs work only 37.6 hours unpaid. Mothers engaged in research do a lot more unpaid reproduction work than their male colleagues who also work part-time.

This traditional labour division in the Austrian research sector reflects traditional gender roles in Austria. To describe this division of paid and unpaid work in terms of partnerships, the term "gender arrangement" is used. Gender arrangements describe different forms of labour

division, from the breadwinner model (one partner earns, one partner cares) to the egalitarian model (income and care are equally divided). Our data show that most mothers employed in research live in a household with a husband who is the main earner, her income is additional (from part-time work) and she cares for the child(ren). 62% of all mothers employed in research belong to this moderate breadwinner model. In contrast, 45% of all male researchers with children are moderate breadwinners. Another 31% of male researchers live in a traditional breadwinner model household, being the only one with an income, while the wife does care work at home or has only a little income.

Table 6: Gender arrangement of researchers with children under 16

	Women	Men
Strong breadwinner model	----	31%
Modified breadwinner model	earner: 2% carer: 63%	earner: 45% carer: 63%
Egalitarian model	23%	19%
Solitaire model	12%	2%

Source: BMVIT (2006)

Approximately every fifth researcher with children under 16 lives in a partner arrangement that offers equal responsibility for income and care: 23% of female researchers and 19% of male researchers practise an egalitarian arrangement, mostly with both working part-time for about 30 hours per week.

4.4. Career implications and barriers

As we have already seen, female researchers with children under 16 work mainly part-time, while 88% of male researchers in the same situation work full-time. As the amount of time in paid work has a significant impact on career prospects, female and male researchers were asked about the main career implication of childbirth on their careers. Women describe employment interruption after childbirth and maternity leave as the main effect on their career. This is often linked with a remarkable reduction in working time and some years in part-time employment. Less promotion in their career is the consequence. One out of four women has changed job because of individual or structural reasons. Men do more work at

home, which is the main consequence for them. Less than one man out of ten takes paternity leave, while 16% reduce their working hours, whether slightly or considerably.

Table 7: Effects on career after childbirth (multiple responses)

	Women	Men
Parental leave interruption	80%	9%
Part-time, working hours reduction	74%	16%
More working at home	50%	57%
Less promotion	50%	11%
Job change	25%	5%
Other*	18%	8%
None	17%	25%

* less income, de-qualified jobs, more stress

Consequences at the personal level are mostly gender-specific (Table 8). When asked[15] about the main barriers when reconciling work and care,[16] female researchers mainly see career disadvantages. Working part-time is seen as the main reason for professional de-qualification, which in turn leads to worse career prospects. When having older children, women at a personal level mainly face personal pressure, stress and a permanent lack of time. Lack of time is also the greatest barrier to fathers employed in research. They talk about time management becoming more difficult, little personal flexibility and a lack of part-time jobs available (for men).

Table 8: Reconciliation barriers (open question, answers ranked)

	Women	Men
1.	Part-time as de-qualification	No flexible working hours
2.	Less career prospects	Meetings outside regular working time
3.	More stress	Time management
4.	No flexible working hours	Little individual flexibility
5.	Lack of childcare	Constant work pressure

Source: BMVIT (2006)

Individual reconciliation experiences are summed up positively. More than four out of ten researchers say that good personal organisation allows them to manage both tasks, while only two out of ten describe reconciliation as difficult (women: 19%; men: 17%). It therefore

[15] This was an open question.

[16] While children are younger than six years old.

seems that individuals already have well developed coping strategies that enable them to practise their preferred reconciliation pattern.

At the motivational level two dimensions are interesting: 21% of all female researchers with children and 7% of male researchers with children like the job more than they did before becoming a parent.

4.5. Concluding remarks

The focus of this chapter is on reconciliation strategies in Austria's non-university research sector, comparing male and female researchers. Better career prospects for female researchers have become of increasing political interest as we head towards Lisbon targets. For more qualified human resources and a competitive European Research Area more women are needed. But, as national data on Austria illustrate, the R&D field is still a male dominated sector, as just one out of five researchers is female.

For a better understanding of differences in career trajectories between male and female researchers, we have looked at the impact of having children on the careers of female and male researchers in non-university research institutions in Austria. The reconciliation of research work and childcare is an interesting and important aspect for careers. First, having children is seen as the main reason why female researchers do not succeed in the way that their male counterparts do. Second, at a theoretical level, feminist researchers argue for an improvement in the classic career concept. This is termed "gender blind", as it is based on a classical male career trajectory (linear occupations, no interruptions, full-time employment). They argue for a better integration of the private sphere and aspects typical of female (research) careers (interruption/s, part-time employment, career loops). Reconciliation, particularly the pattern that female and male researchers with children under 16 use for combining their research work with family/care duties, is of great interest as it concerns both public (work) and private (care) spheres.

Empirical results show a traditional employment structure and traditional gender roles. Men with children mainly work full-time, while just 17% of all female researchers with children under 16 work full-time. Taking into account the high level of qualifications of the target

group, the return on investment seems to be small, as women are not able to fully apply their abilities and competencies in employment and their careers. Female researchers work part-time and do most of the unpaid work, while their male colleagues work full-time and so have better career prospects. Female researchers therefore experience de-qualification and bleaker career prospects. As a result, gender arrangements are also quite traditional in the non-university research field.

These results may be surprising, as personnel in science in some way are supposed to be open-minded and orientated towards equality. In fact, a commitment to gender equality can often been heard in daily discourse. However, at present, there is a remarkable difference between practice and discourse. As Wetterer (2008) points out, "rhetorical" gender equality goes hand in hand with practical differentiation.

At a theoretical level, trying to modify the definition of "career" and integrating specific female career aspects into careers might help women (and men) to develop more realistic images of careers that are better related to their personal life context.

At the structural level, a change in research culture is needed that defines success not by output and/or researchers' presence in the office, but more by performance in relation to working hours. Research institutions need to offer more qualified part-time work to reduce the risk of de-qualification, and more flexible working hours to reduce the pressure on women in science and technology. At this point, it has to be mentioned that from a gender-specific point of view, part-time work is difficult as it re-genders the division of labour between women and men. As long as only women work part-time and men work full-time, a gender-specific work-division is kept alive. This indicates the need for new role models to change the traditional division of labour in the non-university research field. Research institutions have to show interest and flexibility in these matters to show that the reconciliation of research and childcare is not an individual but an organisational concern. This might motivate more women to enter and stay in the research field. Organisations could then obtain and keep both the best females and males. At the political level, general regulations are discussed, as the 40% quota for women in leading positions in Norway is an example for good practice and experience.

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Housework and Childcare alongside Academic Work in the Lives of Engineering and Basic Sciences Turkish Female Academics

Keywords: Turkish female academics, housework, childcare, Turkish double shift, double security promise.

Abstract:

This paper focuses on different ways engineering and basic sciences Turkish female academics manage housework and care together with academic work. It reports the ways private life and academic life interact in their lives. This study is a part of my Ph.D. research in which I used situated knowledges approach of Donna Haraway in combination with intersectionality theory as for methodology. Although the research is based on interviews that I made with 14 Turkish female professors, I will give place only three of my research participants, here. In the research, I found out that 5 out of 14 female academics did double shift and it is a strong possibility that these women do the double shift despite its negative impacts because they want to live under the double security promise of Kemalist patriarchy. The rest of academic women in this research made small reforms from Kemalist patriarchal bargains but in almost all cases these reforms were not related to any feminist or anti-patriarchal cause.

F. Fulya Tepe

1. Introduction

Turkey has got 250 years of Westernization experience. Since the beginning of the 19th Century during the time of the Ottoman Empire, Turkey has turned its face to the West and since then the country has been led by the ideals of the West. While Westernization reforms were very influential in the Turkish public sphere, efforts of westernizing the private sphere remained very limited.[17] Lack of strong reforms in the private life continues to make negative impacts on women's life even today. It is not especially difficult to make guesses about home lives of lower class, uneducated women due to the limited resources they have. Women in this group undertake all housework and childcare. On the other hand, it might be more difficult to

[17] Feride Acar, 1994, "Turkish Women in Academia" in **Proceedings of the 7th Annual International Conference: Women In Higher Education**, 6 – 8 January 1994, Women Studies The University of Texas at El Paso, Florida, p. 4.

imagine the private lives of highly educated and middle class women in respect to gender equality.[18] Women in Turkey form an oppressed group under classical patriarchy, but female professors seem like an advantaged group in the larger disadvantageous women group with their higher education and status. In other words, women scientists are disadvantageous because they are women and they are advantageous because they are professors. However, these highly educated women live in Turkey, too, and there is little evidence to think that they are exempts from the classical patriarchy that lower class and uneducated women are exposed to. On the other hand, modernization theory claims that gender equality should follow with the education. Therefore gender equality experience of female professors in the private sphere is an issue which raises curiosity and it might be more difficult to estimate situation of Turkish female professors about division of labour at home.

There is very little research on this specific women group in Turkey. Feride Acar's research on Turkish academic women, which was published in 1983, focused on the role conflict of academic women and provided little insight about how academic women cope with housework or childcare.[19] Although Eser Köker's unpublished doctoral dissertation, which was written on the same topic with data produced with research participants from Ankara in 1988, offers a richer portrayal of private sphere, it still supported the role conflict argument of Acar.[20]

This paper relies on my Ph.D. research and aims to show different ways engineering and basic sciences Turkish female academics from Istanbul manage housework and care together with academic work. It does not only aim for an understanding how the female academics are managing the double shift and departures from it but also it attempts to understand why they keep doing the double shift despite its negative impacts. By the way, as it is well known, double shift is a concept originally developed by Arlie Hochschild in her book *The Second Shift* which was written in the North American context and published in 1990. It refers to a

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[18] Here, it is important to note that percentage of women in Turkish academia is higher than that of many Western countries. According to data coming from 2004-2005 academic years, while percentage of female full professors in Turkish academia was 26.54%, percentage of female full professors in Istanbul academia was 30.83%. According to a 2003 research report percentages of female full professors in European countries are as follows: Austria 4.4%, Britain 10%, Sweden 12%, Spain 13.7%, France 14% and Poland 18.5%.

[19] Feride Acar "Turkish Women in Academia: Roles and Careers", **METU Development Journal**, Vol 10 No 4, Ankara, 1983.

[20] Eser Köker, **Türkiye'de Kadın, Eğitim ve Siyaset: "Yükseköğrenim Kurumlarında Kadının Durumu Üzerine Bir İnceleme**, Ankara Üniversitesi, Sosyal Bilimler Enstitüsü, 1988, Unpublished doctoral thesis.

situation where women do a second shift for housework and childcare everyday after their first paid shift at work.[21] The paper starts with situating the Turkish double shift historically in line with feminist methodology, in the next section. In the third section, I give a brief overview of methods used in this research. The findings section is organized in two sub-headings. In the first sub-section, I present the first significant thread of experiences in which the "new woman" ideal of 1930s was embodied and in the second sub-section is about departures from the double shift of this "new woman" model. The last section attempts to answer the reason why these women keep doing the double shift although they complain about it and argues that it is a strong possibility that double shift means double security promise for these women in the internal logic of the Turkish Kemalist patriarchy.

2. Emergence of the Turkish Double Shift

In this research, Turkey is considered both in its closeness with Middle Eastern countries and its 250 years old and a rather impact receiving relationship with the West. Thus, my aim is to place modern Turkey in the world and try to understand what is happening in this framework. Works of Chandra Mohanty and Deniz Kandiyoti are very helpful in realizing this aim. The common point of works of these scholars is the criticism they brought to the studies focusing on the Middle East or "Third World" in Western terminology. According to them, Western scholars show Third World societies in their works as if they are homogenous. In 1987, Mohanty objected to the "Third World Woman" concept[22] and similarly, in 1988, Kandiyoti criticized the concepts of "Moslem societies" or "Middle Eastern societies" concepts in her works with this reason. Kandiyoti argued that in order to break with the false homogeneity created with a bird's eye view on these societies, it is necessary to focus on historical particularities. Especially when studying women in Turkey, it is very important to bring historical particularities to the forefront.

Kandiyoti's work on patriarchies is very important in this line. Kandiyoti puts Turkey in the classical patriarchal region in her comparative analysis and summarize the basic

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[21] Arlie Hochschild, **The Second Shift**, New York: Avon Books, 1990, p. 6-7.

[22] Chandra Talpade Mohanty, "Under Western Eyes: Feminist Scholarship and Colonial Discourses", 1988, p. 51, in **Feminist Review**, no. 30.

characteristics of classical patriarchy as follows: In classical patriarchy, girls get married at a very early age and they are oppressed in their husbands' houses not only by all men but also by women who are older than them, and especially by their mother in laws. Nature of women's power in classical patriarchy is cyclical. This means that as women's power increase as they get older.[23] Later, Kandiyoti develops the concept of patriarchal bargains. In a classical patriarchal bargain, women are secluded and their mobility outside home is restricted; in return men are expected to be breadwinners.[24]

In 1930s, classical patriarchy evolves into Kemalist patriarchy with promotion of the "new woman" ideal in the context of middle classes. Ayşe Durakbaşa summarizes basic characteristics of the "new woman" as follows: The "new woman" is expected to contribute to the society and participate in the social life. She is also expected to undertake responsibilities and roles as a professional woman. However, she should also continue to perform her traditional mother and wife roles.[25] Moreover, in this "new woman" model, women's public and social roles are considered more important than her traditional roles.[26] Durakbaşa interprets this "new woman" model as a combination of conflicting images.[27] Kemalist "new woman" ideal did not leave its old features such as woman's home roles, although it acquired new ones. New republican regime normalized this "new woman" ideal especially for the middle classes. However women's education and work in the public sphere was conditioned with the control of their sexuality. So in the republican period, instead of walls which separated harem, this time there was a different practice for patriarchal control of women's sexuality such as female self-control. In this way, Kemalist new woman model was become widespread in big cities and especially in middle classes. All this shows us Turkish double shift emerged and was normalized.

The Turkish double shift, which was promoted by Kemalist patriarchy, had developed in a background of private/public spheres division which grew since Tanzimat. As it is known

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[23] Deniz Kandiyoti, "İslam ve Ataerkillik: Karşılaştırmalı bir Perspektif", **Cariyeler Bacılar Yurttaşlar. Kimlikler ve Toplumsal Dönüşümler**, 1997, Metis Yayınları, p. 120–121–122.

[24] Deniz Kandiyoti, **Cariyeler Bacılar Yurttaşlar. Kimlikler ve Toplumsal Dönüşümler**, 1997, Metis Yayınları, p. 13.

[25] Ayşe Durakbaşa, "Kemalism as Identity Politics in Turkey" in **Deconstructing Images of "Turkish Woman** ed. Zehra F. Arat, p. 140, St. Martin's Press, New York, 1998.

[26] Durakbaşa, p. 143.

[27] Durakbaşa, p. 147.

Western feminists are opposing private/public division because it hides that inequalities in the private sphere condition the inequalities in the public sphere. In this research, I oppose this division normatively with the same reason. However, I think, to be able to catch contextual particularities, it is important to focus on the characteristics of this division.

This section started with criticisms of homogeneity of Middle Eastern societies in works of Western scholars and emphasized importance of historical particularities. In line with this, this section focused on the Turkish context and situated the research topic historically. The next section will define the methodological approach and describe the methods.

3. Methods

In this research, I used feminist methodology. More specifically, I used situated knowledges approach of Donna Haraway in combination with constructivist version of feminist intersectionality theory which regards axes of inequality relational.[28]

When it comes to data production… In this research, I made in-depth interviews with 14 female professors, who work in the engineering and basic sciences departments of universities in Istanbul, between September 2005 and June 2008 intermittently. Each interview lasted near two hours. I used theoretical sampling in this research and I found most of my research participants with snowballing. In the research, I talked with full professors because they are expected to speak more freely compared to academics that are in the lower ranks of Turkish academic hierarchy. Female academics who participated in this research are active in the international publication world in their fields of interest or were active in the past. All the female professors that I talked for this research work in a state university.[29]

It is possible to say that I reached saturation point in the research. Among the research participants of this research, there are married professors with or without children. There are professors who are not married. Some professors in this research live in nucleus families and

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[28] Baukje Prins, "Narrative Accounts of Origin: A Blind Spot in the Intersectional Approach?", **European Journal of Women's Studies**, Vol. 13(3), 2006, p. 280.

[29] In Istanbul, there are private universities besides state universities.

some live in extended families. Some female professors in this research have full or part-time cleaners at home and some did not. Some female professors hold administrative positions and some held administrative positions in the past.

I made all the interviews for this research in the offices of female professors in their universities except for one interview. Except for one, I recorded all the interviews with digital voice recorder. I transcribed 11 of the interviews fully. I selectively transcribed two of the interviews. I told all research participants except for two that I would e-mail them the transcriptions of the interviews and that they could make changes in the transcriptions. In this research paper, due to limited space, I will be able to use research material that I produced with only three research participants.

4. Embodiment of "New Woman" Ideal of 1930s and Departures from It

Findings of this research show that experiences of Turkish female academics in housework and childcare are varying over a continuum where the female academic does all of the housework and childcare on the one hand and where she manages to share at least the housework in a 70% wife, 30% husband proportion, on the other. In between, there are experiences where third parties, such as a paid cleaning woman or female academic's mother, are included in the picture as helpers for housework and childcare.

When overview of the data in the research is considered, basically we can talk about three axes of difference over which experiences of female academics might exhibit variance. These are income level of the household, family type of female academics (nucleus or extended or something in between), and type of gender ideology that the female academic commits. Depending on the income of the female academics' household, she might transfer some or most of the housework to a full time or part-time paid woman cleaner or they might undertake most of the housework herself. When they do not transfer at least some of the housework to a woman cleaner, they sometimes share some chores with their mothers and sometimes also with their husbands if they live in extended families and in the best cases where gender equality is an adopted value, they share it with their husbands in nucleus families, even if it is not an exactly equal sharing. In this research, only two of the research participants (Nar

Elvan[30], Latife Paksoy) had a full-time female helper. Two of the research participants (Nazan Yapıcı, Özgü Denk) had part-time helpers. Eight of the research participants (Demet Onur, Lale Akar, Suna Beyaz, Özgür Gökçe, Ayla Mete, Esin Esen, Derya Başarı and Eda Aydın) rented weekly or bi-weekly female cleaners. Two of the research participants (Abdal Kul, İlke Çobanlı) did not hire any cleaning service. In this paper, due to limited space, I will share with you my interpretation of the data that I produced with only three research participants. In this section, I aim to show you two main threads that female academics follow for dealing with housework and childcare alongside academic work based on the experiences of Demet Onur, Suna Beyaz and Nar Elvan.

4.1. "New Woman" Ideal of 1930s in Flesh

Five out of fourteen women in this research did not share any of the housework or childcare with their husbands because both housework and childcare were regarded as women's jobs. Instead of getting help from the husbands, these women bought weekly or bi-weekly cleaning service in order to facilitate housework. For childcare, they had to create their own personal solutions due to lack of any state sponsored childcare service in Turkey. Two of them hired nannies while the other two relied on their mothers for this. Only one used institutional care but only in combination with her mother's help. In this section, I will give you brief overviews of ways that two of these women developed for managing the Turkish double shift.

Demet Onur: Pushing Oneself for Doing it All and Feeling Exhausted at the Age of 48.

Demet Onur was born in 1956 in İstanbul. Her mother, who is a high school graduate, is retired now. Demet Onur's father, who was also a high school graduate, died several years ago. Demet Onur is married. Her husband is a university graduate and is a businessman. They have a daughter. Demet Onur had a full time position in the university when she gave birth to her daughter. Therefore, she needed childcare service. She had to get a very intensive childcare help from her mother: Her daughter lived in her grandparents' house until she was 10 years old because it was too difficult for Demet Onur to bring the child to her mother's

[30] The names of the research participants are pseudo names. Some names were chosen by the research participants themselves. Some were given by the researcher due to research participants' request and some names were have to be given by the researcher just because it was not possible to get in touch with the participants after the confirmation for the interview transcriptions were taken.

house every working day. However, Demet Onur says she and her husband were visiting their child every evening in her mother's house and this arrangement made things comfortable for them but still she adds that this was not easy for them.

As for housework, Demet Onur bought weekly cleaning service from a Turkish woman coming from a lower class. But apart from this, she had to do housework all by herself because her husband was not "the helping type". Her husband was coming home at dinner time and Demet Onur was supposed to prepare dinner until that time. Demet Onur says she did it all but this was not without a price. She seemed angry to me when she said that she feels very tired at the age of 48 because of trying to do it all during all those years.

After Demet Onur became a senior academic at the university, sometimes she started to leave university earlier than normal time to be able to finish all the housework. For Demet Onur, this was a luxury that she had reached after being a senior academic. After her daughter got married, Demet Onur's responsibilities at home decreased; therefore she decided to increase the amount of work she undertook at the university. Experiences of Demet Onur show that she does a double shift despite the childcare she got from her mother early in her life. Her case shows us how private or family life interacts with academic life. This also reveals life-cyclical nature of private and academic life interactions.

Suna Beyaz: Family Comes First But Only When Work Life is Planned To Compensate

Suna Beyaz was born in 1951 in İstanbul. Her parents were graduates of Teacher's School. Suna Beyaz was married at the age of 21. Her husband is a university graduate. He is a retired clerk. They have two children. While raising her children she got intensive childcare from her mother. She says that it would be too difficult for them if her mother did not help her with childcare.

As for housework, apart from the weekly cleaning service she employed from a lower class Turkish woman, she had to do it all herself for four members of the family. Her husband only did shopping and even in this case, it was always Suna Beyaz who prepared the shopping list. Suna Beyaz categorizes her situation as "without a helper". She thinks that if her husband were a professor just like her, sharing housework could be a more possible option because then husband and wife would understand each other's work situation better. However, another

research participant's situation shows how sharing housework might not be among options even when the husband is a professor.

In the early years of Suna Beyaz's career, her university wanted to send her abroad for research with her family but her husband did not want this. Going abroad for research means to learn quicker for Suna Beyaz. Because she put family before the academic work, she did not go to abroad. However she had to work more to compensate this decision and trying to compensate this situation meant more hours away from the family and children. The case of Suna Beyaz shows us her double shift and also the depth of private life and academic life interactions.

4.2. Departures from Kemalist Patriarchal Bargains

9 out of 14 research participants in this research, depart from Kemalist patriarchal bargains in their experiences. In these departures some part of housework and childcare are undertaken by husbands. In each case, these new negotiations are products of different conditions. Sometimes men undertake some of the second shift because the wife is in the same profession with the husband. Sometimes because of a system of exchange that couples developed and sometimes because of sufficient income level, husbands undertake some portion of the second shift. In this sub-section, departures from the "new woman" ideal of Kemalist patriarchy will be exemplified with the experiences of Nar Elvan.

Nar Elvan: Equality by Money and Prioritizing Child over Academic Work

Nar Elvan was born in 1961. Her mother is a high school graduate and a housewife. Her father is an engineer. Nar Elvan is married and her husband is a full professor just like her. They have a daughter who is a primary school student. Unlike other research participants, Nar Elvan gave birth to her daughter when she was an associate professor and not long after she had her baby she became a professor. This makes one think that Nar Elvan's situation was easier in terms of child care. However, Nar Elvan says that this was not the case because there were students and colleagues who were dependent on her. Moreover, not working anymore just because she already became a professor is out of her work ethic. However, she says that although her workload did not diminish, she is, now, in a position to prioritize childcare in

emergency situations. All this shows us more specifically how being at different ranks in the academic hierarchy affects private life.

Nar Elvan's story of childcare is a bit complicated because she tried different options. First she thought they could have a sleep-in nanny. But then she found it too difficult to live with a stranger at home and she got help from her mother for a limited period of time. Next they went back to the option of hiring a full-time nanny but this time not a sleep-in one. Nar Elvan thinks that childcare turns into a woman's job mostly due to physical dependency of the child to the mother during the first years after the birth and also due to the type of male socialization in Turkey. In Nar Elvan's experience, while the mother does the physical caring such as feeding and dressing, father joins them while they are doing homework of their daughter. Although Nar Elvan interprets childcare as a women's job, obviously it was not she who did this job full-time. Except for a short period of getting help from her mother, she and her husband managed to hire childcare. This tells that despite gendered character of childcare, they were able to buy some equality in childcare.

After her daughter started to school, Nar Elvan and her husband needed a full-time housekeeper. She thinks that she could not imagine how her life would be without this housekeeper. Nar Elvan says that she and her husband share the housework remaining from the housekeeper almost equally. However this makes me think that it is again a bought equality since the amount of housework remaining from the housekeeper should be too little to create division of labour problems at home. Experiences of Nar Elvan exemplify how money can buy some gender equality in the division of labour at home and create a break from the Kemalist patriarchal bargains in both housework and childcare.

5. The Other Side of the Medallion: Double Security Promise

For all the women in this research, not working outside home is unthinkable and for almost half of them doing all housework is natural. So an important part of Turkish female academics do a second shift at home. Most of the time, the rest does more housework and childcare than their husbands at home. From the cases presented above, female professors use different ways to manage their double shift. This is important to know but one might want to go one step

further and ask why an important part of these women keep doing the second shift although they think it is so tiring to do so. Some of the academics in this research obviously complained about the second shift although they never mentioned a role conflict and did not ask even help from the husband. The fact that most of these women did not ask for division of labour at home and the way they naturalize the double shift, bring another idea to the mind. These women might be doing the second shift because they might like to benefit from the type of protection and security that classical patriarchy is assumed to provide. That is to say these women might be living with the double security promise that the Kemalist patriarchy is presumed to provide. In other words, they manage to live in marriage relationships, which are planned and promoted to last life-long, with doing the second shift and they remain self-sufficient in liberal market terms and socially independent with working outside home. Within the framework of dominant values in Turkey, such a position could be seen as a "double security" position. Departing from this point, it could be thought that these women, who embody the "new woman" ideal of 1930s in their lives, formed a position which they can define as a very advantageous position in the internal logic of this system. So, the reason why these women do not stop doing the second shift might be not want to give up from the comfort feelings that this double security promise provides. Thus it would not be wrong to say that there are some strong clues for a double shift might mean a double security promise for some female academics in the Turkish context.

6. Conclusion

Previous research gave little attention to the double shift of female professors and treated it in terms of role conflict of female academics. However, female academics in this research did not describe their double shift with role conflict. Instead some research participants in this research were quite content of being both an academic and the master of the housework and childcare despite the negative impacts of the double shift. Situating the issue to its historical background allowed us to see connections with the republican "new woman" ideal of 1930s. While the embodiment of this "new woman" ideal is the basis of the Turkish second shift, departures from this with the help of money factor, extended family or equal profession card were found out. The idea of sticking to the Turkish double shift despite its negative impacts raises curiosity about its possible reasons. When the related clues are studied, one might infer

that female academics in this research might be doing the double shift because they wanted to benefit from the double security that Kemalist patriarchy promises. In other words, these women might be doing the double shift because they might be feeling socially safe only when they work outside and they are also in marriage relations planned to last life-long. This might be a good explanation of why these women continue to complain about tiredness that the second shift give them while they still enjoy being both an academic and housewife at the same time

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Paying the price: the impact of maternity on career progression of women scientists and engineers in Europe

Keywords: women, career breaks, maternity, science, engineering

Abstract:

Women have succeeded in entering professional careers in science, engineering and technology in increasing numbers, yet there are still few women in higher level positions especially within major global companies. This paper draws on qualitative interviews with 28 female scientists and engineers from across Europe, to highlight the career costs that they experience as a result of taking maternity leave and of subsequently working part time. Some of the assumptions within company culture that prevent women who return after career breaks from achieving their full potential are explored. These include the importance given to availability, visibility and flexibility, as well as the impact of different cultural norms relating to gender and parenting.

Clem Herman

1. Introduction

The retention and progression of women employees after maternity is of widespread concern and has been the focus of a number of high profile initiatives by global companies (Hewlett 2007). The so-called glass ceiling has prevented women from reaching positions of power and influence across all occupational sectors and while these patterns are well recognised and documented, changes have been slow to come about and entrenched behavioural and cultural factors continue to reinforce traditional gender stereotypes. Within the SET sectors these issues are more acute, exacerbated by the lower numbers of women that enter employment, and the perpetuation of masculine work cultures that are resistant to change (Bagilhole 2007). Such gendered occupational segregation has been a persistent contributory factor in perpetuating inequality for women resulting in lower pay and status. With only a few exceptions, women's concentration in sectors such as health, services and education and under-representation in scientific and technical areas is still a prominent feature in most industrialised countries.

As well as empirical studies, numerous initiatives have tried to remedy the under-presentation of women within SET education and employment, and to support their career progression (Phipps 2008). Although there is some agreement on the problem, understanding the causes and possible solutions has been more complex and it now widely acknowledged that there are a number of intersecting factors contributing to the so-called leaky pipeline in these occupational sectors (Bebbington 2002, Blickenstaff 2005). Once in employment, there are a number of key 'attrition points', most notably after maternity and at mid-career level, when women leave or fail to achieve the career progression gained by their male colleagues (Hewlett 2008).

Expectations of professional career development in science and engineering have traditionally assumed a linear trajectory of uninterrupted employment. Many aspects of organisational culture, especially in male dominated sectors, still operate with the traditional model of male 'breadwinner' in mind and taking a career break is a deviation from this ideal. Moreover gender stereotyping can shape and influence decision making by women professionals and their managers at this crucial time and can have implications for career progression and development.

There is now increasing interest in examining the cultural issues that contribute to the persistence of gender inequalities in SET, recognising that changes in legislation or short term injections of effort and funding are not sufficient to change underlying gendered practices and cultural norms, whether this is in industry or within the scientific research community (Bagilhole et al 2007). Moreover, the introduction of equality and diversity policies within organisations does not necessarily make a significant difference if cultural norms and assumptions are not challenged within organisations (Liff 1999, Lee et al 2007).

Women's SET employment in Eastern European countries has received little attention in the research literature and yet offers an important perspective on this issue. There is evidence that occupational segregation was not as pronounced during the communist era and that women made some inroads into traditionally male sectors (Brainerd 2000). Yet despite this, the experiences of Eastern European women in SET attest to the resilience of underlying gender norms in the absence of measures to tackle workplace culture - although gender equality was espoused, underlying cultural norms were not examined or challenged especially

in terms of women's access to power and authority and the gendered divisions of domestic and family responsibilities were left unchallenged and indeed reinforced (Herman, 2007).

Within SET companies there are usually both technical and managerial career routes and for those reaching mid or high level scientific and technical roles (male of female) there is often nowhere further to climb on the career ladder – there are opportunities to move from technical/ scientific roles to management but this entails giving up on technical identity which some women are reluctant to do, having struggled to assert their presence in a male dominated field. With such considerable investment in the technical identity there is perhaps less incentive to leave this behind, which is what is required for a move into senior management. (Faulkner 2007, Simard 2008). Moreover in some companies, the options to move out of technical careers and into a managerial role are limited to particular stages in career progression (usually in their mid thirties) and not possible at a later age. Decisions about promotion into management happen at precisely the time when many women are either taking breaks or have slowed down their career in order to raise a family. This is a general phenomenon but particularly marked in SET companies which have dual career trajectories (both technical and managerial).

2. Methodology

This paper is based on 28 qualitative interviews with women engineers and scientists as part of the EU WiST2 project[31]. The interviewees were identified by companies participating in the project who nominated them for interview. Most had taken career breaks for maternity apart from one who had an extended period of sick leave, another who took time out for personal study unrelated to her work and a third who took leave to care for elderly parents. The majority returned directly to the same or similar jobs in the same companies after their (relatively short) period of leave. The sample spanned 6 EU countries and included two women working outside of Europe. Interviews were conducted using a semi structured interview schedule – participants talked about their careers or working lives within the

[31] WiST 2 (Women in Science and Technology) project run by Science and Society

context of other aspects of their personal and domestic lives forming a narrative or chronological account.

3. Results

Women in this study differ from classic 'returners' who have been out of the workforce for many years. They had taken short breaks (average 7 months) so that the issues relating to loss of skills and confidence were not as acute. Moreover all of them had returned to the same employer after their break, therefore they were not facing the difficulties of finding new employment.

Among the interviewees, sharing some of the childcare with a partner was very common, but most women still took main responsibility for family work. Even if both partners worked part time, women tended to work less hours than their partners. There were one or two exceptions of couples who had reversed roles completely, with their husband or partner taking extended leave and primary responsibility for childcare, but these women still regarded themselves as unusual and were considered to be exceptional role models and pioneers by their colleagues. More frequently, after maternity leave, women increasingly allowed a partners career to accelerate at the expense of their own. Thus, despite their high level qualifications and potential for career success, these women SET professionals were constrained by traditional gender role expectations within their immediate families and social networks and these attitudes continued to form an important influence on decisions that would influence later career prospects.

They were on the whole keen to return to their jobs and exhibited strong career motivation – after all they had undertaken several years of higher education and specialist training in order to reach their current position. This was a clear driver for most of them in wanting to return to work. Only a few mentioned the financial necessity of continuing with their employment. Many also expressed the need to maintain their own professional identity in addition to their role as parent - they wanted to do something for themselves other than being a mother. For many their return to work was achieved despite expectations that they should take a longer break and spend more time at home especially if they had more then one child. For example

> *I feel a social pressure - people keep asking me "So you are going to stop working now with two children" and I say no I want to keep working. .. in France we have special systems with funding from the government to stay at home and take care of your children so I had some remarks from friends and from colleagues which say when are you coming back, will you take one or two years off to care for your children - but I am not planning such a thing. I prefer going back to work, it was not the case for the first child but I feel it more for the second P22*

The impact of maternity breaks is hard to measure accurately especially the longer term impact, and is beyond the scope of this research. What is clear though is that women who have recently experienced taking a break and returning do feel that there is a 'price to pay' when they become a mother. Some try to minimise this penalty by working hard to be just as productive and available as they had previously been – others perceive they are faced with a choice and elect to slow down their career progression at this crucial time. Even after a short break, there were significant issues that emerged for many of the women, often associated not just with the break but also with subsequent part time working on their return.

The timing of maternity leave (often in mid to late 30s) was significant. For one or two who had children in their late 20s or early 30s, this earlier maternity allowed them time to 'catch up' towards the end of their 30s after several years of part time work. Later maternity (late 30s or early 40s) was also seen as being an advantage if women were already established and valued by the company, and their position secured. They seemed to have more bargaining power in their negotiations about working hours and conditions. It seemed they were familiar with the unwritten rules within the company and knew what they would need to do to secure their position.

The interviews revealed a number of assumptions within SET company cultures which together acted as potential barriers to women's progression. A common factor, particularly in the energy sector, was the need for overseas travel which was considered crucial for career progression. This took the form both of long term 'missions' as well as shorter term visits

> *To go abroad for the company is very important for [your] career …what you can say when you work here is if you want to be a manager and so on it's very important to travel P11*

This was closely linked to the notion of **availability** – and for those who were not constantly available, a perception that they were falling short of expectations which could have career implications.

> *... I think it's not the travel itself that's important, it's the fact that you're already setting some kind of restraints, it doesn't look too good if they want you to go somewhere and you keep saying "no I can't, no I can't" because of X Y Z, whatever. P16*

Yet stereotypical assumptions were made about women's availability once they became mothers, particularly in terms of travel, which were not always based on real constraints.

> *there tends to be a lot of assumptions made about what mothers can or can't do. There are all kinds of trips being discussed: "lets' not ask [S] because she can't go." ...Maybe I'm not able to go but I'd at least have liked to have been asked. P16*

With this expectation of an 'ideal' worker being constantly available, women taking career breaks and/or working part time felt they were marginalised and as mothers were not regarded as 'normal' employees. For example one interviewee felt that colleagues treated her differently once she became a mother and regarded her as less productive even though she was in fact working on a full time contract

> *a "lot of women with babies are not working full time so I was considered as not working full time – I **WAS** working full time but I was a mother so I couldn't get the job I wanted. They considered that I wasn't working full time" P20*

These attitudes were not just in the minds of individual colleagues or managers, but in some cases embedded into organisational systems. In one example a women who had been on maternity leave spoke about being reprimanded by a manager for her reduced contribution to the project budget hours - the financial accounting system had not taken this into consideration so it reflected badly on the productivity of her group.

A common experience that women spoke of as a result of taking a career break was that a promotion had been missed or delayed

> *I could have got promotion at the time I got pregnant with my daughter - but when I told them I was pregnant, HR and my boss decided to wait until the time I came back and when I came back, it took me two years to get it - I was very annoyed. I got it eventually but two years after I should have P1*

There was also a fear that decisions would be taken while they were away and indeed this was frequently a reason that some women gave for returning sooner than they would otherwise have wanted to. Even if they had not experienced this personally as a consequence of taking a career break, there was clearly a perception that it was a risk they were taking.

> *I left the office for one year and one year for a woman at this period could lose you a lot of opportunity – P6.*

Returning to work on a part time basis following maternity leave was a common pattern but the prevalence of part time work opportunities differed significantly between countries – so for example it was virtually unheard of to work part time in Italy while this was considered the norm in the Netherlands where it was considered "*almost taboo to work full time if you're a mother" [P16]*

While part time work enabled a suitable combination of work and family life to be achieved, there was a perception by many of the respondents that this entailed a career penalty. This was linked to the notion of **visibility**. The quality and status of projects and assignments given to those on part time contracts was often less demanding and less significant. Certain types of work (project leadership for example) were often assumed to require a full time position. Some women felt that the work offered to them as part timers was less visible and therefore compromised their promotion prospects because their work was literally not seen by those who counted

> *[when you are part time] you don't get the highly visible projects with a lot of exposure to the rest of the organisation which is generally seen as the best way to go to have a good career P17*

Part time working was often regarded negatively by management even if it was encouraged by company policy and there was a recognition that it would be career damaging. One manager advised a member of her team to save up her annual leave and use this to work reduced hours, so that officially she was still working full time. In other words, while the company's policy was to offer part time working, this was still considered problematic and not normalised within the organisation.

Nearly all of the respondents were very positive about the idea of **flexibility** in their working patterns, especially if that meant being able to work from home even occasionally, for example when their children were ill.

> *it's more like the results that count than the hours that you work. Nowadays with remote access it's also quite good that if I'm in a bit later I can also do another hour or so at home and also if they would get ill (I've been quite lucky they have been quite healthy over the past year) but potentially I could do some work from home .P4*

It was also a useful alternative to frequent travel.

> *In a year and a half I travelled only 3 times and my boss he understands this and he told me that if it's not strictly necessary we can manage with ….video conferences and teleconferences and online meetings P8*

4. Discussion and conclusions

Decisions made at time of maternity can be critical in determining future career progression. For example returning to work part time after maternity can be detrimental to career progression, or at least result in slowing down of progression. However there are signs this is changing among younger women and in departments where there are a critical mass of women working part time. There were also examples of older women who had succeeded despite periods of part time work – however they are still perceived within the company as pioneers and role models rather than 'normal' or 'ideal' employees.

Even among those who continue to work full time after maternity leave, there is generally a reduction in the amount of 'availability' either for travel or for extra work on top of contracted hours. How this change is handled by managers and colleagues can impact on career progression opportunities. Similarly visibility of one's work can be crucial to career progression.

While most companies now have comprehensive equality and diversity policies, evidence from this study suggests that their implementation is variable and discretionary– in many

cases line managers acted as interpreters of policies and were seen as gatekeepers to promotion and progression. In some cases managers were very supportive and devised creative solutions for women on their return from maternity leave. However in other cases colleagues and managers were less helpful.

National legal and welfare frameworks include substantial differences in entitlement to maternity and parental leave across the EU. Where leave is only available to mothers, this reinforces gendered roles in relation to parenting, both at a personal but also at a societal level – it is therefore more difficult for individuals to break with traditional patterns. In Nordic countries for example where there is substantial paternity leave, men are clearly encouraged to take an active role in childcare, while this is more difficult elsewhere. These regulatory frameworks are both a reflection of, and instrumental shapers of national cultural difference. Combined with traditionally male work environments with the SET industries, they reinforce a particular view of mothers and their availability for work and career. The term Work Life Balance has entered everyday discourse as a short hand for policies that enable flexible working to be combined with family care, but also more widely as way to articulate the conflicts and dilemmas raised by changing work patterns and life choices.. For parents of either gender, the achievement of a balance between the demands of their working life and those of their other commitments becomes of paramount concern. Considerations are not just practical but also emotional and raise fundamental issues about gender roles as well as personal priorities and ambitions. These need to be addressed in a wider context as well as within company specific policies if we are to see real and sustainable change in the career progression of women in SET.

5. Acknowledgements

I wish to thank the EU WiST project team and all the companies who provided interviewees for this study, and most importantly all of the women who kindly gave me their stories.

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Technology and Masculinity – reconsidered –
New perspectives on an apparently simple question

Keywords: engineering tradition, gender research, symbolic level of professional knowledge, masculinity

Abstract:

The paper argues on the basis of empirical research that strategies for gender equality need to broaden their scope of research from predominantly focusing on the underrepresentation of women to a better understanding of the diverse constructions of masculinity as they can be found both in the core concepts and in the everyday cultures of engineering. My argument thus aims at initiating more research on the professional knowledge of engineers, its historical emergence and progression more in detail. Central questions are: Which social constructions of gender can be found in historical as well as in current ways of drawing the boundary? How are different constructions of masculinity co-produced with professional understandings of technology and of the discipline? How have these social constructions worked as excluding mechanisms?

Tanja Paulitz

1. Introduction

"Men's love affair with technology is something we take for granted". With this starting point the Dutch historian Ruth Oldenziel (1999) analyses the gender and technology relations in early American engineering. However, this starting point marks also a prevalent social stereotype which is rarely further differentiated. Although today there are no more formal barriers for women to attend study programs in science and engineering and although there is more or less a societal consensus that women should have access to all professions, technology hasn't noteworthyly lost its masculine connotation. Empirical data still and constantly show the deep gender gap.

In recent years gender relations in engineering have attracted more and more attention. Not only gender equality campaigners but also representatives of engineering associations and institutions as well as decision-makers in education policy arenas have addressed the problem of the 'gender gap' in the field of technology. The topic is mostly located in the general context of recruitment in the broader domain of science and technology. Gender studies have

already for a long time explored the relationship between gender and technology even if slightly marginal compared to other topics. Unlike though to feminist science and technology studies, the major part of research on the more traditional areas of engineering has tended to neglect the aspect of *gendered knowledge* and has rather stressed the pragmatic dimensions of women's politics.

Yet, it can be assumed that historical and current formations of gendered professional knowledge and their ways of distribution into the general knowledge of a society contribute to strengthen governing social images about engineering as a male domain. Accordingly, in this paper I want to argue on the basis of empirical research that strategies for gender equality need to broaden their scope of research from predominantly focusing on gender equality to a better understanding of the diverse constructions of masculinity as they can be found both in the core concepts and in the everyday cultures of engineering. The key argument thus aims at analyzing the *professional knowledge* of engineers, its historical emergence and progression more in detail. Central questions for this research perspective are: Which social constructions of gender can be found in historical as well as in current ways of drawing the boundary? How are different constructions of masculinity co-produced with professional understandings of technology and of the discipline? How have these social constructions worked as excluding mechanisms?

The broader aim of the project is to contribute to a de-construction of stereotypical gendered images of technology arguing on the basis of the very fundamentals of engineering professional knowledge. It thus allows de-stabilising governing effects of social exclusion that work on a symbolic level and also enhances a more heterogeneous cultural understanding of engineering.

The paper is structured as follows: Initially, the central perspectives in the broader field of gender studies on engineering education are discussed (2). Following this, the theoretical and empirical scope of feminist technology studies is screened in relation to their contribution to the study of the 'classical' engineer (3). Finally, in the next section I describe the major findings of gender studies on the (current and historical) social construction of the 'classical' engineer (4). Special attention is given to my own empirical research on German mechanical engineering design theories (5).

2. Gender studies in the field of engineering education

The relationship between gender and technology is the subject of a meanwhile remarkable body of research on engineering *education and on educational cultures*. The fact that women are underrepresented in this field has been problematized in the context of liberal feminism for many years and has called for numerous political campaigns. Until today projects and initiatives on "women in science and engineering" in universities are primarily concentrated on gender equality concerns. They are often funded by gender equality programmes and are mostly action oriented. But even when they are related to more basic research questions, the 'lack of women' in this field noticeably shapes the problem definition and thus constitutes the starting point for investigations. However, today the major body of this research decisively criticizes the stereotype about women avoiding to go into technology and in contrast focuses more and more on the excluding mechanisms of engineering education cultures and curricula (see e.g. Margolis/Fischer 2002, Dryburgh 1999, Wächter 2003; Thaler 2008; Gilbert et al. 2006, Henwood 2000; for a more complex overview on this question see also Paulitz 2006: 27f.). The central undisputed achievement of this research is to have disapproved the deficit model, namely the perspective on women as deficient in relation to technology. In contrary, it directed the view to technology itself as a domain which is in need to undergo a significant gender change.

The broader overview shows that the main strategy of change until today is to call for an extension of the existing curricula and of the set of everyday practices in the professional culture in order to weaken the dominance of a 'monoculture'. Such an extension of the existing engineering education aims at enhancing interdisciplinarity in the field by offering a broader palette of issues. Thereby also a wider understanding of technology is principally supported. Yet, one consequence of such a reorganization of the domain by supplementing bits and pieces that were lacking so far, is the tendency to replicate the liberal feminist claim to bring more women into technology, only shifted to the level of organizational culture. From a feminist technology studies perspective, the problem of such an extension argument is that on the one hand it remains in the binary gendered framework of the technological field itself. On the other hand it tends to reinforce the direct 'wiring' between masculinity and technology within its own premises. Of course, at first glance this premise appears to be obvious when adopting the insight that the machine is culturally masculine coded and other – notably social – competences are feminine coded and that these dichotomies are persistent in

everyday knowledge. However, if the equation of technology and masculinity is adopted as guiding analytical presupposition, gender research on engineering itself runs the risk of stabilizing gender stereotypes or of gendering technology by the very means of gender analysis. Following Wendy Faulkner's critique, "… the assumption that women will both be more attracted to, and have more to offer to, engineering if it is defined in non-technical terms leaves intact the equation of technology and masculinity" (Faulkner 2000a: 764).

3. The flexible co-construction of gender and (new) technology

Since the late 1980ies constructivist feminist technology studies have theorized the relationship between gender and technology more in detail (see Lohan 2000). As Judy Wajcman (2000) states, the relationship can be seen as a mutual co-construction, "that neither masculinity, femininity nor technology are fixed, unitary categories, but that they contain multiple possibilities and are constructed in relation to each other" (Wajcman 2000: 460). Ann-Jorunn Berg and Merete Lie (1995) stress the political impact of technology design from a gender perspective:

> *"Artifacts do have gender and gender politics in the sense that they are designed and used in gendered contexts. But holding that gender is inscribed in technologies does not mean that they are not open to change. As we have tried to show here, to say that artifacts have gender implies talking about gender and technology as simultaneously negotiated and constructed within the metaphor of the seamless web or of the cyborg" (Berg/Lie 1995: 347).*

Yet, as Wajcman (2000) also indicates, less attention has still been paid to the design aspect than to the question of the use of technology. Although she stresses the point that "engineering is a particularly intriguing example of an archetypically masculine culture" and that the dominant image of masculinity in Western societies "is still strongly associated with technical prowess and power" (Wajcman 2000: 454) feminist technology studies has been so far primarily interested in current socio-technical developments and in future issues. Present and future issues like ICT, Internet, Biotechnologies, Artificial Intelligence etc. have been of central concern. 'Classical' engineering disciplines however were much more rarely the subject of studies concerning this matter. The question, how the traditional engineer has been

socially constructed (historically and until today) has attracted only scant attention to the major body of works in feminist technology studies.

Nevertheless, central insights in the association between masculinity and technology were brought to the fore: Wajcman (1991: 143) in her paradigmatic text "Feminism Confronts Technology" has made a still trend-setting suggestion when claiming to conceptualize this alliance in a more complex way. Referring to the early works of the Australian sociologist Raewyn W. Connell she pushes for the integration of further social categories like 'class', 'age' or 'ethnicity' in order to analyze different variants of masculinity constructions in conjunction with technology. Still relevant remains her theoretical insight that constructions of gender work in a very flexible way. Guiding examples were primarily technological innovations caused by the computer in industrial production and administration. According to Cynthia Cockburn's (1986) research on the gendering of technical competencies there is empirical evidence that masculinity is context-dependent flexibly constructed in order to marginalize women:

> *"For some purposes, then, physique, muscular strength, daring and manual skills are given positive masculine value. In this ideology women are weak and ineffectual creatures. For other purposes intellectuality and analytical power are appropriated for masculinity. Women then become physical creatures, linked to organic processes such as childbirth, feeding, cleaning" (Cockburn 1986: 196).*

On the one hand the male engineer is regarded as the "very epitome of cool reason, the antithesis of feeling", as Wajcman (1991: 145) states with reference to Sally Hacker (1989). On the other hand the corresponding studies have also shown, how heavily technologies can be charged with emotions, with the feeling of power and can thus refresh the myth of adventure and fun (see ibid., see also Faulkner 2000b, Kleif/Faulkner 2003). Theoretical works in gender studies took up these findings and worked out the argument that gender difference is only partially produced by concrete stable content. "More relevant is perhaps the specific quality indicating distance and relations of dominance which is anchored in the principal dualistic form of gender stereotype and that can be connected with diverse contents" (Knapp 1993: 31; Transl. TP).

Particularly since the 1990ies feminist technology studies have explored more in detail the social mechanisms of exclusion and the flexible constructions of gender that can be found in the field of ICTs. Especially the new communication technologies like the Internet have been

investigated in relation to risks and chances for a gender change (for an overview see the following recent publications: Wajcman 2004; Rommes 2002; Paulitz 2005; Lagesen 2005; Zorn et al. 2007). However, regarding the more *traditional* engineering cultures the hypothesis of a flexible formation of masculinity is discussed only rarely. Moreover, feminist technology studies itself have again and again implicitly tended to take a more or less stable image of modern male-coded technology as a starting point to study current societal and technological change. The certainly unintended effect of such a perspective is amongst others to fix a more or less statical, monolithic backdrop, called 'the traditional' relationship between gender and technology as being somewhat clear and evident, and against which the shifts can be explored. Thus the variability of gendering effects that has been theoretically stated for *new* technologies tends to be withdrawn in the case of *traditional* engineering disciplines. From this it follows that the basic premises of feminist technology studies remain faded out or theoretically dishonoured in the case of the 'classical' engineer.

This state of the art in feminist technology studies raises the question, whether the image of the traditional engineer of the industrial age is as well not a monolithic construction, but has to a certain extent been retrospectively simplified. Hence, the theoretically motivated question of the paper is: What are the variations and heterogeneous ways of gendering the traditional engineer and traditional domains within the field of engineering? What are the inconsistencies and contradictions of gendering the professional images in this domain? And how do (or did) such genderings come about? Let me therefore now take a closer look at the available research on the historical and current gendered constructions of the 'classical' engineer.

4. The gendered construction of the 'classical' engineer

Current social constructivist research on engineering predominantly in the Anglo-American discussion (but also in the German-speaking community) indicates that the construction of masculinity in engineering and in its traditional fields is contingent and flexible, too: Wendy Faulkner (2006) and Karen Tonso (2007) clearly act on the assumption that engineers have different conceptions of masculinity at their disposal. Accordingly, the stereotypical public image provides only a reduced variant of the male engineer compared to the bandwidth of

patterns available within the domain's workplace and professional cultures. Anne-Françoise Gilbert (2008) explored the variations between professional cultures in different areas of engineering. Maria Lohan und Wendy Faulkner (2004) recently suggested to bring together in a consistent way men/masculinity studies on the one hand and feminist technology studies on the other, because: »… men/masculinities studies, as with gender studies in general […], has tended to undertheorize technology, while technology studies, even feminist technology studies, has tended to undertheorize masculinity« (Lohan/Faulkner 2004: 320). They argue especially for broadening the theoretical perspective in order to escape from simplified and anew stereotypical constrictions. Thus, for future research their theoretical guideline is »to hold on to gender as an analytical category while empirically remaining open to the existence of a diverse range of potentially contradictory gender-technology relations« (Lohan/Faulkner 2004: 323).

If nothing else the dominant references to the modern male engineer largely underestimate the historical conditions of the emergence of engineering in the industrial age. Especially in the German-speaking context there was a highly significant process of *scientification* (Verwissenschaftlichung) in the course of the 19th century. These conditions can be assessed as contradictory societal changes that form the structural and also epistemological prerequisites for the positioning of engineering as a new member of the academic field (see e.g. Kaiser/König 2006, Gispen 1989). Ruth Oldenziel's (1999) intriguing study on modern American engineering documents also the contradictory conditions of the emergence of engineering as a male middle-class profession. One may expect that against this background the making of the modern engineer seems to be a much more complex process as constantly iterated in the dominant stereotype. Yet, processes of stabilization and/or reconstruction of these modern patterns of the engineering profession in the course of the 20th century are under-researched so far, especially in relation to the gender category for the German-speaking countries. At least historically, gendering processes are to be analyzed in the context of professional struggles for establishing and empowering of engineering as a new influential domain in the industrial society. For today, one can assume that there are variations of the concepts of the engineer depending on specialization, hierarchical positioning and character of the corresponding subdomain within engineering.

Historical studies comparably early pointed out how excluding mechanisms cemented the engineering profession in Germany as a male domain (see Hausen 1993; Duden/Ebert 1979).

In doing so the cultural production of the engineer has been primarily interpreted within the theoretical framework of modern polarization of the nature of gender stated by the feminist historian Karin Hausen (1976). Following both Hausen's approach as well as Joan W. Scott's (1988) considerations on the flexibility of gendered hierarchies, Karin Zachmann (2004) recently explored the exclusion of women in the history of German engineering. Centre stage of her study takes the unprecedented mobilization of women for attending engineering courses in the German Democratic Republic which was launched in the context of the Cold War and the contest of the two super powers. Zachmann also sheds light on the modern prehistory of this mobilization. According to her reconstruction, this prehistory proves to be a multi-level process in the course of which manifold mechanisms of exclusion can be observed.

For the German tradition, Zachmann (2004: 117ff.) highlights the following significant discursive shifts: Initially, from the middle of the 19th century the guiding image of the rational engineer was constructed in the style of the educated *bourgeoisie* (Bildungsbürgertum) that advanced the social rise of engineering into the academic elites and at the same time excluded women who were constructed as irrational and governed by emotions. "It was the scientific elite in engineering who defined the professional identity of engineers and anchored it in prevailing concepts of masculinity" (Zachmann 2002: 199). This scientific-oriented image was later on destabilized and substituted by the concept of the engineer as an academic practitioner evoking the idea of the 'man in action', the artist and/or of the fighter with the forces of nature. It thus anew confronted the governing construction of femininity and stabilized the expulsion of women from the engineering domain. After World War I the guiding pattern was shifted again. Now, the engineer was conceptualized as the leader of the nation who is assigned to harmonize the existing contradictions between the social classes. German National Socialism however designed visibly the image of the soldierly engineer or the engineer as a technical soldier. The symbolic "trilogy of technology, war and masculinity in the professional image of the engineer" (Zachmann 2004: 158; transl. TP) was produced. The study of Zachmann consequently shows how the exclusion of women from the field has been constructed within the professionalization discourse in German modern engineering contingently and flexibly. Whereas her research perspective is predominantly focused on the history of *women* in engineering, it provides an excellent heuristical framework for the investigation of symbolic gender construction in the case of

early modern German engineering, especially for the context dependent compositions of masculinity within the professional debates of the field.

5. Gendering of Engineering Design

Following this heuristical framework the construction of masculinities in modern German engineering was explored more in detail in the course of my own research project on the gendering of theories of engineering design. The project focused mostly on the question of how the professional *knowledge* of mechanical engineering *design*, usually considered (socially) neutral technical fundamentals, shows gendering effects. The central findings indicate that in the engineering discourse around 1900 as engineering journals and textbooks are concerned diverse and partly contradictory compositions of the engineering design activity existed (see Paulitz 2009). They can be interpreted as the result of competing strands within engineering on what counts as relevant knowledge, what is regarded as the appropriate conception of the profession and finally what is accepted as the correct definition of the machine, i.e. the dominant understanding of the central subject of the domain.

Consequently, the premise of *the* male encoding of technology – especially that of the science-oriented rational German engineer – has to be differentiated and turned into the question about different modes of gendering the engineer. In view of the constructions of masculinity the project's results show that there are corresponding modes of gendering the engineering design activity that is the professional knowledge about the engineer's core capability (see also Paulitz 2008). One is the idea of the western, highly educated ‘scientist of machinery’ in the patriarchal tradition of the androcentric *male bias,* a version of the engineer, who designs in a systematic and theoretically scheduled way. The other version shows the powerful and ingenious masculinistic artist. This version of the engineer is seen as voluntaristically inventing machines as the result of a principally incalculable inner process, a professional, who acts on the basis of an emphatically acclaimed masculinity as a special creative resource. Thus the gendering of engineering around 1900 shows a significant interplay between implicit and explicit encodings in the texts. The analysis also shows that the images of gendered engineering design are interwoven with other social categories like ‘ethnicity’ and ‘class’ in order to construct a modern white male elite.

These competing conceptions of the engineer and of the design activity, as found in the material, are constituted with the help of discursive references to other dominant images of masculinity in the modern society around 1900. Additionally, the investigation clearly shows that early conceptions of design in German engineering reflect the economic structures and symbolic order of the colonial world. This indicates that there is a complex bundle of social boundaries at work that calls for further investigation. As both the outcomes of the applicant's own project and the described state of the art suggest these genderings are to be explored as instable, multidimensional processes of co-construction in the course of which flexibly arranged dualisms draw boundaries in order to constitute an image of the engineer that claims "hegemonic masculinity" (Connell 2005).

6. Discussion and conclusion

Following this empirical evidence professional knowledge in engineering shows a gender dimension. Far from being simply neutral and given knowledge about universal laws of nature and technological facts, engineering professional knowledge is socially constructed dependent on context, time and situation. Consequently, the investigation of these processes of social construction of technological knowledge is of central concern for gender studies in this field. One of the basic assumptions for this research perspective is to reflect on its own prerequisites. Thus not a unitary model of 'male' coded technological rationality is presumed. Gender studies in engineering are rather well advised to account for further investigating also the contradiction, disruptions and only temporary stabilizations of gender images in order to enhance a more heterogeneous and changeable understanding of the engineering profession.

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Engendering Knowledge Networks: Empowering Women through ICT

Keywords: knowledge, technology, women, rural, confidence, engineering, empowerment, ICTs

Abstract:

Information and Communication Technologies (ICT) are for everyone and that does not mean for urban or rural communities. Recent developments in the fields of information and communication technology are indeed revolutionary in nature. By definition, Information and Communication Technologies (ICT) are a diverse set of technological tools and resources to create, disseminate, store, bring value-addition and manage information. Knowledge thereby becomes the fundamental resource for all economic and developmental activities in the knowledge society, of which women form an equal part. Historically, the isolation of women from the mainstream economy and their lack of access to information because of societal, cultural and market constraints have led them to become distant from the global pool of information and knowledge. In some developing countries the women are very conservative. This distance is reflected in the levels of empowerment and equality of women in comparison to men, and has enormously contributed to the slow pace of development in the South.

This paper reflects the use of ICT empowers women and balanced gender issues in rural India.

Yvette Ramos, Dillip Pattanaik

1. Introduction

The Indian sub-continent covers an area of 3.29 million sq. kms. It is the 7th largest country in the world. India's population as on 2001at 1,027 million. India accounts for a meager 2.4 percent of the World surface area and yet it supports and sustains a whopping 16.7 percent of the world population.

About 75 percent of the country's population lives in rural areas in over 6,60,000 villages. Known for its diversity, the country accommodates about 25 percent of its population from indigenous and disadvantaged communities (Tribals and Dalits) known as scheduled tribes and scheduled castes. Agriculture is the mainstay of Indian economy and about 60 percent of the labour force and contributes nearly 26 percent of the GDP and accounts for about 18 percent share of the total value of the country's exports.

The literacy rate in the country is 65 percent and 51 percent for females. Twenty seven percent of the rural population lives below poverty line and in some states like Orissa; the poverty rate is 48 percent in rural areas.

Ever since independence, the Constitution of India grants women equal rights with men. But despite the constitutional guarantee of equality and protection to women and passing various legislations towards this end, they continue to enjoy unequal status. The constitution has abolished all discriminations against women, international conventions and declarations have made short shrifts of it, but gender discrimination from the womb to tomb continues. While some relate it to prevailing social conditions like customs, illiteracy, poverty and lack of awareness among women, some attribute it personal characteristics of women like feeling of helplessness, lack of self confidence, inferiority complexes etc.

Isolation of women from the mainstream economy and their lack of access to information because of societal, cultural and market constraints have let them to become distant from the global pool of information and knowledge. This distance is reflected in the levels of empowerment and equality of women in comparison to men and enormously contributed to the slow pace of development in the country. The one resource that liberates women and people at large from poverty and encompasses them is knowledge and its widespread dissemination.

The world is in the midst of a knowledge revolution, complemented by the opening up of entirely new vistas in information and communication technology. Recent developments in the field of information and communication technology (ICT) are indeed revolutionary in nature. The beneficial impact of ICT on the rural economy and quality of life is now widely recognized. ICT in convergence with other forms of communications have the potential to reach the rural and tribal communities as well thereby empowering them to participate in the economic and social progress of the country. The relevance of ICT to rural communities depends upon its ability to provide need based and locale-specific information on health, nutrition, education, natural resource management, livelihood, issues relating to weather, water, energy and agriculture, markets, information on different development programs etc. Women have to be an equal beneficiary to advantages offered by the ICT, and the products and processes, which emerge from their use.

The most critical development issues relating to ICT and evolution of knowledge societies must be approached from global and local perspectives through the joint participation of the public, private, the Panchayati Raj Institutions (the three-tier local government system), non-governmental organizations as well as academia and the members of the civil society. Gender mainstreaming becomes the crosscutting theme in all these issues.

Engendering of knowledge networks opens up avenues for women to freely articulate and share their experiences, concerns and knowledge with the possibilities of their further enrichment. ICT have the possibilities to digitally link each and every woman in the world in star topology network, which opens up endless possibilities for information exchange. This mechanism forms the skeletal process through which women communities could overcome the constraints of seclusion, mobilize resources and support, reach out new markets, and open up avenues for lifelong learning.

Women however are still very much in a minority among the beneficiaries of knowledge networking. Women still face huge imbalances in the ownership, control and regulation of these new information technologies, similar to those faced in other areas. Government, practitioners, and civil society organizations have still not fully absorbed the full potential of ICT in gender development.

ICT models thrive on innovations, customization, and people's participation. Innovative approaches to the use of ICT in the areas of local governance, e-commerce, e-advocacy, e-income generation activities could accrue unlimited benefits to the women community. Equitable access to ICT and autonomy to receive and produce the information relevant to their concerns and perspectives are therefore critical issues for women. ICT strategies can succeed in bridging the poverty gap only if there is a concrete effort towards formulation of enabling policy frame works and avenues, which create opportunities and incentives for women to participate and benefit.

2. Orissa state – an overview

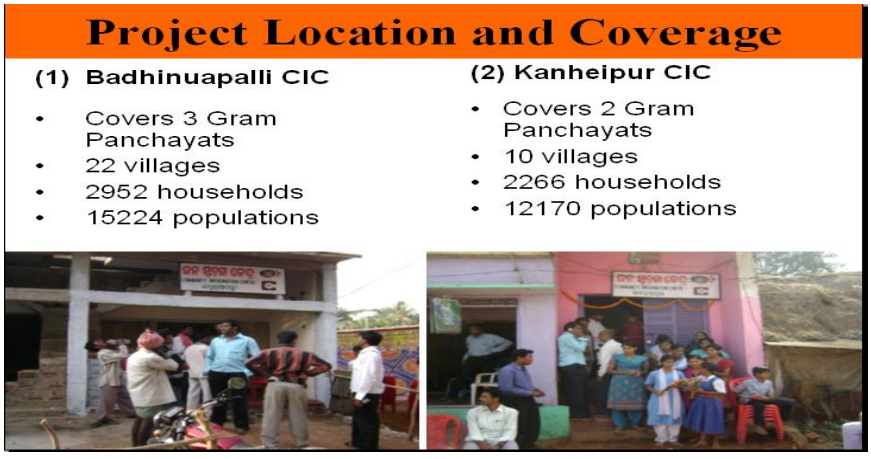
Orissa is the poorest State of India having 48 percent of its 40 million people living below poverty line. 85 percent of its population lives in rural areas spread over 47,000 villages. Population of marginalized and unprivileged communities like tribals (ST) and dalits (SC) forms 38 percent of total population of the State. About 60 percent of the villages are not yet connected with all-weather roads. Agriculture is the mainstay of the economy. Lack of access to information, basic, social and economic services, facilities and goods is major contributing factor to the backwardness and poverty of the rural communities.

3. Community information centre project in a cluster of rural villages in Orissa

Based on the situation and need of recent developed information and communication technology, a comprehensive model 'Community Information Centre' (CIC) has designed by IRMA-India and implemented as a pilot intervention in a cluster of rural villages in Orissa State with support from Connected Nation in October 2007.

3.1. Project Area

Figure 3: Project Location



The CICs located in Badhinuapalli and Kanheipur under Khallikote Block of Ganjam District in Orissa State, covers five Gram Panchayats (local government bodies) with 32 villages, 27394 population and 5218 households.

Each CIC has been equipped with a television, audio-video facilities, generator set, telephone connectivity with dialup internet connection and computers, laptop computers with hardware like printer, scanner, and web cameras and a small library with books in local language.

3.2. Key principles of CICs

- ➔ It is a people-centred programme based on community ownership
- ➔ It is taking into account the local context and the information needs of the local people and provides useful demand-driven services. The program is not meant to demonstrate the power of technology. Usefulness is more important than the use of latest technology.
- ➔ The program is inclusive and to ensuring social inclusion in access.

3.3. Deliverables

The Community Information Centre (CIC) project deliverables encompass in terms of social, economic and political which has to generate benefit for the groups like women, disables, scheduled caste, scheduled tribe, people living below poverty line. CIC is a base to generate awareness among the local communities regarding the benefit of modest ICTs in improving their socio-economic well being and in terms of alleviating poverty.

The CIC has planned to deliver the following services:

- Ready availability of information, procedure, system and guidelines about pro-poor government schemes, plans, policies, programmes and services.

- Easy access to information on health care, education, water and sanitation, animal husbandry, agricultural practices and inputs etc.
- Easy access to timely information on markets, examination results, employment opportunities, weather and disaster related early warnings.
- The communities would be well aware of their rights, entitlements to public services, facilities, Acts, rules and regulations.
- Information on women empowerment, laws and rights.
- Easy, cheaper, faster and timely electronic communication can be made available to the community.
- Availability and application of new technologies which help improving their quality of life and standard of living.

3.4. Partnership at local level

The program is establishing active partnerships with all key stakeholders: the local community, Panchayati Raj Institutions (PRIs), the local Gram Panchayat (local government unit at lowest level) besides Government Ministries/Department/ Agencies, technical and academic institutions, professional bodies, corporate and private sectors etc.

PRIs: With the 73rd Constitutional Amendment Act, 1992 the three-tier Panchayati Raj Institution system has emerged as an effective network of local institutions for local governance. The lowest democratic unit under the PRI system is the Gram Panchayat, which is mandated to plan and implement projects for economic development and social justice. A Gram Panchayat constitutes with a population between 2000 to 10,000 taking a cluster of villages.

3.5. Community Participation

Community participation is vital in all rural and community-based projects. It is broad-based and representative and cut across social and economic status. The local Gram Panchayat is also an active part of the local community. Different kind of meetings at village level, cluster

level and area level has conducted to bring their attention on the use of information center for their access to information and to reach the communities globally involving more women.

Figure 4: CIC Awareness Campaign

Figure 5: CIC Awareness Campaign

Figure 6: discussion with women groups

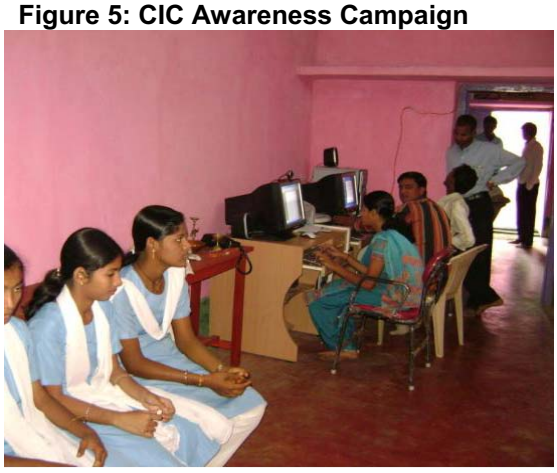


Figure 7: Girls are in CIC

The communities of the project area are now more self-confident and articulate in amplifying their voice, and their participation in the local self-governance system also increased through the Community Information Centre.

3.6. Connectivity

The most feasible and cost-effective system has been used for connectivity. Connectivity and content is receiving concurrent attention of CICs. They are used to satisfy the local community. Still we are far from providing a better connectivity as dial up internet connectivity is rarely connect to the internet.

3.7. Content

Creation and updating of relevant content to suit local needs is a key factor in the CIC program. The information provided is demand driven and relevant to the day-to-day life and work of rural men and women. In addition, semi literate person are being accorded priority in training to operate the center. CIC is providing mainly three types of contents namely, generic (health, government schemes, local news, employment news etc.), dynamic (market, school, examination results, weather etc.) and timely information (wave height, potential fishing zone details, etc.).

3.8. Management, monitoring and evaluation

There is management committee established consisting of experts, local NGOs and Self-Help Groups, local Gram Panchayat, and members from the community including potential women volunteers for managing and maintaining the CICs. Inputs and training on there capacity building is being imparted.

3.9. Outcomes

- Increased demanding power, capacity, articulation, capacity to make lobby and advocacy, fruitful implementation of pro-poor programmes at grassroot level, resulted in reducing poverty.
- Increased participation of women in local development process facilitating accountability, social auditing, optimal use of local resources
- With availability of more knowledge and information, the process of grassroot empowerment initiated and strengthened.
- The social well being of the community strengthened with accessibility to information on health and other basic facilities
- Increased economic status with increased productivity, local entrepreneurship, better market access, value addition to the products.

- Vulnerability reduced stemming from natural disasters, climatic situation with timely availability of forecasting and early warning.
- Application and impact of ICT at community level spearhead holistic development of isolated people at grassroot level.

3.10. Sustainability

➔ The CIC is creating long-term, self-sustaining solutions, which reflecting local needs and require local entrepreneurship. So, it helps to fuel the creation of additional local business and community enterprises.

➔ Local entrepreneurs and communities finding new and innovative ways for increasing production and economic avenues. Business at local public access points is being demonstrably increased.

➔ The CIC is vital in developing a rural urban e-Commerce service network.

4. Building partnerships

In order to build effective and sustained knowledge societies, it is necessary to involve strategic stakeholders from both the public and the private sectors. These could include governmental bodies, corporate firms, financial institutions and NGOs. Fostering corporate partnerships in ICT ventures with venture capital funds for social development projects becomes an important line of thought. This could be done through a plethora of ways, such as ICT-based advertisements, using existing corporate infrastructure for opening of community information centres, bringing about the transfer of technical expertise from the corporate to the development sector, etc. There is a need to explore many more such useful models of participation of the private sector in social development projects.

5. Focusing on research and innovation

From a macro-level perspective, there has been little research done to understand the information needs of rural and isolated communities in terms of the strategic information they wish to receive or produce through the community information centre established by IRMA-India in collaboration with Connected Nation. A knowledge and information-sharing model that puts rural poor in greater control over the kind of information they need and want to produce becomes fundamental to the empowerment of them. For an all-encompassing knowledge and information network that empowers rural poor, governmental and international agencies need to follow an innovative approach to ICT-based knowledge and information sharing supplemented by start-up and capacity-building support, and making full use of available technologies in the simplest ways. Incubator initiatives therefore need to be launched for the creation of dynamic, result-oriented ICT models, which focus on social benefits rather than individual profits.

6. Discussion and conclusion

Expectations are high when it comes to ICT opportunities for rural poor, including new forms of learning, education, health services, livelihood options and governance mechanisms. However, on a cautious note, it needs to be realised that information and communication technologies by itself cannot be an answer and elixir to all problems facing, but it does bring new information resources and can open new communication channels for marginalised poor communities. It offers new approaches for bridging the information gaps through interaction and dialogue, building new alliances, inter-personal networks, and cross-sectional links between organizations. The benefits include increased efficiency in allocation of resources for development work, less duplication of activities, reduced communication costs and global access to information and human resources.

Come what may, these technologies have started to carve their impact on the villagers' lives as mothers do want their children to learn computers so that they can lead a better quality of life. Women have the equal rights to access the information.

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Obstacles and stimuli in the scientific careers of men and women in photonics

Elke Van den Brandt

In the last 5 decennia several studies focussed on the gendered career trajectories in science. Questions as ‘why so few’ and ‘why so slow’ intrigued several scholars. Today we are confronted with a changing context. Two key changes are the internationalisation of science and the increasing importance of the private research sector. The European Commission for example tries to establish a European research area, in which not only different countries are connected with each other, but in which both public and private organisations participate. In this paper we question how these changes affect the scientific careers of men and women. In order to be able to compare different contexts, we limit our study to a single, well defined discipline: photonics. Photonics is a multidisciplinary, key technology that is strongly internationalised and characterised by public-private partnerships.

We present the results of a study consisting of 2 surveys (N=1423), focus groups (N=30), individual in-depth interviews (N=30) and personal observations. We first analyse the female participation in different contexts (different countries and different kinds of organisations). We then discuss the impact of the recent changes in science on the careers of men and women. We conclude that although significant differences exist between countries and between organisations, obstacles in the careers for women appear to be universal and persistent. Photonics is confronted with horizontal and vertical segregation. According to the first questionnaire, this cannot be explained by differences in career history, nor by a lack women’s ambition: women in photonics follow similar career paths and are significantly more ambitious than their male counterparts. Obstacles in women’s careers are the work environment and working conditions. Throughout different questions, women show frustration about the climate at work and contacts with others. Women are less satisfied with different aspects of their current job. Furthermore, they are, more than men, dissatisfied about items they rate as very important (work values). Women also perceive significantly more discrimination than men and have less confidence in the fairness of selection and promotion procedures.

Gender Issues in Environmental Engineering and Research: a Matter of Translation between Gender Studies and Engineering

Keywords: environmental engineering research, gender consulting, gender issues, gender mainstreaming, translation work

Abstract:

In the context of gender mainstreaming, (environmental) engineering research and development are likewise expected to integrate gender issues. However, (environmental) engineering researchers have only little knowledge of what this actually means; i.e. which gender issues are relevant to their own research topic and in which way can these be integrated and followed up. This may be related to the fact that these actors are usually natural scientists and engineers who did not gain any competencies in gender and diversity issues during their studies. To provide researchers with some insight into the importance and relevance of gender issues, and in this way to encourage the development of gender competencies, the state of Bremen's Applied Environmental Research support programme offers project proposers the possibility of obtaining advice on gender mainstreaming. The gender consulting project was launched four years ago, and almost half of the proposers in this support programme have since made use of it.

After a brief introduction to the relevance of gender for environmental engineering and environmental research, I will discuss the approach taken by gender consulting and its current design. This is following by some examples of specific gender issues in environmental engineering projects. Finally, I will present the results of an online survey among addressees of the gender consultancy project, i.e. the project proposers of the support programme. The aim of the online survey was to examine how proposers view the gender consulting service. One particular aspect will be the 'translation work' of gender consulting. Scientific/engineering research, especially, faces the problem that gender issues are not normally identifiable at first sight. 'Translation work' is needed to make them visible.

Ines Weller

1. Relevance of Gender for Environmental Engineering and Research

Integrating gender issues means broadening the perspective, the issues and the methodologies of environmental engineering, on the one hand, and research focusing specifically on the interactions between environmental engineering and society, on the other hand (Schultz/Hummel 2002, Weller et al. 2003, Weller 2004). Examples of new and additional questions that require attention

include: Which implicit and explicit notions and expectations do development engineers have regarding the applications and uses of the technologies and solutions they develop? Is consideration given to potential differences in men's and women's needs, or the contexts in which men and women apply such solutions? Do the research issues and problems being addressed pay sufficient attention to possible gender differences in values, attitudes and access to resources, such as employment, time, income or education? How are different genders and gender relations affected by the results and products of environmental engineering and research?

One example which shows the mostly implicit notions that engineers have about users is the construction of low-energy buildings. One research project has analysed the notions and expectations of engineers regarding the users and their requirements, as well as the expectations and experience of people actually living in such buildings (Rohracher 2006). Centrally controlled ventilation systems are an essential feature of low-energy buildings. These systems have to operate the whole day, and mostly involve a certain noise level. The engineers themselves did not regard these noise emissions as a relevant problem or as impairing the quality of housing. In contrast, qualitative interviews with people living in low-energy buildings or apartments showed that 41% (houses) and 55% (apartments) were disturbed by noise in the bedroom. Some of the users solved this problem by switching off the ventilation system, or by opening doors or windows. Engineers do not anticipate such behaviour because energy efficiency is only maintained when the ventilation systems are permanently operating (Rohracher 2006: 162). The example shows, therefore, that engineers' notions are often based purely on their own personal experience, and that engineers do not consider the specific and different requirements of other users. In this context, Els Rommes speaks of the 'I-Methodology' (Rommes 2002), meaning an approach that generalises the subjective notions and experience of designers and engineers, without considering that users may have their own. Unfortunately, the study mentioned above did not differentiate its findings by gender, although there are records of women being more sensitive to noise (Stölzel 2004)

The gender focus not only includes possible differences between the genders themselves, but also serves as an 'eye-opener' for the differentiation of societies as a whole. It enables light to be shed on the requirements of those at whom the results of environmental research are aimed, or who are affected by such results. A gender focus can help to reveal what are usually automatic assumptions on the part of engineers regarding how their technological solutions are actually used in practice. These assumptions can then be placed in relation to the requirements of different users in different contexts. This would enable engineering solutions to be developed that more

accurately meet specific needs, and help to contextualise environmental research and technologies.

2. Approach of the gender consulting project

The gender consulting project aims to provide advice and guidance on gender mainstreaming to various actors in the Applied Environmental Research support programme, and to develop gender competencies in this field of research (Weller 2007). Another goal is to demonstrate which gender issues may be found in the topics of applied environmental research projects, and how such issues can be analysed. Finally, the gender consulting project aims to elaborate detailed examples of meaningful gender aspects in environmental engineering and research.

The main addressees for gender consulting are the proposers of projects under this support programme. In terms of methodology, the gender consulting project is designed as an iterative development process. The aim is to give due consideration to each specific project's different needs and requirements and to make note of the experience gained in the course of gender consulting. In retrospect, a distinction can be made between the following consulting activities specifically developed and provided by the gender consulting group:

- Examining every project proposal for gender relevance: this step serves to clarify whether research and development themes imply gender aspects that need to be uncovered. If gender relevance is possible, the proposers are offered gender consulting.

- Once-only consulting and information for proposers: in cooperation with project proposers, a review is carried out for the respective project topic to determine whether results of technically focused gender research are applicable, and whether gender issues can be derived for the project.

- Multiple consulting for proposers: in these cases, individual gender issues are jointly developed and prepared for treatment in the form of gender sub-projects (see below).

- Consulting and support for gender sub-projects: the possibility of instituting gender sub-projects was newly developed as part of gender consulting, in consultation with the

Applied Environmental Research support programme. A limited amount of additional funding to examine a gender issue specifically related to the topic of the project can be applied for, in order to support further investigation of such issues.

- Continuous consulting on the integration of gender aspects into ongoing projects: gender-specific themes identified in the course of gender consulting were then integrated into the respective project by the project teams. In these cases, gender consulting is integrated into the entire project process and related, for example, to the wording of questionnaires and the evaluation of results on gender issues.

Generally speaking, gender consulting focuses on identifying the particular gender aspects that can be significant at the content level for applied environmental research projects. The gender consulting process shows which new perspectives and results can be focused on when these aspects are included in research and development. Another aim is to demonstrate examples and to create knowledge about the impacts of environmental engineering and research projects for gender relations in general, and for women and men in particular. The aim is to examine, with reference to specific examples, the consequences that can be expected for the genders and how such consequences can be shaped so that they do not contribute to the continuation or exacerbation of gender inequalities, but help to achieve more gender equality of opportunity instead.

3. Gender Issues in Environmental Engineering Projects

In the gender consulting project, a broad range of research and development themes in environmental research were examined for gender issues. Projects in the fields of energy production, wastewater purification, soil remediation and recycling, for example, were checked. The search for gender issues entered completely new territory, with the project proposers themselves having no ideas of their own in this regard. In the course of the consulting process, which also provided information on gender research findings pertaining to the respective environmental engineering problems at hand, it is often possible to identify gender aspects jointly with the proposers. The identified gender aspects illustrate that environmental engineering issues and problems do have gender relevance, but that these usually imply considerable additional research. The resources and competencies required for such research were not normally available.

For this reason, a ‘Gender Fund’ was jointly developed with the Applied Environmental Research support programme. The fund provides a limited amount of assistance for a gender-related sub-project for which an application can be made in addition to the main research project. The following two examples are a brief description of such a sub-project.

The first example concerns a project for developing an ecofriendly soil remediation technology that is also intended for use in regions in Africa that are semi-arid or threatened by desertification. During the first gender consulting sessions, it became obvious that examining gender issues can support the project in its future aims, given the context of technology transfer to African regions and the gender-specific distribution of responsibilities and tasks relating to supplies/nutrition in those regions. To this end, a gender sub-project proposal was submitted, the aim of which was to study, taking an African garden project as example, how appropriate application of the soil remediation technology can be supported, which problems obstruct such application and how the living and working conditions and requirements of potential users, mainly women, can be taken into account to ensure that successful implementation strategies are developed. The results of the gender sub-project provide pointers to the specific requirements that must be met in order to achieve successful transfer of this low-tech technology, and to the difficulties that may be encountered. The results underscore the fact that successful transfer of technologies is not a foregone conclusion, but requires that potential users be able to integrate such technologies into their everyday lives. The question as to the consequences of concepts and measures for men and women, and gender relations, as demanded by gender mainstreaming, steers attention not only to the aim of equal opportunity, but also combines it with identification of the difficulties and opportunities of integrating new technologies in different contexts.

In the second example, the aim was to develop a technology for processing waste grease. In the course of gender consulting, one issue addressed was that, for this recycling technology to function, it is also essential to provide appropriate collection and sorting systems. These are needed to supply waste grease of the required quality. It became obvious in the course of gender consulting that a better understanding of those who actually use the waste grease collection and sorting systems can also help to improve the efficiency of the processing technology. Two surveys were therefore conducted in a gender sub-project. In a first random survey to determine the level of acceptance for a collection system for household waste grease, it was found that the women surveyed were decidedly against the idea, because it meant additional workload, whereas the men who were surveyed showed a definite interest. Having concluded that, specifically in family households, the collection of waste grease would be a responsibility of women, this area of application was not pursued any further. Instead, a survey was carried out among catering

establishments. This second survey focused on the acceptance of, and requirements to be met by waste grease collecting systems, and did not include any gender differentiation.

As a consequence, the results obtained did not show any differences between genders in their acceptance of the collection and sorting systems, or in articulating their requirements regarding the design and organisation of such systems. The crucial differences that were identified by the survey pertained to how the respective enterprises were organised. On the whole, however, the gender sub-project did enable a better understanding to be obtained about specific everyday practices within enterprises. One basic assumption of the environmental engineering project, namely that waste grease collection systems had not been established as yet in the region, needed revising. The gender sub-project examined which collection systems are used in practice by catering establishments, how these systems are evaluated by users, and what consequences this entails for new waste grease processing technologies. The sub-project also generated new ideas for designing the collection systems. This resulted in the integration of filter systems – a requirement, derived from actual practice, that needs to be met when designing waste grease collection systems, and one that is also of major importance for the processing technology being used. On the whole, the gender sub-project was instrumental in obtaining a better understanding of the potential applications of waste grease collection systems and the problems associated with their use. The sub-project also generated a number of ideas and suggestions regarding the practical design of collection systems, and resulted in improvements to the quality of waste grease and hence to the operational efficiency of the technology used to process waste grease.

So far the examples have shown that gender issues become all the more visible and amenable to processing the greater the extent to which project development is focused on implementing and utilising the project results. This means, conversely, that gender issues are not relevant for all projects, or that gender aspects can be handled by all projects; this is particularly the case with research topics that relate primarily to technical processes and methods. Thirdly, the results also highlight the fact that the question of gender dimensions and the impacts of research for the genders and for gender relations can sharpen awareness of its potential uses and applications, and of the needs of potential target groups and addressees. To that extent, it can help to achieve results and solutions of greater precision and appropriateness.

4. Assessment of gender consulting

After more than four years of gender consulting, a survey was conducted last year among the addressees of this service in order to obtain some feedback on gender consulting. The survey was mainly aimed at finding out how addressees assessed the gender consultancy service, whether and in what ways they use it, how important it is for their own research and how it could be improved. The survey was conducted online in spring 2008. The participants were people who had been involved in the Applied Environmental Research support programme, and the distribution list for the online survey comprised 68 addresses in total[32]. More specifically, the addressees were people who in recent years had received information about the gender consulting service when applying for and implementing their projects. They therefore had the opportunity to take advantage of the gender consulting offer.

One fact worth mentioning about the online survey was that the participation rate was relatively high, at 57%. This indicates a definite level of interest in expressing opinions on gender consulting, and a relatively high level of commitment on the part of those surveyed. The survey also showed quite clearly that those taking part had a predominantly positive opinion of the gender consulting service, and the awareness of gender consulting is also relatively high – just under 70% of those responding stated that they were informed about the service. On the other hand, only 40% of those who were aware of it had actually received consulting on gender mainstreaming issues.

When evaluating the statements on gender consulting summarised below, it is important to realise that not all who made use of gender consulting took part in the online survey. That the data basis for experience gained with gender consulting is relatively small is another aspect that should be taken into consideration. It comprises eleven persons who not only participated in the survey but who also made use of gender consulting[33]

The first finding produced by the survey was that just under 45% of those who participated in gender consulting had subsequently integrated gender issues into their project work in some form

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[32] The state of Bremen's Applied Environmental Research support programme is confined to this particular state – the smallest in Germany – and has a relatively small budget. The funded projects are usually carried out for a maximum of two years; total funding may not exceed € 150,000. The gender consulting project likewise has only limited resources at its disposal – between ten and twenty hours per month.

[33] To date, significantly more projects than this have obtained gender mainstreaming consulting and have integrated gender issues into the content of their research projects (Weller 2006).

or other. Not only were gender-related issues brought into projects, but ideas were also generated for considering gender issues in future project proposals. The possibility of proposing a gender sub-project aimed at addressing specific gender-related issues was of key importance. In those cases where such a sub-project was approved by the Applied Environmental Research support programme, initial findings on gender issues were also produced. The fact that almost half of those who took part in gender consulting also continued to address gender aspects and integrated these in their research is highly noteworthy. This is also shown by a comparison with EU research, where the Sixth Framework Program similarly aimed, with a 'Gender Action Plan', at getting research projects to integrate gender issues at the research content level. In one survey on the effectiveness of gender action plans for the aims of gender mainstreaming, the results were rather sobering. As far as gender mainstreaming at content level was concerned, the survey found that "Integrating gender aspects into the content of research has proved even more difficult in practice (the author: than implementing measures aimed at promoting women) and in most cases is not given any consideration by the projects" (Schneider 2005: 6). It has been found that gender consulting is basically a suitable approach for including gender-related issues in the scientific and technical content of environmental research. A key factor here is that the gender consulting approach – unlike the checklists and informational aids for implementing gender mainstreaming, helpful as they may be – is aimed at identifying gender-specific issues relating to the specific topic of the project *jointly* with the proposers, in a communicative process. Gender research findings in the fields of science and technology are reviewed for relevance to the environmental engineering issues and aims addressed by the individual projects, and placed in relation to them. To that extent, gender consulting is a framework in which 'translational skills' for communication between scientific and technological research, on the one hand, and gender research, on the other, can be developed. The results of the online survey suggest that this is a promising way of tackling the challenge of making gender visible at the level of research content, and an aspect that can then be addressed.

5. Summary

An important result of the gender consulting project is that gender issues can be identified in an interdisciplinary exchange of ideas, focused on potential problems, between proposers of environmental projects (environmental competencies) and gender consultants (gender competencies). The particular impact of gender consulting is more than purely informational, and consists in the specific 'translation' work needed for communication between scientific and

technological research in the field of environmental engineering, and gender research. A discourse process, essential for identifying and integrating gender aspects, is then set in motion. Another important aspect is that discussion be kept open-ended. Those who use gender consulting subsequently decide at their own discretion how to apply the findings, and whether or in what form the gender issues that have been identified are handled in future.

A second element that likewise helps gender aspects to be examined within environmental research and in the development of environmental technologies is the establishment of a 'gender fund'. This enables gender issues of specific relevance to the respective topic and aims of the project to be addressed, and for a limited amount of funding to be requested. This, in turn, is important for subsequent gender consulting, since it serves as an example of gender issues in the context of developing environmental technologies and can therefore promote the process of 'translation' between environmental research and gender research.

However, it is essential to realise here that the empirical basis needs to be substantially enlarged if results are to be generalised. This raises the final question as to how to broader application and review of this gender consulting model can be initiated.

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Gender and Diversity in Innovation Processes

Keywords: gender, diversity, innovation, organisational analysis, innovation pro-jects, case study, ICT, cultural probes

Abstract:

In our paper, we intend to demonstrate the relevance of gender and diversity in innovation processes. More specifically we want to discover if and – where applicable – how a possible interaction of the various scientific strands – gender and diversity studies on the one hand and research on innovation on the other hand – provides important impetus for both sides. We argue that it can be worthwhile to include the diverse needs and prospects of the differ-ent client groups in innovation processes in order to generate "successful" products and ser-vices. Finally we illustrate - based on the inclusion of the innovation and gender/diversity perspective - the research design of an empirically substantiated case study

Stephanie Stein, Nina Bessing

1. Introduction

Research on innovation on the one hand and research on gender and diversity on the other hand emphasise both the need for a variety of perspectives and the focus on the customers' needs and demands. Nevertheless, the different research topics exist unchained next to each other. While gender studies proceed without integrating the current status of research on innovation, studies on innovation usually forget to assimilate gender and diversity dimen-sions (Bessing/Lukoschat 2007: 73).

Against this background the EAF[34] started in 2008 the research project "Gender and Diversity in Innovation Processes". The scientific aims of our research project – with regard to the integration of the different scientific strands – are in detail:

[34] The EAF | European Academy for Women in Politics and Business Berlin e.V. is an independent and non-profit organisation. Since 1996 the EAF has been engaged for a society with equal opportunities for women and men. With our advisory service for business and politics, our research projects and careerbuilding-programmes we promote a diversity-oriented and friendly society.

1. Analysing gender aspects and illustrating their relevance for successful product and process innovations in industrial R&D. For this purpose we conduct projects with several companies in order to show how and where gender and diversity aspects could give new impetus and enrich the innovation processes in industrial research and development.

2. Analysing and illustrating the organisational structures and cultures in industrial research from a gender and diversity perspective.

3. Generating methods and experiences for the purpose of promoting awareness and skill building as the R&D and innovation departments are often sceptical about the need and advantages of diversity concepts.

The paper is organized as follows: First, we describe our research project at a glance, and then we sketch our theoretical background of gender and diversity in innovation processes. In the subsequent sections, we present the research design of one of our innovation projects in the information and technology sector. Finally, we discuss the key factors of our analysis. The project is still running and the final results of our research will be published in 2010.

2. "Gender and Diversity in Innovation Processes" at a glance

The project focuses on two directions: realising innovation projects and conducting organisational analysis. In 2008 and 2009 we are conducting the innovation projects and the organisational analysis. In 2010 we will publish the results of the project and will discuss our presented results with other experts at the symposium of the project.

"Gender and diversity in innovation processes"[35] is financed by the Federal Ministry of Education and Research and the European Social Fund. Our corporate partners are the Daimler AG, the Porsche AG, the Deutsche Telekom AG, the Aesculap AG und the IBM

[35] The research project is based on the experiences and results of the preliminary research project „Discover Gender!" (2003-2006). The project was conducted by the Fraunhofer Gesellschaft in cooperation with the EAF and state-aided by the Federal Ministry of Education and Research (Bessing/Lukoschat 2007: 69 et seq.).

Deutschland GmbH. Our empirical analysis is a combination of quantitative and qualitative methods. A combination of methods seems to be obligatory in order to gain a "complete" picture of the relevant phenomenon.

2.1. The innovation projects

In the innovation projects the EAF works together with other experts of the R&D and innovation departments of a particular organisation over a specific period (normally six month to one year). The aim of the innovation project is to discover future market opportunities for a particular product or service. We attach great importance to methodologies which directly involve the different target groups. Thereby we cope with the challenge to combine our own scientific eye with a customer perspective. Furthermore we focus on the integration of experiences and theories of gender research and finally the implementation of a gender-sensitive perspective in industrial R&D and innovation processes.

The questions associated with the innovation projects are in detail:

- How do the customers needs and desires change due to demographic changes, the alteration of (gender) roles and an increasing individualisation?

- How does a possible interaction of the various scientific strands – gender and diversity on the one hand and research on innovation on the other hand – provide important impetus for industrial research and development?

- How does a gender-sensitive and innovative market research make a contribution to adaptable products which take the desires of all customers into account?

In this regard we apply participatory methods and instruments of innovation management, for example ideation workshops with specific target groups, cultural probes or development of future scenarios (scenario technique).

The applied methods are tailored to the particular needs of each company and might be different for the various stages of each innovation project.

2.2. The organisational analysis

The organisational analysis questions the human-resource (HR) as well as the organisational practices. It focuses the experiences and attitudes in the R&D and innovation departments towards a promotion of diversity in the respective organisation. It refers for example to the encouragement and integration of women in applied research and development. In this regard it is also interesting to reveal the interplay of organisational respectively diversity strategies with personnel structures and practices.

The applied methods are in detail:

- Qualitative interviews
- Quantitative surveys
- Document analysis

We provide the organisations with the individual analysis of their own company. Therewith the organisations receive a critical and objective appraisal of their organisational structure and culture in the R&D departments. Such an assessment provides possible starting points for future actions.

3. Theoretical background

3.1. Concept clarification gender

The challenge in both theory and practice is to incorporate gender and diversity aspects in industrial research and development without reproducing stereotypes and gender roles of men and women. In particular, this means to reflect the concept "gender" consistently and to incorporate gender into a superior diversity concept. Our diversity concept is broad and incorporates various diversity dimensions like gender, age, religion, disability and sexual orientation (Riedmüller/Vinz 2007: 146). Depending on theme and field of research, it is possible and essential to draw on several attributes. As recent product developments for women show, often stereotypes determine women's needs (Buchmüller 2008: 10-19): As soon as product designers are engaged in research and development focussed on women, the newly designed products all look the same: cute, tiny and pink. Therefore we want to emphasise that the formula "shrink it and pink it" is not sufficient. In contrast, product requirements are determined by a mixture of attributes like the age, sex and profession of the customers. This social constructivist perspective reveals that sex differences and our beliefs about appropriate gender roles for both sexes are "produced" in social, cultural and historical context. Gender roles are automatically linked to an individual or the sex of an individual (Bohan 2002; Kimmel 2000; Krell 2008). As a consequence it is not sufficient to incorporate merely the *differences* between men and women while considering gender aspects in R&D projects. Gender aspects can arise where differences between the different sexes, e.g. in terms of stereotypes, were assumed so far, although there are similarities between the sexes. As "[d]iversity refers to a mixture of items characterized by differences and similarities" (Thomas 1996: 5), it is necessary to take the differences *and* similarities into account (Anders et al. 2008: 14; Bessing/Lukoschat 2007: 72; Knapp 2008).

3.2. Gender and innovation

In particular, there is a lack of data relating to decision-making processes in industrial research referring to the gender and diversity issue. "[I]f designers have been unaware of

gender, or gender blind, they may unconsciously design for the male norm in society" (Maass/Rommes 2007: 98). As high pitches of the voice were not taken into account during the development of voice recognition systems, the newly designed and launched product was not successful as it was not able to recognize high – normally female – pitches of the voice (National Center for Women and Information Technology 2003). The example illustrates the consequences of a product innovation that ignored gender aspects in the innovation process.

The exemplification also shows that for the success of research and innovation processes it is exceedingly reliant how new ideas, products and services enter the market and fulfil the customers needs and exigencies. In this regard, it could be worthwhile to focus on the different customer groups at an early stage in the innovation process as there is a positive correlation between market success and customer orientation (Lüthje 2003: 37). In fact, this focus on the customers and their needs in the innovation process is an important link to the integration of gender aspect in applied research: Assumed that globalisation changes markets rapidly and social as well as economic developments influence market shifts, the change of gender roles should be taken into account when analysing the market development (Bessing/Lukoschat 2007: 78). The (gender) alterations, which are prominent for almost every industrialised and developed nation, are expressed in the growing education and labour participation of women and the debate on balanced role allocations between men and women. With regard to gender aspects, one can identify three pertinent trends, which could be relevant for industrial research and development (Brühl/Westphal 2004; Horx 2003; Jaffé 2005):

1 *The increasing importance of female customers*: As the market power of women is increasing, it becomes more essential to deal with their preferences. Studies point out that women pursue higher standards of design, user friendliness and service of technical support then men do (e.g. Horx, 2003)

2 *Traditional male respectively female markets are changing*: Nowadays, the traditional task sharing – women decide about convenience goods and men about major investments – is not appropriate anymore as families and people living in an relationship decide together on consumption. Moreover there are growing individual needs of women and men. On the one hand the automotive and ICT-sectors identify more and more women as an interesting target groups with an own income and

individual decisions. On the other hand the cosmetics industry puts stronger emphasis on men as client group.

3 *The individualisation of societies*: Due to the demographic challenges and shifts of the different markets, the customers require individually adaptable products. Therefore it is essential to become aware of the divers conceptions and forms of life and to avoid stereotypes (Bessing/Lukoschat 2007: 74 et seq).

Consequently, we also try to identify the methods and instruments which are necessary to grasp the newly developed complex and differentiated living conditions of women and men. Such a close-to-the-market analysis makes it possible to integrate successfully the desires and needs of the individuals in development and research processes.

3.3. Participatory methodologies

Participatory approaches, which attempt to involve the user actively, constitute a strong potential to increase the quality and innovative ability of innovation processes. Participatory design approaches, pioneered in Scandinavia, originate from computer systems design. The people who are destined to use the equipment play an important role in developing (designing) the system (Schuler/Namioka 1993: XI). “Participatory design (PD) is a set of theories, practices, and studies related to endusers as full participants in activities leading to software and hardware computer products and computer-based activities” (Muller 2001: 1). Instead of emphasising the “cult of the specialist” our approach endeavours to involve the users during the different stages in the innovation process: The user helps to identify the problem, finds ideas for a possible solution, and he or she evaluates the proposed solutions. Therewith the method assures that the invented product both meets the needs of customer and is usable.

As the users become part of the design team and “in order for them to take on this role, they must be given appropriate tools for expressing themselves” (Sanders/Stappers 2008: 9). Recently there exists a multitude of methods. Unfortunately they are seldom deployed to detect the desires of men *and* women. As the previous paragraph points out (industrial) R&D

needs to be gender-sensitive in order to revise a stereotypical view on the customers. The integration of gender-sensitive techniques into participatory methodologies is important in order to exhaust the know-how of the users. Such an explicit involvement of the customers and their knowledge about their own needs makes it possible to ameliorate the processes and products in industrial research and development.

Moreover participatory designs go beyond the integration of users (men and women) as they involve *all* people concerned by the final result. This means for example that a workshop for a newly developed software should not only aim at the principal (management) but also at all people who are directly and indirectly affected by the software somehow: customers of the organisation and users of the software, but also other employees with know-how that is relevant for the software development. Therewith the fitting accuracy of processes and products will increase (Bessing/Lukoschat 2007: 78).
While considering on and integrating different perspectives, it is important to take into account that users are affected by social structures of organisations and societies (Hammel 2003: 59). Furthermore the sole consideration of the customers' need is often not sufficient as users only see and describe what they know and what they are used to (Herstatt/Verworn 2003: 42f.). Therefore is it necessary to constantly advance and critically reflect the methodologies also with regard to included gender bias.

3.4. Conclusion

In summary, we conclude that the intention of a gender- and diversity-sensitive innovation management is not simply the integration of that one *female* perspective. Moreover it is essential to focus on the variety of needs and expectations of all (female and male) customers with their individuality and with regard to other dimensions of diversity. In this connection, the newly designed product should not be based on gender stereotypes, because otherwise "the technology will congeal and reinforce these stereotypes" (Maass/Rommes 2007: 99). This also means that the R&D teams should be aware of the gender and diversity dimension within their work. Then the product acceptance will be higher and it might be possible to enter a new or dominate an existing market.

4. Research design of an innovation project

As the EAF intents to demonstrate empirically the relevance of gender and diversity aspects in innovation processes empirically, we conduct different research projects with several organisations in different branches. The conscious choice of the companies we are cooperating with was directed by thoughts about branches where gender and diversity aspects (should) play an important role. In this regard, we decided to investigate the markets for information and communication technology (ICT), for mobility and transport as well as for medical engineering. Every product or service in these branches faces the different needs and requirements of the diverse customer groups. Subsequently, we present a case study about gender and diversity aspects in the ICT-sector. Information and communication technologies have "led to a worldwide reorganization of fundamental transactions and relationships, including the division of labor, the financial markets and the knowledge market" (Jensen 2007:33). We will exemplarily explicate our innovation project "G – Gender Inspired Technology" which is a research project conducted by the Deutsche Telekom Laboratories (T-Labs), the EAF and the Interaction Design Studios (IxDS)[36]. The Project started in January 2009.

4.1. Research questions

The aim of the research project "G – Gender Inspired Technology" is to gain multi-faceted information – in reference to electronic ICT – about the consumers' behaviour of women, about their demands referring to the product and their utilisation contexts. On the basis of this information, we finally create ideas for a gender inspired technology with regard to new hardware, accessories and services.

Over the past years, the requirement to organise and coordinate one's life increases for private and public life. In this respect we question how ICT and especially mobile communication is able to improve the life of female users. These issues were identified as appropriate and

[36] www.ixds.de

important in the initial research project "Women's Phone"[37] as well as in other studies investigating female needs and demands concerning ICT product (Rosser 2005; Sprint/Nextel 2005). Thereby we focus on three main areas of research:

1. *Micro-communication*: We want to receive information about the communication patterns of the probands, their social connectivity, communication rituals and individual motifs.
2. *Privacy and data control*: As ICT influences private and public life, it is interesting to identify strategies and demands of female users to control and canalise personal data and to adhere privacy, especially in public life.
3. *Non-communication and time-out*: As ICT founds its way into public and private life, time for relaxation and recreation become rare. We believe that boredom and breaks are important in order to improve the quality of life and to recover from information overload due to (electronic) communication. How important are places and time for recreation? What appears to affect recreation? And overall: Do people really need time-outs from communication?

4.2. Research design

For our empirical examination, we combine different methods to gain comprehensive information about the different target users, their wishes, behaviour and habits. According to our approach to combine the innovation and gender perspective, we pay attention to a participatory design and instruments of modern innovation management. In particular, we use *cultural probes* and *ideation workshops* as parts of our research.

4.2.1. Cultural probes

Cultural probes can be defined as "diary studies" with a bundle of playful materials for self-observation within the probands' everyday life. Such probes serve as a source of inspiration

[37] The research project "Women's Phone" was conducted by the Deutsche Telekom AG in cooperation with IxDS in 2007.

and they make people rethinking the daily routines, feelings and desires (Graham et al. 2007; Hulkko et al. 2004). They are especially tailored to the respective research contexts and test groups. Consequently they mirror the researchers' assumptions in a visual as well as physical way. In this respect, also researchers have to be aware about their gender assumptions in order to avoid addressing stereotypes by their research tools (Bredies et al. 2008). Our probe kits contain a diary respectively scrapbook with small exercises and enough space for comments or impressions, an instant camera, pens, a pair of scissors, some post-it notes and postcards to help the users to document their daily routine, communication behaviour, needs and desires. Figure 8 illustrates the content of the probe kit.

Figure 8: Probe Kit

One might regard the cultural probes as a non-rewarding method without appropriateness as a reliable qualitative method for social scientific research. However, there are already a lot of insights out of the probes which are contrary to some of our stereotypes and assumptions concerning the younger generations: Most of the tested female participants did not match the image of a user, who wishes to own a cute, tiny and pink mobile.

4.2.2. Ideation workshops

After two weeks self-monitoring with the cultural probes, the participants attend an ideation workshop. Ideation workshops are an adequate method to develop new ideas and solution. Within the workshops the probands are slightly directed by a coach. Different creation techniques, presentation and moderation methods collect, structure and combine several solution ideas again and again. Therewith it is possible to develop modified perspectives and novel methods of resolution. The techniques aim at seeing beyond one's own nose.

Moreover the ideation workshops provide a deeper insight into the desires and needs of the given population as they give the opportunity to arrange role playing games. This "participatory theatre" as research tool studies narratives of identity, group behaviour and structures, illustrates social experiences and actions. Consequently self reflexivity arises because of the double role as being inside and simultaneously outside a role (Lamnek 2005: 651 et seq.; Stahlke 2001). In our context, we use it as a tool for user generated scenario building. Furthermore the group discussion at the end of the workshop affords the opportunity to recess issues which often arose during the workshop and in the probes.

We focus on women of different age groups. In the end we will have tested five groups. The composition of the sample was directed by thoughts about the different phases of one's life. In this regard we identified four stages: Teenager, young women in education as well as entrants, women in managing their business and private life, and the "silver agers". Table 9 gives an overview of the composition of the several target groups:

Table 9: Size and composition of the sample

Group	Age pattern	Number of people within each group
1	14-18	14
2	19-28	12
3	29-48	15

Group	Age pattern	Number of people within each group
4	50-65	15
5	to be defined[38]	15

Within each group we also emphasise various demographic characteristics, e.g. employment status, educational background, migration background, way of life. Thus it is possible to compare potential differences between the different cohorts. For instance, we assume that younger women do not disrelish permanent (electronic) communication as it might show a well-functioning network in their peer group.

The first outcomes of the first two age patterns verify that the group participants proved themselves to be highly motivated and trustworthy as they all returned almost all the materials. Besides, the documentation of the exercises as well as the completion of statements respectively figures and the scenario analyses were very comprehensive and accurate. The probes offer intimate insights from the subjects' private lives. Our co-operation partner, IxDS, develops design concepts and scenarios based on these insights. Afterwards IxDs engineers prototypes and tests them with the participants. The project is not finished yet. Therefore the final results will be published in 2010.

5. Discussion and conclusion

In our paper, we emphasise the relevance of gender and diversity aspects in industrial research and development. Until now there are only a few research projects, which combine these two different scientific strands: innovation on the one hand and gender and diversity on the other hand. Against this background, we propose an interaction of both strands as this may provide important impetus for both sides.

[38] As the project is not finished, we haven't decided about the composition of the last group. We plan to examine a male user test group in order verify our results achieved within the first four groups.

We proclaim that knowledge about the end-users respectively customers is essential for industrial research and development. Globalisation changes markets rapidly and should be considered when analysing markets and market demand. Moreover we argue that demographic trends and the social change of traditional gender roles of men and women have a strong impact on the society as individualisation comes to the fore. In this respect it can be worthwhile to focus on the diverse needs and prospects in order to avoid stereotyped innovations or products for a male norm society. Therewith it is important to reflect the concept "gender" consistently and to link gender into a superior diversity concept. The diversity concept should take the differences and similarities between the sexes respectively other diversity dimension into account. The consideration of gender aspects is important for a better understanding of the clients' needs and for producing saleable products. Nevertheless, more research results and examples of good practise, which point out the professional and scientific benefits of an integration of gender aspects in industrial research and development, are absolutely essential.

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Female Engineers: what kind of job?

Keywords: female, engineer, students, employment, graduates

Abstract:

This paper considers the working activities of Engineers from two perspectives: before and after entering the job market. The first evaluation is based on the answers given by students in the last year of their university curricula; the second one refers to the kind of activities carried out by Engineers after 5 or 3 years since graduation. The evaluations from students have been collected through personal interviews to 78 female and 58 male students in Electronics, Informatics, Telecommunication, Mechanics at the University of Bologna (Italy). The kind of activities carried out on the job market results from data collected by AlmaLaurea in Italian universities[39]. All the data are presented in a gender perspective.

Miretta Giacometti

1. Introduction

According to the survey carried out by AlmaLaurea among the graduates in Italian universities, the graduates in Engineering earn the second highest average salary (after 5 years since graduation Engineer' salary is € 1678 against € 2026 of the graduate in Medicine) and register the lowest rate of unemployment (5% after 5 years since graduation).

The data provided by the Italian Ministry of University show that in the academic year 2007-2008 the Faculty of Engineering registered the lowest percentage of girls who decided to start their university studies (about 20% of girls enrolled in Engineering out of the total students enrolled in the same Faculty).

These data put in evidence the need to launch policies to increase the number of girls who choose a university curriculum in Engineering.

[39] Each year AlmaLaurea carries out a survey among graduated in any Faculties of the Italian universities in order to monitoring their position on the job market after 1, 3 and 5 years since graduation. The presented data have been collected in the year 2008 (www.almalaurea.it)

Any policy should start from the assessment of the situation; this paper analyses some aspects of female Engineers when still in the university study and when already entered into the job market. The presented results aim at stimulating a discussion on the best ways to improve the private and working life of female Engineers.

2. What job in the future?

The university students have been asked about some topics which they consider as relevant for the future working activity:

- key aspects for choosing the job;
- factors which facilitate or prevent career advancement;
- founding a company.

2.1. Key factors for choosing the job

Ten suggested answers plus one open answer were proposed for evaluation. Each answer was scored from 0 (not important at all) to 3 (very important). The suggested answers were: coherence between university training and working activity; possibility to be creative; working environment and human relationship; recognition of one's own qualities and skills; balance between working and private life; potential advancement in career; secure job; income; time flexibility on the job; possibility to become a leader. The three resultings of the most important factors were the same for female and male students, but with different percentages: the male answers are more distributed among the ten possible ones (Table 10).

Table 10: Three most important factors for choosing future job

Factors	Female %	Male %
Potential advancement in career	73	58
Recognition of qualities and skills	65	58
Working environment and human relationship	64	61

2.2. Factors which facilitate or prevent career advancement

The students were asked about factors that, in their perspective, facilitate or prevent career advancement. Nine factors facilitating career advancement were proposed for evaluation. Each one was scored by the students from 0 (not important at all) to 3 (very important). The proposed factors were: doing with passion; continuous effort; adaptability to difficult situations; good level of knowledge; availability to travelling around; preferring working to private life; being able to take decision; flexibility in working time; being determined in personal relationship. For both females and males, the three most important factors were: being able to take decision; doing with passion; continuous effort. It is worth highlighting that "being able to take decision" is considered the most important aspect by a percentage of girls definitely higher (73%) than boys (56%). This gap might be considered as a confirmation of the stereotype that being determined in taking decision is felt by girls more "difficult" than by boys (Table 11).

Table 11: Three most important factors for facilitating career advancement

Factors	Female %	Male %
Being able to take decision	73	56
Doing with passion	71	71
Continuous effort	65	68

Ten factors preventing career advancement were proposed for evaluation. Each one was scored by the students from 0 (not important at all) to 3 (very important). The proposed factors were: taking care of others, underestimating one's own skills, difficult work/life balance, strong competition on the job, no personal vision, tiring working hours, men in leadership position, shortness of success role models, unavailability to transfers, low interest for highly-responsible positions. For both females and males, the three most important factors preventing career advancement were: no personal vision, low interest for highly-responsible positions; underestimating one's own skills, but with different percentage. Females seem more aware than boys about the importance of having a clear vision and being determined to reach highly responsible position. This awareness looks in contrast with the low percentage of women in leadership position, which confirms that other factors prevent females from reaching the highest positions. Or may be that the girls are aware but are not willing (Table 12).

Table 12: Three most important factors for preventing career advancement

Factors	Female %	Male %
No personal vision	55	51
Low interest for highly-responsible positions	41	36
Underestimating one's own skills	38	36

2.3. Founding a company

Students were asked whether they imagine themselves as a future entrepreneur. The answers from females and males were very different: only 26% of girls against 49% of boys had this picture in their future. The main motivations in favour of this choice are: personal satisfaction, independence, income (Table 13).

Table 13: Three most important motivations for funding a company

Motivations	Female %	Male %
Personal satisfaction	24	37
Independence	15	22
Potential income	14	24

The main reasons against funding a company are: financial constrains, too much risk, too much working time (Table 14).

Table 14: Three most important reasons for NOT funding a company

Reasons	Female %	Male %
Financial constrains	40	27
Too much risk	17	10
Too much working time	9	17

Table 5 shows that the perception of financial constrains is definitely higher for girls than for boys, which matches with the well-known unbalance between women and men in getting financial support from banks and other private sources. The highest perception of financial constrains may also be explained by the highest risk aversion of females (17% of girls against

10% of boys gave this answer as most important factor). Females' and males' evaluations are the opposite with reference to the importance of risk and working time.

The high gap between females and males as future entrepreneur (26% against 49% of positive answers from Engineering students) almost disappeared when the same question was put to students in the Faculty of Economics[40].

The training provided in this Faculty not only increases the attitude to found a company but also reduces greatly the gap between females and males: 68% of girls and 71% of boys think that in the future they might become an entrepreneur. The economic background also cancels the gender gap with reference to financial constrains (18% of girls and 18% of boys mentioned this factor) and also with reference to the risk, which was mentioned by 10% of females and by 10% of males students in Economics. Besides the general positive effects in terms on employability, including Economics into Engineering curricula might be considered a tool of gender balance.

3. What job today?

The data presented in the following lines refer to females and males graduated in the Faculty of Engineering in Italian universities. Their position on the job market is considered after 5 or 3 years since graduation, with reference to: rate and time of employment, kind of employment, sector of activity, average salary.

[40] This question was answered by 73 female and 71 males students in the last year of university curricula in the Faculty of Economics of the University of Bologna.

3.1. Rate of employment[41]

After 5 years since graduation, more than 90 % of female and male graduates is working, but the percentage of females is lower than males. About 4% of females against 2,4 % of males neither is working nor is looking for a job, but these figures should be considered jointly with the information that 1.6% of females and 0.7 % of males are neither working nor looking for a job as at that time they are engaged in further university study or compulsory internship. The percentage of females looking unsuccessfully for a job is double than males. The comparison between employability after 5 and after 3 years shows that the gap between females and males is almost the same (Table 15).

Table 15: Rate of employment after 5 years and after 3 years since graduation

Employability	After 5 years		After 3 years	
	Female	Male	Female	Male
	%	%	%	%
She/he is working	92.9	96.3	88.8	91.1
She/he neither is working nor is looking for a job	4.2	2.4	4.7	6.0
She/he is not working but is looking for a job	2.9	1.3	6.4	2.9

Source: AlmaLaurea, 2009

3.2. Starting date of working[42]

The percentage of females who started a working activity before graduation is lower than males (18.4% against 22.4%) which might partially explain the shorter time taken by females to get graduated and the better score reached.

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41 The number of females graduates in Engineering interviewed is 310 (which is 82,7% of total female graduated) and the number of males interviewed is 1363 (which is 81.1 % of total males graduated).

42 The questions about starting date and kind of employment were answered by 288 females and 1312 males Engineers.

3.3. Kind of employment

After 5 years since graduation, almost 80% of women has a permanent position against almost 90% of men. Consultancy is given by females more than males. Part-time working activity is 2.5 times higher among females (table 16). With reference to permanent activity, the gap between females and males is slightly wider after 3 years since graduation. Even if Engineers have got a high level of employability, they still experience some gender discrimination.

Table 16: Kind of employment after 5 years and after 3 years since graduation

Kind of activity	After 5 years		After 3 years	
	Female %	Male %	Female %	Male %
Permanent	79.9	88.0	68.6	79.5
Temporary employment	8.0	6.2	10.4	7.0
Consultancy	9.0	4.4	12.6	7.8
Part-time	8.7	3.6	8.5	3.8

Source: AlmaLaurea, 2009

3.4. Sector of activity

Females are employed in Service sector more than men; the most relevant activities are consultancy and civil servant. In the Industry sector, Mechanics employs 17% of females and Building as well (Table 17).

Table 17: Sector of activity

Sector of activity	**Female %**	**Male %**
Agriculture	1.0	0.4
Industry	51.7	62.0
Service	47.2	37.6
Mechanics	17.0	23.6
Building	17.0	18.0
Consultancy in different areas	9.4	10.6
Public administration and Army	7.3	2.4

Source: AlmaLaurea, 2009

3.5. Salary

The average monthly salary declared by male Engineers was € 1739 against € 1451 declared by female Engineers. The gap is due not only to the more diffused part-time among women, but also to gender discrimination from the companies, as it is shown by the comparison among full time employees.

4. Discussion and conclusion

The survey among the students in Engineering shows that females' and males' evaluations are not so different. Focusing on one factor which is not among the three most important ones influencing the future job: "importance of balance between working and private life" it results that the gap is not so big as one might expect. This factor was evaluated very important by 22% of males and enough important by 66%. It was evaluated very important by 43% of females and enough important by 49%. So young males consider private life very or enough important as females do.

This attention to private life by young males makes it easier the way towards a gender balance.

The survey among the graduates in Engineering shows that some gender discrimination still exists, but the opportunities offered on the marketplace to people with this kind of qualification reduces its negative impact. This should stimulate young women to have their working career in Engineering fields.

Women's Underrepresentation in Technological Disciplines within Western Cultures: Issues and Possible Interventions

Keywords: STEM, Mentoring, USA, Europe, Higher education, Gender

Abstract:

Concern over the issue of women's underrepresentation in the so-called "STEM" (science, technology, engineering, and math) disciplines has been well documented in the literature for more than two decades. This paper will discuss the results of a two-fold examination consisting of: (1) issues with which women must deal when they choose to matriculate in one of the STEM disciplines (e.g., their personal identities as females, interaction with male peers and faculty, feelings of isolation, etc.); and (2) some recent interventions in the United States, Australia, and Canada, that ultimately aim to address such problems. A variety of programs designed to increase rates of enrollment and reduce the attrition levels of women undergraduates within the engineering disciplines will be reviewed. Of special interest will be the uses of holistic residential programs that include mentoring, counseling, tutors, and planned group activities as components of those strategies. Possible reasons for the disparity between males and females within engineering will also be examined.

Sharron Frillmann, Hale Oner-Keifer

1. Introduction

Concern over the issue of women's underrepresentation in the so-called "STEM" (science, technology, engineering, and mathematics) disciplines has been well documented in US scholarly literature for more than two decades (Seymour & Hewitt, 1997). Proactive efforts to address the problem would seem, on the surface at least, to be making a difference. For example, the National Science Foundation (NSF) reports on its website that, beginning in 2000, women earned more science and engineering bachelor's degrees than did men, and that this number has been on the increase every year (with the exception of 1988) since 1966 (NSF, 2006). However, upon closer examination the data tell a slightly different story. Aggregated within the NSF totals are such disciplines as the biological sciences, social sciences, and psychology, all of which traditionally attract far greater percentages of females than males. In sharp contrast are the computer sciences, mathematics, and statistical sciences, in which women earned a total of 20,724 baccalaureate degrees in 2004, as compared to

50,436 that were awarded the same year to men. Worse yet are the engineering disciplines, where women and men in 2004 earned 13,257 and 51,418 bachelor's degrees respectively (NSF, 2006).

Trends such as these are not unique to the US, nor are they the exclusive province of Western cultures. Women's low representation in the technological disciplines is a troubling phenomenon that has been observed in many nations. For example, Galpin (2002) characterizes the participation of women in the computer sciences in more than 30 countries as being generally "low – most countries fall in the 10 to 40 [percent] range with a few below 10 [percent] and a few above 40 [percent]" (p. 94). Another study (Bradley, 2000) examined data concerning a diverse selection of fifty-five countries from the UNESCO Statistical Yearbook to determine the levels of sex segregation among students in higher education. The author reports that in 1990, men were overrepresented in the fields of mathematics and science "by a factor of 5.4 in Finland, 4.4 in Denmark, 4.1 in Sweden…3.1 in Norway…[and] 3.0 in Japan" (Bradley, 2000; p. 8). In Turkey, engineering departments consistently have the lowest percentages of women both as students and as professors (Zengin-Arslan, 2002). Whereas in Germany, concerns over the demographic imbalance within engineering led the Joint Commission for the Reform of Higher Education in Land North-Rhine/Westphalia to create a special task force in 1998 called the "Expert Commission on Making University Engineering Courses More Attractive for Women." The Commission's findings were published in April 2000 in a booklet titled Wanted: Women engineers! (Dasse, 2002).

The purpose of this paper is not to provide an exhaustive examination of gendered trends within all of the STEM disciplines worldwide. Suffice it to say that, while there are exceptions, many countries – in particular those considered to be "Western" – exhibit evidence that is markedly similar to that which has been well documented in the US; namely, that women students' representation in the technological, mathematics, and engineering disciplines is not in parity with their proportion of the overall population. The discussion that follows will instead examine some of the lines of inquiry into potential causes of this phenomenon, considered by many nations to be an urgent problem. It will also give examples of some interventions currently in use, with special attention being given to mentoring. It will conclude with an overview of the forces that are pushing for change.

2. A Chilly Climate for Women

The search for explanations as to why women continue to be a minority population within the STEM fields of study in so many cultures has taken several directions. For example, one portion of the literature on postsecondary persistence has been strongly critical of the cultural environment that pervades these disciplines on college campuses. In the US, Hall and Sandler (1982) hypothesized more than two decades ago the presence of a cultural deterrent against women and other marginalized groups within STEM educational environments that they termed a "chilly climate." Subsequent studies have found support for their chilly climate hypothesis, not only for women who matriculate in these disciplines but for minority groups as well. For example, an investigation by Bonous-Hammarth (2000) found that measures of academic climate were negatively associated with persistence in engineering for the study's target group consisting of 330 African American, Native American, and Latino undergraduates. Even more recently, Anderson and Kim (2006) found that, despite large majorities of them declaring initial interest in a STEM major upon enrollment in a four-year institution, fewer than half of the African American and only slightly more than half of the Hispanic first-year students in 1995-96 had persisted to a bachelors' degree by the Spring of 2001.

The chilly climate hypothesis (Hall & Sandler, 1982) has in also given rise to a large body of relevant literature within social psychology. For example, Vogt (2003) administered surveys to 409 male and 304 female American undergraduate engineering students matriculating at four large west coast universities during the spring semester of 2002, for the purpose of investigating whether or not "there is something particular about the engineering pipeline that may subtly inhibit women" (p. 221). The investigator found that environmental variables such as discrimination affected academic self-confidence and self-efficacy, and these "in turn had a fairly strong correlation with GPA" (p. 227). More importantly, previous biases about women's perceived inherent academic and math abilities "seem to have been unsubstantiated by this study," declares the author (p. 233). However, "[i]n terms of discrimination, the women felt that their male peers did not respect them as equals…and that men had an advantage because of their heightened confidence levels…[T]he women in this study also seemed to recall more frequent interactions with professors that were discouraging" (pp. 234-235).

Nor are such findings unique to the US. In order to discover what would cause otherwise qualified women students to attrite from engineering, Wächter's (2005) administered questionnaires to 699 engineering students (335 females, 364 males) in Austria, Finland, France, Germany, Greece, Slovakia, and the United Kingdom. In addition, qualitative interviews were held with students who were either studying engineering, who could have but chose not to, or who had left the discipline or dropped out of school, in all of the aforementioned countries except Greece. Women respondents reported feeling relentless pressure to "perform better" and to "constantly…prove [their] technical competencies. Often they are also addressed as 'the secretary," and additionally they "are confronted with subtle but persistent discrimination in the form of jokes, remarks, [and] different exam standards…Gender fair language is not used and is made fun of" (Wächter, 2005; p. 54). Engineering will need to provide a more accepting and inclusive environment if women are to feel a part of it, declares the author, and her article concludes with 20 specific recommendations for improvements to the discipline.

3. Gender, Choice of Major, and Attrition from STEM

Efforts to create a more ethnically diverse and gender-neutral environment within STEM have led also to investigations of differences between the socialization processes of males and females. For example, Margolis and Fisher (2002) and Seymour (1995) found that female socialization plays a major role in eventual choice of college major. In the recounting of their study of computer science majors at Carnegie Mellon University, Margolis and Fisher (2002) declare that women's apparent lack of interest in and/or disaffection with computer science is not genetic, nor is it accidental or inherent to the field, but that these are instead the results of many external influences. They trace the process back to the earliest roots of gender socialization within the home where, early in life, computing is all too often assumed to be the exclusive province of males.

Likewise Seymour (1995), writing with regard to all of the STEM disciplines, points out that girls and young women are subjected to gendered preferences expressed overtly and subtly not only by parents, but by teachers and school counselors as well. The author notes the existence of an impressive body of research about the processes at work that effectively

discourage young girls' interest in mathematics and science, the consequences of which "are discernible by ninth grade" (p. 438). However, at the time this study was published, far less had been written concerning the experiences of young women at the undergraduate level who choose to major in science, mathematics, or engineering (SME). What was then known was (a) that women's persistence rates were significantly lower than men's; and (b) that both women who persisted in, and those who switched out of, an SME major had higher predicted GPA scores than any of the men (Seymour, 1995).

Seymour's article describes an ethnographic qualitative study undertaken with a sample of 335 US male and female undergraduates from seven study sites in four different geographical regions. for the purpose of shedding light on the causes of high rates of attrition from SME among both male and female undergraduates "of good mathematical ability" (p. 440). What she found was that, "[w]ithin a relatively short time of their entry to college, women who felt intelligent, confident in their abilities and prior performance level, and who took their sense of identity for granted, began to feel isolated, insecure, intimidated, to question whether they 'belonged' in the sciences at all, and whether they were good enough to continue" (p. 458). The author adds that ultimately, those young women who resist such negative feelings and choose to persist in one of the STEM fields may encounter a lack of acceptance and even overt hostility from their male student peers, which in turn provides yet more evidence for the chilly climate hypothesis (Hall & Sandler, 1982).

In the years since the publication of Seymour's (1995) seminal article, many additional studies have been conducted among US STEM undergraduates that have substantiated her findings (e.g., Brainard & Carlin, 2001; Cross & Vick, 2001; Goodman, Cunningham, Lachapelle, Thompson, Bittinger, Brennan, et al., 2002; McLoughlin, 2005; Murphy, T. J., Shehab, R. L., Reed-Rhoads, T., Foor, C. E., Harris, B. J., Trytten, D. A., et al., 2007). Again, such reports have not been unique to American research subjects; similar conclusions appear in studies of populations in Turkey (Zengin-Arslan, 2002), Finland (Husu, 2005), Austria (Beraud & Cooper, 2005), Canada (Williams & Emerson, 2001), Australia (Cobbin, 1995), and "all over Europe [specifically France, Germany, Greece, Austria, Finland, Slovakia, and the UK]" (Sagebiel, 2005; p. 146).

4. Interventions

The call for curriculum reform. The search for causes of women's and minorities' underrepresentation has prompted some to reexamine the curriculum content typically found within STEM programs. For example, Busch-Vishniac and Jarosz (2004) have proposed a complete redesign of all engineering curricula from the ground up, focusing exclusively on content as opposed to pedagogy. Far too few studies have addressed the content issue, choosing instead to concentrate on innovative methods of delivery, state the authors. Rather than retrofitting superficial pedagogical changes, they advocate the creation of an entirely new product that is more attractive to underrepresented groups without losing salient technical material. A later work by the same authors (i.e., Busch-Vishniac & Jarosz, 2007) criticize the mechanical engineering curricula of nine US institutions on the choice of topics and advice the topics to be more appealing to a diverse group of female and male students.

Views similar to those of Busch-Vishniac and Jarosz (2004, 2007) have likewise been expressed by Reed Stevens and his colleagues (viz., Stevens, Amos, Jocuns, & Garrison, 2007), who assert that most engineering curricula are excessively laden with activities that will be of little value to the practicing engineer in the workplace. Like Busch-Vishniac and Jarosz (2007), Stevens et al. have issued an outspoken call for a purging of superfluous subject matter from the typical engineering course load. And on the other side of the Atlantic, the "Expert Commission on Making University Engineering Courses More Attractive for Women" (in Germany) has advocated the systematic reevaluation of existing curricular models, revisions in delivery methods, pilot programs in advising and mentoring, and supplemental training as needed for young women enrollees (Dasse, 2002).

4.1. Uses of mentoring

The phenomenon of women experiencing serious erosion in their levels of self-confidence is a theme that recurs repeatedly in the US literature pertaining to their high rate of attrition from engineering (cf. Judge & Leary, 2005; Cuny & Aspray, 2002; Murphy et al., 2007; Seymour & Hewitt, 1997; Etzkowitz et al., 1994). In marked contrast to the women's experience, Seymour and Hewitt (1997) cite three separate studies which found that the self-esteem and

career aspirations of the women's male peers actually increased during the same period. Such profoundly different responses along gendered lines have highlighted the need for a closer examination of the contrasts in socialization between females and males and of their distinctly different gender roles and expectations, as well as their acquired differences in learning styles, with the goal of tailoring intervention strategies that more specifically address the needs of women students. One especially noteworthy attempt in this direction is the work of Chesler and Chesler (2002). Their powerful article makes the case for what amounts to a profound cultural change within the discipline of engineering, and they propose what they describe as "a social contract for a caring community more supportive of all members' personal and professional growth and success" (Chesler & Chesler, 2002; p. 49, emphasis added).

→ In order to explain why such a change might be necessary or desirable, the authors first describe some significant ways in which early socialization differs according to one's gender. For example, from a very young age, females tend to assign greater importance to group affiliation over individual achievement than do males. Young girls usually are more successfully motivated by encouragement, while boys are more comfortable with challenge; girls prefer collaborative engagement on tasks, whereas boys lean toward competitiveness; and consequently, young women tend to envision their successes within the context of group affiliation, while young men are directed to strive for individual achievement (Chesler & Chesler, 2002).

→ Such differences in socialization are especially relevant to the issue of women's eventual success or failure in the sciences and engineering, state the authors, "because women are often less confident in and more alienated by the culture of fields that do not fit with their own learned styles" (Chesler & Chesler, 2002; p. 49). Specifically, upon entering the typical engineering program, women often find themselves immersed in an environment that emphasizes individual competition over cooperation and provides few opportunities for the collaborative and interactive learning formats that are more suited to their needs. And in stark contrast to a supportive, encouraging atmosphere, all too often they discover that they must fight for their academic survival against their department's attempt to "weed them out" of the program. As Seymour and Hewitt (1997) explain, engineering schools have historically viewed attrition as normal and even desirable, believing that the way to maintain enrollments was

through recruitment rather than retention. Efforts to deliberately eliminate or "weed out" the students who, it was believed, would eventually drop out anyway (for whatever reason) led to the creation of "gateway" courses designed to accelerate the process (Seymour & Hewitt, 1997).

Such policies have been shown to be very detrimental, not only to women students but to minorities as well. Furthermore, mentoring, as traditionally practiced within engineering, "does not fit well with the ways in which most women were socialized," state Chesler and Chesler (2002; p. 51). The mentor-protégé relationship model that is most often encountered within the sciences and engineering focuses upon challenging the protégé for the purpose of fostering independence, they explain, and its underlying assumptions are derived from the so-called "heroic journey" mythology of ancient Greece. (see Chesler & Chesler, 2002). Consequently the newly minted engineer usually enters the workforce as a competitive loner, ill-prepared to function successfully within the cooperative team environment that is found in most industrial work settings. Factoring in the differences in socialization between females and males, it becomes clear that women and minority students would tend to be alienated by such hazing practices masquerading as "mentoring".

→ Chesler and Chesler (2002) do, however, powerfully argue in favor of an alternative form of mentoring as an element critical to the success of any endeavor aimed at reducing women's attrition from engineering. Indeed, mentoring is the key element in their retention strategy, they state, but with a significant difference. In contrast to traditional dyadic models and the "rite of passage" approach to mentoring described above which have been shown to pose problems for women in male-dominated fields, the authors suggest an alternative which they refer to as collective mentoring.

→ Collective mentoring is unique among the various other approaches to mentoring as usually seen within an academic context, in that it places the responsibility for the creation and wellbeing of the mentoring team on senior faculty members and department heads. The would-be protégé is not expected to take sole responsibility for finding an agreeable mentor or for the maintenance of the mentoring relationship. Instead, the dyadic model of mentoring is replaced by network of relationships that comprise a mentoring team, and oversight of the activity becomes the responsibility of those in leadership positions. Thus the department leaders may manage to create a

caring community that facilitate successful performance, retention and advancement of their women students (Chesler and Chesler, 2002; p. 52)

→ The vision of Chesler and Chesler (2002) is likewise shared by Kahveci, Southerland, and Gilmer (2006), who report the success of a mentoring program that was implemented as part of a retention strategy for female science, mathematics, and engineering undergraduates at a major American research university. The focus of their study was the "Program for Women in Science, Engineering, and Mathematics," or PWISEM, a living-learning community established to encourage the participation of female undergraduate students in the science, mathematics, and engineering (SM&E) disciplines. Students enter this program in their first year and live together in an off-campus residence hall. They are given the opportunity to participate in a variety of PWISEM activities that include panel discussions, lectures, mentoring, advising assistance, research internships, tutoring, and field trips. "Thus, the program places a premium on student interactions with faculty and with other students," explain the authors (Kahveci et al., 2006; p. 35)

→ Another study (Kahveci et al., 2006) using a static-group pretest-posttest design to gather data via questionnaires from 35 PWISEM students and two control groups, one comprised of males and the other of females, who were enrolled in an honors chemistry curriculum resulted in with findings that happen to have much broader implications –which suggest that "[S]ome aspects of the learning environments in which many women feel most comfortable – particularly those which are interactive, cooperative, experiential, and learner-focused – are also congenial to many young men" (Seymour, 1995; as cited in Kahveci et al., 2006; p. 37; emphasis added). So regardless of gender the SM&E culture itself is important for success (Kahveci et al., 2006; p. 37).

4.2. Mentoring in other nations

Mentoring strategies such as those advocated in the US by Kahveci and colleagues (2006; see also Kahveci, Southerland, & Gilmer, 2007) and by Chesler and Chesler (2002) are being given serious consideration by reform-minded scholars elsewhere. For example, an

interesting proposal by a group of professors in Italy (viz., Amaroli, Beatrici, Ferrario, Mich, & Perini, 2002) enthusiastically describes plans to create a comprehensive mentoring project at their university. Their "basic motivation" for doing so, they explain, "is that of setting up an environment that is conducive to the increase of women research scientists…" (Amaroli et al., 2002; p. 4). Among their three major objectives is the creation of a long term strategy "to attract women in science and technology, through the participation to [sic] specific initiatives in collaboration with high schools and universities, aimed at promoting the discussion on gender diversity and [sic] science/technology" (p. 4). Hopefully they will eventually publish a report on the outcomes of this bold initiative.

In the Netherlands there is now a "national expert organization" that is making efforts "in many different ways to increase the involvement of women and girls in science and technology education…" It is important to note that this entity, which goes by the acronym VhTo, also states on its webpage that "[f]emales as well as male students and engineers are supported by these innovations" (http://vhto.nl/over-vhto/englelse-pagina.html; emphasis added). Intriguingly, Amaroli and colleagues (2002) report that the VhTo organization is conducting a mentoring project that they find "most interesting " (p. 3), although their article provides no additional details, nor does the organization's website.

Another mentoring program examined by Amaroli and colleagues (2002) is the Ada Lovelace Project, named in honor of a British mathematician and begun in 1997 at the Psychological Institute of the University in Koblenz [Germany]. Its purpose is to motivate young women to choose a career in the science, engineering, or mathematics [SEM] disciplines. Female students already matriculating in one of the aforementioned fields are trained as mentors, after which they are sent to "visit girls in schools and discuss their reasons for choosing SEM at the university level [and] talk about ways to fight obstacles…" (http://www.uni-koblenz.de/~alp/projekt_en.htm). Despite these impressive amounts of outreach (16,000 girls visited/ participated), however, there are evidently some in Germany who have yet to be convinced of the value of mentoring as a retention strategy for women students in STEM. Much more research concerning the benefits of such programs is needed in countries outside the US.

5. Factors Driving the Impetus for Change

5.1. United States

In the US, consequences of the disparity between women and men matriculating in the hard sciences can be readily observed in the workplace, where engineering, in particular, continues to suffer from a serious diversity problem. And this, in turn, perpetuates the disparity between the earnings of males and of women, especially minority women. For the fact is that Western cultures bestow their largest tangible rewards (especially financial) upon those who are competent in the technical fields. Without access to decision-making positions in sectors such as engineering and technology, women will continue to be denied social and economic empowerment (Brainard & Carlin, 1997). Furthermore, if the United States is to meet its growing need for world-class talent in these disciplines, it logically follows that higher education must more aggressively recruit and retain capable students not only from among women but from other underrepresented groups as well (Chubin, May, & Babco, 2005). Failure to do so will continue to translate into massive losses of opportunity for individuals, deficits of talent in the US workforce, and an irreparable loss of the creativity necessary for the shaping of this country's future (Cuny & Aspray, 2002).

5.2. Other nations

As in the US, other nations also have begun to recognize the need to fully develop their human capital as a means of remaining competitive on the world stage. Consequently, efforts to increase women's levels of participation in the sciences and engineering are likewise being made by organizations abroad, both governmental and within the private sector. One example of the latter is VISNET II (http://www.visnet-noe.org/html/partners/html) , a multinational consortium consisting of 12 partner institutions in seven European countries. While it has historically been largely a trade- and research-based organization dedicated to advancements in audiovisual systems, today several of its members have taken up the cause of gender imbalance within STEM. "VISNET partners are very serious about addressing the underrepresentation of women in science," declares the organization via its website, which then gives a short overview of several of its activities including a "gender watch system"

aimed at attaining gender equality in education and the workplace, along with a nine-point action plan for doing so (http://www.visnet-noe.org/visnet_one/fem_science.html).

Other attempts to raise women's levels of participation in the STEM fields have been outgrowths of a larger effort to improve overall professional competence, widely seen as "a prerequisite for enhancing the competitiveness of European higher education" (Manoliu, 2004; p. 4). One of the more notable of these is the Bologna process, which came about in 1999 following a conference of European ministers of education that involved 29 countries. On 19 June of that year the consortium issued the Bologna Declaration, a resolution calling for widespread standardization of European higher education by 2010 (Alexandre, Cardoso, Portela, & Sá, 2008). Over the course of the next several years the number of participating nations has grown to 40 and the goals in the Declaration have been refined and reinterpreted. Today, the Bologna process calls for the reorganization of European systems of higher education so that (a) agreed-upon standards will be put in place, enabling citizens to move easily from one country to another (within the "European Higher Education Area" [EHEA]) for further study or employment; (b) the overall quality of European higher education will increase, thereby attracting non-European students to study and/or work in Europe; and (c) the EHEA will provide Europe with a broad, high quality and advanced knowledge base, which will in turn ensure "the further development of Europe as a stable, peaceful and tolerant community" (Harvey, 2004; p. 1).

European scholars are in agreement that the implementation of the Bologna process will have widespread transnational consequences, many of which are not yet fully clear. Furthermore, the character of the process tends to vary between localities and organizations. For example, the European Commission has tended to view the Bologna process in economic terms, whereas in Berlin the "social dimension" with emphasis on reducing social and gender inequalities, building trust in social institutions, democratic participation and open debate, and appreciation of diversity in gender, ethnicity, religion and social class (Kwiek, 2003; pp. 16, 41) is receiving the most emphasis.

6. Conclusion

In her overview of public policy issues that are driving the push for women in STEM, Sevo (2006) notes that the demographics of the US student body are changing, and "that the underrepresented groups are quickly becoming the majority. If we are designing education for the majority, then we should be designing for girls, African-Americans, Hispanics, and immigrants – that is, a culturally diverse population" (p. 5). While it is certainly true that no two nations are identical, and that interventions shown to be effective within one culture are not necessarily going to work for another, it can nevertheless be said that education within a global context must of necessity also meet the needs of "a culturally diverse population." Furthermore, as has been shown, pressures to remain competitive within an increasingly market-driven and knowledge-based international marketplace are forcing nations to develop previously untapped sources of human talent. While one can certainly make other arguments in favor of diversity within STEM – e.g., quality of life arguments, social power arguments, educational equality arguments - in the final analysis, it is the relentless pressure of international competition that will ultimately bring about the seismic cultural change needed within these disciplines. As previously explained, it is this, in essence, that is being advocated from both sides of the Atlantic – for example, by Kahveci and colleagues (2006) in the US, and by Wächter (2005), writing from Germany. Women's participation within STEM disciplines is unlikely to increase significantly until the climate is perceived to be more accepting and inclusive by the populations that have hitherto been underrepresented within them.

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Investigation of the causes for the low attraction of female students in engineering careers

Keywords: female students, technical studies, engineering careers

Abstract:

This work presents the comparative results of a research conducted among male and female students of 26 technical universities of European countries. The questionnaires investigate the influence of family, school and social environment in the choice of studies, the correspondence of university programs with the expectations of the students etc. The research was extended, interviewing men and women in the working sphere, where women engineers present slower professional development compared to men. The conclusions of this research are particular important for the configuration of studies at Technical Universities and for the incorporation of women engineers in the technical sector of each country.

Panagiota Rouni, Theodora Kokla, Panagiota Katsakiori

1. Introduction

Throughout the European countries the number of young people undertaking engineering studies is falling, for this reason the European Union focus in intiatives attracting more young people and especially girls, provided that their presence is lower than boys, in the engineering profession. In Greece there is high number of female students in the Schools of Architecture and Civil Engineering but the number of female students to study Mechanical, Electrical or Naval Engineering remains low and the number of female engineers who establish their own company or have a high position in their company's rank remains also low. The under-representation of females in the engineering profession has become a 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. However, many studies have shown that women engineers can bring different views, diversity the mono-cultural engineering workforce and broaden the impact that 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

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 fight against gender gap in the European society.

The main objective of the research project 'Creating cultures for women in engineers WOMENG', which was conducted from 2002 through 2005 by seven partners[43] was to understand the reasons why women are not attracted by technology in general and engineering in particular and to propose efficient tools that could be used to correct this situation. The number of women engineers can be augmented by increasing the number of female students who study engineering and finish their studies and by reducing the number of female engineers who do not follow an engineering career after their studies. In order to achieve this on a European level it is necessary to understand the procedure someone has to follow to become engineer in each country and which are the factors and social stereotypes influencing the decision of young girls in each stage of their path.

2. Methodology

The research has been organized into three interlinked items:

I. Reasons for choices: aims to understand 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? 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 engineer. The next important time is to choose a course at university. Then, she must decide to pursue an engineering career so we also look at the first job. How easy was to

[43] Womeng Consortium: Institute for Interdisciplinary Studies of Austrian Universities (IFF/IFZ) (Prof. Dr. Christine Waechter), Witec Finland (Dr. Päivi Siltanen), Conference of Heads of Engineering Schools of France (CDEFI) (Dr. Yvonne Pourrat, Project Coordinator), Ecole Nationale Supérieure des Arts et Métiers (ENSAM – Paris) (Dr. Anne-Sophie Genin), Institut National des Sciences Appliquées (INSA – Lyon) (Dr. Jean Soubrier), Bergische Universität Wuppertal (Dr. Felizitas Sagebiel), The Greek Women's Engineering Association (EDEM) (Theodora Kokla), Faculty of Economics of the Technical University of Kosice (Dr. Oto Hudec), Scotland University of Stirling (Dr. Maureen Cooper).

get this job? How much training does the company give its engineers? How easy is it to become promoted?

II. Success – Non persistence: Not all women who choose to study engineering are successful. So the second theme of the research aims to identify internal factors (like self-confidence) and external factors (such as family 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.

III. Organisational culture and social change: This theme aims 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.

For the monitoring of the three interlinked themes of the 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 [1]. Tools that were used combine qualitative and quantitative methodology are thoroughly presented in a specific previous publication [2]. The design of the 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;

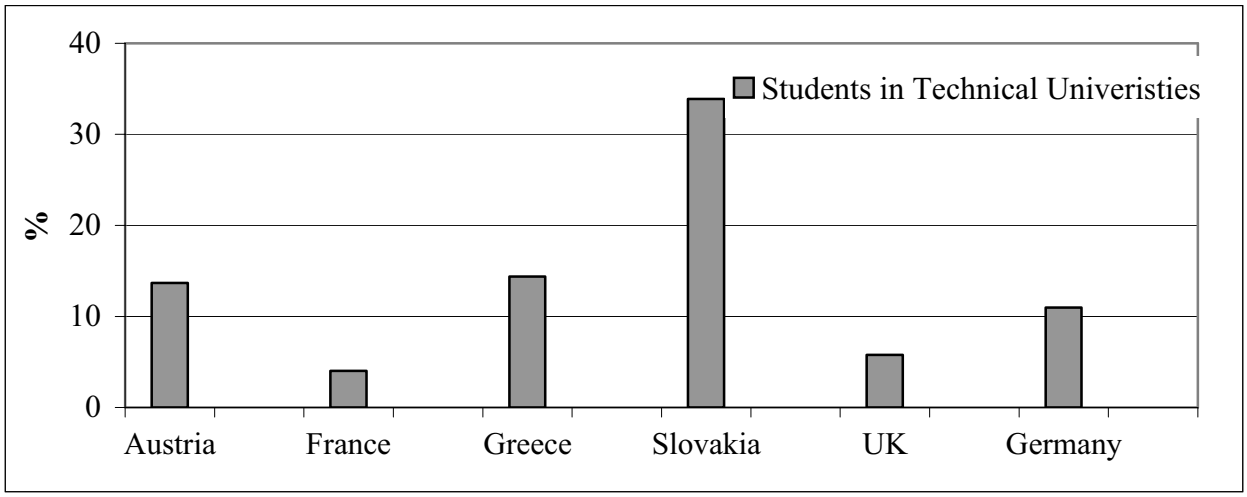
2. The standard problems of research design in human and social sciences, first of all the choice of qualitative, quantitative or mixed methodology, according to the needs of the research topic;

3. The large-scale issue, generating a huge amount of data.

Specifically, 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[44] 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”. Even if the participating countries differ by the size of their population or the percentage of students in engineering (Fig. 9), the same number of questionnaires was handed out in all countries.

Figure 9: Percentage of engineering students per country



The sampling philosophy was based on three assumptions:

1. The same methodology and sampling method 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.

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

Based on these, 200 questionnaires were handed out in each country the following way: 50 male and 50 female engineering students and 50 male and female students who could have chosen studying engineering but chose another faculty. According to the mean percentage of female engineering students in each country, 50% of the 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. The universities involved in the research are presented in the Table 1. 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, one with "good practices" in hiring and employing female engineers, and, if possible, one in the construction sector.

In Greece, the National Technical University of Athens (NTUA) and the Technical University of Patras were chosen for the distribution of questionnaires among students of enginnering. NTUA is the first Polytechnic School founded in Greece with a long tradition whereas the Technical university of Patras was established in 1967 but soon became one of the best known Universities in Greece. NTUA is situated in the capital of Greece, Athens, and the Technical University of Patras in Patras, the third city in population in Greece. The NTUA buildings are settled in a special campus, whereas the buildings of the Technical University of Patras are settled in the same campus with other University Schools, where the meeting of students from various disciplines is facilitated.

The female students' percentage were during 1999-2000 especially in Greece:

– Chemical engineers (42% female students, the highest relating to the other engineering studies)
– Civil engineers (30% female students)

Mechanical, electrical and computer engineers (8% female students of 8% which was the lowest)

Accordingly with the above persentages the NTUA questionnaires were selected from:

- 5 female and 5 male students of chemical engineering
- 7 female and 7 male students of civil engineering
- 13 female and 13 male students of mechanical, electrical and computer engineering

and the Technical university of Patras'questionnaires were selected from:

- 3 female and 3 male students of chemical engineering
- 4 female and 4 male students of civil engineering
- 8 female and 8 male students of mechanical, electrical and computer engineering

The number of the completed questionnaries per country is presented in Table 19.

Table 18: Universities involved in the research by questionnaires

Country	Q1: 100 questionnaires to engineering students (goal 50 men/50women)	Q2: 100 questionnaires to students who could have chosen engineering, but did not (goal 50 men/50women)
Austria	Graz University of Technology Vienna University of Technology University of Linz	University of Graz University of Vienna University of Linz
Finland	University of Oulu University of Helsinki University of Tampere, University of Jyväskylä	University of Oulu University of Tampere University of Jyväskylä
France	ENSAM in Paris Centrale-Lyon INSA-Lyon Université de Technologie de Troyes ENSCP in Paris	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 Technical University of Aachen University of Wuppertal Technical Univ. of Applied Sciences, Berlin University of Applied Sciences, Stralsund	Technical university of Berlin Technical University of Aachen University of Wuppertal Technical university of Applied Sciences, Berlin
Greece	National Technical University of Athens Technical University of Patras	Pantheion University Athens University of Economics and Business, University of Piraeus National and Kapodistrian University of Athenss
Slovakia	Technical university of Kosice Slovak University of Technology,Bratislava Technical university of Zilina	Technical university of Kosice Matej Bel University, Banska Bystrica Safarik University, Kosice University of Presov
United Kingdom	Glasgow University Strathclyde University Napier University Edinburgh Heriot-Watt University	Glasgow University Strathclyde University Napier University Edinburgh Heriot-Watt University

Table 19: Completed questionnaires Q1 and Q2 per country

Country	Q1 in engineering students			Q2 in non-enginnering studies		
	males	females	Total	males	females	Total
Austria	45	34	79	55	58	113
Filand	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
Slovak Rep.	49	49	98	51	49	100
Un. Kingdom	56	50	106	32	41	73
Total	364	335	699	282	355	637

When using cross-comparisons in social studies, two main categories are identified [3]:

- A vague and abstract variable-oriented approach, based on quantitative data from many countries. That methodology misses the connections to actual empirical process, social bases and specific phenomena, but enables comparisons between many different countries.

- A case-oriented approach, on the other hand, 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.

Ragin proposes “to formalize qualitative comparative methods without departing from the general logic of case-oriented approach” [3] 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. Mixed methodologies, which are still emerging, have been thoroughly described in [4]. 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. 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 and when it was possible, collected from EUROSTAT.

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 information about selected companies.

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 and to find reasons and explanations for results observed in data I and II.

→ Quantitative and qualitative methodologies were designed to allow mixed and iterative methodologies: some questions are common to questionnaires and interviews or focus groups. The sets of data in seven different countries form a rich database offering possibilities of testing a number of associations, correlations, etc. This means that direct access to the data, which is the usual research situation, is no longer achievable. 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.

→ During the project, we also encountered practical problems. 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 to find 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. The number of interviews and fieldwork about professional sphere per country are presented in Table 20. 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. 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.

Table 20: Interviews and fieldwork about professional sphere per country

Research in	Austria	Filand	France	Germany	Greece	Slovakia	UK
Women engineers	2	3	1	2	-	2	1
Hunan Resource Managers	2	2	2	2	2	1	-
Managers	5	6	6	7	4	4	6
Representatives	2	1	1	2	2	3	-
Men engineers	-	-	1	1	-	-	-
Retired women engineers	4	4	3	4	3	4	3
Internet	2	2	2	2	2	-	2

5. Discussion and conclusion

Most of girls choose engineering studies because they are interested in mathematics or in sciences at school or because becoming an engineer offers good professional perspectives and social recognition. Despite the differences in the educational system of each country, children are also influenced by the professional status and educational level of their parents and from examples in their social environment as well. In the following figures 10-13, the educational level of parents (mothers and fathers) for male and female engineering students is presented. It is obvious from the greek data that the university education of parents – not necessarily in engineering- is a positive factor for the girls to choose engineering studies whereas the boys choose the engineering studies even if their parents are not university graduates.

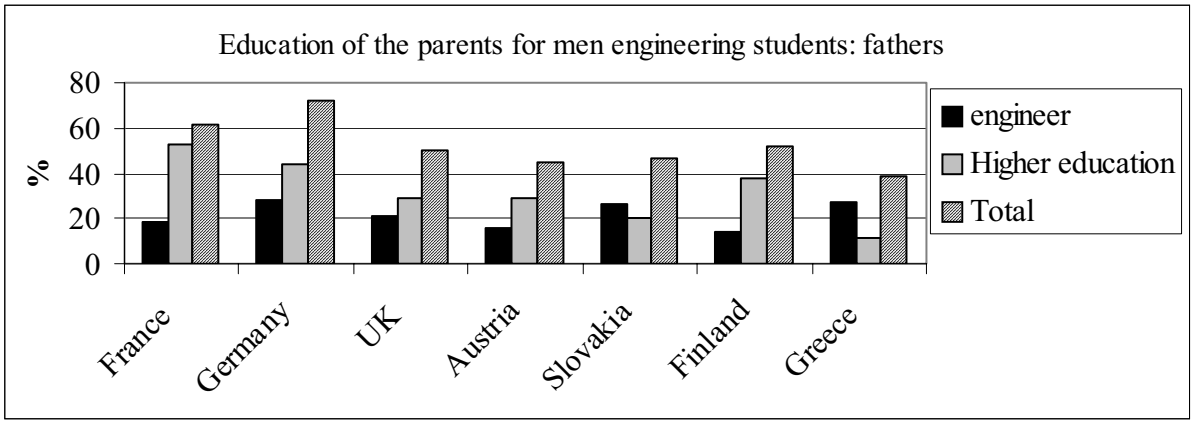

Figure 10: Education of the parents for men engineering students: fathers

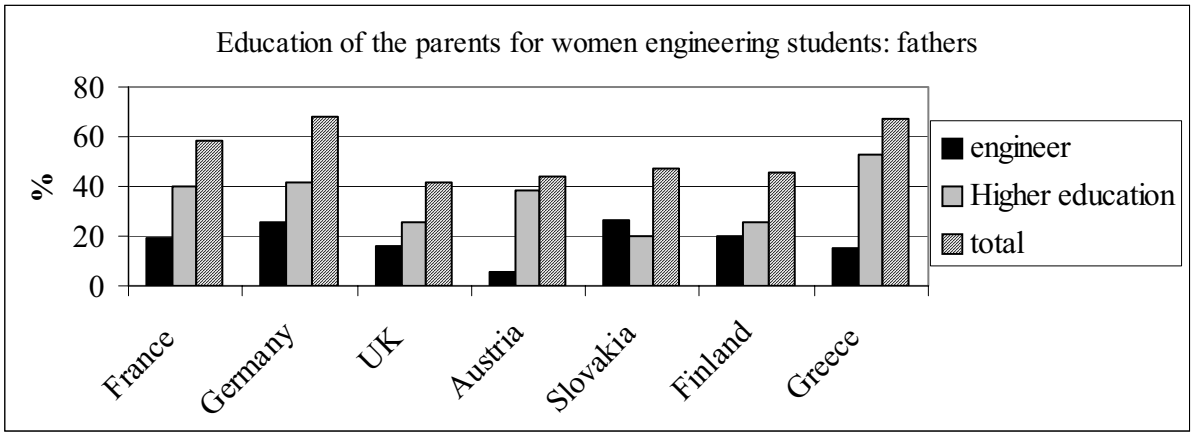

Figure 11: Education of the parents for women engineering students: fathers

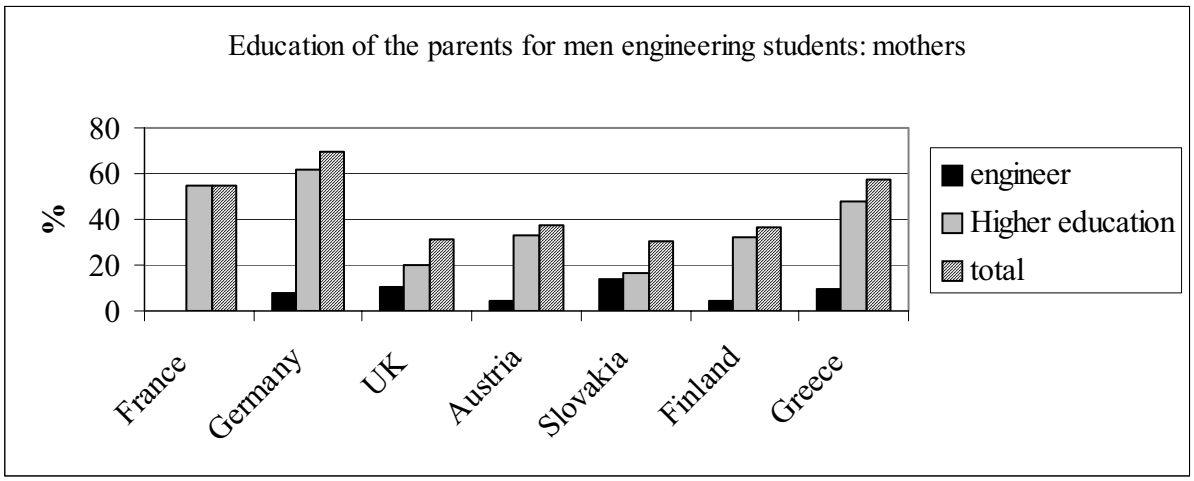

Figure 12: Education of the parents for men engineering students: mothers

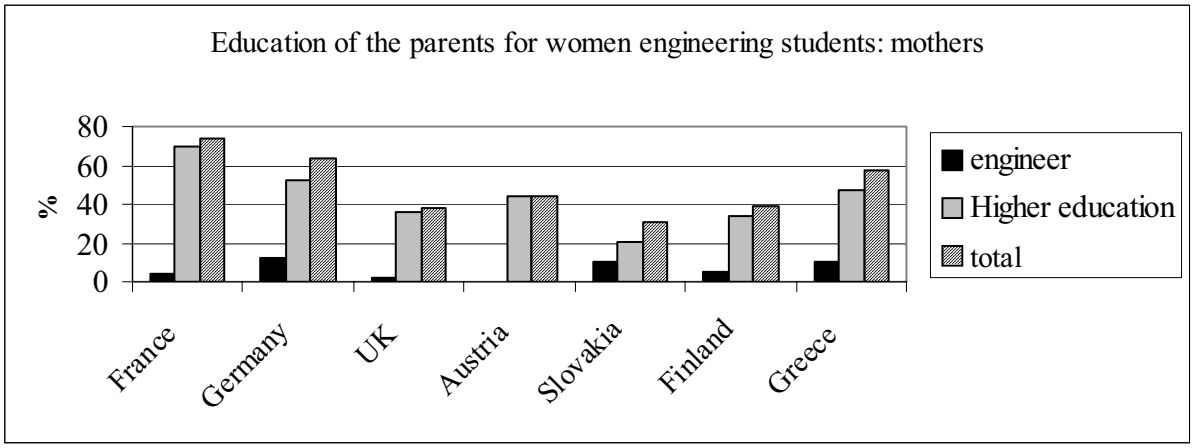

Figure 13: Education of the parents for women engineering students: mothers

In the question if femminity fits with the image of a female engineer, the Greek male engineering students were negative (fig. 14) influenced by the professional stereotypes of Greek society.

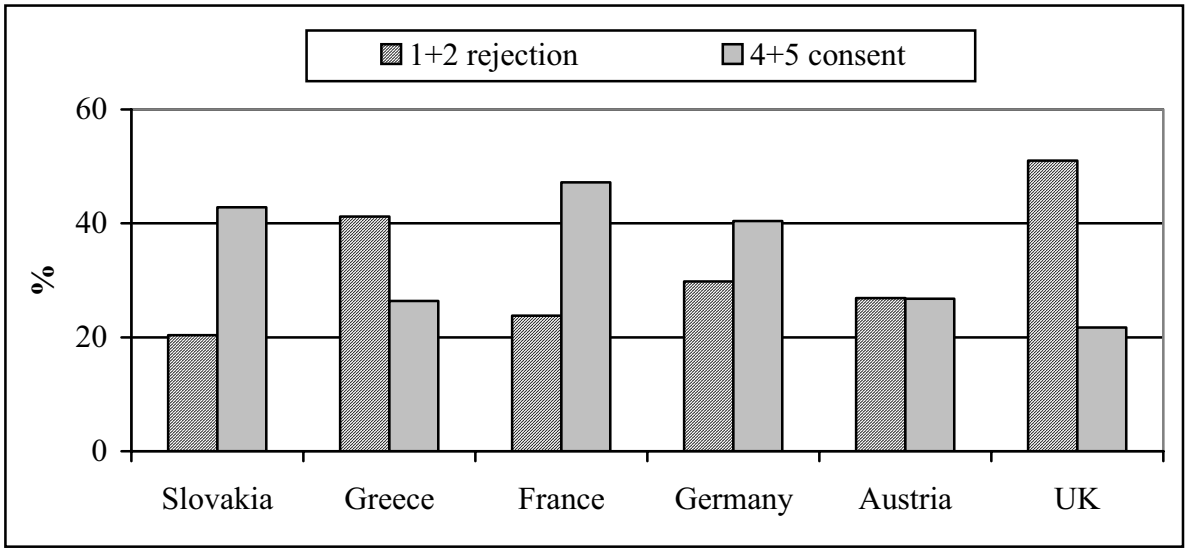

Figure 14: Femininity fitting (%) with the image of a woman engineer (answers of male engineering students)

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 of the profession of engineers. It is important to emphasise that engineering is a caring subject, responsive to the needs of society by providing more information about careers and courses through web pages, 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. Welcome events at the start of semester, team work, institutional and peer support will help to integrate female students into the family of engineers. 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.

In terms of the labour market, things are much more difficult for women and especially for female working in the technical sector. It was reported that people graduating from engineering schools search for the personal, social and mental satisfaction and that the salary is not the most vital factor. In our samples, both male and female students have similar ambitions and motives. All students, male and female start with the same expectations but female engineers do not get as easily promoted as male ones. From the interviews collected, it was obvious that the stereotypes and the discrimination towards women are present even in the first job. A great difference was apparent between what the companies promise for equal opportunities at work and what is really happening.

Dual carreers, the conciliation of personal and professional life, the pressure and the sense of feeling guilty for not conforming to the expectations of the company and the society are the most frequent problems of female engineers. 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 field. Good practice companies have a code of conduct that does not allow harassment or discriminative behaviour and they 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 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. Networking and mentoring programs are important ways of bringing women in technical fields into contact with interested young women. Contrary to young men, young women seldom know engineers of the same sex in their environment so role models, are an important source of information, motivation, affirmation, and support. Consciousness-raising programs could appear to increase young women's interest and motivation to pursue careers in science or engineering. 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 [5]. In order to implement gender-sensitive recruitment policies, a standard evaluation procedure about empoloyemnt percentages should be established. This would contribute to more comprehensive, gender-specific company data, which up to now are not available.

Acknowledgement

The research was conducted in the frame of the project 'Creating cultures of success for women engineers' Womeng RTD funded by the European Commission in the 5th FP, Specific Prpogramme "Improving the Human Research Potential and the Socio Economic Knowledge Base" (HPSE-CT-2002-00109).

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International Mentoring – A Model of Best Practice of Gender-Equal Human Resources Development

Keywords: career development, mentoring, women in science and technology, international cooperation, model of best practice

Abstract:

Based on the observation of a continuing under-representation of women in science and technology, the article describes the implementation of the international mentoring programme TANDEMplusIDEA for high potential female postdocs of natural science and engineering. Alongside five important quality criteria for mentoring it comments on preliminary results of the programme and presents mentoring as an effective instrument of gender-equal human resources development. A special focus is given to the benefits of an international mentoring concept and international cooperation in executive development.

Elke Breuer, Carmen Leicht-Scholten

1. Introduction: Women in academia, science and technology

Although the number of women in science and engineering has constantly risen over the last years, they are still under-represented in both industry and academia, especially in leadership positions. Although in Europe around 30% of all graduates in science, engineering and technology are female, the number of women in top positions drops to 14% (European Commission 2005). Germany is among those countries with the lowest percentage of women: In 2007 only 8% of all professors in engineering were female (Statistisches Bundesamt 2008). At the same time it is interesting to observe that the number of women decreases the higher it goes in the hierarchy. In 2007, 51,8% of all university graduates in Germany were women, and they accounted for 42,2% of all dissertations, but only 24,3% finished a postdoctoral lecture qualification, and only 16,2% were professors (Statistisches Bundesamt 2009). This so-called “leaky pipeline” is a phenomenon observable throughout Europe. During the last years various studies have analysed the barriers that women in scientific careers face, with

recent findings more and more indicating that structural barriers have a stronger impact than individual obstacles.[45]

One important finding is that female scientists feel less encouraged and supported, and only marginally integrated into the scientific community (Lind 2006). At the same time mentoring and networking structures are considered as crucial for professional careers. As Allmendinger/Fuchs/von Stebut (2000) state, successful scientific careers are essentially based on informal structures that are provided by scientific mentors. The better junior scientists are integrated into their scientific community, the more likely is it that they stay in academia. This likeliness is much higher for women (93%) than for men (54%). The study also showed that women get less support than men in important career situations, that they have less access to professional networks and can hardly find female role models in science. These findings were confirmed for example by Krimmer/Zimmer (2004). The female respondents of their study replied to 65% that power in science was primarily bound to informal networks; 69% of all interviewed female professors felt less integrated into these structures than their male colleagues. The importance of mentoring and networking has also been stressed by consultancy firms like McKinsey & Company who recommend: "Coaching, network-building or mentoring programs can be highly effective in raising women's awareness of the limitations they impose on themselves and enabling them to manage their careers in a male-centric environment" (McKinsey & Company 2007: 21).

These research results are especially relevant for the male-dominated culture of engineering. Academic human resources development needs to take them into account if it aims to provide a constructive and supportive working atmosphere for all scientists. Against this background, during the past years formal mentoring programmes have been developed at universities as a strategy of equal opportunities. The term mentoring refers to the relationship between a more experienced person (the mentor) and a less experienced person (the mentee) with the aim to support the latter's personal and professional development and career (Löther 2003). In Germany, there are currently around 100 programmes at universities that support women on all stages of qualification.[46] Their reasoning is not only an issue of equal rights for men and women, but also of economic considerations. More gender diversity among the staff makes a

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45 For an overview on the situation of female scientists in German universities see Lind (2006).

46 Mentoring programmes are also extensively used by major companies, e.g. Bosch or Deutsche Bank. In the programme TANDEMplus RWTH Aachen cooperates with Siemens in one of the first mentoring cooperation schemes between academia and business (Leicht-Scholten 2007).

major contribution to the creativity and quality of research, and enriches the competences that are necessary to solve complex problems (Wissenschaftsrat 2007). Therefore, in the long run it will also benefit the scientific and cultural climate by enriching the diversity of role models, norms and views on gender and science (Leicht-Scholten 2008a). Not least, gender- and diversity-oriented human resources development is a necessity seen against the demographic background of a future shortage of excellent staff in many countries. To remain competitive in the future, European universities will have to attract and retain women on all levels of the academic hierarchy, especially in top positions.

In this article we will present the concept, objectives and modules of the first international mentoring programme for female scientists of natural science and engineering. Without being able to discuss the general ambivalence and limitations of mentoring (for example Strasser/Schliesselberger 2000), we argue from the standpoint of a proven effectiveness of mentoring programmes at universities. We would like to show how the established model of mentoring can be expanded through an international approach which allows additional benefits for the participants. While the scientific evaluation of the project is not yet completed, we will present preliminary results with regard to the various stages of implementation. Thereby we hope to show mentoring as a concept to tackle the underrepresentation of women in science and technology and will especially point out the benefits of international cooperation in executive development. In our case its strength lied in the strong cooperation between technical universities and a potential transfer of female scientists.

2. International mentoring at technical universities – TANDEMplusIDEA[47]

2.1. Partner universities: The IDEA League network

The IDEA League is a network of five leading technical universities in Europe, Imperial College London, TU Delft, ETH Zurich, RWTH Aachen University and ParisTech. They cooperate in research and education, aiming to establish Europe as a technological and

47 For an overview on the project see also Breuer/Leicht-Scholten (2009).

scientific leader.[48] Under the leadership of RWTH Aachen, the IDEA League's central group on equality and diversity has developed and implemented an international mentoring programme for female postdocs of natural science and engineering. Funded by the 6th framework programme of the EU between 2007 and 2010, the project TANDEMplusIDEA contains the conception and implementation of a modular mentoring scheme for female scientists and its scientific evaluation. The project coordination is based at RWTH Aachen's department "Integration Team - Human Resources, Gender and Diversity Management" (IGaD). Here, the programme TANDEMplusIDEA is part of a coherent strategy of gender- and diversity-oriented human resources development that sees mentoring programmes as a tool to attract and promote high potential female scientists on the different career levels.

2.2. Objectives and participants

The programme TANDEMplusIDEA supports and encourages high qualified female research staff to apply for and obtain leadership positions, thus increasing the number of female professors on European and international level, Ultimately, the project aims to achieve a better balance of sexes in academia, science and technology. This could lead to improved gender equality in science and more diverse research cultures at universities, enriching research and education in general.

The international dimension makes TANDEMplusIDEA extraordinary and adds an extra profit for the participants: It addresses issues that are important for worldwide careers, facilitates international exchange and networking among scientists, and fosters further collaborative working in Europe. In this sense, the programme also benefits the participating universities because of increased employee retention among the project's participants and potential scientific collaborations.

Participants of the programme are sixteen high qualified female scientists, four each from the four partner universities London, Delft, Zurich and Aachen.[49] The mentees were chosen in a two-stage selection procedure based on written applications and interviews with expert

48 More information: http://www.idealeague.org.

49 ParisTech is an associated member in TANDEMplusIDEA as the university joined the network after the project had already been conceptualised.

committees. A good assessment of the potential mentees is essential for the success of the programme because it is necessary that the participants can identify with its concept and have a clear idea of their own goals (Hansen 2006). All mentees had completed their PhD at least a year ago and were pursuing a career in academia. The chosen scientists represented various fields of science and technology, with 66% coming from natural science and 33% coming from engineering.[50] The group was not only international because of their affiliation to the four partner universities, but also with regard to the origin of the scientists who hailed from eleven nations.

2.3. The programme

TANDEMplusIDEA was realised between February 2008 and March 2009, with the final event, an international conference, taking place in October 2009. The programme was based on three modules: one-to-one-mentoring, training and networking. In the mentoring part, the mentees were paired with a scientific mentor of international reputation. They were free to choose a male or female mentor, according to their needs and expectations. Choosing a female mentor can have a special importance: Being mentored by a female professor means for the mentees - often for the first time – to meet an excellent female scientist in their scientific field and to find a supportive role model. The other two instruments of networking and training served as an introduction into the scientific community and as a further qualification for a career in science (Leicht-Scholten 2007). At a Summer and a Winter School, TANDEMplusIDEA offered training seminars that were conducted by external trainers and dealt with topics related to international careers in science and technology. Networking events with international speakers complemented the programme and offered the participants the possibility to exchange and network among the group and with external speakers and guests.

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[50] This classification includes interdisciplinary areas like computational chemistry. In the course of the programme it also turned out that many research areas were interwoven with each other. This interdisciplinarity confirms the profitableness of combining the two target groups of natural scientists and engineers in one mentoring programme. For further results on the adjustment of mentoring programmes to the different scientific disciplines see Leicht-Scholten (2008).

2.4. First results

In our remarks we are oriented at research on the evaluation of mentoring programmes. In particular, we have appraised the programme against the framework for the successful realisation and implementation of mentoring programmes by Hofmann-Lun/Schönefeld/Tschirner (2000), Hansen (2006), and the quality criteria developed by the German networks Ada Lovelace Mentoring e. V. and Forum Mentoring e.V. in cooperation with Arbeitgeberverband Gesamtmetall and Siemens AG (2008). With these criteria in mind, we have structured our evaluation according to our own experiences and would like to comment on five key areas.

2.4.1. Structural affiliation

As Hofmann-Lun/Schönefeld/Tschirner (2000) observe, an important factor for the successful realisation of a mentoring programme is a strong structural affiliation and backing from the top management of the institution. In a university, this role will be ideally filled with a representative of the rectorate, the steering committee, or the deanery (Hansen 2006). This condition was met by the programme TANDEMplusIDEA in two ways. The programme had the support and commitment of the top executives of all four partner universities. Each event was opened by the rector or president of the host institution. Additionally, the coordinators from the partner universities – the project coordination at RWTH Aachen as well as the national coordinators at the other three institutions – held influential positions in the fields of human resources and/or gender mainstreaming.[51] In that sense, the project consortium had the required knowledge to implement the project successfully. It also allowed the partners to integrate the programme into their executive development.

Within the project consortium the coordination at RWTH Aachen was responsible for the overall conceptualisation, realisation, evaluation and public relations of the project. The

[51] As mentioned above, at RWTH Aachen the coordination was based at IGaD (Integration Team – Human Resources, Gender and Diversity Management) that is directly situated at the rector's office. At Imperial College London, the deputy director for Human Resources was responsible; at ETH Zurich the Office of Equal Opportunities for Women and Men, and at TU Delft a senior staff member in the department of personnel and organisational development.

project partners supported that work and were in charge of the implementation and organisation of the project events at their institutions. The cooperation was very successful; however, it cannot be denied that there was a certain friction loss caused by the decentralised structure of the consortium. For example, the mentees had two contact persons, the project coordination and their national coordinator. It might be argued that a better supervision is possible if only one person is responsible for the mentees, as that would allow a better overview on their development. On the other hand, the advantage of the applied model was a direct contact person at each of the four universities, which allowed a closer supervision than a single coordinator could have achieved.

2.4.2. Introduction of the programme

The evaluation of mentoring programmes has shown that extensive information on the programme for all involved groups is a success criterion; a finding that corresponds with our own experiences with other programmes. In the realisation of TANDEMplusIDEA it was secured through several elements. During the personal conversation in the selection interviews the mentees were informed about the prerequisites and proceedings of the programme. The same applies to the mentors when they were contacted by the coordinators. At the beginning of the programme both parties received an extensive mentoring brochure that collected important information on the programme and the mentoring concept. Additionally, the first training seminar introduced the topic of mentoring and provided the opportunity to solve questions. During the whole duration of the programme, the coordinators were available for help and support.

The preliminary analysis of the first evaluation sheets shows that an intense supervision of the mentoring relationship is necessary and desired by the participants. One lesson learned is to postpone the naming of the mentor. The mentees were asked for suggestions for potential mentors before the programme had started. While this proceeding had been intended to guarantee a soon start of the mentoring relationship, several mentees later commented that their choice would have been easier if they could have named a mentor after the introductory session. The information of mentees (and mentors) might also be an issue to discuss with regard to the decentralised structure mentioned before.

2.4.3. Implementation

Relevant factors for the implementation of the programme are with Hofmann-Lun/Schönefeld/Tschirner (2000) the realisation of a framework programme of training seminars and networking events, as well as the consideration of the participants' expectations. Both requirements were fulfilled by TANDEMplusIDEA. All events, both seminars and both networking events, were tailored to the needs of the participants with regard to content, duration and place. The mentees' suggestions for the next meeting were requested after each event. The events were organised alternately at the four partner universities, each time offering new stimuli, introducing new organisations and people, and thereby preparing stronger bonds for future international mobility and exchange.

2.4.4. Evaluation and quality management

The necessity of quality management and scientific evaluation of mentoring programmes is stressed – among others – by Hansen (2006) and Löther (2003). As the latter indicates, it is useful to collect qualitative and quantitative data, and to interview the participants at the beginning, in the middle, and after the end of the programme. The evaluation of TANDEMplusIDEA reflects this demand as it is based on three written surveys conducted with the mentees at each stage of the programme. The data contrived allows an evaluation of the overall success of the programme TANDEMplusIDEA, but also enables the further development of (international) mentoring programmes in general. In addition to these questionnaires, each training and networking module was evaluated by the participants. A desirable extra for a follow-up of the programme might be a survey of the expectations and experiences of the mentors. In general, as Löther (2003) observes, the evaluation of mentoring programmes focuses mainly on two aspects: its successful realisation, and the long-term effects of the programme on the mentees. She also remarks that these evaluations are usually difficult because the programmes (and their funding) end before long-term effects can be observed.[52] Höppel (2003) also points out that achievements of the mentees cannot unambiguously be traced back to their participation in the programme but are rather due to their scientific excellence.

52 A long-term evaluation of TANDEMplusIDEA will be realised at IGaD at RWTH Aachen.

2.4.5. Benefits

Having said the above, some important preliminary assessments of TANDEMplusIDEA can be mentioned. They were collected through formal and informal interviews at the programme events, and reflect in particular the satisfaction of the mentees with the modules mentoring and networking. In an intermediate survey, 75% of all mentees pointed out that their mentoring relationship was extremely beneficial. One mentee commented:

> "I really enjoy the mentoring part. I have a great mentor, the cooperation is very useful, and it gives me new ideas and opportunities."

Evaluative remarks also suggested that the majority of mentees was extremely content with the networking effects, not only with their mentors and other invited speakers, but also and in particular among the peer group. This positive consequence of peer mentoring has already been noted in the evaluation of other mentoring programmes (e.g. Leicht-Scholten 2008b, Bagilhole 2005). However, the international dimension of TANDEMplusIDEA was especially appreciated:

> "It was in particular the international focus of the programme that appealed to me. Academia is very different in each of the four countries, and the mentees are very international. This gives us an insight into career opportunities in different countries. The project helps me to consider various career paths, offers orientation on my scientific way and enables me to share experiences and network with other international female scientists." (one mentee)

Research shows that it is normal that not all participants profit the same from all three modules. As Leicht-Scholten (2008b) points out in her comparative study on mentoring programmes with disciplinary focus, those mentees who are not as satisfied with one of the instruments take much more advantage of one or the two others.

Another positive result was indicated recently when one mentee suggested the group to scientifically collaborate. This approach is a good sign that the network was established successfully and will continue on its own in the future.

5. Conclusion: International mentoring as a model of best practice

In this article we have depicted the realisation of the international mentoring programme TANDEMplusIDEA and described first observations and results. The preliminary findings are very positive, especially regarding the programme's strong structural affiliation and its successful implementation. The most important criterion for the latter's evaluation must be the participants' satisfaction. As could be gathered from first evaluative remarks, the programme was valuable for the participants who benefited personally and professionally, in particular with regard to the modules mentoring and networking. A special benefit was noted due to the international dimension of the programme. In this sense the programme has proven the worth of its innovative claim. It has shown that international cooperation in executive development can work and be beneficial for all involved – mentees, mentors and universities. This fact is extremely important in a scientific climate that demands increased international cooperation, flexibility and mobility from scientists. In this sense, we believe that TANDEMplusIDEA can serve as a model of best practice for gender-equal human resources development.

TANDEMplusIDEA was the first mentoring programme conducted in this constellation; necessarily lessons will need to be learned for potential follow-up projects. Our recommendations especially refer to the following points:

- Define a clear structure of contact and addressability among the coordinators.
- Start the matching of mentees and mentors after the introductory session, make sure everybody is familiar with the concept of mentoring at the beginning of the programme.
- Provide an even stronger support system for the mentors.

Although the final evaluation and follow-up appraisals will need to confirm the effects of the programme, we believe that TANDEMplusIDEA has made one step to tackle the under-representation of women in science. Besides raising awareness for gender issues among the participants and supporting individual scientists, the programme started a strong network and encouraged female role models. Referring back to our starting remarks we hope that the programme helped them to be better connected in the scientific community, preventing them to drop out. The long-term evaluation at RWTH Aachen's IGaD will especially focus on the

specific surplus value of the international dimension of the programme, in particular with regard to the international cooperation and potential transfer of knowledge and scientists between the participating universities.

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Staff development and the reform of the German higher education system – A chance for a more diverse workforce!?

Keywords: Bologna process, further education, lack of skilled workers, diversity, staff development

Abstract:

On the one hand, the present lack of engineers, expected to grow even more over the next years, is a well-rehearsed theme in Germany for some time now. Of late, this has been combined with a demand for a more diverse workforce. On the other hand, the Bologna process has brought about a fundamental change in the organisation of higher education in Germany. This new system of B.A. and M.A. courses, with the Bachelor as the standard grade to enter employment, offers many chances and challenges to HR management, and especially to staff development. It is argued, that if universities and companies made full use of the possibilities of the reform, this would be one way to deal with the lack of skilled workers and to increase the diversity of a company's workforce.

Isabel Beuter

1. Introduction

Annually, some 27 billion euros are spent on the training of workers and employees in Germany.[53] In comparison, the sum of 1.9 billion euros spent on the first round of the German "Excellence Initiative" looks almost small. Even so, universities have undergone intensive efforts to gain funds from the initiative, while at the same time almost ignoring the training market for further academic education. Yet, the current reforms within the Bologna process offer universities favourable conditions to begin a change.

However, are the universities really the ones in charge, or is there a lack in demand from the economy? The concept of "life-long learning" seems firmly established, and companies express a growing need for further education to deal with the growing shortage of skilled workers (Werner 2006). Social scientists have even declared the training society ("Die

[53] This is according to the 5th survey on further education if the *Institut der deutschen Wirtschaft Köln* (Werner 2006).

Weiterbildungsgesellschaft", Arnold/ Gieseke 1999), but instead of a strong demand from companies, universities can only report individual requests – if any. So far, the plea for a greater permeability between vocational and academic training, voiced by Bensel/ Schlegel (2003) seems unheard.

Combining the discussions on the change of the higher education system due to the Bologna process with the discussion on the lack of skilled workers, especially engineers, I will argue that the Bologna process may not only be an answer to the lack of skilled workers but also prove to be a way to increase the diversity of the work force in companies.

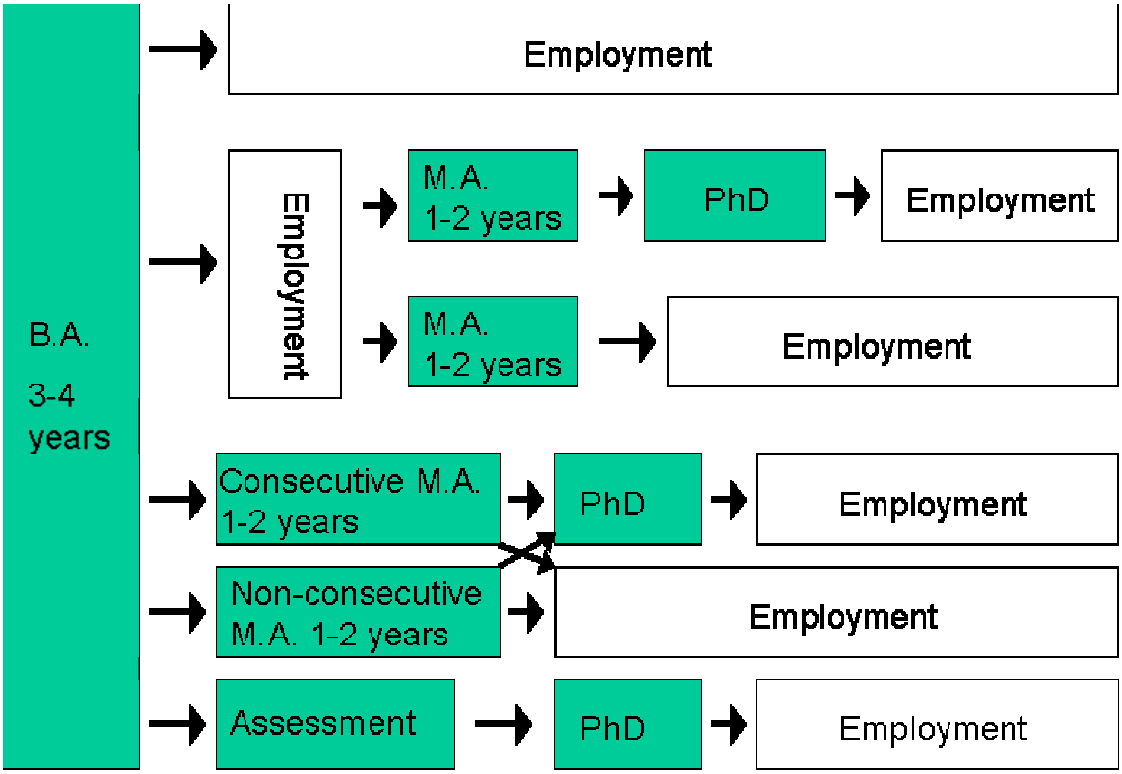
2. The Bologna process in Germany

The Bologna process and with it the creation of a European Higher Education Area has brought about a reform process in the higher education landscape in many European countries. A central aspect of the Bologna process is the harmonization of degree structures across Europe. B.A. and M.A. courses, the common degrees in the USA and the UK, were agreed on as the standard structure across Europe.

For Germany, the previously one-tier courses lasting four and a half years in theory and seven years on average (Wex 2005: 37), now are divided into B.A. courses of 3-4 years and M.A. courses, lasting 1-2 years. One of the great hopes of the reform in Germany thus has been to shorten the study time, leading to graduates being available for employment at a younger age. For the universities one of the consequences of the reform was that the content of the curricula had to be reduced accordingly. This means that the employees companies get do not bring the same qualifications as graduates with a diploma used to – at least if they have a B.A. degree.

One of the furthest reaching changes of the reform is the fact that the possibilities for educational planning in the life course have grown considerably, as shown in the following summary (Figure 15):

Figure 15: Structure and potential of the new courses



Source: translation from an HRK graph, http://www.hrk.de

For students, the new structures bring more individualized and more flexible study and vocational pathways. With the Bologna process universities could become "an integral part of the knowledge society and of lifelong learning" (Rehn 2007: 93).

So far, this clear distinction of consecutive, non-consecutive and (part-time) training M.A. courses after or during a time of employment as set out in the theory of the system and as normal in other countries, however, has hardly been implemented at German universities (Rehburg 2006: 205/206). As a logical result, most students plan to continue their university education with a Master course directly following their B.A. (Minks/ Briedis 2005: 19). As a negative consequence, universities, companies and students are losing out on the opportunities this reform could bring for the use of the higher education system for further (vocational) training.

2.1. Changes in skills and knowledge

The (political) wish to successfully establish the Bachelor as the standard degree for entering the job market in Germany has to main components. Firstly, it aims to cut down the age at which academically trained workers begin their employment career. Secondly, it aims at the general employability of graduates rather than in-depth specific skills, putting more emphasis on methodological competences to acquire specialised knowledge and on soft skills. For the development of new B.A. courses in engineering this means that the former diploma courses had to be reduced in specific content. At the same time, new content in the field of soft skills and methods had to be included in the curricula. Graduates leaving university with a B.A. thus have a different skill and knowledge profile compared to graduates with a diploma; more specifically they can be expected to lack in-depth expertise. Engineering faculties and companies initially argued against the Bachelor since the qualifications gained in a three-year university education in engineering would not equal the diploma. Since they could not stop the introduction of the B.A. and M.A. structure, one of the newer press releases of one of their networks, the association of faculties of engineering 4ING[54], from 29 September 2008, concentrated on arguments for a direct consecutive engineering education, advising students not to leave university before having reached a Master degree. From the point of view of life-long learning, the shortage of skilled workers and the need for a more diverse workforce, the arguments voiced against a Master course in the form of further education after a certain time of employment, cannot be supported by here. The following chapter will try to explain this, mainly from the side of the companies and their HR management.

3. New challenges for HR management and staff development

The changes in skills and knowledge that have to be expected as a result of the new system are just one aspect of the new challenges faced by staff development officers. Equally important from the point of view of HR managers is the potential change of employees' expectations, especially of those going into full-time employment with a Bachelor degree. The new two-tier systems offers a natural possibility to correct or to modify earlier decisions

[54] See http://www.4ing.net for details.

concerning a professional path at the beginning of a study course in the light of much better information and without negative consequences (Weiler/ Heuer 2003: 217). The concepts for staff development within companies have to consider these expectations if they do not want to risk losing employees who are considering retraining and a change in their professional career.

In the following I will look more closely at the challenges regarding recruiting, the further education of employees and the need to consider new and alternative career paths, especially with a view to staff retention.[55] These three areas are examples of HR management where the challenges of the changes due to the Bologna process can be best turned into an advantage regarding chances for a more diverse workforce.

3.1. Recruiting

Concerning potential new employees, HR managers are faced with a new "market". Until recently, someone with a German engineering diploma had a clear and pretty much unquestioned reputation for a good education - regardless of the university he or she had graduated from.[56] The new Bachelor and Master degrees have changed this. As yet, exactly what to expect from B.A. graduates is an unanswered question for most companies. What knowledge will they bring with them? How good will the soft skill training be that is expected to be an essential part of the new B.A. courses? How much specific knowledge will B.A. graduates lack compared to engineers with a diploma? With more and more B.A. graduates entering jobs over the next years, these uncertainties will, of course, lose their significance in any recruiting decisions. Whether this is also true for the question of the university a candidate graduated from remains to be seen.

Concerning the often even highly specialised Master courses, the exact details of the particular course a candidate has graduated in can potentially be taken from the diploma supplement provided. The specialisation can on the one hand be seen as a special asset of a

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55 The change of system in higher education, of course, also affects other areas of HR management, e.g. the question of salaries, that cannot be further looked into in the context of this paper.

56 Although the reputation of the engineering diploma was particularly good, the difference in quality of a university education was generally seen to be small in Germany (Teichler 2005: 16, Opitz 2005: 22).

candidate, on the other hand it holds the risk that general knowledge is missing due to the specialisation. Either way, recruiting officers have to learn to read and evaluate the information provided.

One way of dealing with uncertainties in qualification and a potential mismatch in qualification and demand are trainee programs. They are used to introduce new employees to the specifics of the work place and the company they entered, often with a view to a future management career. Regarding potentially necessary changes in these trainee programs, first studies have shown little difficulty in this area since the programs have always been highly individualised (Bergs/ Konegen-Grenier 2005: 29/30).

Recruiting activities are often supported by activities for students getting into a first contact with the company during work experiences or when writing their diploma thesis. Whether it will be possible to continue these activities in the same way seems at least doubtful at present. Time for work experience and for Bachelor thesis alike have been cut down considerably in order to bring as much theoretical knowledge into the curricula as possible. From the point of view of diversity management, programs like YOLANTE[57], designed especially for female students in the natural science and engineering, in the long run possibly cannot be continued in their present form as a result.

There is, however, the other side of the story: if fewer jobs are given to candidates already known to the company and not through a transparent process after a public announcement this can be considered a positive development. The call for more transparent procedures as a prerequisite for equal opportunities is, after all, central to the discussions about the situation of women scientists.[58]

The advantage of recruiting B.A. graduates, whether already known to a company through specific student programs or not, is the chance to find young employees. The possibilities to form them in the interest of the company are seen to be a clear plus of young employees. First

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57 For details of the programme see http://www.siemens.de/yolante.

58 Lind (2004) offers a comprehensive overview on the research about women in science, looking also at reasons for their under-representation that can be deduced from a wide range of studies.

figures[59] have shown that less women than men continue their studies after a B.A. degree and thus are available on the job market earlier than their male counterparts. Should women try to enter the job market with a Bachelor rather than a Master degree, companies could use this to their advantage in the recruiting process with the aim of a more diverse workforce.

The latest overall figures no longer show a difference in the proportion of women students in B.A. courses in relation to M.A. courses.[60] Future development still needs to be watched closely, however, since the reorganisation of study courses in Germany has not been completed yet. Also, in order to give reliable information, data has to be broken down according to disciplines.

Regardless of the degree but potentially depending on the gender of those addressed in recruiting activities, company strategies have to consider what potential employees look for in an employer. Offering the chance to go back to academic training without losing one's job could be an advantage over competitors when trying to recruit young graduates with a Bachelor degree.

3.2. Further education

Already in 2003, Weiler et al. stated that the function and biographical order of the Master degrees would have to change equally to the scale of the Bachelor degree becoming the standard degree when entering the job market (Weiler et al. 2003: 71). Employees who do start a professional career with a Bachelor degree thus are the most likely candidates for further education courses organised in the form of an M.A. – either because they are interested in a change of career or because they have to answer changing requirements in the job market.[61] Further academic education in the form of a Master course can, as any other form of further education, either be seen as a way to increase the knowledge in a particular field, e.g. the Bachelor degree of several years back, or they can be used as a retraining

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[59] For a first look at gender specific outcomes of the Bologna process s. Muehlenbruch / Beuter / Dalhoff / Loether (2004). Overall, even four years on number of graduates of the new system are still to small to give a final analysis.

[60] The data are regularly published by the HRK, the latest figures go back to the winter term 2007/2008.

[61] Of course, further training can also be organised in other forms, e.g. in-house training, job rotation or specific limited courses like (foreign) language courses.

course, enabling the participant to go into a new field of work afterwards. Training offers can further be undergone preventive, i.e. expecting upcoming changes, or curative, i.e. closing gaps in knowledge or following changes in the job description. Common to all offers it the fact that they can only survive on the market if there is some form of quality control involved. M.A. courses at universities, especially those having passed accreditation, theoretically have clear advantages over other offers from unknown or small competitors (Merk 2006). In order to use this advantage, they have to be developed with the potential use as further education offers already in mind (Wex 2005: 175, Wefers 2007: 27).

For M.A. courses to become a serious alternative to other forms of further education, they would have to be offered as part-time, correspondence or open university courses. Otherwise, they could only be used for further training by those who are without employment or those who are on a sabbatical. In March 2009, only 35 out of 4198 courses fulfilled this requirement.[62] This means that at present companies would have to think about ways to allow for long-term absence from jobs in order to be able to use further academic education as a tool in staff development.

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So far, the only area where further education and a job are combined professionally are Master of Business Administration courses (MBAs), with many part-time or evening and weekend courses on offer (especially from private institutions) and considerably good support from the side of companies available.[64] Of course, here one can find valuable experiences to be looked into when trying to organise other further education M.A. courses and employment.

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62 This is according to the online information available at http://www.hochschulkompass.de

63 This is according to the online information available at http://www.hochschulkompass.de

64 MBA courses combining business and management modules with a clear focus on engineering like the "MBA for Engineers" indeed are highly regarded courses in Germany (Bergs / Konegen-Grenier 2005: 36). Over all, different options for further education, e.g. company universities or the use of sabbaticals, have in the past not played an important part in Germany (Becker 2002: 240/241).

3.3. Alternative career paths and retention

The relatively broad acceptance of MBAs as a specific type of M.A. courses reflects the way traditional career paths are looked at. Professional success is largely defined as making it to the top – the top being a position in management. However, this may be too narrow a look at careers[65], excluding many talented and successful employees. The relevance of this topic was brought up by the "Women in Industrial Research" initiative of the European Commission[66], resulting in several publications on the issue (EC 2003, EC 2005 and EC 2006). Talking to (especially) women in positions in industrial research reveals that many do not regard a management career an interesting option since this would take them away from the lab and hands-on R&D experience. At the same time, without other options expressing positive work evaluation, they lacked the support and regard for their work.[67] This can easily result in a decline in motivation, or, at worst, in leaving the job – both possibilities meaning harm for the success of the company. Therefore, in order to keep good employees on board or in order to gain new personnel, alternative possibilities to reward good work have to be considered. In research related fields, many engineering positions being linked to research and development, project work, extra payment or additional leave are reward schemes outside the "normal" career ladder in the form of promotion into management positions. The chance to go into further training might be another reward scheme with positive outcomes for the employee and the employer. In addition, in a field where new discoveries or new developments are a decisive factor, further training should be seen as a necessary element for long term success.

The missing or narrow career options described are one reason for employees to consider leaving a company. Another reason is the difficulty in returning to a job after a break, e.g. for child care reasons. Many female engineers are expected not return to research after a break but to look for different employment options. The relatively higher unemployment rates

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65 For the discussion on career paths and possible others ways of defining a career see also Lehmann (2002).

66 This initiative was prompted by the Women in Science Unit of the Directorate-General for Research, following more general discussions on the role of women in science, the bad representation of women in scientific professions, especially at universities, and the gender dimension of science, e.g. in medicine. For several years, the author was involved in this initiatives on different occasions and in different projects, e.g. the Women in Industrial Research Conference 2003 in Berlin http://www.eubuero.de/arbeitsbereiche/fraueneuforschung/industrieforschung/wir

67 These impressions, taken from the discussions and papers around the EC initiatives, are supported by the examples from companies brought together in a conference in Vienna in 2006 and a publication on the business perspective of women and science in technology (EC 2006).

among female engineers in Germany compared to their male counterparts (Biersack/ Kettner/ Schreyer 2007) could, amongst other explanations, be linked to the fact that after a break in employment the knowledge they have is outdated and thus not considered to meet the expectations of an employer. By using M.A. courses as a way of getting back into the job, bringing not only the past professional experience but also latest developments in the field, the door for job returners could be opened without a need for expensive campaigns like the "return2job"-Initiative[68] of the German Federal Ministry for Education and Research. Although they are certainly meant well and bring new opportunities to those taking part, they also hold the danger of stigmatising women. Using a part-time M.A. course to keep in touch with the discipline and with the company would open new ways to deal with breaks in full-time employment.

Linking these two reasons for leaving a job with the considerations concerning offers for further training and thus with a chance to change positions or work areas or the chance to keep up with new developments could be a decisive factor for the decision of an employee to stay with the employer. In a time where it is getting harder and harder to find qualified personnel, especially in engineering jobs, retaining those already employed within the company, is an important factor. Only then will the call for "more engineers" no longer be translated into a call for more "young male engineers"[69] (Biersack/ Kettner/ Schreyer 2007: 4).

5. Discussion and conclusion

So far, in Germany the changes coming with the Bologna process have not led to a real change in the organisation of further academic education.[70] This is true for the way companies look at further education as much as for the way universities have reacted to the possibilities of the reform process. Thus, both sides are losing out. Universities are not using the potential to win a source for the funding of course offers and thus their survival.

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68 For further information see http://www.obs-ev.de/aqua/berufsrueckkehrerinnen-berufsrueckkehrer/

69 One explanation for the fact that the engineering workforce in many companies is still rather homogeneous can be linked to the fact that in recruitin the pool for job candidates is often filled with new graduates only.

70 Research into this field is not yet wildly available; one of the first exceptions is the tri-national study by Bredl et al. (2006), looking at Germany, Austria and Switzerland.

Companies, on the other hand, are not actively searching for further training possibilities at universities. Whether this is due to the lack of appropriate offers from universities or due to a lack of understanding of the chances lying in the reform still needs to be researched further.

Concerning the possible effects on HR management described in this paper, looking at the reforms in a new way is suggested to be a way forward. Instead of looking at new and young recruits as the only way of keeping up with the ever changing technologies, further training of employees can be one way to bring together reward schemes, staff development and further (academic) training for the benefit of a company. Although the costs for further academic education are high, especially if companies allow for parts of the study to be conducted during working hours, the costs are regularly by far lower than the costs for the fluctuation in personnel (Pepels 2002: 131). Also, it has to be seen as cheaper to invest in further training than not finding anyone to fill a position. In a time where skilled workers are hard to find, M.A. courses are a possibility to retrain employees in the latest developments in their area or in a new area of engineering, for example.

Looking at the need and the wish for a more diverse workforce, establishing new career paths and listening to the voice and wishes of those who do not follow the traditional career path can become an essential aspect of winning the so-called "war of talents". With regard to mothers and fathers taking family leave this means that „one decisive point in the future will be to create alternative career patterns that are accepted within the companies in the sense that work breaks no longer equal career breaks or even the end of a career" (EC 2005: 31). With a Master degree as a normal[71] break in (full time) employment, special initiatives for returners could become unnecessary.

Combining further academic training offers, staff development and diversity management may thus prove to be an effective and clever move to increase a company's workforce diversity.

[71] Normal in this context meaning something that is done for different reasons and by many people with different backgrounds.

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- Spirit -
A Life-Cycle Based Gender Mainstreaming Concept at the University of Stuttgart

Keywords: Gender concept, female academic education, diversity studies, women in natural sciences and engineering

Abstract:

Despite social and political efforts to achieve equal opportunities, women remain a minority in natural sciences, technical and corresponding occupational study fields. The University of Stuttgart takes the female professor program of the state authorities as a challenge to re-evaluate the current methods in this field of equal opportunities. If necessary, steps will be taken to amend, augment and optimize these methods. This article presents a new complete concept: girls and women will be surveyed within the framework of an integrated and complete life-cycle model. This life-cycle model connects different target groups and packages of measures with regard to content and organisation.

Barbara Burr, Peter Göhner, Sabina Jeschke, Wolfram Ressel, Wolfgang Schlicht

1. Introduction

In spite of social and political efforts to achieve equal opportunities, women remain a minority in natural sciences, technical and related fields. We present the gender concept of the University of Stuttgart. First, the steps for promotion of female students within natural sciences and technical fields are developed.

Tackling under-representation of women in sciences and the demand for equality of sexes, the ongoing reform dialogue has become a vital facet. A special look should be taken at education-economic perspectives as well as aspects of innovative capability and quality assurance [Eur99, Eur01]:

- The under-representation of women in scientific and technological fields has technological implications such as design, quality and diversity of products. In fact, creative innovations cannot be “all-inclusive” without the inspiration of women: products might be designed faulty because their usage options were only viewed under

considerations of requirements of special groups (e.g., examples are airbags, artificial heart valves, voice recognition systems [Sch03]).

- The absence of women from certain technological fields poses a hard challenge for industry and economy: the demand of qualified specialists cannot be satisfied by men willing to pursue an academic education [Win04]. The existing loss of interest by men in technical and engineering subjects intensifies the challenge [Koc03]. Moreover, demographic development in Germany and global competition exaggerate these challenges.

- Technical disciplines graduates are filling important jobs in our society. These are characterized by fields of responsibility and extensive influence. Technical authorities are a key factor of shaping our society [Wä98]. The under-representation of women in these fields is a central drawback to an equal participation of women.

In fact, there are lots of single initiatives aimed at “breaking down the gender-gap” in German universities. Each engaged by different single persons that include offices for equal opportunity but also individual professors, centres, or initiatives in single institutes. Consistency, continuity and transparency are missing due to the lack of a comprehensive strategy. This leads often to a "twofer" for some target groups while other arrangements and initiatives are missing. Communication and information campaigns aimed at reaching a broad group. Creating a common understanding of challenges and requirements are an exception. The objective of universities should be concentrate and coordinate existing and successful measures. All arrangements result from one coordinated gender master plan,

- that comprises the full life-cycle from kindergarten to professorship with leadership function,

- whose single steps make a seamless, coordinated transition between different measures possible,

- that incorporates all areas (education, research and organization)
  and that includes a concept of family-friendly policies for all members of university.

The female professor program is a characteristic component of the gender master plan of the University of Stuttgart.

The under-representation of women in technological fields becomes particular visible in predominantly scientifically and technologically aligned universities like the University of Stuttgart. Contemporaneously, a large percentage of future scientists and engineers are trained here. These universities are in charge to overcome the gender gap in the technological disciplines. This is justified broad and early commitment of gender management. Additionally, women are nominated as top position holders of technical disciplines in order to increase diversity in research and education presenting female role models to new generations.

2. Situation-(Deficit-) Analysis

Girls and women are still under-represented in technology-oriented programs. The University of Stuttgart is well aware of these challenges being a long term driving force to raise the percentage of females. The structure and development plan SEPUS of the University of Stuttgart [Rek07] defines measures. Each of the listed measures is successfully proven. However, the University of Stuttgart neglects a master plan that connects all of single measures and sustainable networks that build on and support each other. The concept presented here pursues the goal of integration and sustainability of measures. The University of Stuttgart is a fully profiled university oriented towards technological and scientific programs and the concept of equal opportunity is aligned with this profile. Therefore, the focus is on the recruitment of women into technical disciplines. They are initially acquired for scientific and technical degrees, then promoted depending on their talents, and supported on their “job ladder” inside or outside university. The objective is to boost the percentage of female students in scientific and technical disciplines from currently 20% to 30% (within the entire university from 34% to 40%) and the rate of female young scientists from 18% to 30% (within the entire university from 21% to 30%). The target in these disciplines is set for an increase of female’s professors from 6% to 10% (same within the entire university) within the next five years. Furthermore, 30% of the professorships have to be newly appointed until 2012. Therefore, a considerable increase is possible.

Baden-Württemberg is striving for a long term increase of the quota of female professors to 30% (defined by the head of the Office of Scientific and Technological Affairs, Frankenberg).

3. Implementation of the concept SPIRIT

The SPIRIT program follows a life-cycle model. Girls and women accompanied from kindergarten to professorship by multi-faceted programs: Single activities are powered variably depending on period of life, build on each other and are interconnected. Attaching importance to systematic advancement of female migrants, the requirements are provided with different concepts of socialization compared to the migration background.

3.1. Measures for Each Scope of the Life-Cycle:

- *1: Gender Sensitivity Training Courses for Educators*

To spark interest of kids in natural and technical sciences, the University of Stuttgart designs, prepares and implements gender- and diversity sensitive professional training for educators. The Institute of Social Sciences provides evaluation and counselling.

- *2: TechToy*

Awakening the enthusiasm for natural sciences and engineering, the University of Stuttgart provide engineering toys appreciated by both genders. A co-operation of different chairs of engineering, the Institute of Educational Science and Psychology, and the Institutes for Social Sciences, Technology and Environmental Sociology [ZR00] support the development of toys and pedagogic concepts that is built on the initiative “Wissensfabrik” (knowledge factory). This concept could look similar to Roberta.5ex®- teaching materials of the Fraunhofer IAIS for LEGO Mindstorms robot building.

- *3: Exhibition Team University of Stuttgart (ETUS)*

Focused on public relations with target groups (preschool and elementary school age, junior high school, teacher, etc.), a team is assembled that includes the development of publicity programs for events including the Day of Sciences (“Children’s-Campus – Program for young

researchers"), and exhibitions like "Land of Ideas". This project can be designed on experiences of the Student Counselling Centre and the marketing office.

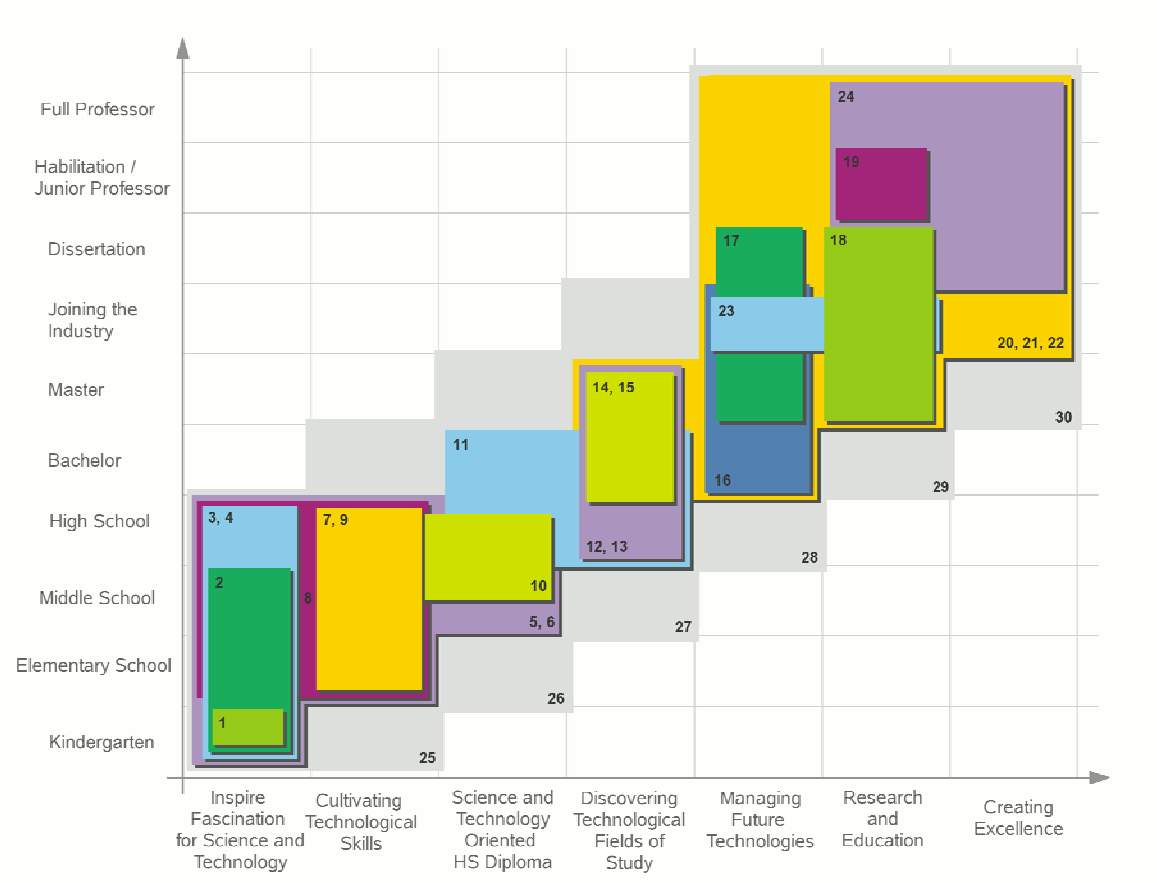

Figure 16: Life-cycles from kindergarten to professorship

- *4: Rent-a-Scientist & SchoolgirlUni*

Pedagogically trained and coached (by the Institute of Educational Sciences and Psychology) professors and research staff visit pre-schools and schools, and answer questions from fields of sciences and engineering in age-based and culture-based lectures. Additionally, the University of Stuttgart offers pupils the possibility to come to university (student/schoolgirlUni).

- *5: Girls' Day*

Girls are invited to university to gain an insight into the scientific and technical fields. Sparking the girls' interests, specialized subjects from different departments are being prepared, and experiments are conducted. This program will be expanded considering culture-specific differences.

- *6: Partner Schools*

Direct connections to partner high schools give female students a chance to gain early insights into academic research and education. We benefit from the close connection with the "Mine-Mint"-Network. Participating partners are the Institute for Hydraulic Engineering, the Department of Physics, the Department of Chemistry, the Department of Computer Science, Electrical Engineering and Information Technology, and the "Landesgymnasium für Hochbegabte in Schwäbisch-Gmünd".

- *7: Gender Sensitivity Training for Teachers*

The training course is designed to enhance skills of teachers in gender and diversity – sensitive didactics in technological and scientific subjects supported by the Institute of Social Sciences. It develops guidelines based on examples to fascinate students. The University of Stuttgart takes advantage of the unique situation created by the restructuring and modularization of the academic education of teachers in Baden-Württemberg.

- *8: Technology-Camps*

Technically-oriented summer camps of pupils and university students ("Stuttgarter Forschungsferien") teach selected topics of modern sciences in a hands-on approach in high school level lectures and in close cooperation with professors. Prospective, we offer mono or co-educational summer camps. The SPIRIT program plans to offer stipends for students of financially weaker families.

- *9: TechnoClub "Test your University"*

The TechnoClub at university offers workshops and one-semester courses for female high school students in order to familiarize them with the daily routine at universities. These courses include a lab for Robo-Rescue and courses for electronics and soldering with special attention to culture- specific interest. This mono-educational concept is based on a long running and successful program "Try the University" ("Probiert die Uni aus").

- *10: Studium Experimentale*

Based on the idea of "SchülerStudium" at the FU Berlin, the "Studium Experimental" offers high school students university level courses in a more compact form including the final exam. A participating student receives priority in acceptance process at university. The credit point earned during this period is fully applicable to any future course of compatible studies. We are currently engaged in defining the necessary legal framework (crediting, BAföG).

- *11: Mentoring "Transition from High School to University"*

The Campus Mentoring program matches selected university students with high school students to mentor them at the end of their high school and the beginning of their university education.

- *12: Gender Sensitivity in Technologically-Oriented Courses of Study*

The University of Stuttgart, under the leadership of the vice rector for academic affairs, creates concepts and guidelines for gender sensitivity in all courses and especially in technological-oriented courses, taking advantage of the opportunity offered by the restructuring of all courses, including their content, to the new, modular bachelor/master system in Europe.

- *13: New Technologically-Oriented Programs*

Female students are often disenchanted to curriculum of engineering and natural science programs caused by the missing social relevance and/or missing self-confidence to pursue studies in these fields. We are planning to implement a number of new programs specifically addressing the specific interests of female students build on the experience from the Galilea project at the TU Berlin [DJTW06, DJSW07, EJN+07, EJN+08, DEJ+08a, EJNS08, DEJ+08b].

- *14: Diversity Studies & Technology Management*

It is necessary to understand the role of female engineers and scientists to attract women for technological fields. To address these requirements, we are creating a program for diversity studies in the engineering sciences with a focus on technology management. The courses are credited as minors or mandatory elective courses in the engineering, economics, scientific and social studies programs.

- *15: Program for Stipends: "Opportunity"*

The University of Stuttgart plans to create specific stipends for female students of the natural sciences and engineering in close cooperation with successful regional companies and research institutions, and with the European Social Fond, ESF. The "Opportunity" program complements the existing stipends: stipends for PhD students under the "Landesgraduierten-förderungsgesetz", Schlieben-Lange und Margret von Wrangell Programm.

- *16: Femtec Region Stuttgart*

The University of Stuttgart is planning to expand the existing cooperation with the Femtec program and its associated career building program. The associated career building program teaches leadership qualifications easing the transition to a successful, professional career of females.

- *17: Entrepreneur Initiative SPIRIT*

Based on the joint project "Erfolgreich ist weiblich!" (in cooperation with TTI GmbH), we are creating an informational and consulting offer for students, post graduates and alumni that wish to found their own start-up. This network will provide gender specific support.

- *18: Mentoring for Women in Science and Research*

The access to informal networks is decisive for professional success. The University of Stuttgart is expanding existing mentoring programs for women in science to support more female students in career strategies. The program provides support for highly qualified graduates, post graduates and post docs.

- *19: Mentoring Program "ProFiL BW"*

The University of Stuttgart designs a program to support excellence in scientific careers, following the mentoring program "ProFiL"[72] of the universities in Berlin. The participants receive support in planning their careers, including training leadership and management skills required by a professorship.

- *20: "Ladies' Community"*

Female students often feel isolated during their studies. This necessitates a community building among female students beyond single study programs. We have created a work group to design a concept for realizing such a community: regular seminars with successful female entrepreneurs and researchers, social gatherings and a special web portal.

- *21: Colloquium "Women in Leadership Positions"*

Female students often miss role models, women who have mastered the obstacles and challenges. To counter this effect, we are planning to hold seminars where women from research and business share their experience with female students.

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[72] http://www.profi-programm.de

- *22: Family Friendly University*

The University of Stuttgart has implemented a number of measures: child care ("Kinderbetreuung für Kinder von Studierenden der Universität Stuttgart" STUPS e. V), semester break child care, and the "Stuttgarter Forschungsferien". Additionally, we are aiming at the creation of on-campus dorms with integrated child care and on-campus housing of employees with access to child care centres. Researchers will profit from dual career models, family friendly work processes, and specific support of researchers during the first years, and working at home. We are aiming to be the first university in Baden-Württemberg to gain the certificate as a "family friendly" university awarded by the audit council of the Hertie-Stiftung.

- *23: Re-Entry Program "SPIRIT returns"*

Knowledge and skills of qualified females is lost to the market due to the obstacles in returning to job after child birth. Based on the BMBF-Program "Wiedereinstieg für Ingenieurinnen leicht gemacht", the University of Stuttgart is planning to help woman to re-enter into the job market such as additional scientific training to re-qualify.

- *24: Dual Career Service Program "DuCaSUS"*

Accepting an appointment for professorship usually involves moving to another city. A similar situation exists during the post-grad and post-doc studies. The career of the partner is a decisive factor. Dual Career Services can advance the career chances of researcher couples. Currently, the University of Stuttgart is expanding the dual career supporting policies already common in appointment negotiations to include post-grads and post-docs in the dual career service program "DuCaSUS".

3.2. Comprehensive Measures for the whole Life-Cycle:

- *25: Chair for "Diversity Studies & Technology Management"*

The Institute of Construction, Production and Vehicle Technology creates a new chair focusing on gender and diversity, based on the example of the "Chair for Gender Studies and Information Technology" at TU Munich. The academic focus is interdisciplinary courses for participants of the new program "Diversity Studies and Technology Management" and for other students.

- *26: Gender Components in New Appointments*

The University of Stuttgart is trying to appoint scientist as professors whose research focus integrates a gender and diversity focus. Examples are “Diversity in Usability Studies”, “Diversity in Design and Construction” (for a chair in civil engineering), “Gender Aspects in Biomedical Technology”, etc.

- *27: Media Offensive “Fascination Technology”*

One of the vital challenges for engineering and sciences is the public interest. While being accepted as important for technological innovations and therefore economic growth, they are also perceived as boring subjects. This might be no problem for men whose studies are often the result of technological affinities. However, women are more interested in social relevance than technology. The planned media offensive focuses on presenting mathematics, science and engineering as a fascinating element of our culture. The methodology could be based on the experiences gathered in the popularization of mathematics at the MATHEON centre of research.

- *28: Media Offensive “SPIRIT”*

A program can only be as good as its general acceptance. This is one major challenge of the most current gender programs and measures to overcome. Gender programs have to incorporate and implement public relation strategies. This includes online presentations aimed at addressing students living in more rural areas.

- *29: eCRM “SPIRIT”*

One major factor in the success is the network to participating high school, and university students, and researchers. Our gender concept will only be successful if we address these “customers” directly and tie them to the University of Stuttgart. To this end, an eCRM (electronic customer relationship management) will manage all transactions between the University of Stuttgart and the participants. As a result, they are addressed directly and the life-cycle process can be specifically tailored to each participant using intelligent agent systems.

- *30: Brain Storming “SPIRIT”*

The University of Stuttgart performs an annual brain storming on gender topics and diversity to define, select and implement further measures, with the participation of all interested institutes. The aim is a higher degree of flexibility and a stronger bound to the rest of the university.

3.3 Measures to Ensure Structural Implementation and Sustainability:

To ensure the implementation and sustainability of gender concepts the following catalogue of measures are implemented:

- *Pervasive Implementation throughout the University:*

The single measures are placed within the jurisdiction of existing institutions (e.g. the office for equal opportunity), organizational centres (e.g. career or academic counselling), and the chairs of the institutes. Concrete tasks, their implementation and adaptation are fixed in target agreements with the president of the university. Additional measures focusing on strengthening the gender competency are the object of future appointment negotiations and target agreements. Internal projects reinforce the acceptance and broad basis for the concept.

- *Collaboration with Existing Equal Opportunity Programs:*

Plans of equal opportunity in the academic [Thö02] and non-academic fields [KS04] ([Rek07]) define an catalogue of measures aimed at achieving equal opportunity for women, based on detailed analysis of the current state. The structural and organizational preconditions for these measures already exist.

- *Collaboration with the Female Professors Program:*

The program to increase the ratio of female professors becomes a vital part of the gender concept. Individual professors assume the operative responsibility for particular measures. These measures have already been made to increase the public visibility of the program.

- *Strengthening the Scientific Gender Competency:*

The chair of "gender in the engineering sciences" is a component for the success of the gender concept. It strengthens the scientific background and provides the expertise required in the evaluation and long term quality control. The chair provides new input for additional projects and necessary adaptations. The competency of the chair is enhanced by the support of the office for equal opportunity and related chairs.

- *Financing:*

Financing for the SPIRIT program is based on a three-column model:

  - *Budget:*
    The shift to success-oriented funding allows further or extended measures. Target agreements with institutes initiate additional measures. Measures focusing on students can be funded from tuition fees.

  - *Third Party Funding:*
    Third party funding is an important component in the development of new concepts. The European Union, the ESF and the National Ministry of Science and Education, and industrial partners have been increasingly supportive of gender and diversity projects.

  - *Endowment:*
    It is planned to found a SPIRIT-Foundation to raise additional funds for the gender concept. This foundation approaches industrial partners engaged in the Femtec project, regional SMEs, alumni, and private donors. The financial goal is an endowment providing a total annual funding of 500,000 Euros.

- *Responsibility*

The implementation of a gender concept is seen as a vital challenge for future success of technologically oriented universities. The coordination, development and quality control is the responsibility of the president of the university. Further developments are coordinated with the commissioner for equal opportunity under the leadership of the president.

4. Summary

Natural sciences and technology-oriented universities take special responsibility for the participation of women and girls for the evolution of technologies in our society: women are still under-represented in almost all natural sciences and technological fields. This under-representation has consequences. The demand for adjustment for women is not a demand for equality of opportunity in a country like Germany where success is tightly connected to

advancements in technology, and the future requirements for qualified personnel cannot be only met by the current number of male graduates.

The University of Stuttgart takes the female professor program as an inducement to re-evaluate the currently used measures and proceedings of equal opportunity and treatment. It is also advisable to anchor the measures in research and education. At the same time continuity has to be raised by developing a complete gender concept that views females along a life-cycle model. The realization of such a gender concept based on the observation of this complete life-cycle with measures of different target groups – schoolgirls, female students and female scientists. This will become an attractor of the University of Stuttgart on national and international levels.

Within the scope of the process, the university administration manages the existing activities and expands them. A numerous additional innovative measures are currently being prepared and sustained by a financial package containing budgeting, third-party funds, and endowments. The professorship within the female professor program serves as seeds for new impulses and develops institutional and sustainable responsibilities. The gender statement is being created under the leadership of the president including a road map with measures for quality control and operative realization.

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Gender and Diversity as an Organisational Development Strategy at Technical University Aachen

Keywords: gender and diversity, organisational development, women in higher education, change of scientific culture, integration of gender aspects in research and teaching, human resources development at universities

Abstract:

Current economic, social and political conditions demand for new strategies and innovative answers to future global challenges such as demographic change, globalisation or skilled labour shortage. In the competition for the most qualified and bright people new strategies and concepts are required and institutions of higher education have to act increasingly according to the needs of the market; in particular women and minorities have to be addressed, included and promoted within the educational system otherwise these institutions will face severe problems in the upcoming years. The presentation will give an overview of a comprehensive gender and diversity management strategy at a technical university with special focus on measures in organisational development. In this context RWTH Aachen University has established a strong scientific unit the "Integration Team – Human Resources, Gender and Diversity Management" to support faculties, management and administration to implement this strategy and to actively pursue the desired change of organisational culture.

Carmen Leicht-Scholten

1. Introduction

In order to find answers to global challenges, organisations must start to incorporate the perspective of gender and diversity in their decision-making processes. The gender and diversity approach describes the entirety of all measures which lead to the acknowledgement and appreciation of diversity as a positive contribution to the overall success of an organisation. To ensure this Technical University Aachen is incorporating two different strategies which in combination will change the scientific culture and support excellent scientific performances that can cope with these global challenges: Firstly more women and diverse people will be involved and promoted at all levels of decision-making and secondly gender and diversity aspects will be taken into account in human resources, organisational development, research and teaching. In particular in exposure to heterogeneity German

universities have to catch up with other European institutions of higher education (Luciak 2008). Their knowledge on diversity among the workforce and student body is still at the very beginning. In this context change processes with special focus on gender and diversity have to be initiated. An efficient organisational development is crucial when introducing comprehensive change processes like gender and diversity management to an organisation. Therefore a gender and diversity oriented organisational development which strives to initiate a change of organisational culture from within is being implemented at RWTH Aachen University in the framework of the overall gender and diversity strategy. As one of the first universities in Germany, RWTH Aachen University is actively dealing with equal opportunities by establishing a strong scientific unit "Integration Team – Gender and Diversity Management" which is responsible for the realisation of this strategy.

2. Integration Team Human Resources Gender and Diversity Management

In the course of the successful participation of RWTH Aachen University in the German excellence competition in 2007 the university has initiated a comprehensive reorganisational process in order to implement the strategy "Mobilising People" (cf. figure 1) which was formulated within the Institutional Strategy. Thereby RWTH Aachen University considered the implementation of a proactive gender and diversity policy as a central part of this reorganisational process which integrates these perspectives into the mainstream of the university.

The integration of gender and diversity aspects requires both the consideration of the peculiarities of the university structure as well as the overall strategy of the university. Only if gender and diversity come to the fore of decision-making processes within this system a cultural change is possible. According to that RWTH Aachen has established the scientific unit "Integration Team – Human Resources, Gender and Diversity Management" in the framework of the German Initiative for Excellence.[73] The Integration Team is the first address for faculties and facilities of the university regarding questions of gender and diversity issues. Its main objective is to contribute to the successful implementation of diversity and equality

[73] For more information please visit http://www.bmbf.de/en/1321.php

in teaching, science and administration at all levels of decision-making and to accompany related change management processes at the university.

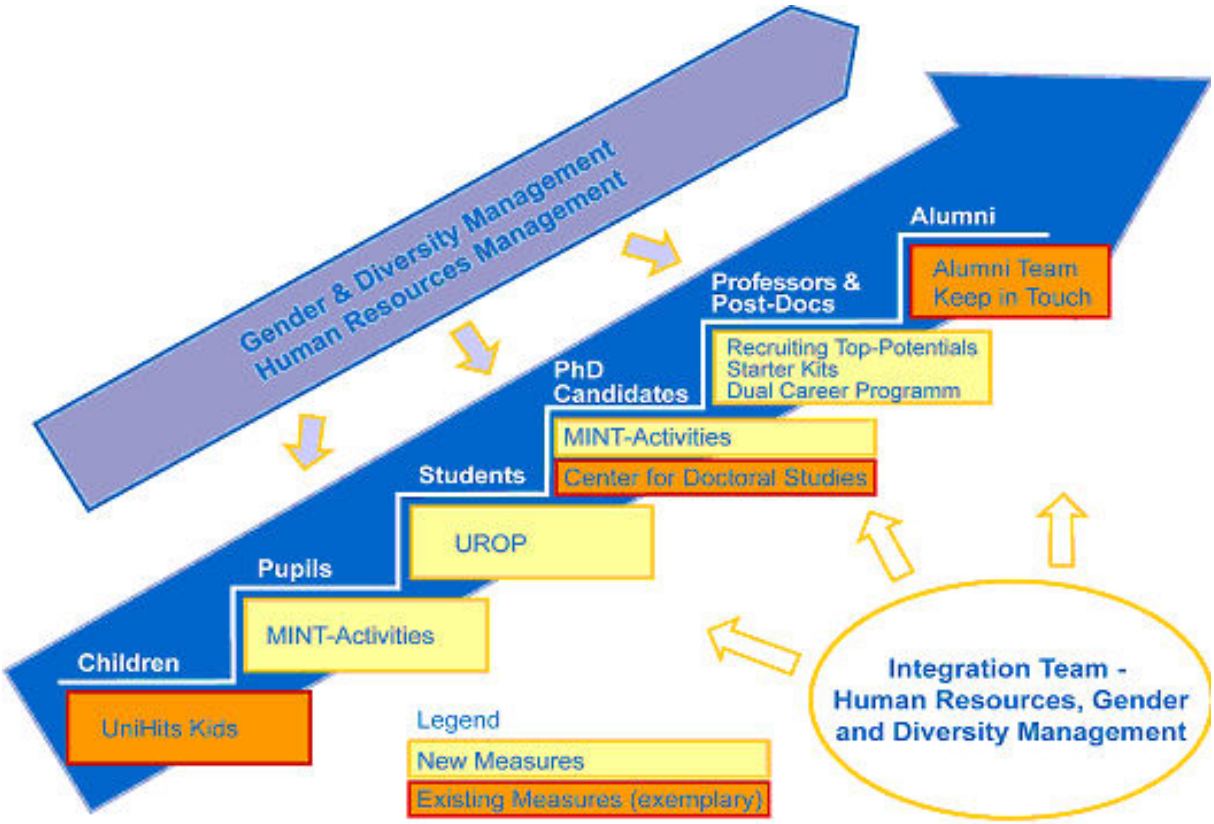

Figure 17: Institutional Strategy of RWTH Aachen 2007, p.49

For the implementation of a coherent organisational and human resources development concept regarding gender and diversity aspects of all existing activities and responsibilities of the university have to be scrutinised, e.g. specific measures and activities to promote discriminated groups, curricula, further education, recruiting or public relations. In this context five main fields of activity can be identified: university management, human resources development and promotion of junior scientists, research, teaching and studies as well as social conditions (Kahlert 2003, Macha and Fahrenwald 2007, Leicht-Scholten and Wolf 2007). In particular the development and arrangement of human resources management strategies which incorporate aspects of gender and diversity and also focus on the strengthening of central and peripheral employee responsibility, contribute to the realisation of structural equality as a mainstream task. Next to measures to enhance the percentage of women and minorities on various academic levels, gender and diversity aspects are integrated in teaching, research and human resource development. One central task in this strategy is the sensitisation of different stakeholders at the university and to support, advise and accompany

them in carrying out a successful gender and diversity strategy. In the following organisational development as one central area of activity will be depicted in more detail.

3. Gender and diversity management at a technical university – theoretical contextualisation

RWTH Aachen University's gender and diversity policy combines gender mainstreaming and diversity management into a joint approach by capitalising on the strengths of both concepts (Leicht Scholten et al. 2009d). Therein, the category gender is being understood as a core element across the other diversity dimensions without ignoring the interdependence of single attributes (Krell 2009). Through the incorporation of diversity management as a transformative and pragmatic approach with gender mainstreaming as a predominantly political strategy, effective and sustainable change processes can be accomplished, and a gender and diversity fair university can be established. With the concept of gender and diversity management RWTH Aachen University combines the two approaches into a complex model by focusing on the corresponding synergies that will result (Leicht-Scholten et al. 2009d). Hereby the university enters new grounds in the scientific field of gender and diversity studies.

The existence of diversity is not an asset per se instead the appreciation of similarities and differences has to be exemplified by every member of the organisation. The main objective of gender and diversity management is to eliminate all forms of discrimination and to establish a culture of open exchange and appreciation where individuals can work to their fullest potential. This will consequently lead to a culture of critical exchange and to a positive identification with the organisation.

The gender and diversity approach of RWTH Aachen University pursues as an integrated top-down approach both, equality between women and men and the acknowledgement of differences and similarities between organisational members which exceed the gender dimension (e.g. ethnicity, skin colour, age, religion or sexuality). Processes involving innovation, creativity or complex-problem-solving are in particular important at institutions of higher education. According to various studies diversity can improve these processes and lead to more productivity and better results in organisations (European Commission 2005). Thus

for RWTH Aachen University diversity among the work or student body is seen as an asset and economical advantage (Leicht-Scholten et al 2009d). Additionally the growing diversity of employees, customers and business markets, force organisations to act more flexibly according to the needs of their stakeholders and the market (Cox 1993 and Thomas 1991). To successfully face these challenges, old behavioural patterns in organisations have to be questioned and most probably changed in order to profit from the advantages of diversity (Cox and Blake 1991). This is in particular a challenge for homogeneous and monocultural organisations in which a dominant group defines the values, rules and norms for every organisational member and occupies most of the executive positions (Vedder 2007). Also at RWTH Aachen these structural conditions are prevailing; women and other minority groups are underrepresented in all areas of the university. However the university acknowledged these conditions and decided to proactively change structural inequalities within the university system. A comprehensive gender and diversity strategy seemed to be most suitable in pursuing these kinds of change processes. In this context many measures have been developed and implemented aiming at changing the prevailing monocultural conditions at the university.

4. Gender and diversity oriented organisational development

RWTH Aachen University understands the realisation of equal opportunities as a leadership responsibility and therefore as an integrated approach within the self-monitoring concept of the university. One focus lies in the establishment of a gender and diversity oriented organisational development which is formulated in the profile of RWTH Aachen University and on the institutionalisation of equality on all levels of decision-making in research, teaching and administration. In order to obtain this goal RWTH Aachen University includes equality in monetary and structural control systems. In the framework of the establishment of the scientific gender and diversity department RWTH Aachen University has introduced various measures in organisational development aiming at changing the university culture from within (cf. figure 2).

The main objective of organisational development is a social change in organisations (Schein 2000 and Gairing 2002). All members of an organisation are involved in this process and

asked to prepare the organisation for new requirements from within. At RWTH Aachen University these change processes have been initiated through the successful participation in the German Initiative for Excellence, seeking to proactively meet future global challenges. In detail these challenges encompass the sharpening of the scientific profile as an integrated, interdisciplinary, and international university of technology as well as global competition and the promotion of top-level research at German universities. To this end, RWTH Aachen University has jolted a complex process of re-orientation and re-focussing involving every member of the university. One crucial component in this change process is the incorporation of gender and diversity aspects in all areas of the university (cf. figure 2). This fundamental restructuring process started with the identification of all existing measures, projects and resources for the development of a coherent organisational development concept regarding gender and diversity aspects (RWTH Aachen University 2007).

The gender and diversity profile of RWTH Aachen University is communicated through the development of a catalogue which compiles all existing activities of the university. Altogether 260 activities are listed in this catalogue presenting the total of offers for all status groups at the university – “from pupils to alumnis” (cf. figure 1). The final evaluation of the catalogue seeks to improve the coordination of existing activities inside and outside the university and will show possible shortfalls. The analysis of the current situation in administrative and academic facilities is subsequently accomplished and complemented with single action plans specifically designed for every faculty and facility. Agreements on objectives complete the process and the scientific gender and diversity unit supports the implementation of these measures through process consultation and attendance at the different faculties and facilities of the universities. Here the scientific gender and diversity unit works in close cooperation with the departments of planning, development, controlling and human resources as well as with all faculties and administrative facilities.

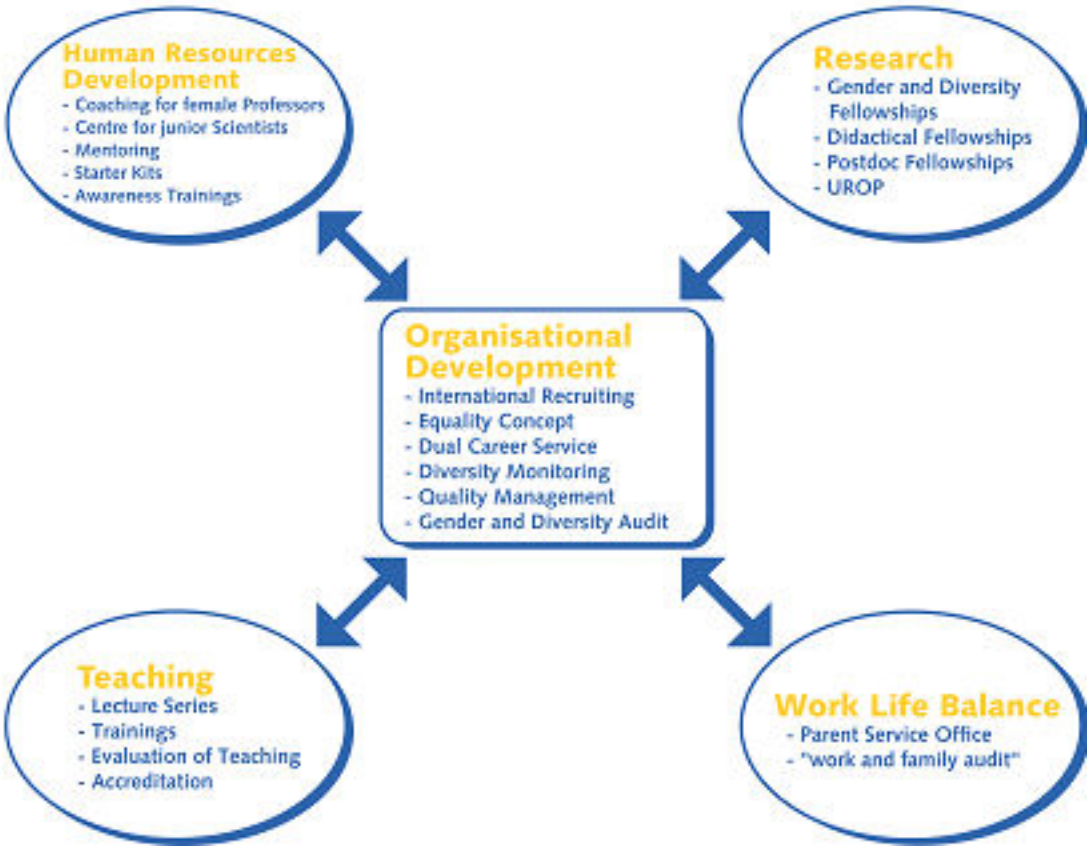

Figure 18: Influence of gender and diversity measures on organisational development

- To further the establishment of gender and diversity aspects in organisational development with fixed agreement on objectives, the scientific gender and diversity unit developed an equality concept (Leicht-Scholten et al. 2009a). This concept which was approved by the rectorate, comprises target agreements on the basis of a balanced score card. These objectives make it possible to establish equal and sustainable structures at the university. The concept has recently been awarded by a nationwide expert committee in the framework of the "Female Professorship Programme" by the Federal Ministry of Education and Research. For the first round of the programme 113 universities applied altogether, of which 79 were evaluated positively. RWTH Aachen can now receive up to 450.000 Euro p.a. over the next five years.[74]

- The recruiting concept "International Recruiting" of RWTH Aachen actively encourages diverse people to join the university. The proactive approach allows a specific recruitment of excellent international scientists, in particular female scientists

[74] For more information please visit http://www.bmbf.de/de/494.php

from all over the world. A new marketing strategy which focuses on the internationalisation of the university will be applied in this context, hoping to attract candidates from all over the world through job advertisements in international magazines and representations on fairs. In addition to the "International Recruitment" strategy the "Dual Career Service" at RWTH Aachen offers support to newly-hired top-level scientists and their families. The programme aims to attract and retain high qualified national and international scientist and their families by providing them with various service offers. In addition a web-based Welcome Centre serves as an orientation guide, and special events and meetings for newly-hired scientists and their families are offered on a regular basis in order to facilitate their integration in Aachen.

- At RWTH Aachen quality management is used for improvement of processes for the obtainment of equal opportunities. The main objective of quality management under equality aspects is the examination and optimisation of processes which foster equal opportunities at RWTH Aachen University. Through continuous analysis and evaluation, measures and activities are being scrutinised and further developed regarding their efficiency and impact. Currently lecture evaluations and graduate questionnaires are being revised and improved. Additionally several regulations such as the realisation of the target agreements formulated in the equality concept or controlling and evaluation of gender and diversity measures, guarantee the success of equality measures under the premise of an efficient quality management. In the framework of the implementation process evaluation, controlling and quality management are crucial. Therefore the scientific gender and diversity unit is developing an audit for equal opportunities at universities. The overall objective of this audit is the development of a framework for a coherent gender and diversity policy. The audit could be an effective instrument on how gender and diversity awareness can be sustainably raised and institutionalised at universities and to eventually develop a gender and diversity policy that stimulates and realises a gender sensitive change management process at research institutions which is clearly supported by top executives. The focus lies on the development of an instrument which is able to assess the degree of success of an institution which claims to pursue equal opportunities or a gender and diversity strategy (Leicht-Scholten 2009b).

- Monitoring of diverse students and employee groups is hitherto not present in controlling processes of most German university (Bakshi-Hamm and Lind 2008). In other European universities diversity monitoring is already institutionalised and used as an instrument to assess the needs of diverse groups. In the framework of RWTH Aachen's gender and diversity strategy a possible diversity monitoring was discussed. The importance of the capture of data which exceed the category gender was identified; correspondingly a first data collection will follow on a voluntarily basis in fall semester 2009. Students will then have the opportunity to specify their backgrounds (e.g. ethnic/migrational background or disability) during the enrolment at the university.

- Furthermore, the university also institutionalised equality in various agreements and directives. Gender and diversity aspects were incorporated in the mission statement, preamble of the basic order, objective and performance agreements with the state of North Rhine-Westphalia, a gender equality plan and in management by objectives between rector and the scientific gender and diversity unit. In the area of organizational development many changes have been initiated and also accomplished. The holistic gender and diversity approach supports these processes and furthers a change of scientific culture.

5. Conclusion

With its strong engagement on gender and diversity issues RWTH Aachen University takes on the role as a precursor among German universities. It was the first technical university to provide a sustainable structural framework for the implementation of a comprehensive gender and diversity approach. This paper gave a short overview on the organisational development strategy and its corresponding measures in the framework of the gender and diversity strategy. As a core field of activity organisational development reflects the interdependence of strategic actions and practical implementation. Even though most measures in this area are being executed on a strategic or structural level, practical activities are initiated as well (cf. figure 2). Furthermore an effective organisational development can also incorporate interdisciplinarity at all levels of the university by trying to integrate the gender and diversity

perspective into all areas. The main objective is to initiate and further cultural change on a structural and personal level among all members of the university. With the establishment of the scientific gender and diversity unit RWTH Aachen University breaks new and innovative grounds. Following research in gender and diversity and based on corresponding studies the scientific unit which is located between science and administration works scientifically and application-oriented likewise. With this double function, the scientific unit is unique in Germany. Based on the low percentage of women in leadership positions at the university the scientific unit has developed in its first year of existence the conceptual and organisational establishment of different diversity dimensions. Thereby, already existing gender measures were converted into a coherent overall management concept. RWTH Aachen University is still in the beginning of this process and has taken on the challenge to include the dimensions of diversity in all areas of the university. A basis for the main objective of the Institutional Strategy, a university which includes and appreciates diverse people, is established. It is essential to further the triggered measures and activities and therefore to establish gender and diversity as integral parts within the university and beyond the Initiative for Excellence.

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Gender equality in study courses at Swiss technical colleges: The path to change in electrical engineering, business IT and biotechnology

Keywords: Engineering, gender-sensitive teaching, department cultures, action research, female students

Abstract:

Against the background of the ever present differences between men and women in technical studies, the central question of this project focuses on how technology based courses at technical colleges can be made into a more attractive option for both genders. The aim was, on the basis of existing knowledge and best practice examples and together with course directors, faculty and students, to develop strategies and sound measures for gender equality in technical courses.

The general concepts and the concepts regarding content and didactics as well as the structural and personnel backgrounds of the three technical courses of electrical engineering, business IT and biotechnology offered in the Zurich University of Applied Sciences (ZHAW) were examined in terms of gender equality and the basics for gender equality in study courses were developed.

The involvement of different actors (male and female) in this project (action research) has contributed to the acceptance of the subject matter and has increased the willingness of those participating to bring (in the future) the acquired gender competence into the classroom.

Nadja Ramsauer, Thea Weiss Sampietro

1. Introduction

How can technology based courses in technical colleges be made into a more attractive option for both genders? This question is the driving force behind this project for development and change in the three disciplines of biotechnology, business IT and electrical engineering at the Zurich University of Applied Sciences (ZHAW).

“Engineering courses must maintain the number of male and female students and even increase it. To become more attractive, a modern comprehensive image must be shown of technology, also all academic aptitudes and life plans as regards to studying – especially those among women – should be taken into account. We must overcome all reservations that exist

concerning the place of women in the field of engineering." (Jansen-Schultz & Dudeck, 2005, 2). Our project does not follow the "Best Practice" model of making women suitable for engineering. We see it the other way around, that engineering should be made to suit young women as well as men in order to provide a varied, interdisciplinary, socially and practically-orientated training. Furthermore, at the School of Engineering at ZHAW there are already projects which focus on young women. These come in the form of information days and basics courses for prospective female students. From 2001 until 2003 a women-only basics course was set up for the course of "Communication and IT".

The desired goal of our project is to commence a reform of the content and the curriculum of technology based courses, aiming for diversity. The "Gender Category" as we put it, does not only relate to young women but also consciously includes the perspective of young men and all prospective students. Also they are not satisfied with a conventional understanding of technology and want to be able to bring into harmony their technology studies with their life-plans and learning-paths.

This focus has consequences for the theoretical approaches which are favoured in the upcoming projects: Not a deficit model, but rather if possible, adequate experience-based descriptions of gender differences, similarities and dismantlings[75] as well as the different departmental cultures[76]. We cross approaches with one another, to track the mechanisms of bias between genders, what's more, to take in to account the inclusive and exclusive function of the specialised cultural field of study for men and women. The statement that gender category cannot be brought into harmony with technology based courses, but rather that some courses and departments must be diversified. This is an important conclusion of the project.
From other projects geared towards change, it is recognised that it is of great importance that the college is involved in a scientific investigation for long lasting changes in the curricula and in the organisation. Therefore it is also important that decision makers (both male and female), for example course directors and lecturers are brought in and included during the change process. We have chosen this as a starting point. The project that is envisaged here

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75 See Wetterer (2003), Maihofer (2006), Ulmi & Maurer (2005).

76 Gender constructions are inscribed in the internal processes and in the work culture, "it is an integral part of organizational practice, to differentiate according to gender and hierarchy," Wilz (2003, 43f) zit. In: Ratzer (2006, 15). Up until now the different professional cultures have been examined, especially in a university context, but hardly in the technical colleges. See Krais (2000), Beaufays (2003), Krais & Beaufays (2005).

was enacted by the ZHAW between January 2007 and May 2008, with partial funding from the Federal Office for Education and Technology (BBT). Leadership lies with the Department directors of the ZHAW School of Engineering.

2. Starting positions and project aims

According to the scenario put forward by the Swiss State Office for Statistics, the number of students in technical colleges is set to increase over the next ten years, that said however women will remain in the minority, especially in technology based courses. Although in the last ten years we have witnessed a small increase in the proportion of women, there is a general difference between the technical colleges and the universities, where the proportion of women is clearly higher[77].

The technical colleges must now offer innovative training in order to attract good and motivated students, both male and female. Gender competence is an important component here. Courses of study arranged with gender-competence in mind are an attractive training for all students.

Technology based courses in technical colleges are still partly aligned to the acquisition of factual knowledge and hardly bring up for discussion the fact that technical projects are now complexly embedded in political and social fields. Many stereotypes maintain that men have an unquestionably better grasp of technology. Young men and women who distinguish social aspects from technology and perceive a masculine image of technology do not come against this traditional entrance. Moreover, often teaching staff unconsciously ignore women who show technical competence and over estimate men.
From this background it is important for education from a technical college, which is attractive for both men and women, that the following criteria are considered. Firstly, that problem-based and practically-orientated learning is placed in the foreground of the educational theory. Secondly the link with context must be picked out as a central theme in

77 In the last ten years, the proportion of women in technical disciplines / engineering courses at Swiss universities has risen from 17% to about 24% between 1995 and 2004 from 5% to over 13% in technical colleges. This sharp increase is above all due to the high proportion of women in the Department of Chemistry and Life Sciences (see Schneiter & Umbach-Daniel (2005, 8f)

technical learning content. Thirdly, the direction of the value system must be changed in the learning sphere and within the professional culture in the direction of divergence i.e. the didactic knowledge of the teaching staff must be updated constantly. Lecturers should take into consideration the different technical experience of all students so that use it to contribute to the dismantling of sexually stereotypical presumptions of ability. Fourthly, that the changes in the labour market require a stronger customer orientation which takes into account interdisciplinary knowledge and conciliatory skills.

2.1. How will Gender aspects be implemented into technical study courses? The state of the project for change

Especially in the technical universities the missing projects will be stated alongside research gaps in gender-specific study choice behaviour, which aims on the basis of existing research results for the development of gender equality in teaching and learning in technical courses. The existing projects for change focus primarily on the sensitisation of young women for technical courses[78]. In addition to manuals, in Switzerland there are recently university didactic offers for university members concerning Gender Competence[79].

In the ZHAW, as already mentioned, from 2001 until 2003 – parallel to the regular courses – a women-only course was offered. For women this was an attractive offer, however in this project content was left untouched and the didactical concepts of the standard courses were only marginally changed.
It remains that projects which start with the creation of courses and the curricula are still rare in Swiss technical colleges. Now what stands in the foreground is the motivation to study, the study supports and if necessary the backing of the entrance into a profession.

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78 Today in the Swiss advanced technical colleges there are, thanks to the federal program „ equal opportunities between women and men in advanced technical colleges “ (from 1996,) numerous projects which are established in technical studies. With the technology taster days and robot weeks, prospective customers are sensitized for a technical study.

79 Gender expertise in university management, training module http://www.genderstudies.zfh.ch/downloads/Gender_BE.pdf.

Projects for the reform of study courses which focus on structure, didactics and learning content, are mainly found abroad[80]. The existing research results must be taken by the persons responsible for teaching in the technical college as a basis for the development of new learning content and teaching methods. Furthermore, experience from German and Austrian projects show that lasting effects are achieved only if both male and female decision makers are involved in the reform process.

2.2. Project aims

With the present project it was necessary to develop relevant fundamentals which it needs in order to create gender equality in courses offered by the technical college. Besides the overall concepts and the didactic and content-wise concepts, the structural and personnel background of the three mentioned technical courses (biotechnology, business IT and Electrical engineering) were examined. The perspective of both the course directors and the lecturers as well as that of the students was considered in the development of the following goals:

- Process available knowledge and build upon it in the three courses together with the course directors and lecturers to develop strategies and concrete measures for gender equality in technical courses.

- Encourage discussion in the three courses concerning the inclusion of educational and didactical knowledge and content criteria which take into account the gender question: how the curricula can be reformed towards gender equality?

- Development of corner stones for the specialist and optimal theoretical motivation design of the three technical courses of study for men and women with the consideration of lecturers and students.

- Sensitization of the lecturing heads and heads of departments in the area of equal opportunities and research into gender.

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[80] See the overview in the main report of the project, Weiss Sampietro & Ramsauer, 2008.

3. Path to change

How was the discussion on the theme of gender stimulated and the decision makers in the project integrated and sensitized for the theme of gender? How were the spheres of activity disclosed, how were the measures for a gender-sensitive design of teaching realised?

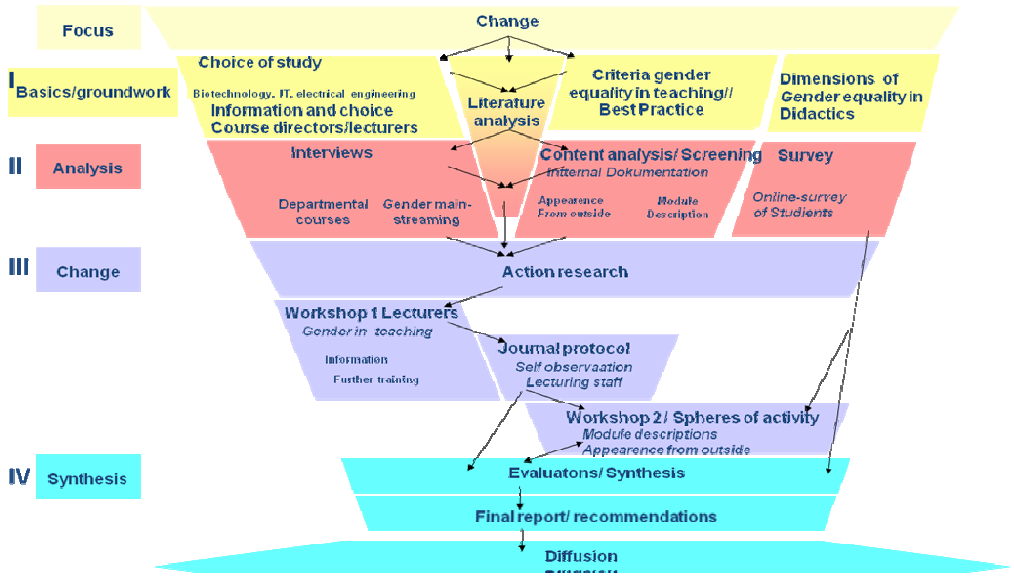

Figure 19: Project design

After having worked on the first phase of gender-sensitive teaching criteria and Best Practice examples from existing research results, followed the inclusion of the directors of the three courses and well-chosen lecturing staff. The qualitative and quantitative methods which were used are shown in fig. 1 in the overview presented.

The model for the analytic phase geared towards change was firstly the method of integrative "Gendering" which was developed in the gender competence project at the University of Lüneburg and secondly the method of the action research. We have formulated starting points for gender-sensitive didactics in technical courses of study with consideration to our theoretical implications from the gender and departmental research as well as from the existing recommendations for gender-appropriate teaching, whereby we try to avoid stereotypes where possible. Four levels were considered: technical content, methodical didactic, social-communicative and a personal.

3.1. Criteria for gender equality

The analysis of the curricula covered the following questions: does the teaching of specialist content resulting from the research take gender into account? To what extent are didactics and study organisation enough for the criterion of gender equality? Is gender competence promoted to lecturing staff and students as a key authority?

Relevant criteria for gender equality were related to the application of technical disciplines, the inter-disciplinary aspects, the vocational references, intercultural aspects, emphasis on linguistic ability, varied teaching methods and learning methods, ecological aspects, female role models in teaching and research, a comprehensive approach and evaluation of technology results. On this base the performance of the three study paths has also been analysed externally and a screening of the module descriptions has been set up. The choice of the criteria for gender equality has turned out to be very significant, because at first sight these aspects do not address gender relations. Intuitive defensive reactions can be avoided with the involved parties compared with the gender topic, and an approach surprising for them be chosen.

We mainly focus here on the detailed description of procedure in the conversion part, or in the part of the project which involved the participating lecturing staff reflecting on the implicit and explicit Gender-knowledge and concrete measures and attempted to work on gender-sensitive aspects in their lessons. Methodically we lean upon the action research[81] and the college evaluation concepts in which through inclusion of the actors and actresses, new knowledge is found.

81 See Altrichter & Posch (1998)

3.2. Workshops and journal protocols

Firstly the twelve lecturing staffs (three of which were course directors[82]) were introduced to a first workshop on the topic of gender. On the basis of theoretical concepts and on gender and departmental research they could reflect on their personal approaches on the topic. On the basis of literature research the criteria for gender-sensitive teaching was presented to them which had not at first broken down the terms and conditions of technical studies. A second element in the conversion phase was a two month journal entry. The lecturing staff examined the content and teaching methods on the gender content of their own lessons and wrote notes every week. The purpose of the journal programme was also to uncover aspects of real departmental culture in the courses of electrical engineering, Business IT, and biotechnology and to reflect on any gender aspects within. And finally the attitude of the students themselves in their interactions was to be critically observed too.

The additions in the journals might not be totally open, with some written in advance. On the one hand they refer to the "how things are": what is already taken into consideration content-wise and methodically in their teaching, which fulfils the above mentioned criteria of gender equality? On the other hand the lecturing staff gave an account of "how it should be": Where can starting points be seen, so as to integrate additional aspects of gender aspects into teaching? The descriptions of how things are and how they should be were made within the following four dimensions, with various stimulating questions underpinned:

- A subject specific content dimension
- Methodical didactic dimension
- Social-communicative dimension
- Personal dimension[83]

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82 It a balanced participation of specialists and generalists was sought after. Five lecturers in technical fields, three lecturers focused on basics and four from the general education subjects kept a journal (8 men, 4 women).

83 For example, questions about role models in the delivery of content material, the choice of appropriate teaching methods, also with a look to application in later professional field, questions about the culture of communication and feedback and attitudes and perceptions as a teacher.

After the journal phase a second workshop was set up, in which the results of a student survey[84] as well as the analysis of the performance of courses and the aims and content of the teaching modules would be presented. The participating course directors and lecturers contributed their individual module description on the aspect of gender-sensitivity and based on journal evaluation and compiled suggestions for gender-sensitive teaching in the three courses. In conclusion there was further discussion on the three courses as regards to the different spheres of activity.

4. Looking back and looking forward

It has proven itself worthwhile to integrate the department heads and lecturers into the project via journal guidance and workshops. With the documentation and reflection of content and methodical aspects of their teaching they could contribute to the results. From the outset, an interdisciplinary discussion has been ongoing among the lecturing staff.

4.1. Gender sensitive activities in the courses: How things are

The evaluation of the current state of the lecturing heads led to a surprising result: the lecturers already incorporate many of the above mentioned criteria on gender equality. They try to include the perspective of both genders in the choice of examples, bring up for discussion the theme of work experience and career plans of the students, employ alternating, varying didactic teaching and promote teamwork and practical relationships. Especially in the course of biotechnology – a new discipline without much established and traditional theories and schools of thought – there is an open and level departmental culture with builds upon diversity and which consciously address both men and women.

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[84] To determine the motives of the study choice as well as the experience and the claims of the students in their studies, there was an online questionnaire in the winter semester in 2007/08 of the classes in the 3rd semester in biotechnology, electrical engineering as well as Business IT. With a return of just 70% the survey delivered 73 valid records.

The priorities of the lecturing staff show that there are already existing manuals and checklists on gender-equal didactics[85] which are only partly applicable on the context of technical education: firstly, such checklists suggest a conversion which can be carried out easily and do not give enough mention to the limitations of departmental culture. Secondly, the recommendations cement common gender-specific attributions, for example the belief that men are more outspoken then women. With good intentions a different beginning is nurtured here, which aims primarily at the alleged difference between men and women and not just at the general difference among students i.e. diversity. If technical teaching staff would highlight gender as suggested in the manuals, then that would trigger a defensive reaction from the students against the topic of gender. The lecturers of technical courses mention this constraint in their journals, in that they do not see everywhere a possibility to pass on the results from the gender research investigation, as this would seem false and dogmatic to them.

The analysis of the journals showed that lecturing staff preferred a differentiated and undramatic change as regards the gender category. They stress again and again in the journals and workshops the fact that there are larger differences within each gender than between them and so in this sense they cannot confirm the estimated difference or deficit. Instead the lecturing staff prefers to go for the similarities between the genders or keep a humorous relationship with stereotypes in order to dismantle them

4.2. Gender sensitive perspectives in courses of study: How it should be

The desired goals which are detailed in the journals refer to the fact that the lecturing staff see many points of contact which are hardly convertible partly on account of underlying circumstances. The lecturing staff are conscious themselves that there is a limited scope of action at the technical college. Many social models have been made concerning the connection between gender and technology and represent a restriction for projects for change in technical colleges. In particular they are dependent on the fact that women choose technical occupations and meet the entry requirements for technical colleges. This entrance is – as the figures show – narrow for women. Obviously existing role models work to create, especially

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85 See WBZ / SIBP Working Group (2000), Baur & Marti (2000), Merz (2001).

during adolescence – a critical time for choosing one's career path – a high pressure for standardisation. (see Schuster et al. 2004).

Even with these conditions in mind, the lecturers still see possibilities for improvement. They lack action-training best practice examples or instructions which would allow them to introduce the gender topic into their teaching content. Firstly, independently from the gender category, many lecturers judge gender as important to create open questions among the students which would not lead to a "right" or "wrong" answer. Breaking open the "yes/no answer patterns outside the journal programme would also lead to a change in attitude and models in the study courses, but their fear is that not all of the lecturers will agree.

With the training forms the lecturers see a large potential for change: In many vessels they would have the possibility of promoting teamwork and the independent working out of solutions. They feel the time factor is restrictive. Over and over again it is mentioned in the journals that there is no time for trying out new forms of teaching because "I must push through my material" and this is most easily done by teaching from the front. The Bologna reform and the organisation into modules of courses has led to the view of the lecturing staff that teaching material has grown in compared to teaching time and the teaching content has become more strongly sequenced. This has damaged interdisciplinary collaboration and exchange within the faculty.

The lecturers judge positively and deserving of change the increased content in relation to the future occupational area as well as the impact of role models. They suggest for example that there should be an increase in the number of professional women as lecturers in the three courses or that as regards internships, companies in which (leading) women are employed should be sought after. Beyond the transfer of technical contents, this would function as role model and have a positive effect in for female students in particular.

The directors of the three courses of study due to their role see the need for improvement, particularly in areas that are not directly linked to classroom activities. Firstly, the appearance of the courses will be changed on the outside so that young women feel welcome by the description of the working climate and that attractive future vocations are represented. The brochures could more strongly emphasize issues about sustainability, in relation to the diversity (gender, age, and ethnicity) of the user of the technology products and the social

relevance of technology. Secondly, the module descriptions should be changed in such a way that it will not only say which technical but also which social and communicative skills the students could gain. Content from the gender research could be integrated with individual subjects in the material and mentioned explicitly in the module descriptions.

4.3. Critical evaluation of the results

Projects which do not make women suitable for technical studies but rather wish to assess the mentalities and structures of the courses make an ambitious claim which can only be fulfilled gradually and with a long term change in mentality. The most important condition is the support from the departments and course directors. Their positive attitude in relation to structure changing projects has a consequent effect on the lecturing and research staff and can only bring on the desired discussion about their own departmental culture.

The discussion among faculty members who teach many different subjects has proved in this project to be extremely stimulating. In this way ethnographically personal teaching can be taken from an outside perspective: how to generate and convey our expertise? How to deal with the majority and minority status of the students and how do we perceive heterogeneity or homogeneity in lecturing? How do we try to break apart stereotypes using humour and promote the diversity of learning?
At this point interesting research opportunities open up. It is still hardly investigated how the departmental cultures in technical courses at technical colleges differ. Nor do we know much about the learning needs and perceptions of technology among male students or their future career paths. Both –the departmental cultures and research into men – could result in a shift of focus which no longer has at the centre the relationship between women and technology, but rather the relationship between different technical disciplines and social life-perspective variety.

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Motivating Factors and Barriers to Study Engineering - Gender Differences and Possible Consequences

Keywords: gender, choice of field of study, occupational image of an engineer

Abstract:

This article will show some results of a questionnaire study on the motivation for choosing a certain course of study among 320 engineering students and pedagogical students, which was carried out by the Ada-Lovelace-Projekt[86] within the framework of the EU UPDATE Project[87]. The study focussed on the students' technical-related interests and experiences during primary school, their self-image and self-confidence concerning their performance in their studies and their technical competence, as well as to the image of the occupation of an engineer and their own expectations for their career. The support of the social environment as a potential influential factor for choosing a course of study was analysed, too. From these results it is possible to draw conclusions about potential conditions and motives for choosing a certain course of study among young female engineers. Recommendations with the aim of attracting more young women to the engineering sciences can be offered.

Judith Ebach, Martina Endepohls-Ulpe, Janine von Zabern

1. Introduction

The participation of women in the field of engineering is really low, especially in Germany when compared with the average of the European Union (BMFSFJ, 2008). To be an engineer doesn't seem to be an attractive professional perspective for most young women. To enhance the interest of female students in engineering studies and professional opportunities in engineering, it seems to be important to know possible motivating factors and barriers young women experience during their childhood and their school career, as well as to know their occupational image about being an engineer.

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86 The Ada-Lovelace-Project is a mentoring project in Rhineland-Palatinate. It aims at motivating young women for studying science, mathematics and engineering (www.ada-lovelace.com)

87 UPDATE = **U**nderstanding and **P**roviding a **D**evelopmental **A**pproach in **T**echnology **E**ducation

Studies in Germany about the motivation of female engineers for studying and the situation of their studies reveal potential influential factors for choosing a certain course of study and for the young women's contentment with their studies. Technical topics e.g. are hardly being dealt with at school (Vogel & Hinz, 2000), which also applies explicitly for primary school (Endepohls-Ulpe et al., 2008). Interests at school and the subject choice in sixth form develop clearly sex-specific to the disadvantage of the natural scientific and technical subjects (Köller et al., 2000), and even if the young female engineering students have better marks than their fellow students they still show less self-confidence in their professional/specialist performances (Schmelter, 1998). The image of an engineer as a hardly team-oriented person who likes fiddly work (Schwarze, 1998) doesn't attract young women to these jobs, either.

The UPDATE Project, which is funded through the Sixth Framework Programme of the EU, wants to find out about motivating factors and barriers for young women to study and to take part in the technological field. The Ada-Lovelace-Project at the University of Koblenz-Landau is one of 16 partners of the EU UPDATE Project and conducted the German part of an international questionnaire study. Engineering students and non-engineering students were asked about possible influences on the choice of their field of study, e.g. their experiences with technology during childhood and at school, their family background, their favourite subjects at school and about several aspects of the professional image of an engineer including their own career expectations. Some central results of this questionnaire study will be presented in this paper along the following four main dimensions:

- Experiences in primary school time with respect to science and technology
- Self-image and self-efficacy referring to technology
- Occupational image of an engineer and career expectations
- Support of the family and significant others for choosing a non-traditional career

The results reveal motivating factors and barriers for studying engineering especially among women. Conclusions about required changes in the educational system, helpful support and about changes in the occupational image of engineering as they are represented in public will be drawn.

2. Methodology

Two groups of students with very different courses of subjects were included in this study: male and female engineering students and male and female students of educational science. Differences between the subsamples were to reveal information about the variables which support or obstruct an engineering career in general and about barriers or motivating factors especially for women.

The authors adapted a questionnaire provided by Doina Balahur from Alexandru Ioan Cuza University of Iasi, Romania, to the special needs of the planned sampling at different universities and target groups. As a second source for items served the German version of the Womeng questionnaire, which was delevoped for and applied by a German team of researchers in the context of the EU Womeng project (Pourrat et al., 2005).

Two questionnaires, according to the two target groups, were constructed:

- a questionnaire for engineering students
- a questionnaire for non-engineering students

About 80% of the questions are identical in both questionnaires. Some items differ because of the different subjects the two target groups chose to study.

2.1. Description of the sample

The sample was drawn in a non-representative way, as the questionnaire was applied at several universities and universities of applied sciences in Rhineland-Palatinate. A total of 320 students filled out the questionnaire:

- 179 non-engineering students (49 male (27.4%) and 130 female (72.6%))
  (University of Koblenz-Landau)

- 141 engineering students (79 male (56.0%) and 62 female (44.0%))
  (Several universities of applied sciences in Rhineland-Palatinate)

2.1.1. Main subject

Table 21 shows the distribution of main subjects of the non-engineering students.

Table 21: Course of study of non-engineering students, sex

Subject	Male N (%)		Female N (%)		Total N (%)	
Educational science	4	(8.2)	10	(7.7)	14	(7.8)
Teaching in primary school	19	(38.8)	78	(60.0)	97	(54.2)
Teaching in secondary school	21	(42.9)	36	(27.7)	57	(31.8)
Other	5	(10.2)	6	(4.6)	12	(6.7)
Total	49	(100.0)	130	(100.0)	179	(100.0)

The high percentage of women in the pedagogical fields of study is typical for the distribution of sex among the teachers at primary and secondary school (lower than sixth form) in Germany.

Table 22 shows the main subjects of the engineering students. Here, one can observe a great variety of engineering sciences and technical courses of study since students from different universities of applied sciences took part in the study. The distribution is not representative, either. A specific goal of the questionnaire survey was to involve as many female engineering students as possible, so as to reach a balanced distribution of the random sample.

Table 22: Course of study of engineering students, sex

Subject	Male N (%)		Female N (%)		Total N (%)	
Medical technology	17	(21.5)	11	(17.7)	28	(19.9)
Laser	23	(29.1)		(19.4)		(24.8)

technology			12		35	
Mechanical engineering	14	(17.7)	10	(16.1)	24	(17.0)
Food technology	4	(5.1)	7	(11.3)	11	(7.8)
Environment protection	1	(1.3)	9	(14.5)	10	(7.1)
Computational sciences	3	(3.8)	4	(6.5)	7	(5.0)
Applied informatics	6	(7.6)	0	(0.0)	6	(4.3)
Computing engineering	4	(5.1)	1	(1.6)	5	(3.5)
Bio-technology	1	(1.3)	0	(0.0)	1	(0.7)
Electrical engineering	4	(5.1)	1	(1.6)	5	(3.5)
Measurement technology	2	(2.5)	2	(3.2)	4	(2.8)
Other	0	(0.0)	5	(8.1)	5	(3.5)
Total	79	(100.0)	62	(100.0)	141	(100)

2.1.2. Age and Nationality

The students were between 19 and 48 years old. The mean age of the total group was 23.4 years and the median was 22 years. Concerning age the sample doesn't reflect the normal distribution, which is not unusual since obviously most of the students are young people. Nevertheless, the sample groups (non-engineering vs engineering; male vs female) don't differ significantly in their distribution of age (proved by analysis of variance).

More than 90% of the students of both subsamples have German nationality. The other students are from European and African countries. There are no significant differences in the distribution of nationalitiy for the subsamples and for sex.

2.2. Analysis of data

The analysis of the questionnaires was done with the statistical programme SPSS. As a first analysis basic statistical characteristics were calculated. Principal Component Analysis with subsequent Varimax Rotation was used where the number of items had to be reduced for some main factors. For the further analysis of group differences, the factors were used as dependent variables.

Differences between engineering students and non-engineering students, as well as between female and male students were tested with Analysis of Variance. The T-test for independent samples was used to test gender differences for those items which were only asked in one of the two questionnaires.

3. Supporting and motivating factors for studying engineering – possible barriers

The results of the questionnaire survey cannot be portrayed fully within the bounds of this article. Therefore, the following section contains a selection of potential influential factors from the fields of family and school, as well as results about the self-image and image of the occupation of a typical engineer.

3.1. Experiences in primary school with respect to science and technology

Already in primary school one can find proof for distinct differences between the sexes concerning technical-natural scientific interests and expectations concerning self-efficacy (Endepohls-Ulpe et al., 2008). Therefore, in the study at issue the students were asked about their favourite subjects and technical experiences at school, as well as about how they assessed their performance in natural sciences and technology in primary school, and whether they also spent time with natural scientific and technical activities out of school. Furthermore,

the participants were asked in how far their father and mother supported them in learning natural scientific and IT topics at that age.

3.1.1. Favourite subjects

Expected differences in the favourite subjects can be noticed already in primary school (1=didn't like this subject, 4=favoured subject):

a) male students liked mathematics more than female students (M=3.43 vs M=3.17), independent of their later choice of course of study (p=.05).

b) The differences between the subsamples for the subjects "German", "Sachkunde = General Knowledge, Local Geography and History", "Religion", "Craft / Design", "Art", and "Music" during primary school are similar in their tendency: female students preferred these subjects in comparison to male students, and non-engineering students preferred these subjects in comparison to engineering students ($p<.05$).

3.1.2. Technical experiences in primary school

When asked about their technical experience in primary school, 95 students (29.8%) affirmed that they had learned something about technical topics in primary school, 139 students (43.6%) hadn't learned anything about technical topics in primary school and 85 students (26.6%) didn't remember.

3.1.3. Self-efficacy related to science and technology / parental influence

Besides the concrete experience in school as referred above, the students were asked about their general experience with technology and science during primary school. The items covered aspects of self-confidence and success at school, of their (technical) interests in

leisure time, and asked about the support the students used to get from their parents for learning something in the area of natural science and technology.

Four relevant factors could be identified through factor-analysis for self-efficacy related to science and technology and the parental influence during primary school:

- Intellectual-based interest in science and technology and high self-efficacy
- Practical-based interest in science and technology
- Support of the mother
- Being ambitious, combined with support from the father

Engineering students, male (M=.27) and female (M=.28), describe themselves as highly interested and self-confident in technical and scientific themes and challenges in primary school. For non-engineering students a significant gender difference can be recognized. Male students (M=.19) were significantly more interested and self-confident concerning technical and scienctific themes and challenges in primary school than female students (M=-.39). As a consequence, the two female groups differ significantly in their intellectual-based interest in science and technology and their self-efficacy. Figure 15 shows this interaction effect, and the great difference between female engineering students and female non-engineering students in self-efficacy and intellectual-based interest in science and technology during primary school becomes obvious.

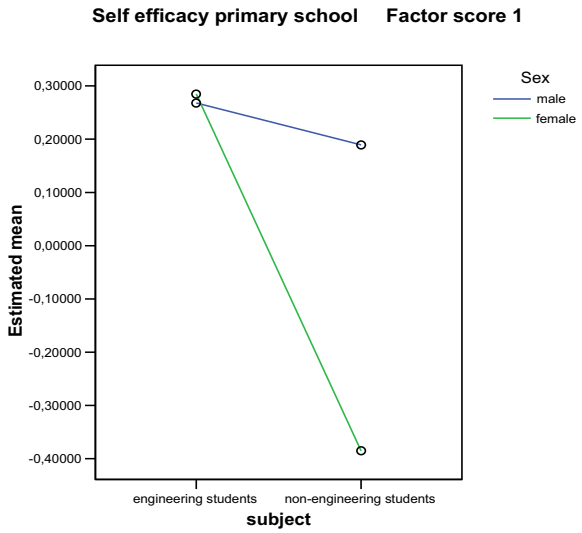

Figure 20: Factor: Self-efficacy and intellectual based interest in science and technology during primary school, interaction effect.

Male engineering students score highest in the factor “practical-based interest in science and technology” (M=.65). During primary school they really liked to play with technical toys at home or together with friends. They liked to plan, construct and to experiment. The male non-engineering students also score positively in this factor (M=.34). The female students score significantly lower in this factor of practical-technical interests and experience; Female engineering students score higher (M=-.20) than the female non-engineering students (M=-.45). Proved in an analysis of variance, both main effects (gender and course of study) are significant.

For the third factor “support from the mother”, young women remember much more support from their mother, teaching technology (e.g. computer) and science (M=.13) than young men (M=-.16) and they assess the support from their mother as more important than their male colleagues. As to the support from the father combined with ambition toward technical and mathematical assignments (fourth factor), a similar result can be observed: there is an impressive influence of the father for female students (M=15) in contrast to male students (M=-.21). Female students felt bad when they weren’t able to solve mathematical and technical problems during primary school. Especially female engineering students score high on this fourth factor of ambition and support from the father concerning mathematical and technical assignments (M=.35).

3.2. Self-image and self-efficacy

To get an impression of the self-image and the self-efficacy in current lectures students were asked to characterize themselves along 17 items. They had to compare their effort and invested time, their success and confidence in the current lectures separately, with men and with women in their current lectures.

The self-image of the sample can be described along five main factors:

- Social and leading competences
- Intellectual competences
- Technical competences and machine orientation
- Thinking creatively and innovatively
- Hard-working and ambitious

Differences between engineering students and non-engineering students occur in an expected way: engineering students describe themselves as much more technically competent and machine-oriented (M=.49) than non-engineering students (M=-.35). Non-engineering students on the other side describe themselves as much more socially competent and having more leading competences (M=.24) than engineering students (M=-.30).

Gender differences, too, are well known: female students describe themselves significantly less as intellectually competent than male students (M=-.16 vs. M=.22), independent of their course of study. They also describe themselves as less technically competent and machine-oriented (M=-.26 vs. M=.42), but both, more creative, innovative (M=.09 vs. M=-.15) and more hard-working and ambitious (M=.20 vs. M=-.29) than the male students.

Regarding technical competences and machine orientation, which will be an important piece of the self-image for engineering students, female engineering students feel less competent (M=.24) than male engineering students (M=.70), but more competent than male non-engineering students (M=.01); (female non-engineering students: M=-.49).

Results of different self-images of the students depending on gender are totally confirmed by the gender differences which occurred when students were asked to compare themselves to other students on different aspects in current lectures. Especially the self-confidence of young women relating to their achievements and technical abilities is significantly lower in comparison to young men.

3.3. Professional image of an engineer

3.3.1. Ideal characteristics for working in an engineering occupation

The students of both subsamples were asked to discribe the characteristics a person should ideally have to be able to work in an engineering occupation. For 19 different character traits they had to assess the importance for an ideal engineer.

With factor analysis the ideal characteristics for working in an engineering occupation could be reduced to three main competences:

- Leading competences and team orientation
- Work/life balance and social competence
- Thinking logically and having technical competence

For the attributes summarized as "thinking logically and having technical competence" all subgroubs agree similary, but engineering students attribute more leading competences and team orientation to an "ideal" engineer (M=.12) than non-engineering students (M=.-.07). They also believe much stronger in the idea that an ideal engineer has to keep a work/life balance and should be socially competent (M=.17) than non-engineering students (M=-.12). These ideal characteristics, which are in contrast to the former (sometimes even actual) professional image of an engineer in Germany, are mostly mentioned by female engineering students (M=.18 for leading competences and team orientation; M=.29 for work/life balance and social competences). They have the most progressive professional image of an engineer as a social competent, creative and team-oriented person with leading qualities who is content with his/her private life and who is able to harmonize private life and work.

3.3.2. Occupational image of an engineer

The occupational image of an engineer as stated by the students of this sample can be described along four central attributes which were extracted from eleven statements:

- Work-life balance is difficult
- Heavy workload and technical responsibility (goes well with femininity)
- Machine orientation with monotonous assignments
- Many managerial assignments (doesn't go well with femininity)

Male students believe much more often that an engineer cannot find a balance between work and family / partnership / children (M=.20) than female students (M=-.15) who are apparently more optimistic about this aspect of being an engineer.

When seen in connection with the results of the ideal characteristics of an engineer the engineering students have a more modern occupational image of an engineer than the non-engineering pedagogical students: non-engineering students believe much stronger in an engineer as a machine-oriented person doing monotonous work (M=.16) than engineering students (M=-.22). Engineering students in comparison with non-engineering students more often think that the occupation of an engineer is characterized by a heavy workload and technical responsibility. Nevertheless, they think that this goes well with femininity (M=.13 vs. M=-.10). Managerial assignments are significantly more associated with the career of an engineer by engineering students (M=.11) than by non-engineering students (M=-.06). But in contrast these assignments do not go well with femininity in the opinion of the engineering students.

3.3.3. Women in engineering: experiences in current lectures and expectations for the job

Only engineering students were asked about their experiences and expectations. Statements as for example "My technical department supported female students" or "Instructors in technical lectures made comments that demeaned women" had to be assessed on a scale from 1 = total disagreement to 4= total agreement. There are four items the students agreed with (Mean about 2), independent of their sex:

- My technical department supported female students
- It is easier to find a job in the technical field for a man than for a woman
- I believe that in technology men are generally offered higher-payed jobs than women
- In technology it is more difficult for a woman to balance the career and the family than in most other fields

There is only one significant difference in the experience of male vs female engineering students (T=-2.10; df=131; p=.037): female engineering students (M=2.31) agree more often than male students (M=1.93) that certain fields of technology are easier to go for as a woman than some other fields of technology.

3.4. The support of significant others to choose a career as an engineer

The engineering students were asked about the experienced support of familiy members, teachers and friends to choose a career in technology and how important they would assess this support (1=unimportant; 4=very important).

Mother (M=2.81) and father (M=3.03) both offered great support for the decision to study engineering. Especially their daughters assess their support as really important (Father: M=3.11; mother: M=3.07).

From the following relevant persons, female engineering students got much more support than male engineering students: mother, sister, female teacher, female role model, female friend, male friend, female peer. Apparenty, the supporting people are, with the exception of male friends, female relevant others.

4. Discussion and Conclusions

Already primary school (in Germany: 6 to 10 years old) seems to be an important phase for the development of technical and mathematical interests. At this early age, gender differences become obvious as young girls in general show lower interest in mathematics and a lower self-efficacy in science and technology. This result of a lower self-efficacy on technological activities of young girls is approved by a study of Endepohls-Ulpe et al. (2008) with 235 primary school children.

The later female engineering students in contrast can be characterized as ambitious girls with a relatively high interest in mathematics at school and a high self-efficacy in natural science, technology and mathematics. They considered difficult technical and mathematical assignments as being a challenge and loved solving them. In contrast to their male colleagues (male engineering students) they didn’t have that much practical-based interest in technology like playing with technical toys, planning, constructing and doing experiments. It seems to be

important to show young girls that they don't need to be a person who likes fiddly work for becoming a good engineer.

The furhtering of technical interests and interest in science and computing at this early age comes from the family, but not from school. Technical experiences in school are rare and do not influence later decisions for technical studies in a positive way. Pupils who later on decide to become an engineer only remember for these early years a high intellectual-based interest in science and technology, independent of gender. They feel very self-confident for the relevant subjects and topics at school. Results of an interview study with 45 teachers in primary school (Endepohls-Ulpe et al. 2008) actually reveal that technology as a topic is not given much attention to in primary school.

The support from the mother for learning technology and science seems to be much more important for female students than for male students. The father, too, had an impressive influence during primary school, especially for female engineering students who were ambitious to solve mathematical and technical assignments. This large influence of parents in this early age – mostly the technically interested father – was already discussed by Janshen & Rudolph (1987) in the 80s. They saw that this influence was an important factor for socialisation of the later female engineers, and indeed it still appears to be significant for the present generation of engineering students.

For the furthering of the interest in technology and natural sciences it seems to be a central starting point to further technical self-confidence. In this field female engineering students assessed themselves much more self-confident than pedagogical students, even though they correspond to the "typical female" characteristics, such as creativity, ambition and diligence, at other self-assessed personality traits. According to Wender & Popoff (2005) technical-related self-confidence can be increased e.g. via a social environment, which is marked by affirmation and respect towards girls dealing with natural sciences and technology, as can be proved from the above results concerning the area of family.

In the area of schools, to further technical interest during primary school and the development of a positive technical-related self-image it can be recommended that technology lessons in primary schools should be extended significantly. To reach this it will be necessary to start the changes with the training of teachers. Next to support from the family – which can be hardly

influenced by schools and society – it would be desirable to have special technology offers for girls in primary school. These activities should be marked by positive experiences and they should explicitly strengthen technical-related self-confidence.

In the phase of deciding for a certain course of study the significance of supporting important relevant others can also be noticed. It is mainly female family members and female peers who motivate the young female engineering students. This result confirms first furthering concepts and actions, as e.g. mentoring of female pupils and the selected "use" of female role models from the field of technology and natural sciences (e.g. Ebach, 2006).

Young female engineering students are known for their highly progressive image of an "ideal engineer". At the same time they are also quite optimistic about combining family and work. Such a motivating professional image should replace the traditional occupational image of an engineer more and more, and it should be spread in society. Especially professional associations and the media could be useful in this process.

The results on experiences in current lectures and on the expectations for the engineering job show that a discrimination of female engieers is seen by both, male and female engineering students. This discrimination refers to difficulties in getting a (high-payed) job and in balancing the career and the familiy in technology.

Thus, results that were found by Schwarze (1998) are still confirmed 10 years later. The equality of female engineers still needs improvement. Here, it is especially important that the economy, politics and the professional associations improve the working conditions of the female engineers and help making it easier to harmonise the family and the job.

Female engineering students obviously see some fields of engineering which are better to go for and to be successful as a woman. This may be interpreted as a perceived restriction in their occupational choice, or as a motivating chance for women to successfully stand their ground as an engineer in the job market. Therefore, it could be seen as a possibility to motivate young women for engineering studies when they are increasingly shown those fields of engineering where female engineers work successfully.

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Educational Gender and Diversity Projects at RWTH Aachen University: Interdisciplinary Strategies to establish Gender Mainstreaming in various Teaching Scenarios

Keywords: academic career, gender differences, post-doc-phase, career orientation and planning, comparison of chemistry and political science

Abstract:

In order to successfully implement gender mainstreaming in engineering education, a sustainable strategy for teaching gender competence must be interdisciplinary and parallel, to take effect. Results of the following projects will be interwoven to create a comprehensive gender expertise in further education. The projects represent a "diversified" approach, which combines research and teaching, school and university education and training in interdisciplinary research areas (computer science, communication studies, secondary teacher training) and "new" research areas, such as eLearning 2.0, community and mobile learning and web science.

Mostafa Akbari, Thiemo Leonhardt, Anne-Christien Pielka, Ulrik Schroeder

1. Introduction

2008 we started with our gender and diversity studies. Particular is that we work at a computer science chair at the RWTH Aachen University and 50% of our graduated research team are women. Our interest in this field is caused to the lack of qualified persons in engineering and natural scientific employment market that attends with the minor representation of women in engineering or natural disciplines at german universities. At the RWTH Aachen University the part of women in engineering and natural disciplines is mere 15.8%. So the RWTH Aachen manifests the integration of equal opportunities and diversity as central aims, in order to create and implement faire conditions of working, learning and teaching. So our University donates doctorial fellowships for gender and diversity research in different disciplines.

In our three doctorial theses we want to implement gender und diversity on different levels of learning and specially make the next generation learning tools ready for every boy and girl. On the first level we build workshops for young pupils to arouse their interest for mathematics, engineering, computer and natural science. In this context we prepare and qualify teacher training students with gender and diversity skills. In the future those teachers will teach their skills as competence to their pupils. On the next level we enhance the future learning infrastructure at the universities. More and more eLearning and specially blended learning will be offered at universities. This is characteristic for the most engineering and science studies because of their large student groups. To establish a barrier free, gender and diversity friendly study we research the joy-of-use and hedonic factors for those. Those research results are implemented directly into the RWTH Aachen University's eLearning portal. To establish a higher success rate and new learning paradigms we analyze and explore additionally new ways of learning. This is necessary as a consequence to gain new students with different gender, social and cultural roles.

2. Development, Testing, and Evaluation of Gender-Sensitive, Inter-Disciplinary, Computer Science Approaches for School Education

Teachers play a significant role in supporting young women to follow their interests. Unfortunately, they also increase the social prejudice that young women are not suitable for mathematics, computer science, natural science and technology. Our conviction is that teachers hold a key position for changing the cultural assignment of males to engineering. For this reason our focus is to implement gender-sensitive teaching practice seminars as a regular part of the didactic teaching module of teacher training at RWTH Aachen University. In addition to the effect that more teaching material will be developed, tested at school and scientifically evaluated, it is our goal to raise the awareness of students completing teaching degrees for secondary school for gender and diversity issues in the MINT field.

Therefore the central objective of this doctorial thesis project is to develop further learning units exemplarily based on results of the evaluated, successful project Roberta - *Mädchen erobern Roboter*. As a priority, results of gender and diversity research and concrete examples will be integrated conceptually into lectures and seminars of the didactic computer science

module. In this case gender-sensitive learning materials for lecture series and workshops are designed by all of our students. Thus we teach the theoretical knowledge about gender and diversity research results to enable all students to develop gender and diversity awareness in the classroom. The first seminars start this April.

A didactical focus of the learning units is multidisciplinarity. In this way computer science can be experienced as useful both personally and socially. This can be achieved by solving problems in different disciplines with impressive research results and methods of computer science. This approach is based on the recognition that girls and young women use computers cooperatively and utility-orientedly and are also interested in the societal impacts of information technology (Schelhowe 2004). The interconnection of learning content from different subjects at schools not only has a positive impact on the effectiveness of the learning process, but may also have compensatory effects such as an increase in students that choose computer science and other MINT-subjects at school. This follows from the assumption that girls reject the principle of "technology for technology's sake" and, in contrast to boys, do not regard the "feasible" as the "useful" (Westram 1999).

All learning units for the schools are didactically designed in a way, that pupils can discover, test and develop computer science, science and technology skills. This involves the development of skills such as perception, observation, testing and planning strategies. At the same time, team work and communication skills are trained and "social skills" will be fostered by the collaborative acquirement of knowledge and group presentations.

In a second step we expand the practical school studies by testing and evaluating the learning materials in everyday school life and in new specific workshops. In accordance with “Mädchen machen Technik” our own project “go4IT!” was established. Since January 2009 our team offers regional schools free robot workshops for girls at the age of 12-13. The innovations in “go4IT!” are an offer of continuative workshops in 8th and 9th form that aim at a sustainable change in the attitudes of participants towards MINT and are integrated into the computer science teacher training at the RWTH Aachen. The “go4IT” project provides students in teacher training the opportunity to get practical experience in teaching successful gender and diversity lessons. Due to a successful sponsor acquisition at least 20 workshops are arranged and will be held in 2009. Thus, up to 240 girls will attend the workshops this year.

In this way graduates get experience in gender-sensitive teaching practice, and will transfer this into their professional life to further teaching units. They also take these experiences and materials to the learners in school, so that awareness can be raised and a multiplication of the approach is possible.

We are convinced that these theoretical and practical measures (self-reflection on own behaviour and teaching) can improve the teacher training in computer science at the RWTH Aachen significantly. On the other hand, we try to transfer the above research results regarding girls in the MINT-field to similar phenomena in linguistics with boys to contribute to a fair education.

3. Gender and Diversity Sensitive, Hedonically Attractive Design of Elearning Systems

In German higher education the use of eLearning is increasingly widespread in various teaching scenarios. The RWTH Aachen University has recognized the advantages of eLearning (within the institution) and acts as a role model for other Universities by using the university-wide teaching and learning portal L²P. Due to the large and heterogeneous user group of the eLearning Portal L²P, there is reduced usability in some areas. The aim of this doctorial project is to improve the usability of eLearning systems by identifying relevant hedonic and pragmatic criteria for eLearning portals in teaching and learning contexts. Gender and diversity issues inferred from the demands of the user group are integrated into the development of the RWTH Aachen University´s own eLearning portal as a retroactive effect. In effect it is necessary to design the eLearning system and its associated support offers in a way that ensures the same degree of support for users when they use, teach and learn with the eLearning portal. Doing so an interdisciplinary approach and perspective including the fields of psychology, computer science, education science, sociology and communication science is taken.

The web-based teaching and learning portal L²P of RWTH Aachen University is used as the concrete object of the research project. On average, the approximately 35,000 users of L²P are active in nearly 1000 course rooms per semester. The existing virtual course rooms cover all scientific disciplines taught at RWTH Aachen University. In L²P lecturers have the

opportunity to support their in-class teaching (lectures, seminars, exercises, etc.) with virtual course-rooms. Within a course room lecturers can offer the students learning materials, write wiki pages, post announcements, send emails to all participants and arrange surveys. Each virtual course room includes an area that allows students to start discussions, to create their own wiki pages and to share documents.

Many factors, such as previous experience and self-confidence in dealing with media and computers, affect the use of the human machine interface. A non user-friendly conception or design of the system and its support services can act as barrier and distract from the actual learning processes or work. Therefore, the analyses of users, their characteristics (gender, learning type, age, interests, etc.) and their pragmatic and hedonic needs are essential for the success and sustainability of an eLearning portal used in everyday university life.

The intention is to integrate diversity and gender as categories of analysis in all phases of the development and implementation of eLearning in order to design and implement a hedonically attractive, gender-oriented eLearning (Smykalla 2008), by adapting and extending the existing eLearning portal of RWTH Aachen University. The portal is one of various components that help to advance gender mainstreaming and the gender equality policy at the RWTH Aachen University: On the one hand, an equivalent, hedonically attractive usage is offered to students and lecturers. On the other hand, the accompanying qualification measures help to sensitize lecturers and students for ´gender´ and ´diversity´. This imparts awareness, objectives, strategies and skills for gender mainstreaming.

It is a fundamental problem of software products, like the previously described teaching and learning portal, to embrace the needs of a broad, heterogeneous user group. The whole eLearning system, its functions, the integrated and outsourced support services have to meet user requirements. However, users are different in their specific needs, skills, interests, cultural influences and reception conditions. Their past experiences in dealing with and using interactive software are not equal. These diversity factors influence the understanding and usage of interactive software products significantly. As a rule, for economic reasons or out of ignorance, only a rough specification of user groups will be made. Hence, essential aspects and information about the differences and similarities of differentiable groups are neglected. The adoption of a so-called standard user often means that existing services and offers only address subsets of the actual user group. This fact is rarely up to never recognized.

Furthermore, many eLearning systems, including L²P, are extended by new functions. There are increasingly complex systems that confront users with new, additional requirements. This creates a risk that the product is no longer used, since the number of unsolved problems steadily increases. In effect the user is no longer motivated to employ the system because its degree of attraction decreases. This scenario must be avoided by taking into account the possible diversity groups (total volume of users) and their pragmatic and hedonic needs throughout the entire system (including the support measures). Given that the doctorial project is anchored in the daily development work and support of the teaching and learning portal L²P access and insight into the production and the establishment of an eLearning portal is guaranteed. Because the software process employed for L²P is incremental, iterative and includes formative evaluation and user-centered design, the research results will be integrated constructively into the development and re-design processes. These results will be evaluated accordingly. By anchoring the project in the regular development process and support of L²P, explicitly advantages in terms of empirical studies (interviews, questionnaires, user testing, etc.) that are mandatory for the research project.

For example a distinction can be made according to the criteria of age, disability, technical knowledge or computer skills, faculty membership and the associated learning cultures and learning types. In addition, measures will be deduced from the gender and diversity sensitive analysis and the appropriated design. These results will be presented in form of guides and checklists that can be transferred to the development of other software projects in which a web based and interactive (eLearning) software is developed. Similarly, the gender and diversity sensitive knowledge will be applied in the implementation of blended learning events (Kritzenberger 2005) as part of the accompanying qualification measures of L²P (e.g. training concepts) with the aim of sensitizing lecturers and academic staff for gender and diversity issues and imparting the appropriate skills. Teaching that is influenced in this way will contribute to gender and diversity sensitive graduates who can provide these skills in the labor market.

4. Gender- und Diversity-Sensitive Design of Mobile, Distributed Approach to Elearning Supplies

The goal is to develop and evaluate a novel, web-based social network in an educational context. As a prerequisite, a learning network will be specifically will be designed, developed and built with user-centered methods for interaction on mobile devices. This is realized at the RWTH Aachen integrating its students, teachers and future students with their different social and cultural roles. The impact of technology use on the planning of learning and on the target group's motivation will be analyzed and evaluated, as well as the collaborative development of knowledge. The evaluation includes the analysis of study success and the competence enhancement attained through using the formed learning network, focusing on gender and diversity issues and various media skills of learners.

Since different scientific disciplines like pedagogy, psychology, sociology, and computer science play a role in the context of web-based social learning, the existing evaluation methods and results are examined in this interdisciplinary context and expanded in terms of WebScience.

Usually private social networks of students do not matter in closed scenarios of the universities. This means that in addition to the learning management systems of universities the students form their own networks because the cooperation and exchange with friends and fellow students are functionalities that are appreciated by students. The social dimension of a service supports the work in academic studies. There are other social networks that are often mentioned such as mySpace, facebook, studivz etc. where students participate to discuss problems within their field of study or exchange learning material. S-Inf.de and maschboard.de are platforms that take these aspects of student learning into account. These platforms were founded in the years 2000 and 2005 by students from RWTH Aachen University and have operated by themselves since then. There you can download and upload lecture videos produced by the students themselves, lecture notes and protocols of (oral) exams. maschboard.de nearly has 6000 active and registered users ("Statistics - MaschBoard - The engineering Forum at the RWTH Aachen"). This number corresponds with the number of mechanical engineering students at the RWTH Aachen. Other than the previously mentioned websites there are other similar services provided by students for students on the

World Wide Web. These examples show that there is a need for systems that support cooperative work between students in a way that they can build their own learning networks.

This assumption and the prognosis that more people will access the Internet from mobile devices than from the PCs in the next 10 years impels us develop a mobile online community with social structures that will support individual learners. The development of mobile services and applications is currently at its beginning (Seider et al. 2008). "Mobile access to the Web may become the dominant mode in many nations [...]" (Shneiderman 2007). However, attractive applications, specifically in terms of eLearning 2.0, are still pending. "Working to develop the mobile Internet as an extension of the PC-based Internet requires the development of services that can be smoothly integrated with application mobile devices." (Seider et al. 2008).

Mobile services enable pupils and students to create, share, and exchange microcontent at any time. Their community may also include teachers. Learners should have the opportunity to access their learning network at any time and any place. This supports the motivation and organization of learning. "Therefore, in this 'new paradigm', the eLearning course does not offer much as a 'virtual space' (virtual campus, virtual classroom), but a space for communication between students, peers and tutors. And so, it offers students and professors resources to help them to improve their own Personal Learning Environment (PLE). (Bartolomé, 2008) In effect the access to educational resources could be a component of leisure activities and thereby become fully integrated into the students' lives.

5. Outlook

In this paper we described our approach to improve gender and diversity in learning and teaching. The evaluation of the projects explained before is our next step. In the meantime our research group has started new research projects with focus on gender and diversity sensitive evaluation of blended learning scenarios. Through intensive exchange with other active research groups in this field at the RWTH Aachen University we are building a network. All these measures will help to increase the number of engineering and science students in the near future and support them to access successful learning.

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How to achieve Competence in Issues of Gender and Diversity Studies?

Keywords: curriculum development, intersectionality, trans-cultural teaching, curriculum module, gender and science studies

Abstract:

It is widely discussed that knowledge and skills in gender studies and/or diversity studies can help to apply science and technology at our service. But how can scientists, engineers, and managers achieve this competence? Diversity studies, gender studies and intersectional theory are academic areas where questions of social justice, gender equality, cultural identity and mechanisms of inclusion and exclusion are discussed. Because they are mostly taught in social sciences, cultural sciences, and humanities, students of economy, natural sciences, or engineering hardly get access to this knowledge, although they might need to apply these skills in their professional career. In this paper I distinguish four different interpretations of 'gender and diversity' in science and engineering and present a module and some syllabi of courses on 'gender and science studies' that translate knowledge of social and cultural studies to the interests and needs of students in science and engineering.

Helene Götschel

1. The value of gender and diversity competence

That knowledge and skills in gender and diversity can help to apply science and technology at our service is widely discussed in academia, politics, and economy. Moreover, during the last decade, more and more academic and research institutes have included gender perspectives in the studies of science and technology, as a new area of research. The European Union and its member states encourage and support activities in these directions. However, talking about gender and diversity in science and engineering creates different associations for different actors in these areas. Although the associations might be related and overlapping, at least four different conceptions, as far as I see, could be distinguished. When researchers in industry and academia as well as politicians talk about gender and diversity in science and engineering, they could take the notion to mean: (1) Strengthening the position of women and minorities in science and engineering; (2) Reflecting education within science and engineering from an inclusive perspective; (3) Rethinking design and developing new consumer products for

various user groups, or (4) Adding questions of science and technology to the interdisciplinary research field of gender and diversity studies and vice versa.

Each of these four conceptions refers to relevant circumstances and crucial research questions. At the same time, we should keep in mind that these four conceptions, although entangled, point to different aims, problems, and solutions. Initially, I will give the reader a rough overview of these four conceptions of gender and diversity in science and engineering. However, I will mainly emphasize the challenge to include basic knowledge of gender and diversity studies into the education of future scientists and engineers. Including such aspects into education is more or less related to all four conceptions, since it (1) can help to make science and engineering more welcoming to women and minorities, (2) requires continual reflection on the teaching process, (3) stimulates new knowledge that enables scientists and engineers to rethink designs, concepts, and theories in their area of work from a gender and diversity perspective. But most of all, including such aspects (4) would clarify how well-established industrial fields, such as mechanical process engineering or chemistry, can gain from innovative and only recently established academic areas within the humanities and cultural sciences, such as gender and diversity studies. Moreover, to concentrate on the question how future scientists and engineers can learn about and reflect on gender and diversity mirrors my own more than ten years of experience as a lecturer on science and gender at various European universities.

Strengthening the position of women and minorities in science and engineering is an important task not only in most industrialised Western countries. Statistics reveal that the proportion of women in science (particularly in material sciences) and engineering at enterprises and universities is far from being balanced. The bewildering difference on a global and even European scale raises the question of the origin of the varying realities across countries and cultures (e.g. Bessenrodt-Weberpals 2003; Burke/Mattis 2007; Sagebiel 2006). Historical and biographical studies explore the situation of women and minorities working as scientists and engineers or under training in these areas. These biographies and interviews offer insights into the working-life in academia, industry, or education. Moreover, they create role models and help us to understand mechanisms of discrimination as well as of success (e.g. Jordan 2006; Phipps 2008; Rossiter 1995).

Increasingly, historical, sociological, and anthropological analyses of scientific and technological institutions, such as laboratories, research groups, and associations, uncover the traditional white and masculine culture of science and engineering. Their self-image is analysed, as well as e. g. the aims and values that are established and forwarded, the often chilly and unwelcoming climate in sciences and engineering, how scholars are supported or hindered in their careers (e.g. Hasse/Trentemøller 2008; Seymour/Hewitt 1997). Although the underrepresentation of women in science and engineering is far from being solved yet, in most German university departments it is at least understood as a grave problem that must be dealt with. Other mechanisms of exclusion and discrimination based on less visible differences, however, such as ethnic and cultural origin, sexual orientation, or physical abilities, are not yet taken fully into account.

Reflecting education within science and engineering from an inclusive perspective is seen as a contribution to increase the number of women and minorities in so called masculine areas of study as physics or civil engineering. Educational research is performed for secondary education and higher education. The results show a need for changes in curricula as well as in teaching methods, including not only the process of imparting knowledge but, at the same time, the reflection of discriminatory or encouraging interactions in the class room. A first reorientation has taken place and worldwide new curricular and didactic approaches have been developed aiming to include persons of all learning styles and genders (e.g. Arnot/Mac an Ghaill 2006; Bush-Vishniac/Jarosz 2007; Gransee 2006; Leicht-Scholten 2007).

Gender engineering, rethinking design and developing new consumer products for various user groups, meanwhile, has been proven as a successful way to increase the quality of consumer goods for a wider range of satisfied users. Japanese-global Shoe Company Mizuno, for example, used ‘gender engineering technology’ for developing running shoes with a design that reflects the difference in running styles of male and female customers, related to typical differences as e. g. in weight, bone structure, and connective tissue.[88] The best known German project is ‘Discover Gender’, accomplished by professor for ‘Gender and Diversity in Organizations’ Martina Schraudner at the Fraunhofer-Gesellschaft, the largest organization for applied research in Europe. The study ‘Gender Aspects in Research’ aims to develop

[88] For the press release of Mizuno’s gender engineering technology see: http://www.sgma.com/press/117_Mizuno-Introduces-Gender-Engineering-Technology-in-Running-Shoes. For critical commends see the podiatry website http://www.podiatry-arena.com/podiatry-forum/showthread.php?t=23738.

compatible and transferable guidelines for the assessment and systematical integration of gender perspectives in various fields of research (Bührer/Schrautner 2006).[89] These guidelines give engineers and scientists a rough introduction into gender and diversity concepts. But critics highlight that this celebrated showcase is merely a checklist of quite basic and simplified questions related to a framework of difference feminism, while ignoring current results of gender and science studies, most of all ignoring the concepts of 'performing gender' and 'doing gender'(Bath 2007; Maaß/Weller 2007).

2. Gender and diversity in science and engineering

Including questions of science and technology into the interdisciplinary research field of gender and diversity studies and, vice versa, including questions of gender studies and diversity into natural and engineering sciences, is a topic widely discussed at European universities. At most universities nowadays centres for gender studies or gender studies programmes can be found, some including natural or engineering sciences. The University of Leeds/United Kingdome, for example, holds a Master of Arts Programme in Gender and Technology[90] and the Freiburg University in Germany, for instance, hosts the Centre of Competence: Gender Studies in Computer and Natural Sciences[91]. To be able to work on questions like equality and diversity in the city, inclusion by design, gender, environment, and energy, a Centre of Space, Technology and Gender, e. g., was founded in 2008 at the Aristotle University of Thessaloniki/Greece[92].

But while gender studies are a well defined research field and area of study with an internationally more than thirty year tradition (Waaldijk et al. 2008), diversity studies are not (Krell et al. 2007). Only recently some US-American universities launched diversity studies programmes with the aim to examine the history of inclusion and exclusion and to promote

89 See the project's website at http://www.genderchancen.de/EN/

90 See the project's website at http://www.gender-studies.leeds.ac.uk/prospective-students/taught-postgraduates/

91 See the project's website at http://gin.iig.uni-freiburg.de/h_seite_engl.php?h_men_engl=1

92 See the project's website at http://newton.ee.auth.gr/genderIssues/

social justice, equality, and awareness of cultural identity.[93] So far, in the German speaking discourse, questions of 'race', ethnicity and culture, sexualities, queerness, and 'transgenderness' are rather seen as an enlargement of the intellectual framework of gender studies by taking into account the concepts of intersectionality that is the interrelation of different cultural patterns of oppression, than seen as concepts of an 'umbrella area of expertise' called diversity studies that embraces gender studies amongst other. On the one hand, the theory of intersectionality is strongly related to social sciences (especially sociology and political science[94]) and examines the ways in which socially and culturally constructed categories interact on multiple levels to form inequalities in society. Diversity, on the other hand, in the meaning of plurality and variety, is both used in cultural studies (e.g. postcolonial studies or media arts) to describe the inclusion of people of diverse cultural and religious backgrounds as well as in economics (e. g. business administration or organizational studies) to describe a business tactic for better supporting the variety of its workforce and therefore better serving heterogeneous customer requirements.

All these concepts and theories, it might be diversity, gender, or intersectionality, are developed and discussed in social sciences, cultural studies and humanities only. In Germany however, as well as in many other Western countries, institutions of engineering education tend to insist on their tradition to exclude non-technical competences (Hoeborn/Sagebiel 2003; Ihsen 2005). Therefore students of natural and engineering sciences hardly get a chance to learn about topics such as identity, social class, gender, race, ethnicity, sexuality, sexual orientation, age, disability, religion, and culture, and their entanglement, although they might need to apply this knowledge and skills in their professional career. Thus the discussion of the reworking of the cultures of physics and engineering and the reorganisation of the curriculum in these areas is absolutely essential and seems to become more and more taken seriously.

But how can the students in science and engineering achieve competences in issues of gender and diversity studies? I argue that it is not possible to enable the students to do so without giving them basic knowledge in fundamental thinking styles, methods, theories, and concepts

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93 Anyhow, the University of Maine at Fort Kent holds a Diversity Studies Minor, an interdisciplinary mix of anthropology, sociology, literature, religion, and music courses. See the university's website http://www.umfk.maine.edu/academics/programs/minors/divstdy/default.cfm

94 Stockholm University/Sweden, though, established a Master Programme in Intersectionality Studies, where the centres for gender studies and for international migration as well as the institutes for history and pedagogy are involved in. See http://sisu.it.su.se/search/show_education_info/8548?area=7

of gender and diversity studies, which might be a challenge for students coming from a traditional physics or engineering programme. But it will certainly be a very exciting, enriching, and future-oriented challenge, as long as the curriculum and teaching methods keep the target group, with its special background, knowledge, needs and interests in mind.

In German speaking countries the discussion on the curriculum development process in engineering education has a longer tradition than the science education reform. Prognoses of labour shortage in engineering, changed requirements from industries and enterprises, interest and support of trade unions, and greater flexibility of universities of applied sciences might be some of the reasons for it (e.g. Neef/Pelz 1997; Schwarze/Webler 1998). Admittedly, within the last ten years the discussion on the curriculum transformation in natural sciences increased. Meanwhile some outstanding projects and initiatives have been started to integrate gender into natural and engineering sciences.[95] At Vienna University of Technology/Austria e. g. the project 'Gender into Lessons' was performed between 2005 and 2007. For the first time at an Austrian institute of higher education electrical engineering as well as technical physics were analysed and revised from a gendered perspective[96]. The scholars of the 'Forum of Competence: Gender Studies in Computer and Natural Sciences' at the University of Freiburg/Germany achieved the inclusion of the programme 'Gender Studies in Computer and Natural Sciences' into the study regulations and examination rules of computer science of the university and are currently developing teaching modules for gender studies in computer and natural sciences, to be used in various learning scenarios including blended and virtual learning.[97] The University of Hamburg/Germany was one of the first to develop courses on gender and science studies, between 2002 and 2006 within the project 'Degendering Science'. I will in the following present this project and its results in greater detail and as an example how to achieve competence in issues of gender and diversity studies in natural sciences. As the University of Hamburg has no engineering classes, the programme was developed solely for science. But nevertheless it might offer suggestions for engineering education as well, because the classes focused manly on material sciences such as chemistry and physics, and

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95 See e. g. the database of the Coordination office of the Women's Research Network NRW to support the Bologna Process in terms of gender mainstreaming: http://www.gender-in-gestufte-studiengaenge.de/en_intro.php?lg=en; or see the special edition of Zeitschrift für Hochschulentwicklung on „Gendergerechte Lernangebote an Universitäten und Hochschulen', vol. 2(2008), no. 3 (www.zfhe.at; not available in English).

96 See the project's website at http://www.tuwien.ac.at/dienstleister/service/koordinationsstelle_fuer_frauen foerderung_und_gender_studies/best_practice_projekte/ (Information only available in German)

97 See the project's website at http://gin.iig.uni-freiburg.de/h_seite_engl.php?h_men_engl=1

the classes where at the same time part of the 'technoscience profile' of the gender studies programme and could be attended by students of the Hamburg University of Technology and the Hamburg University of Applied Sciences too (Bauer/Götschel 2006).

In 2002 the Faculty of Education and Psychology of the University of Hamburg launched the project 'Degendering Science - Extending the Conception and Curriculum of the Natural Sciences' at the Institute for Science Education. It was financed by the academic programme 'Equal Opportunities for Women in Research and Teaching' of the Federal/Regional Commission for the Planning and Research of Education and the German Federal Ministry of Education and Research for four years and a month. The project Degendering Science aims at changing and extending the contents and the very understanding of what the natural sciences are supposed to be. Its intention is to make natural science more attractive to university students by building two-way-street (Musil 2001) between the natural sciences and gender studies. To teach this new understanding we[98] developed a curriculum module on Gender & Science Studies. The concept is based on the insight that underrepresented groups within the sciences like women and minorities might have a heightened interest in being able to reflect social aspects of technology and natural sciences. One strategy then to create more inclusive natural sciences is to change the curriculum of science education as well as finding ways to bridge the gaps between technology and natural sciences on the one hand and the humanities, cultural and social sciences on the other. At the intersection of the Gender Studies Programme, the Faculty of Mathematics, Informatics, and Natural Sciences, and the Institute of Science Education (Faculty of Education and Psychology) we taught interdisciplinary classes in 'gender & science studies' and developed a curriculum module for students with majors or minors in gender studies, science education, or natural science.

3. An interdisciplinary module on gender & science studies

Based on earlier teaching experience with interdisciplinary courses at the faculty of mathematics, informatics, and natural sciences (Ebeling/Götschel 2000; Götschel 2003) and on the classes teaching science and gender at the faculty of education, we started to develop a

98 The project was designed and performed by Robin Bauer (competences in chemistry and philosophy), Dorit Heinsohn (chemistry and pedagogy), and Helene Götschel (physics and social history).

'Module on Gender & Science Studies'. This module (see fig. 21) guides students from different academic disciplines and with different previous knowledge through the field of Gender & Science Studies. According to common standards of their major field, students can attend two courses in case they choose gender and science studies as their 'field of key skills' or they attend up to six courses in case they study a gender and science studies minor.

Introductory Level	Natural Science and Gender		Natural Science and Society
Advanced Level	Scientific Knowledge	Controversies in Science	Socialisation as a Scientist
Research Level		Reflexion of Scientific Practice	

Figure 21: The curriculum module 'Gender & Science Studies' and its six elements

The students start with one of the introductory level course. One of them centres at sex & gender as the main focus; the other one contains broader fields of interest, like general ethical questions etc. This course also mainstreams gender aspects into its curriculum, so that gender aspects will always be a point of reference when approaching science studies issues. The students can proceed to the advanced level courses after completing at least one of the introductory classes. They may also choose to take both.

The students have to take at least one course in the advanced seminar level and may take the research class at the end of their studies, in order to attain their total number courses. On the advanced level in depth seminars are offered in some of the areas that we find especially relevant in the field of gender & science studies. Again, most seminars comprise a broader approach to science studies issues in order for the students to have lots of connecting points to their own experiences and backgrounds, as well as to enable them to put the gender & science discussions into their general contexts. The three areas of the advanced seminars structure the field of gender & science studies – how it presents to us at this point – into (1) epistemological questions, (2) the question of the consistency of the different academic cultures of the natural sciences and humanities which we have to transgress within gender & science studies, and (3) the question of the socialisation into scientists. If students have taken

introductory and in depth classes in this module, they have acquired a basic understanding of the field and are then able to participate in a research project of their own. The emphasis here is put on fostering the skills of the students to connect their theoretical knowledge with empirical research methods. We therefore chose the approach of laboratory studies[99] as a means for students to observe and reflect gender and science in the making. In the following I will give as an example one course that has already been taught for each level.

The introductory level course 'The Natural Sciences and Gender Relations' acquaints the students with the self-understanding of the natural sciences. It introduces crucial terms relevant to gender studies like sex and gender[100]. The emphasis lies on discussing important research results of the field of gender & science studies, which are dealing with biology, chemistry, physics and technology from a reflective perspective. Approaches that are analysing the connection between the natural sciences and gender relations on different levels were also taught: women in the sciences, the production of sex and gender through the natural sciences, and how gender relations are inscribed in scientific knowledge. The classification of these research approaches is subject of the seminar as well. The advanced level seminar 'Feminist Philosophy of Natural Science' focuses on epistemological questions, especially on feminist alternatives to the concept of objectivity in the natural sciences. The seminar also introduces pre-feminist theories on scientific knowledge production to help students understand the theory-laden feminist approaches better and to enable them to situate them within the general discussion, among them the Edinburgh School's strong programme, social constructivism, actor-network-theory and Marxist standpoint theory. Then feminist concepts such as contextual empiricism, agential realism, strong objectivity, and situated knowledges are discussed in detail. The research seminar 'Reflecting Scientific Experiments' introduces students to case studies, theories and methods of science studies, especially laboratory studies, as well as gender analysis. Students deal with historical and philosophical studies on the role of scientific experiments and learn how to observe the role of experiment within laboratories or classrooms according to ethno-methodology and go into the field. They can observe the role of experiment in scientific research or in science education. The latter they can choose to observe either in schools or universities. They also learn how to write and present reports on their observations (Götschel/Bauer 2006).

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99 For an introduction into the schools of science studies see Yearley 2005.

100 In German, there is no distinction between 'sex' and 'gender'; 'Geschlecht' can mean both or has to be specified further.

4. Strategies for trans-cultural teaching

Teaching an extremely heterogeneous group of students within the field of gender & science studies requires not only a bridging of the gaps between different scientific disciplines, for which the term inter- or transdisciplinarity is commonly used these days. It rather involves the more demanding task of initiating dialogue across the borders of two academic cultures in a 'post-science wars'[101] climate with students who have mostly been socialized in one of those cultures. I use the term trans-culturality, to emphasize that this brings up more and different requirements, especially for teaching strategies. If gender & science studies are supposed to be a genuine trans-cultural exchange, it seems necessary that scholars and students from both cultures are asked to critically reflect and expand the self-understanding of their respective scientific cultures of origin. Both cultures entertain certain myths about themselves that need to be questioned. One crucial step in this process from our point of view concerns the concept of objectivity that is employed. The understanding that the natural sciences are generating objective knowledge in terms of political and ethical neutrality has to be contested from a critical and including perspective. On the other hand, some gender studies scholars by now have produced some myths of their own that seem to support the claim that their academic approaches are superior to those of scientists. Besides the problematic epistemological and political implications of this attitude, it has a negative impact on building two way streets between gender studies and the sciences. Feminists like the biologist and historian of science Donna Haraway (1988) or the physicist and philosopher Karen Barad (2007) have provided epistemological concepts that are suited to bridge the gap between gender studies and the sciences by not generally privileging one culture over the other, but critically engaging them in a productive dialogue to create more accurate and politically accountable descriptions of this world.

Besides providing students of gender & science studies with alternative concepts of objectivity I want to briefly mention two other levels that have to be taken into account when teaching trans-culturally. The first level I want to call attention to is that of language in the classroom. It has to be part of the seminar to reflect on the fact that crucial terms have different meanings and usages in different academic disciplines. The most important ones should be negotiated and provisionally defined for the duration of the class or until the

101 For an introduction into the 'science wars' see Parsons 2003.

students feel the definitions need to be revised due to some learning process. Besides this general issue, gender studies scholars (in Germany) have developed some figures of speech that are implicitly derogatory or at least problematic in regard to the sciences, especially biology, and furthermore reproduce the disciplinary boundaries between the two cultures instead of transgressing them.[102] The second level we want to mention here is the question of didactic methods that are employed in gender & sciences studies classes. In our experience those methods were most promising that involved a high amount of interaction between students, that fostered communication skills and that created lots of opportunities for students to contribute their own disciplinary expertise. In summary, trans-cultural teaching proved to be best conceptualized as an ongoing process of learning not only for students, but for the teachers as well. That makes it a demanding and challenging, but all the more rewarding job.

5. Concluding remarks

The module 'gender and science studies' was primarily developed for the new bachelor programmes in science education and natural sciences at the university and for the gender studies minor. The overload of the science education programmes with courses in natural science and basic pedagogical knowledge caused that the new curriculum will unfortunately not longer contain gender and sciences studies. Therefore future science teachers will once more not be provided with the opportunity to critically reflect on their own disciplines as part of their regular professional education. Moreover, as crucial multipliers of scientific images they should have these competences to provide future generations with alternative and therefore more attractive visions of the natural sciences. The gender studies programme, instead of being developed into a gender studies minor programme, was abandoned for political and organisational reasons. Students from humanities and social sciences therefore can no longer in a trans-cultural way learn together with students of science and engineering. Expected least, parts of the module are a component of the 'key skills area' at the faculty of mathematics, informatics, and natural sciences. Professor for Gender and Mathematics Andrea Blunck and Professor for Gender and Informatics Ingrid Schirmer teach and further develop these courses for a more interdisciplinary instead of a trans-cultural class (Blunck

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102 The 'naturalisation of gender' as a discursive strategy e. g. reduces theories of scientist to determinist thinking. See Bauer 2006.

2008). Nevertheless, the evaluation (Bauer 2006) of the project Degendering Scence showed that it is challenging, crucial, and possible to create a trans-cultural learning surrounding where gender studies and natural sciences can meet and create space for the reflection of antiquated cultural norms and prejudices as a first step to diversify our ideas and actions.

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Gender and Diversity in Engineering Education – Fit for a Career

Keywords: Gender and Diversity in Engineering Education, Problem Based Learning

Abstract:

Here it is described how the teaching of social skills has become part of the engineering curriculum. The professorship Gender Studies in Science and Engineering at the Technische Universität München (TUM) offers a number of courses and workshops where not only several non-technical skills are passed over to the students but also gender and diversity as integrated aspects are taught. For the teaching of new knowledge modern teaching methods such as Problem Based Learning are used which is a very interesting approach for the students. Here, different concepts are depicted that encourage similar institutions to include social skills in the curriculum and implement alternative teaching methods.

Susanne Ihsen, Sabrina Gebauer, Ester Höhle

1. Introduction

Globalisation and modernisation contribute to society, being more and more diverse. Organisations, e.g. companies, have to deal with requirements resulting from these changes. Companies are introducing diversity offices and try to care for the different needs of their diverse workforce. The concept of Diversity Management refers not only to the fact that the diversity of people is treated with respect and highly value, but also is an economic need.

Gender and diversity are topics that are relatively new in the engineering field. There are two ways both topics come in. The first way is the technical development, the product innovations, developed under a gender and diversity focus. It is more and more important to develop products that fit better for the needs of different customer groups.

The second way to include Diversity Management is the personnel development. Companies searching for engineers today have to care for different groups of people, like older

employees, women employees or various minorities. Diversity Management includes gender as one dimension of diversity. In Europe, the gender dimension is often seen as most important in Diversity Management as in the technical field gender equality is far from being reached. German companies are searching for men and women engineers due to a lack of highly qualified employees.

Certainly the two lines meet each other! The idea behind gender and diversity strategies is to support a diverse workforce, which will hopefully lead to the product developments having a diverse customer group in mind. More elder people, women, foreign citizens and teenagers have the power to make purchase decisions. This makes it necessary to meet their demands. The key for customer-oriented products is: product development in mixed teams. Mixed teams consisting of a variety of generations, ethnic and religious backgrounds and genders are more liable to fulfil diverse customer wishes. This means that these topics have to be integrated into engineering education.

2. Teaching social key competencies in the engineering education

Ihsen and Buschmeyer (2008) show that this topic on gender and diversity sensitivity can be seen as one of the major key competencies that a professional engineer should have. Because the engineering profession is changing into a modern profession where not only technical research and development are possible occupational profiles but also marketing, sales, customer service and target group orientated innovations, it is necessary to prepare the engineering students for different directions. This means that engineering education has to become closer to engineering everyday-problems and needs more elements of social skill training. Here, the sensitisation for gender and diversity topics is one important element. By that, the TUM as the educator for future employees offers an answer to expectations of future companies.

3. Teaching students on gender and diversity through Problem Based Learning

Implementing new approaches in the students' behaviour (social interaction) as well as in their attitudes (gender and diversity) are high challenges for the students and sometimes provoke reluctant reactions. This makes it necessary to use teaching methods that do not only appeal to their cognition but to their personal experience. To familiarise with the gender and diversity topics the approach of Problem Based Learning has proved to be very successful.

The approach of Problem Based Learning has been introduced into higher education and engineering education during the past years. The main goal of this approach is to teach students how to learn and to change the curriculum towards more student centred learning. It is important for students to learn skills that are necessary in the "real world" of the engineering profession. These skills are "problem analysis and problem solving, project management and leadership, analytical skills and critical thinking, dissemination and communication, interdisciplinary competencies, intercultural communication, innovation and creativity, and social abilities" (Kolmos 2007, pg. 2) . Problem Based learning teaches self-directed, sustainable, situation-oriented and transferred learning. The pre-knowledge of the learner is integrated and the student makes new experiences by solving cases. In the following a few examples of teaching social skills and gender and diversity by using Problem Based Learning and other approaches will be depicted.

To implement Problem Based Learning, a realistic problem has to be provided to the students and it is attractive for them to imagine it. To integrate the needs of customers when developing a new product offers very interesting and appropriate cases for this learning method. As soon as they understand that this might be a problem they are able to handle it. By changing their roles, the students widen their point of view very quickly and become sensitised towards aspects of gender and diversity.

To work in mixed teams demands more skills from the engineers than often is thought. Tolerance, communication skills and empathy are only few features to name. Studies prove that engineering graduates and industry often miss non-technical key competencies and social skills (Ihsen/Buschmeyer 2007). These competencies are an indispensable part for a successful career.

4. Integrating gender and diversity in the engineering curriculum

With the combination of active teaching and learning in the engineering education, students experience the needs of core competences and get to know what gender, diversity, and equality mean in their future professional life. The cases they work on are chosen in a way that they could be realistic and applicable. By that their motivation and concernment rise. The students are asked to work in groups, dealing with topics of the engineering profession, to take over group presentations and leadership and to develop problem solving strategies. It is most important that students imagine the problem and are curious to find a solution by critical thinking and self-directed learning strategies (Kolmos 2007). Hence, Students start to think about how to use the new knowledge for their work.

Research has shown that engineering students, especially female and "non-typical male" students, wish to find more interdisciplinary research and Problem Based Learning to improve the engineering study programme (Wächter 2007). One possibility to do so was integrating the Liesel Beckmann-Symposium into the lecture "non-technical requirements in the engineering profession" as part of the study program of electrical engineering and information technology, and to open the symposium to students from mechanical and civil engineering programmes.

The idea of integrating students into an expert's conference was a novelty. It was based on the idea that they should understand the topic of gender and diversity through other forms of teaching than lectures or (student only) seminars (Ihsen/Buschmeyer 2007). By getting to know experts from industrial and university research and personnel development in a technical company the students realised that the topic of gender and diversity is part of their future profession. With these insights the students became more able to understand aspects of integrating gender and diversity into technical working processes from a more practical point of view, without the usual prejudices that engineering students (and teachers) often have towards these topics.

5. Theoretical and practical experiences have to be combined to sustainable knowledge

By working on this topic students start to realise the importance of diversity for their future careers. The aim of Gender Studies in Science and Engineering is the combination of active teaching and learning in order to know what gender, diversity and equality mean.

Teaching them what this is and what it means for their (professional) lives sensitises them towards more responsibility. The department "Gender Studies in Science and Engineering" developed a study offer for electrical engineering and information technology, which corresponds to the non-technical needs of students in their future engineering profession. It consists of a number of different courses and workshops that round their engineering curriculum. Here, they can enrich their engineering curriculum by non-technical courses and improve their social skills. Students deal with gender and diversity in combination with other topics, related to their professional lives. These courses try to be an active support for the students to plan, organise and master themselves. They are based on action theory and Problem Based Learning and are self-awareness courses.

In different seminars like "presentation and communication for engineers" or "successful through teamwork" gender and diversity are two topics next to others, which make it much simpler to talk about the issues with the mainly male student-group. There, students learn to self-organise their learning processes, moderate discussions and work in small groups. They learn more self-awareness and reflect about their and their colleagues' behaviour and self-representation. They practice to give and receive personal feedback in a protected laboratory setting. "Presentation and communication for engineers" prepares the students for giving professional presentations. In their engineer curriculum the students hardly ever have an opportunity to practice presentations or lectures in front of a crowd until their final diploma speech. Hence here, they don't only learn the theoretical basics of presenting but also practice it and see other students practice it and discussion the right and wrongs. In "successful through teamwork" the students do several exercises of forming, moderating and working in groups where they have to solve small tasks together. Then, they analyse their group roles and become aware of communication processes and group dynamics.

In other seminars and lectures on “interdisciplinary aspects of the engineering profession”, “job application”, and “career planning” students learn about gender and diversity as part of their future professional skills. The diversity aspect that students have not been confronted with before in their studies is integrated throughout all the tools the students have to work in.

Furthermore we have developed an interdisciplinary course programme dealing with gender and diversity in organisational development. Here, students from different subjects like business administration, electrical engineering and consumer science come together to learn about several topics of organisational development from a gender and diversity perspective. The main focus of the seminar lies on Diversity Management and customer oriented product development. The students have to point out the interaction between these two topics and the consequences for personal development and organisational structures. They learn about the idea that diverse teams are more liable to create customer-oriented products than homogeneous teams and at the same time can experience this in the seminar. In addition to that they see that not only the economic aspect of customer-oriented product development is to highlight. They have started to be more sensitised of invisible power structures and more aware to work successfully in diverse teams themselves.

Their task in this course is also to teach each other about several topics of organisational development from a gender perspective. While teaching, and therefore thinking not only about the topic but also about possible teaching methods, students start to apply their implicit knowledge about target group orientation, about their own professional life and how to use the new knowledge for their work. During the first course in summer 2008 we learned how the view towards the topic changes from a rather reluctant attitude towards the insight that these issues might concern the participants as well and be used in a constructive way.

6. Role play as one method of integrating gender and diversity issues into teaching

One method to familiarise students with gender and diversity issues used in the seminar described above is the role play. A very interesting exercise for the engineer students is on product development in connection with role plays. The problem which is presented to the

students in an introductory presentation is, that many products have been developed that had never found a market because customers did not buy them. The reasons for this could be that the development has never been customer oriented and that the future users weren't integrated in the development process.

The method of this workshop is a role play, to make students realise the different needs of diverse user groups. The participants are first asked to develop a role they knew, but that is not their own. With this task they have to think about needs and requirements they would not have thought of in their "own role". Representing the chosen role they are divided into two groups and are asked about the needs they have from their new perspective towards a future car (group one) or a future technical household (group two). For the students it is very exciting to see how different and even contradictory their requirements are.

Gender and diversity aspects become evident within this workshop; the roles differ in age, gender and professions. They have different needs when they are parents or seniors. The students realise that they can not only develop products for their own needs – a task they had never thought of before. The takeover of another role makes it possible to experience these needs and thus students understand the theory better than they would have when only hearing about it.

It is striking to discover on their own, that if they had chosen the same role like their fellows, the development would not have been the same. This is an important conclusion since they have to understand the differences between target group orientation, diversity and stereotypes. For the future the participating students are supposed to see gender and diversity aspects in their own research activities as relevant questions that have to be dealt with when they develop products as engineers. They were sensitised to mention gender and diversity aspects in their future research and development by attending the symposium which told them that a gender and diversity perspective should be an integrated part in all of their future work.

7. Conclusion

The inclusion of key competencies development that comprehends diversity sensitisation in the traditional engineering curriculum increases students' qualifications for their future profession. This is one starting point to integrate aspects of diversity into professional structures, with diverse teams and a better orientation on the needs of the manifold customers. This becomes a win-win situation for the engineers as well as for the companies. The introduction of gender-sensitising courses at TUM has shown to be a very successful pilot project and would like to encourage similar institutions to follow.

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Work-Life Balance on the way to the top

Keywords: Work-Life Balance, Leadership, Women Engineers, Networks

Abstract:

The following paper will focus on models of Work-Life Balance in Science and Engineering. It will present two recent studies carried out by the Technische Universität München. The first one focuses on women in managing positions in the industrial fields in Bavaria. We wanted to know whether those women face special measures and support on their way to the top and found out that they describe their success as being due to a network of supporters. For those women who have children it is also important to find family friendly structures in companies, supporting the combination of career and family needs. Next to women in leading positions we asked Bavarian companies about their measures to support women's careers up to management positions. These results confirm the second study which focuses on the combination of career and family needs for male and female engineers. We found out that especially bigger companies searching for qualified engineers are starting many programs to become more family friendly even in rather male dominated fields – and meet more and more the requirements of future employers.

Susanne Ihsen, Victoria Hantschel

1. Introduction

Women in leadership positions in IT and technical subjects are still rare in Germany. Especially in IT and technical professions the job market is manly dominated. The higher the hierarchies the more seldom you meet women. Although companies aim for an added value in the form of company bond, major employee motivation and soon return to the job after parental time with measures for more family friendliness, questions for a reconcilability of career and family often remain unsolved for academically qualified technical experts and management. Part-time careers which enclose flexible working hours as well as flexible places of work are still rare in German companies; the part of women executives is still low.

On behalf of EWMD (European Women in Management and Development) Gender Studies in Science and Engineering at Technische Universität München focuses in a recent study on women in managing positions in these fields in Bavaria.

Next to women in leading positions we asked Bavarian companies about their measures to support women's careers up to management positions. The results of the study confirm

another study for VDI (Association of German Engineers), which focuses on the combination of career and family needs for men and women engineers.

2. Successful women in IT and technical professions – What draws them to Bavaria and how are they supported?

The recent EWMD study focuses on women in leading positions in IT and technical professions in Bavaria. Only a small part is chosen: a subject group where women are obviously rare and a German federal state that keeps especially in these branches a variety of working places ready.

First part of the study was to analyse Bavaria as industrial base. Statistics, regional and national measures for women's advancement were analysed to get a preferably exact impression of Bavaria as industrial location.

Part of the location study is a detailed internet research of companies residing in Bavaria. Statistics and documentations were analysed as well as the offers of companies to support women. „What are companies doing to recruit women, to keep them and to give them possibilities to get into a leading position?“ was the central question of the company survey, that completed the internet research.

Unfortunately the attendance to take part in our questioning was not notably high. This is typical for such a subject and points out that the theme “advancement of women” is not even perceived as a location advantage in many companies. Because of the fact that those companies obviously agree to such an interview that value their measures as positive and enjoy making them public, the results were not to be considered as representative. In the centre of the company analyse were two interviews with employers in the Bavarian IT and technical branches. These were presented as so called “Best-Practice” examples for other companies. For that purpose Gender- and Diversity-delegates were interviewed to find out what employers do to recruit women, to keep them and to alleviate them the advancement into leading positions.

Next was an online survey with women in a leadership position in IT- or technical professions in Bavaria. The results of the online survey were completed with interviews. In both parts we asked for the reasons why the women live in Bavaria and for the promotion prospects that the interviewed experienced. We examined how women are boosted and which measures and offers they used to get into a leading position.

In the course of the evaluation many exciting points which are summarised in the following arose: It became clear that Bavaria as industrial location provides a richness of attractive jobs that can be considered as a principal reason to move to or to remain in Bavaria. Besides, supporting programmes and women-specific subjects play a minor part. The women who have decided to move to Bavaria do this because there are good occupational and career opportunities for them, but also for their partners. In addition, the location Bavaria offers a high standard of living and is perceived as an attractive place of residence.

There are no special supporting measures for women in leadership positions in Bavaria. Statistics about women in leadership positions also do not exist.

The interviews with the women display that all of them got very involved with their own career, sometimes without supporting programmes and role-models. Often they formed a network of supporters on their own that gives them occupationally as well as privately functional and emotional support. Thereby it strikes out that most direct career boosters are men, while other women are often seen as supporters in the emotional sense. Also the spouses of the women are a part of this support network. Above all the superiors supported them to reach positions that they did not credit to themselves at all.

In addition to the career support by single persons the women search for direct support themselves. This is especially coaching that gives many women the possibility to deal with the particular position and acting during their career. Thus, many of the questioned women recognised their strengths and weaknesses and consider coaching-offers as very positive for the particular career development.
Networks also belong to important factors of the particular career. Besides, another function is ascribed to pure women's networks in comparison to gender-mixed networks. Women's networks are perceived rather than an emotional support on the same eye level and are estimated above all because of the inter-communication and the role-model character. In

contrast, networks with women and men are valued as more important for the particular career.

Besides the women, we examined resident employers of the IT and technology industry in Bavaria. Our both best-practice examples focused on family friendliness to win women for the company and to keep them. Nevertheless, the study also shows that it is not easy to receive corresponding statements of the companies to their particular measures.

To sum up, we maintain that Bavaria as an industrial location offers well conditions for women in IT and technology professions to attain a leadership position because of the outstanding infrastructure. However, many possibilities to directly support women in leadership positions can still be improved by the companies and the politics.

Some points will be considered in point 4 “recommended course of action”

3. Male and female engineers in the ambivalence between profession, career and family

In the presented study of VDI alumni of technical subjects as well as women and men engineers were questioned about the reconcilability of profession, career and family. Special consideration was paid to executives and those who are going to be an executive. The statements were contrasted to family friendly measures and company-offers to extract how companies can be seen as attractive employers.

In a first pre-study 35 students, who were finishing their studies during the year of the survey, were questioned about their wishes and concerns regarding work-life-balance in the first years in the job. In parallel Human Resources Managers of eight selected technical oriented companies were interviewed by phone about their companies` offers for reconcilability of profession, career and family. These companies had a size of 3.000 to 370.000 employees and employ many women and men engineers. The proportion of women in leading positions is between one and ten percent, the part of women in the headcount is between 12 and 50 percent whereas most of the women work in the production. Since some companies are

globally oriented, they are under the influence of other cultures which particularly can be seen in the concept of "Diversity Management"[103].

For the main study the database was enlarged to get a broad impression of companies. Further companies were caught by networks, internet platforms of the BMFSFJ, the BDA, the VDMA, the Bavarian ministry of social affairs and similar distribution lists of the VDI etc. It was examined what kind of family friendly measures the companies offer. This refers to concrete offers like an own child care facility or cash benefits for special family measures as well as to work schedules of the company. These can contribute to a better reconcilability of career and family when used accurately. It was especially asked for the offers provided for executives.

For the questioning of the engineering executives a standardised questionnaire was developed, too, focusing the point „career" it was asked if the female and male engineers are in a leading position.

For the study we assumed that family friendliness is worth for the companies at the latest when they are confronted with a low quote of qualified employees, as it is already the case in some regions of Germany and especially for the engineering professions.

Our study focuses on the engineering professions as occupational field where women are underrepresented but increasingly looked for by the companies. In this so manly dominated profession possibilities for work-life balance have been almost irrelevant so far. Focusing the increasing lack of technical skilled employees women are spotlighted whom the companies can only find with offering accordant measures (cp. Ihsen 2006).

The central conclusions of the study are: Huge companies got a lot of professionalised offers to facilitate the reconcilability of career and family to their employees. They also often have a clear policy to solve the compatibility problems. Companies that don't have such a policy differ eminently in their attitude towards executives who wish to have more time for their

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103 ***Diversity Management***, the creation dimension of diversity, contains after Cox „planning and implementing organizational systems and practices to manage people so that the potential advantages of diversity are maximized while its potential disadvantages are minimized." (Cox 1993, 11)

family. Already 75 percent of the DAX30-noted companies present their programmes for better work-life balance to the public[104] (cp. Ihsen 2006).

Individual agreements are possible almost everywhere. Female and male engineers need to conduct negotiations if they want to find an individual solution for themselves. Especially in small companies legal terminologies are the current way.

Over 50 percent of the questioned HR Managers consider a time-out of their employees for 12 months and more as negative for the company. At the same time they encourage their executives to make individual agreements. Women and men engineers very often only take a short parental-time. So they fit to the expectations of their employers. Family friendliness is still taken as an absolute women's subject. Men who want to break out of the traditional gender roles often face conflicts and irritations, because in technical oriented companies there are almost no considerations to fathers in parental-time. Fathers who want to take part-time or parental-time face a lot more different conflicts than women (cp. Buschmeyer 2008). The results of the pre-study showed that in seven out of eight companies it is principally possible to work in part-time – even as an executive. These persons that already were in a leading position when deciding to work part-time often have the best chances to be kept by the company. In contrast starting and carrying a career in part-time is still very difficult. The main survey of 25 companies revealed that part-time work is possible. In 16 companies part-time is even imaginable for executives. In 11 companies the possibility to work part-time was already realised by executives. In nine of these companies executives who work part-time are seen as almost or absolutely positive by the company. In ten companies they are seen as almost or absolutely positive by their colleagues.

Almost 69 percent of the engineering executives work between 41 and 55 hours per week. Over 60 percent would favour to work between 31 and 40 hours per week. For most of them this is connected with the wish for having more time for the family.
80 percent of the engineering executives wish for a better and cheaper child-care instead of increasing child benefit. Missing public or internal measures for child-care are co-responsible for long time of absence of the male but after all of the female employees. Especially those who aim for a leading position feel a dilemma between knowing their children well and

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104 Cp. http://www.lte.ei.tum.de/gender/DAX%20Praesentation.pdf (Stand 28.5.2008)

considerably caring for them and not jeopardising their career at the same time. Most of the asked women engineers state that they would like to stay at home for the first 3-6 month to take care of their children, so they are at least in the first time the first relation person. They wish that such a time-out should be connectable with their career.

Children still have different effects on the careers of women and men. While almost 50 percent of the male executives state that their career plans are not influenced by having own children, this is only the case for 25 percent of the women. But female engineers state with almost 50 percent that they learn skills with having children that are very usable for their career.

4. Recommended course of action

Concerning the EWMD study we were able to define different measures for companies and politics. The most outstanding ones will be illustrated now: Women that have gained experiences in the US often consider a rate regulation as the only possibility to raise the proportion of women in leadership positions. Companies that want to raise the participation of women particularly in leadership positions can achieve this with quota or target agreements. Our two best-practice examples expose the possibility to raise at least the part of applicants, e.g., by "soft rates" with the Head Hunting or by specific address in job advertisements.

Another point for companies is the visualising of role-models. In many companies are already women in leadership positions which make career successfully - even with children and in partial-time. Women can orientate at these role-models, learn from them and interchange.

From the Bavarian economic and social politics there is also a backlog demand that concerns the subject women in leadership positions. Women's-supporting measures meanwhile are distinguished and promoted at many places. However, up to now the subject "career" plays a rather minor part. Statistics about women in leadership positions could help to spotlight the subject and would deliver dependable dates on which other measures could be based.

Adaptable and dependably long opening hours of sufficient day-care facilities and schools are necessary for parents in leadership positions. Because there is still a deficit here, more and more companies are willing to invest in day-care to bind their employees to the company.

For every level in politics it is important to expand the activities especially to start at the specific subject “executives”. The increasing lack of engineers, the demographic change and the risen search for female experts accent the importance for companies and regions to invest in women's-supporting measures in leading positions, as well as in childcare and family friendly working conditions.

The role of diverse career-networks is the mutual support of the members. Besides, it should be their challenge to make the subject “women and leading positions” obvious and to sensibilise the male members for that, too. Furthermore, members of networks should return their ideas and information that arise from the networks to the companies and so contribute to a necessary cultural change. Women networks are taken as emotional support and offer the possibility to get to know some role-models. For additional career support it is reasonable that women in higher positions are active network members and take part continuously, so they will be recognized and adapted as contact persons.

With the results of the VDI study recommendations can be conveyed for companies that want to support their executives with family friendly measures. Also advices and suggestions for women and men engineers who are already or want to be in a leading position and want a work-life balance can be deduced. (Prospective) executives who decided consciously for the reconcilability of career and family are normally willing to take this as criteria for a new job or even changing the job if seeing better possibilities at other places. Besides offers that are for all employees of the company, some point should be considered that addresses especially (prospective) executives. The following listing can support the companies:

1. Cultivate clear structures of communication and appoint contact persons.
2. Reveal a positive attitude of the company.
3. Convey role-models.
4. Appoint, organise and provide standards for time-outs.
5. Cultivate contact during time-outs and show that a re-entry is favoured.
6. Part-time offers for facilitation of the re-entry.

7. Extend and adapt child care.
8. Provide adaptable working times and places.

Women and men engineers that are longing for a leading position normally deal realistically with the possibilities of taking a time-out. Women normally return to company after a few months, men don't take a longer time-out at the moment. But as our survey shows they want to take part increasingly.

For years politics try to contribute to the reconcilability of career and family and to facilitate the re-entry. The present study shows that there is particular demand for child care. The clear statement of 80 percent of women and men engineers that they are willing to abstain from an increase of child benefit to get better and cheaper child care facility offers instead makes clear that there is still a lack of offers that especially burdens the executives. Here it is essential for politics – together with companies – to attach.

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Barbara Roth

Munich's gender-sensitive education – extend girls' world to the fascinating field of engineering / Motivating girls to go for jobs with interesting tasks, career prospects and steady incomes

Keywords: gender-sensitive engineering education, mono-education, girls only lessons, STEM, quota, technology and natural sciences, school meets science

Abstract:

The goal is set: extending girls' world to the fascinating field of engineering and motivating them to go for a profession in STEM (Science, Technology, Engineering, Mathematics). Most of the described projects are examples out of the daily-life in (pre-) schools. Practical experience and qualitative interviews are often the most successful way to find out, what is in fact helpful for achieving the goals, proving whether assumptions are valid or receiving precious hints for developing new strategies. In this paper the most significant conclusions are:

1. a lot of evidence points out clearly, that mono-educative "girls-only" lessons or schools motivate girls for STEM with the highest results up to now. This seems to be an international phenomenon, with reporting countries including Australia, France, and Austria.
2. a simple and basic pedagogical principle is, that before preparing lessons, a teacher has to consider in depth the individual precondition of every pupil involved. Considering gender means thinking thoroughly about all socialisation influences that might have occurred. This requires a high-level of gender-knowledge in addition to self-reflection and awareness of the own sex-role of each teacher and educator in (pre-) school. Without this a gender – sensitive reflection on teaching is not successful. Therefore every female and male teacher and educator in (pre-) school facilities has to be trained in gender-sensitive aspects of learning and teaching.
3. Thirdly, technical education has to start very early, before socialisation influences "kill" girls natural curiosity about nature and science.
4. the method and approach used in teaching natural sciences or any STEM-related subject determine the success. Gender–sensitive teaching aiming at motivating girls for STEM can counteract socialisation and should be inquiring, experiment orientated, including problem-solving and practical examples out of the daily life of the girls. It should use the girls´ creativity and be challenging.
5. we are in need of mandatory and reliable quotas for male trainees in studies and vocational training: at least 30 % male governesses (child care assistants), 30 % male Kindergarten educators and 30% male primary school teachers.
6. diversity initiatives should be linked to accountability systems and tools to measure progress. Educational facilities have to do what you usually do in business: set goals, plan, check, and act if results do not comply with the scheduled goals.

Barbara Roth

1. Background: selected Factors that may negatively influence girls' career choices

1.1. Gender

Our conception of what women and men are and what they are supposed to be is produced by the society in which we live. Gender – the social „Geschlecht / sex" of a person – is made by us in everyday lives in our interactions with others as a socially constructed category.[105] This day-to-day, continous production of gender has been called "doing gender".[106] Processes of "doing gender" are not only carried out in our society by individuals, but also through socially-standardizing practices such as legislation or the institutions of the family and marriage. "Doing gender" thrives on continually establishing a dual order. People are divided into two sex categories – boy or girl. From these categories, gender characteristics are derived, like preferring blue and pink, being technically or linguistically gifted and so on. In the course of her or his life the human being is "made" into a girl or woman or a boy or man in a complex process of rearing and education, social norms and values, stereotypes, identification, images, and traditions.[107] Their influence on perception is mostly unconscious and thus very difficult to change. A wide range of influences may prevent girls in Germany from identifying themselves with STEM or even as technical gifted in general.

1.2. Tradition in Education

Teachers and pedagogical staff have probably decided to pursue a career with relatively low income and low recognition for different reasons. One may be, that they prefer interacting with people to any kind of technical occupation. In addition the pedagogical staff, especially

[105] cf. www.genderkompetenz.info; Humbold University Berlin; 2009.02.18

[106] West, Candance/ Zimmermann, Don H.: Doing Gender. In: Gender and Society 1 (2), 1987, S. 125-151.

[107] cf. www.genderkompetenz.info; Humbold University Berlin; 2009.02.18

in pre-school education, is mostly female with a traditional socialisation focused on nurturing and caring qualities. Especially nursery and primary school teachers experienced no or very low technical training themselves and on average have only rudimentary training in learning by discovery and through technical experiments.

Furthermore most teachers have been instructed mainly in their special field. They acquire specialist knowledge in e. g. English, Latin or History, without any knowledge of the broad opportunities in the technical field. They have unconscious reservations towards engineering and technology. Without special training, teachers and pedagogical staff tent to transfer their own experience, attitudes, values and preferences to the children. Hence a gender-sensitive reflection on one´s own attitude and experiences should become a mandatory educational theme for every teacher and all pedagogical staff.

In addition it is necessary that the proportion of male governesses, pre-school teachers and elementary school teachers is increased.

1.3. Culture

... “made in Germany” by German engineers (assuming male).

On every list of famous German achievements there is much of mention of engineering and technology products and services. The Federal Republic of Germany leads the world in many ways with regards to engineering excellence. Ever since the birth of industrialisation the nation of Germany has been an innovative force in these areas and many goods bear the 'made in Germany' logo. As a whole, products that are made in Germany have a good reputation of being well designed and of good quality. Traditionally German engineers perceive themselves as a member of an exclusive closed inner-circle of sophisticated men. To give an impression of the attitude and culture in this inner-circle of male German engineers let me quote a German Engineer in electro-technology and teacher at a vocational school in Munich. As I described what I have been working on and explained for him that schools in Munich are trying to motivate girls to study engineering, he answered: „I don´t see the point in this. Actually German engineers are world-wide famous and very successful. That shows that the exclusion of women has proved of value.“ He was not joking. And it did not appear

to him, that his comment was discriminating. His comment was full of conviction. As I learned later on, he has never been trained in the business advantages of diversified teams[108] and Gender Mainstreaming and grew up in a male-dominated and male-educated environment. He never reflected upon what German businesses have lost because they have missed diversification in engineering completely. Besides these economical losses there is another very important aspect to this kind of attitude. In this atmosphere of a "male, white, middle class shark-pool" girls and women are at risk of isolation and exclusion in technical courses in schools, in apprenticeships, at university and at work. In consequence all the staff - male and female - has to be trained in Gender Mainstreaming.

... "less geek, more chic"[109]

Especially in IT the stereotype of the geeky-programmer, pale, dark circles around the eyes, badly dressed with a weird hair cut, stuck behind his computer for at least 16 hours a day and not capable of speaking in whole sentences, acts as a deterrent for girls. An IT specialist, managing director of a fast growing web hosting solution provider company, who was male for 29 years, reported after her gender transition, that she had to face problems she (he) did not have before becoming an attractive very feminine woman. Since transitioning she reports that it was really difficult to get guys to take her seriously. It was very difficult to establish credibility she had been granted in former days when she used to be a man. "She is concerned that IT is not seen as a sexy career path: There is a view that if you want to get on in IT, you can´t be feminine, you can´t be attractive."[110]

1.4. Common general prejudices in Germany

The strong traditional picture of the German housewife, "who is in charge of saving the Universe" puts heavy pressure on women who go for a career for themselves. According to German tradition, women are meant to be the upholder of moral standards, responsible for

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[108] e.g. Europeam Commission: Community research Unit C4: women in science and technology – the business perspective, 2006

[109] cf. Armstrong, Lindsay: "Less `geek`more chic is the way forward" in Financial Times, U.K., Special Report Digital Business, May 14 2008, page 2

[110] Whitehead, Peter: "No longer a member of any boys´ club" in Financial Times, U.K., Special Report Digital Business, May 14 2008, page 6

development of social life, volunteering, and raising children. These kinds of prejudices appear in publications regularly, even in famous and acknowledged German newspapers. Especially two prejudices seem to be a huge burden to women. Prejudice number one is that children are only happy and develop positively if they have been raised by their mothers alone. Children need "the heartbeat of their mother" the whole day long.[111] Full-time day nurseries, kindergartens and schools lead to mental disorders and developmental problems of children, such as drug addiction, hyperactivity, learning disability, and lack of concentration.[112] Prejudice number two is that young women who judge a mixture of professional work and child care as ideal are are a minority. If mothers have the choice between staying at home with their children or going to work following a professional career most of them stay at home and take care of their children because caring and nursing is the real nature of woman[113]. Both prejudices are thoroughly proven as wrong, though highly recognised in German society.

1.5. Influence of television

In Germany on television nearly 50% of the professions represented are limited to three occupational areas. These are public order and security, media and humanities/arts and TV-specific professions. This is followed by health (7.6 %) sports (6.1 %), education and social affairs (4.6 %) metalworking industry (0.7%) science (0.4 %) and computer science (0.3%) the latter including related professions.[114] Due to this under-representation of STEM in Media there is a lack of role models in the media for (female) engineers.

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[111] Meves, Christa: „Die ersten Jahre sind grundlegend", Interview printed in the FAZ, 06 Februar 2007

[112] cf. www.faz.net Gesellschaft: „Elternwohl und Kindeswohl"; „Mama oder Krippentante" et cetera, 2009.02.22; Bayrischer Rundfung, BR alpha: Geist und Gehirn: Mutter-Kind-Beziehung, 2008.05.18; cf. attachment theory of John Bowlbyand Mary Ainsworth

[113] cf. eg: Interview Neil Gilbert, soziologist in the German Newspaper „die Zeit" February 26 February 2009, http://www.zeit.de/2009/10/Interview-Gilbert, 8 March 2009

[114] cf. Dr. Michael Mangold: Die Berufswelt im Fernsehen, in: Macht.Fernsehen.Frauen Einfluß des Fernsehens auf die Berufsorientierung von Mädchen und jungen Frauen, Bündnis 90/ Die Grünen NRW (Hrsg.) 2008

2. Educational system in Germany

2.1. Overview

In Germany, each of the 16 federal states is responsible for its educational system. Furthermore, so-called "free cities", apart from the capitals, exist in most of the federal states. These cities are allowed to establish their own education concepts within the legal framework of each federal state. Thus, the city of Munich has a traditional right to establish its own schools, kindergartens and crèches (day nurseries) and is Germany's greatest provider of educational and learning services, as far as German municipal councils are concerned. It is mandatory for every child from the age of six to attend school for twelve years. In addition, every child has the right to attend a kindergarten (from three to six years). From 2013, this right will be extended to include children who are under three years old and who will have the right to a place in a crèche (day nurser2.2. Educational facilities in Munich preparing for university

It is mandatory in Germany that all children attend the Grundschule (primary school) until grade 5. Depending on their success in Grundschule they change/ switch to a Gymnasium or a Realschule or a Hauptschule afterwards. The latter not listed here, because it is not preparing for University.

- Kinderkrippe (Crèche or day nurseries, under three years old)
- Kindergarten (three to six years)
- Grundschule (Primary School, six to ten years)
- Gymnasium (highly academical Secondary School qualifying for university entrance)
- Realschule (Secondary School, preparing for vocational training or post secondary schools)
- Fachoberschule and Berufsoberschule (Post Secondary Schools)
- Meisterschulen und Technikerschulen[115] (advanced vocational qualification, Schools for master craftspeopl)[116]

[115] Master craftspeople and comparable qualified people are awarded a Higher Education Entrance Qualification since October 2008 for Universities of applied science. Additional Preparatory Courses or Assessment Tests may be requested for admission, depending on the kind of Entrance Qualification and certificates one holds (technical-oriented, business administration, humanities subjects and so on).

[116] The Chamber of Crafts for Munich and Upper Bavaria awards the title „Master of Craftsman". The Chamber represents about 67,000 member enterprises with about 280,000 employees. Tasks comprise self-government of the economic sector, protection of interests and services. The Chamber also executes public tasks which have been assigned by the state e.g., the registry of craftspersons and the regulation of vocational training and certification. The Chamber ensures a common and united representation of the concerns of all craftsmen vis-a-vis politics and the general public.

3. Gender and Diversity Movement City of Munich

3.1. Diversity and equality are the basis for innovation and quality of life in a thriving city

The Munich city council acknowledges that equality and diversity are crucial for an innovative and dynamic city that offers a high quality of life to all its inhabitants, and promotes this conviction among all of its staffs. Gender equality is an important aspect within this process. Its promotion represents an integral policy of the City hall and all its departments and has been furthered through the department of the equal opportunities commission since 1985. The strong legal involvement of the equal opportunities officer and her participation in important decision-making processes make her and her team a pivotal stakeholder within the "Gender and Diversity Movement in Munich". This demonstrates the City of Munich's commitment to a culture of openness and respect by taking a stand for the comprehensive implementation of gender and diversity management at all levels of activities. Schools and pre-school facilities recognise the significance of gender aspects in teaching and develop projects and training relevant to gender equality.

3.2. The City of Munich is actively implementing constitutional obligations

The city of Munich shows a strong commitment to implementing German constitutional law (clause 3 chapter 2 sentence 2 of the German Fundamental Law/Constitution (Art. 3 Abs III S. 2 GG)[117]) by actively ensuring the equal participation of girls and women in the fields of culture, business, politics, and every other area of life via a host of measures, as well as ensuring their access to top positions in every field.

[117] Art 3 Abs. 2 Satz 2 Grundgesetz: „Der Staat fördert die tatsächliche Durchsetzung der Gleichberechtigung von Frauen und Männern und wirkt auf die Beseitigung bestehender Nachteile hin."

4. What´s in it for girls?

Jobs with career prospects, steady incomes and interesting tasks

- There were practically no unemployed engineers in Europe in 2008.
- In July 2008, German companies were looking for 40,569 more engineers while only 4,013 engineers were looking for a job[118]. A BITCOM[119] research reports 45,000 job vacancies in the ICT[120] market in September 2008.[121]
- Ca. 60 % of leading positions are filled with engineers.[122]
- According to meta studies on well-being and health the most important influence on health is self-efficacy and job satisfaction.
- According to the concept of "flow"[123] what makes you feel happy is the successful resolution of problems. Normally, engineers are hired for interesting tasks that include solving problems.
- According to basic human rights everyone has the right to choose a life based on individual talents, interests, and future prospects rather than on traditional concepts and overcome role models.

5. What do we do to motivate girls for STEM (Science, Technology, Engineering, Mathematics)

Description of some selected projects

5.1. Prerequisites

[118] Institut der Deutschen Wirtschaft Köln, published in Frankfurter Allgemeine Sonntagszeitung, FAS, Nr. 203, 30/31 August 2008, page C4

[119] German Association for Information Technology, Telecommunications and New Media, representing 90 % of the German ICT market, according to BITCOM 2009

[120] ICT means Information and Communications Technology (Informations und Kommuniationstechnik)

[121] http://www.bitkom.org/de/themen_gremien/54621.aspx 1 March 2009

[122] Financial Times, U.K., 2008

[123] cf. Csikszentmihalyi, Mihaly: Das Flow-Erlebnis. Klett-Cotta, Stuttgart 2000

Essential to successfully motivating girls for STEM is the right attitude, conviction, and knowledge of staff working in (pre-) school settings. Hence the city of Munich trains the staff on aspects of gender diversity and gender mainstreaming in different circumstances, and the consultant for gender-sensitive education for Munich schools[124] has developed multiple concepts of education and training for teachers. Every school has to assign a teacher the position of girls' officer. She is trained regularly, supervises the implementation of gender mainstreaming in daily school life and organises special projects. Furthermore a network of educators who organise events such as the "Girls´Day" meet regularly for professional development. It is mandatory for Headmasters to attend training sessions on gender mainstreaming. Some schools assigned a teacher as boys officer and these meet regularly as well. Gender equality is also a topic for kindergartens. Since 1998 a consultant for gender-appropriate pedagogy in Munich Kindergartens[125] has been training staff in gender mainstreaming and gender sensitive education in various ways. The aim is to integrate the internal and external world of the children in the pedagogical work and enhance the individual strengths and abilities of each child as a counter balance to social pressure and traditional role expectations. This includes regular meetings of staff to review their work, materials and habits (e.g. books, "dress-code" of the children, costume-materials, access to technical materials, motion and body exercise, etc.).

The main four prerequisites for staff working in (pre-) school settings for successfully motivating girls for STEM[126]:

- They must be able to recognise that boys and girls may be being differently treated in their establishments; thereby recognising that some adverse socialisation may have occurred and that this needs a counter balance.[127]

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[124] Fachberatung für geschlechtergerechte Pädagogik in Schulen, Pädagogisches Institut München, Mrs. Gabi Reichelm

[125] Fachberatung für geschlechtergerechte Pädagogik in Kindergärten, F5, Mrs. Gabriele Nuss and Mrs. Coruh-Schmidt

[126] cf.http://www.earlytechnicaleducation.org/chapter2.html ,1 March 2009 and Faulstich-Wieland, Hannelore: Geschlecht und Erziehung, Grundlagen des pädagogischen Umgangs mit Mädchen und Jungen, Darmstadt 1995 (Gender and Education, basics of the padagogical treatment of girls and boys) and multiple Interviews with Kindergarten headmasters, educators and quality managers for gender justice in schools ; Budde, Jürgen, Scholand, Barbara, Faulstich-Wieland, Hannelore, Geschlechtergerechtigkeit in der Schule. Eine Studie zu Chancen, Blockaden und Perspektiven einer gender-sensiblen Schulkultur, Weinheim (JUVENTA) 2008.

[127] One Kindergarten head master with a very successful technical education calls her Kindergarten "a rubber boots Kindergarten" („Gummi-Stiefel-Kindergarten") meaning every girl (and boy) has to wear clothes suitable for any kind of movement at any weather

- They need to ensure that boys and girls have equal access to activities of technical nature. This may mean allowing only girls to use certain materials at certain times.

- They have to ensure a gender-sensitive learning environment for both sexes.

- They may need to give explicit help to girls to encourage their interest in technical activities.

5.2. The Bavarian Education Curriculum for Kindergartens (BEP, "three to six years old") on Nature, Science and Technology and the project "Tiny Tots Science Corner"[128]

5.2.1. Mission

The BEP and the Tiny Tots Science Corner are meant to give the children the opportunity to experience nature and technology and strengthen their natural curiosity and guide children's eagerness to experiment by giving them a playful introduction to the natural science.

5.2.2. Process

The Tiny Tots Science Corner initiative consists of various basic building blocks including workshops, materials, an internet platform, a certification of Kindergartens as "Tiny Tots Science corner" and a national day of action called "Early Discovery Day" to encourage Kindergarten teachers to integrate more natural science and technical content into their programming. The BEP is a compulsory curriculum for the Kindergartens and includes technical projects. The accompanying publications on BEP offer a wide range of examples.

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[128] cf. Haus der kleinen Forscher, Naturwissenschaft und Technik für Mädchen und Jungen; http://www.haus-der-kleinen-forscher.de, 28 February 2009 "Tiny Tots Science Corner"

5.2.3. Workshops

A one-day introductory workshop on Tiny Tots Science Corner provides educators with basic pedagogical knowledge and prepares them to carry out the first experiments e.g. "water." The half-day follow-up workshop gives participants the opportunity to share their experiences.

5.2.4. Experiment cards:

The Tiny Tots Science Corner will provide participating Kindergarten facilities with experiment description cards grouped into "projects" focusing on individual topics, such as "water," "air," "light and color," etc. Each project consists of approximately ten experiments. These experiment cards are reported as very helpful, because staff in pre-school facilities tend to be inexperienced in technical matters and feel encouraged to use the material via the simple and short explanations on the experiment cards.

5.2.5. Implementation

The Tiny Tots Science Corner pilot program has been running in Berlin since 2006. In October 2007 three delegates from Munich were trained in the concept and the material of the Tiny Tots Science Corner. From January 2008 to July 2009 292 of the pedagogical staff have been instructed in Munich. The pedagogical counsellors expect about 80 % of the participants to work with the materials in the Kindergartens and day-care facilities.[129]

5.2.6. Are the BEP and the Tiny Tots Science Corner Gender sensitive STEM projects?

The educator supervisors for Munich trained by the project team of Tiny Tots Science Corner in Berlin did not report a gender sensitive aspect in the training.

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[129] Interviews with the regional quality managers/ pedagogical councellors of Kindergartens in Munich in Mathematics, Nature and Science and Technology, Mrs. Brückner, Niederalt and Pörschmann in March 2009

The German title of the project excludes female children: “Das Haus der kleinen Forscher” - in German there is both a she- and he- form for job descriptions, which is ignored. The German title of this project only mentions the masculine form for “Forscher” (researcher / scientist) and addresses only the boys. Because the council of the City of Munich requested it, there is a (in the Internet unreadable) subtitle “Naturwissenschaft und Technik für Mädchen und Jungen“ (natural sciences and technology for girls and boys) and is printed in very small letters on every paper publication. The web page of “Tiny Tots”does not refer to any gender sensitive aspects.

If one, like in an article on the web page of “Tiny Tots Science Corner”, addresses only female educators in Kindergartens in Germany that nearly represents the reality in Munich with only 1,5% of Kindergarten educators being male. It may help promote the cause of increasing the proportion of male educators in Kindergartens if both male and female educators were addressed in every kind of publication.

The BEP is a curriculum and refers to gender questions in a special clause about gender-aware education in general but not specifically related to natural sciences, mathematics and technical instruction. The additional publication on the BEP[130] gives in the section nature and science general advice on the realisation of different projects but does not refer to gender topics there.

The gender sensitive aspect of technical education for the “Tiny Tots Project” and the BEP in the STEM field is left alone to the Kindergarten educators.

The department for Kindergarten education of the City of Munich trains the Kindergarten educators on the gender – sensitive aspect via the educator supervisors, the so called regional quality managers for STEM in Kindergartens and the consultant for gender justice in pedagogics for Kindergartens of Munich. They offer a range of education and training in the field of gender equality and gender-sensitive teaching for the staff.

[130] cf. Bayerisches Staatsministerium für Arbeit und Sozialordnung, Familie und Frauen & Staatsinstitut für Frühpädagogik (2005): Der Bayerische Bildungs- und Erziehungsplan für Kinder in Tageseinrichtungen bis zur Einschulung. 2., aktualisierte und erweiterte Auflage. Weinheim, Basel: Beltz.

5.3. Toy-free-time in Crèches or Day Nurseries an Kindergartens[131]

5.3.1. Background and aims

The project Toy-free Kindergarten was developed in the District of Upper Bavaria in Germany in 1992 by members of a study group initially in order to prevent addiction. One of the basic considerations was that the competences of children may be effectively enhanced if the children themselves become the creators of learning processes. The aim was to recreate scope for playing as well as fantasy and creativity and thus enhance self-affirmation and self-assurance.

5.3.2. Results

The results of the accompanying study showed that especially the following competences are enhanced by the "toy-free Kindergarten" project:

- creativity,
- autonomy,
- capacity for play,
- problem-solving,
- critical thinking,
- technical interest,
- and psychosocial competence.[132]

5.3.3. Basic rules and features of "toy-free-time"

Normally for three months all toys and materials for handicrafts (such as crayons, paper, scissors, tools) are removed from the rooms of the kindergarten. Only the furniture, blankets and pillows remaine. At the children's request and if there is no other possibility, required materials and tools can be used, but no toys.

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[131] cf. aJ Aktion Jugendschutz Landesarbeitsstelle Bayern e.V.: „toy-free Kindergarten" www.spielzeugfreier kindergarten.de, 22 Februar 2009 and Interviews with eudcators

[132] cf. Dr. Winner, Anna: accompanying study toy-free kindergarten, aJ Aktion Jugendschutz, Landesarbeitsstelle Bayern e.V., 1996

The Kindergarten teachers commit themselves to observing the children actively and to be present as partners. However, they do not make any offers, do not provide any rash solutions and do not place any substitute materials at the children's disposal.

The concept of Toy-free Kindergarten needs detailed planning and preparation of the project by a professional team. For the first project in a Kindergarten experts accompany the project and advise the educators. The first project started 1992, it was evaluated and the documentation was published 1996.

Over the years after a lot of practical experience with the toy-free-project, different kindergartens developed their own style in realising the principles of toy-free-time in Kindergartens[133]. Different Kindergartens vary the toy-free-time project in time, strictness, observation, and evaluation. The educators commit themselves to the toy-free-project because they are convinced of the special opportunities this concept includes.

Every kind of toy-free time in Kindergartens requires good co-operation with the parents, grandparents and all psychological parents of the children.

5.3.4. One day in a toy-free kindergarten environment[134]

"As usual the children came to kindergarten between 8 a.m. and 9 a.m. With only a few children of the group being present, conversations on recent events, also with educators, were very popular. With more and more children arriving, the desire for activities and playing became stronger. Often, concrete ideas for playing were born from „unsystematic" activities of the children. These included both role plays and working with materials or even explicit „construction projects". For example, in the facility's garden a wigwam was built. Jointly, the children thought about what was necessary for this project and talked to the educators who could be of assistance in organizing the materials. Due to the kindergarten's location there was no problem in making an excursion to the woods where branches could be collected.

[133] cf. Interviews with different educators at Kindergartens in Munich, 2008/2009

[134] Schubert, Elke; Strick, Rainer: Toy-free Kindergarten, aJ Aktion Jugendschutz Landesarbeitsstelle Bayern e.V., 1994, p. 10

Inspired by the genuineness of their idea, the children even managed to transport big and heavy branches back to the kindergarten. Then it took several days for the wigwam to be completed, with boys and girls equally participating in the building activities. The wigwam was the starting point for other playing ideas, e.g., the children made Indian clothes from leather remnants, and from these remnants originated a mobile. Help from the educators was only wanted for organizing materials and organizing and handling of tools, when it came to realizing new ideas."

5.3.5. Quotations

A mother about her daughter

> *„At the beginning of the project I had quite a few doubts that my daughter would want to continue to attend the Kindergarten; at least I expected endless discussions with her. Now I am delighted about the fact that she is happy to go there. It was not rare for her to come along and say 'kindergarten is boring'. Nowadays, in contrast to the time before the project, she talks about what they did in kindergarten."*[135]

One parent (sex not mentioned)

> *„Contact with the other sex has become simpler. Prior to the project they used to play almost exclusively with playmates of the same sex, now this is not so important."*[136]

5.3.6. Summing up

I would like to point out that any and all toys are removed from the play room, and even materials such as crayons, paper, scissors, tools, etc. are no longer available. Only the furniture is left in the room. The children are informed about the toy-free period in detailed conversations. While some groups put their toys into an adjacent room together with their educators, others found their rooms empty at the beginning of the project. At the children's request and after mutual consent, required materials and tools can be used, but no toys.

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135 Schubert / Strick, 1994, p. 18

136 Schubert / Strick, 1994, p. 17

Thus the children have to come up with their own ideas about what they want to do. They have to decide, communicate their decision and develop a technical spirit of research, while working with the simple crafts materials they had requested and were offered. In addition to the psychological aspects they train their manual skills as well.

In general the project toy-free time in Kindergartens especially fosters imagination, creativity, communication competence and self-confidence – all prerequisites for a successful future in engineering.

Gender-sensitive aspects.
Kindergarten educators, who had been trained in gender-sensitive aspects, reported brief interventions necessary because of quarrels over the tools. They had to intervene in order to make the tools available for the girls as well. Some reported the necessity to encourage girls in a very strong way in the beginning. After a while the boys and girls interacted equally enjoying the scientific and constructive play.

In addition to all the advantages named earlier, the project encourages girls to enjoy technical manual work and to interact with the boys in this field. It strengthens the self-efficacy and self-esteem of girls. It is a project that integrates the natural curiosity of girls in the day to day experience in day-care facilities and encourages them to keep up their technical interest even after the toy-free time.

5.4. "Girl´s day"

5.4.1. What is Girls´Day - Future Prospects for Girls´?[137]

Girls´day is a nationwide career orientation day. Numerous companies, businesses, research labs and institutions invite female pupils in grade 5 through 10 to visit their places of work for one day, opening up their labs, offices, workshops and editorial offices. Girls'Day provides female pupils with an opportunity to gain practical insights into the world of work, particularly in technical and technology-related fields. The focus is on hands-on practical experience.

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[137] cf.www.girls-day.de 1 March 2009

5.4.2. What are the goals behind this nationwide activity day?

On Girls'Day, female pupils see how interesting and exciting work such as that of IT specialists, biophysicists or car mechanics (repairwomen) can be. Girls test their skills in hands-on activities and experiments, allowing them to widen their career spectrum. Previous impressions can be reinforced while misinformed views about the world of work can be corrected. Becoming familiar with new, unknown careers opens up girls' eyes to their own career options. It also gives them a chance to make contact with potential employers early on. Beyond that, decision-makers in companies and universities become aware of the diverse strengths and skills of today's female pupils.

5.4.3. How do Munich schools participate in Girls´Day – 'Future Prospects for Girls´?

Every year the Munich superintendent of schools, Mrs. Weiß-Söllner, recommends in a personal letter to all head masters to send girls to the Girls´Day. Included in this letter is more information on the Girls´Day. Furthermore the teachers who are responsible for the organisation in the schools are invited to the Pedagogical Institute for an information afternoon about the Girls´Day and an accompanying contact person at the Pedagogical Institute is named.

In April 2009 in Munich 27 municipal schools took part in the Girls'Day, most of them with several classes (each class containing 25 to 32 pupils). That is to say that at least 1200 girls of municipal schools attended the Girls´Day 2009. Currently parallel to the Girls`Day a Boys´Future Day is being established. In 2009, 14 secondary schools sent boys to a Boys´ Future Day encouraging boys to consider jobs where the male sex is under-represented such as hospital nurses or primary school teachers and Kindergarten educators.

5.4.4. Results of the Girls´Day

52 % of the girls who participated in the then so called “girls and technology day” in 1990 in Munich decided to go for a career in STEM[138].

5.5. Special lessons "self-confidence training" for girls

5.5.1. Aim

The aim is to enhance the self-esteem of the girls so far that they are sufficiently self-assured to develop their personal abilities and make choices without limitations set by strict gender role expectations. And thus widening the array of possible career choices for girls to the field of STEM.

5.5.2. Process

A wide range of schools offer “self-confidence training” for girls. The Pedagogical Institute of Munich has been training female teachers in “self-assertion for girls” for many years. When the teachers have achieved a formal specialist qualification in this they regularly give courses for girls in their schools in the afternoon.

5.6. Special lessons Information Technology (IT) for girls

5.6.1. Aim

The goal for girls-only lessons in IT is to motivate them for IT. Thus a couple of secondary schools (Realschulen) and some Gymnasiums (Grammar schools) in Munich offer special Information Technology lessons for girls.

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[138] Prof. Dr. Ihsen, Technische Universität München: „„Wie verändert der Girls'Day technische Studienfächer, Wissenschaft und Technik?“ How does the GirlsDay change engineering education in Universities, Documentation of the national symposium „Girls´Day“, Haus der Deutschen Wirtschaft, Berlin, 5 December 2007, page 29

5.6.2. Process

In some schools the regular Information Technology lessons are separated into girls and boys only groups. Other schools offer special courses for girls in the afternoon.

In reality, what is in fact taught and in which manner depends largely on the teachers. So the encouraging effects of girls-only lessons in Information Technology seem to be influenced by the content of the lessons and whether the teachers have been trained in gender-sensitive education.

According to a survey by the British Computer Society motivation for girls to go for a career in engineering or ICT[139] seems to depend on the content of the courses. Girls said, that they didn´t want a career in IT because "it is just being a secretary"[140]. Further research showed that these girls had attended ICT lessons in schools which taught them only how to handle text – processing software or how to improve their touch typing abilities. But girls prefer creativity and problem-solving tasks and want to be challenged. So they decided not to go for a career in ICT because they believed typing is ICT.[141] They had never learned anything about the reality in ICT careers.

5.7. Girls-IT-clubs

5.7.1. Aim

Girls should be encouraged to develop web pages, should be instructed in programming and equipped with hardware knowledge, thus be empowered to enjoy the creativity of information technology and the "IT-Spirit".

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[139] ICT = Informatics and Communications Technology

[140] cf. Financial Times U:K.Special Report Digital Business: Where are all the women in IT? November 8 2006, page 4

[141] „Would you enjoy a cookery course, if you only learned opening cans?"

5.7.2. Process

A couple of schools organise Girls´ IT clubs, some in Cooperation with "KommIT - Frauen in IT- und Multimedia"[142], “Women in ICT and Multimedia”. The teachers encourage girls to build web pages, enhance their Internet research abilities and become skilled mechanics in regular lessons in the afternoon.

5.8. Differentiated Co-education[143] in Physics at the St. Anna Gymnasium

5.8.1. Background

Until 1987 the St. Anna Gymnasium used to be a girl´s (only) school with focus on mathematics and sciences. During these years the same number of girls took up so-called Leistungskurse, advanced courses, in Mathematics, Physics or Chemistry as boys in co-educational schools. At that time the results of the girls used to be very good in these fields. After the school became co-educational and more and more boys attended the school, the proportion of girls in Nature and Technology advanced courses dropped to the national average e.g. 11% in Physics in 1995. The head of the physics department, Verena Schroll, and her female colleagues observed that they themselves had all attended “girls-only schools”. They therefore started a so-called differentiated co-education project.

5.8.2. Aim

The idea was to develop girls’ self confidence within their own capacity in physics in a girls-only group in physics (so called mono-education lessons) so that they would be able to compete with boys in the following years. Meanwhile they would continue to have educational advantages of a co-education system, girls and boys together for other lessons.

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[142] c.f. www.frauenkompetenz.de , 8 March 2009, an independent association for female competences in business

[143] Differentiated co-education means, that special lessons are taught in “girls only” and “boys only” groups, that is to say mono-education or mono-educative teaching

5.8.3. Process

In grade 8, girls-only groups were formed for physics lessons. A team of female physics teachers developed physics lessons considering girls' interests, for example more medical or biological contents, and exchanged ideas with each other about their new materials.

5.8.4. Results

The results proved that Mrs. Schroll[144] and her colleagues´ assumptions were right. Even only one year, "girls-only" physics lessons in grade 8 combined with teachers´ training in gender-sensitive education, extremely improved the girls motivation for physics. The school achieved a sustainable proportion of 25 to 40 percent female pupils in advanced Physic courses in grade 12 and 13. That is more than twice the average in Bavaria.[145]

5.9. Differentiated Co-education in Mathematics at the Luisengymnasium[146]

5.9.1. Aim

The assumption of Mrs. Ulrike Schätz at the Luisengymnasium was, that if girls were taught mathematics in a mono-educational situation they would achieve better results.

5.9.2. Process

In grade 11 the girls were offered the possibility to decide if they wanted to attend a mono-educational or a co-educational course in mathematics in grade 12 and 13.

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[144] Verena Schroll, head of the physics department, St. Anna Gymnasium Munich

[145] Verena Schroll: Monoedukativer Physikunterricht: Gute Noten für Mädchen, www.leaNet.de 17 Februar 04

[146] cf. Schätz, Ulrike, Wortprotokoll des Bayerischen Landtags, 14. Wahlperiode, 6. Februar 2002, Stellungnahme der Experten, Anlage 4, page 71 ff. and: Schätz, Ulrike in: Bramkamp, K. and Jost, M: Hochbegabte Mädchen und Frauen Begabungsentwicklung und Geschlechterunterschiede higly gifted girls and women, gender differences and talent development in Labyrinth, DGhK, 69 /2001, page 18 ff

5.9.3. Results

An impressive study showed that the girls who had chosen mono-educational instruction were much more successful in mathematics than those girls who were instructed in co-educational courses. Further research proved, that the girls who had decided to attend the mono-educational mathematics course had been less successful in grades 8 through 11, than the other girls of the classes. Both groups of the girls had to write the same final exams, the central state Bavarian Abitur[147] in mathematics. The results of the girls of the mono-educational mathematics courses were on average one mark better than the results of the reference group on a scale of 6 possible marks.

The observations of teachers at the St.-Anna-Gymnasium and the Luisengymnasium were strongly confirmed by a study of the institute for pedagogical psychology of the Ludwig-Maximilians-University of Munich in 1995[148]. Tested were about about 1300 girls, most of them in mixed classes. The reference classes of the St.-Anna-Gymnasium were girls-only classes. Most of the teachers in mixed classes had even attended a "Reattributionstraining", a special way of verbal interaction with girls in lessons.

The girls instructed in co-educational or mono-educational lessons were surveyed (for a comparison) according to motivation, interests, and attitudes towards physics. The results were amazing. Confidence in their own capacities was in all groups of girls the same before their first physics lesson. After three months, the survey showed a clear growth in confidence of the girls in mono-educative girls' classes, while a decrease in confidence of the girls in mixed classes was observed. Interest in physics was significantly influenced positively by girls only lessons. The girls accepted their unique situation in sex-separeted courses in a co-educative school more and more. Their attitudes towards physics showed a distinct difference. Girls from mono-educational classes had a higher motivation for physics during leisure time, for active participation in lessons, for choosing physics courses when possible and for taking up a profession including physics. A more recent study (Kessel, 2002[149]) confirms the former results and proves that a temporary separation of puberty-aged boys and girls in physics

[147] diploma from German secondary school qualifying for university admission or matriculation

[148] cf. DFG Study: Az: FR 472/16-2, 1995 – 1997 Mädchen und Physik – girls and physics, according to V. Schroll, SAG Munich

[149] cf. Kessel, Ursula: Undoing gender. Eine empirische Studie über Koedukation und Geschlechtsidentität im Physikunterricht, Weinheim/München 2002 (an empiric study on coeducation and sex-identity in physics)

increases the number of girls motivated for this subject. As a consequence girls do not exclude training for a profession in physical or STEM- fields from the start. Especially during puberty, the time of search for individual and sex- roles, girls hardly identify with a subject as strongly male-connoted as physics. During mono-educative instruction one can obviously find a situation where sex becomes an irrelevant category.

5.10. Differentiated Co-education in a couple of Realschulen (secondary schools) in Munich

5.10.1. Aim

The aim is to give a counter balance to socialisation influences to both sexes, girls and boys.

5.10.2. Process

Several “Realschulen” in Munich have developed a concept of gender-sensitive separated courses for girls and boys for different subjects, like mono-educational lessons in physics for girls and boys-only courses in languages. In addition “Sexual education”, “HIV-prevention”, “self-confidence – training”, “stop – smoking”, “talent-development”, “IT-Clubs” and “career choice” education lessons are taught in girls and boys only groups.

5.10.3. The results are currently in discussion.

5.11. A school with a career choice project - the Willi Graf Gymnasium

5.11.1. Aim

The career choice project at the Willi Graf Gymnasium targets at broadening the horizon of girls for less common professions.

5.11.2. Process

The girls´ officer and counsellor for grade 5 to 8 at the Willi Graf Gymnasium, Mrs. Mareile Müller, combines different projects in grade 8 in order to motivate girls for STEM. The girls start with a project (5 hours) "Princess, nurse or mother?" developed and realised by an independent association called MIRA[150]. The aim is to work with the girls on the opportunities and limitations of a women planning her life and to point out the multiple choices they have. The project includes the following objectives:

- The girls appreciate their competences and abilities.
- They take a positive attitude towards themselves.
- They verbalise their hopes and desires for their future.
- They realise different options.
- They identify the first steps towards their future.

Mrs. Müller reported that the educators were impressed how unrealistic and low reflected the expectations of the girls were. This first project opened the mind of the girls for the option of a future in STEM. The following two days the girls took part in different STEM related projects organised by "girls do technology", "Mädchen machen Technik"[151], from the Technical University Munich. The girls worked in a strongly self-developing and experimental way in different groups in the fields of Robotics, Chemistry, Architecture and Biology. The girls successfully constructed, programmed or analysed.

5.11.3. Results

The feedback of the girls was very positive. They praised the creativity, the team-play, the self-activeness and the discovery-oriented work atmosphere. After these three days, a lot of them mentioned that they could imagine working in the field of STEM:

[150] http://www.miramue.de, 8 March 2009

[151] For further information. http://www.maedchenmachentechnik.de/

5.12. "School Meets Science" - the municipal girls-only Bertold Brecht Gymnasium (BBG)[152]

5.12.1. Aim

"School Meets Science" wants to inspire girls for a career in research in natural sciences.

5.12.2. Process

The BBG is the first public girls-only school in Bavaria with a natural sciences and technology focus and an ongoing co-operation with the "Helmholtz Zentrum München - German Research Center for Environmental Health" [153](städtisches Bertold-Brecht-Mädchen Gymnasium mit Naturwissenschftlich-techologischer Ausbildungsrichtung).

In Bavaria from grade 8 on pupils have the opportunity to focus more on languages, social or humanistic science, or on natural sciences and technology. The municipal Bertold Brecht Gymnasium Munich is the first public girls-only Gymnasium in Bavaria which offers a focus on nature and technology. That means, that the girls occupy themselves more with natural sciences (Chemistry, Physics) and informatics, in addition to the standard education in mathematics, German, history and other more classical subjects.

Special features in the framework of the focus on Natural Sciences and Technology at the BBG:

- Nature and Technology lessons in grades 5 to 7 concentrate on experimental work in small groups
- "School Meets Science": The Helmholtz Zentrum München invites classes from grade 5, 7, and 9 to a interdisciplinary science project week, where they also meet female role models
- Sustained co-operation in form of additional single project days at the

[152] Very famous examples and role-models for the success of mono-education are Hillary Clinton and Madeleine Albright

[153] The Helmholz Zenter Munich investigates chronic diseases which develop from the interaction of environmental factors and individual genetic disposition. They combine the fields of biomedical and environmental research with emphasis on excellent basic research, internationally used experimental platforms and clinical cooperation groups, as well as centers for translational medicine, in collaboration with the Munich universities and with other leading institutions, both national and international. Particular effort is laid on the promotion of junior scientists and personnel development.

Hemlholtz Zentrum Munich in grades 6 and 8

- Day to day lessons are enriched by real research examples of the Helmholtz Zentrum München, e.g. applied statistics in Mathematics via an example of heart attack or stroke statistics of scientists from the Helmholtz Zentrum München
- Chemistry as a main topic from grade 8 on
- Informatics in grades 9 and 10
- Experimental Physics and Chemistry in grades 8, 9 and 10
- Nature and Science internships
- Girls´Day STEM-internships

The pupils present the results of their project work at a concluding conference, open to parents, scientists and interested audience at the Helmholtz Zentrum München and at the BBG "open house" ("Tag der offenen Tür"). In addition to the practical and experimental experience the girls gain presentation-experience and receive positive feedback from the visitors, which is a huge motivation for the girls.

5.12.3. Results

The project "School Meets Science" is evaluated with support from the IPN Kiel. The study focuses on the image of natural sciences in the evolving pupil. It is designed as a long-term study that goes along with the project. First results show that the understanding about the general functioning of general sciences is positively influenced by the project.

6. Interviews, analyses and reports of teachers and pedagogical staff

The pedagogical staff mentioned the following hindrances and support for their work:

6.1. Hindrances

- not enough room (e.g. Kindergartens have no extra room for experimental learning, and not enough room for storing the experimental material)
- not enough money for experiments, technical equipment and computers
- classes are too large(up to 32 pupils per class) for experimental teaching or self-discovery individual learning
- not enough teachers
- not enough time for preparation for the teachers (e. g. at Rosseau Lake College in Ontario, Canada teachers give 16 lessons per week, in Bavaria teachers at Gymnasiums give 24 lessons per week)
- not enough room for teachers in schools to work and prepare lessons and projects in cooperation with colleagues (in many schools teachers do not even have their own desk)
- "when special educators leave the project dies" - typically a lot depends on single persons
- over-loaded curricula in nearly every field
  and hence not enough time for example- and discovery-oriented learning

6.2. Supporters

- very commited and highly motivated individual teachers and pedagogical staff, who work together in the evening and at weekends
- pedagogical freedom
- support from the headmasters
- support from the municipal council
- support from the colleagues or an interacting team of colleagues
- associations which support teachers, like MIRA or KommIT
- Co-operation partners like the Helmholtz Zentrum München or the TU Munich (Technical University Munich), "mädchenmachentechnik" from the TU Munich, etc.
- support from businesses, e.g. the group of companies that finance and accompany the project "tiny tot center"
- gender-sensitive colleagues

7. Postulations

- Prerequisites for staff successfully motivating girls for STEM[154]: Teachers and pre-school educators should be ...
  - open to the fascinating world of science and engineering.
  - sensitive for gender[155] related obstacles and supporters for learning.
  - innovative: allowing girls to develop a research spirit in experimental self-learning.
  - self-reflected and enquiring role – models.[156]
- Continued education and training for teachers and educators includes ...
  - mandatory training in gender mainstreaming with practical observation exercises and role plays for educators and teachers.
  - Improving skills of observation and perception of gender related behaviour.
  - equipping educators and teachers with a wide range of adequate reaction concepts as a counter balance to socialisation influences.
  - equipping teachers and educators with a wide range of experimental projects.

- Kindergartens and Créches need an extra room for experimental learning.
- Educational facilities need more money for experiments and technical equipment.
- Experimental or self-discovering individual learning requires smaller classes.
- Teachers need more time for preparation in schools and fewer lessons per week.
- More room in schools to work and prepare lessons and projects is needed.
- An indispensable prerequisite for experimental and self-discovering individual

[154] Science, Technology, Engineering, Mathematics

[155] "The existing differences between women and men are of a biological and social nature. Sex refers to the biologically determined differences between women and men. Gender refers to the social differences. These are learned, are changeable over time and have wide variations both within and between cultures. Gender equality refers to a situation in which all human beings are free to develop their personal abilities and make choices without limitations set by strict gender roles. The different behaviour, aspirations and needs of women and men are equally valued and favoured." http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id =27 , 8 March 2009

[156] e.g. "teachers used to help girls and explain to boys"

learning is an over-view and un-load of curricula in nearly every field. The new curricula should be focused less on content and more on example-oriented life-long-learning methods.

- Sustaining the natural curiosity and interest of children in experimental technical learning has to begin when they enter any kind of educational facility.
- Reliable quotas for studies and vocational training have to be implemented: at least 30 % male day care assistants, 30 % male Kindergarten teachers and 30 % male primary school teachers.
- Differentiated co-education with girls only groups in Mathematics, Physics, Nature and Sciences can become a benchmark for quality in educational facilities.

8. Successful projects, selected examples from other countries

8.1. There is a great number of different projects and concepts for increasing the number of women in STEM in other countries. In the following an overview is given:

- Girls only lessons in mathematics and natural sciences (Australia, France, Austria)
- Technical corners in Kindergartens with reserved times for girls (France)
- Advertising campaign “women engineers year” (Australia)
- Information about engineering at school- and graduation parties for parents and pupils (USA)
- Scholarships for female engineering students (Ontario,Canada, Australia)
- Special training for school counsellors in the advantages for girls in STEM (Quebec, Canada)
- Accompagnement Recherche Formation (Canada, Quebec: school staff is advised on change management, special features regarding women in STEM)[157]
- (Billboard) advertising with female role-models in STEM (companies mostly in

[157] cf. Lafortune, Louise: „Un modele d`accompagnement proffessionnel d´un changement“ Presses de l´université du Quebec, 2008

USA)

- The whole curricula is examined for subjects that can be realised in a way that motivates girls for STEM (Australia)
- Technical summer camps for puberty-aged girls, parents are invited to the final presentation (Australia)
- Gender-sensitive language, e.g. for attracting girls to a workshop: “Engineering builds the future. Your job is to make it sustainable.” (Austria)
- media gender-sensitivity: A well recognised daily soap for teenagers in Australia was “enriched” with a female chemical engineer, one year later the application of girls for this field of study increased by 30%.

8.2. Attracting more women to the Carnegie Mellon School of Computer Science (SCS) in USA[158]

Carnegie Mellon University is home to one of the premier computer science departments in the USA. In 1994 the University set the goal to increase the number of female students at SCS at least to 30%. They hired a team of scientists in order to reach the goal. The study is based on more than 100 interviews with computer science students of both sexes over a period of four years, as well as classroom observations and conversations with hundreds of college and high school faculty. The interviews capture the dynamic details of the female computing experience, from the family computer kept in a brother´s bedroom to women´s feeling of alienation in college computing classes. The authors investigated the familial, educational and institutional origins of the gender gap. They also describe educational reforms that have made a dramatic difference at Carnegie Mellon. The percentage of women entering the School of Computer Science rose from 7% in 1995 to 42% in 2000.

9. Outlook

Fear of and reluctance to change is the main obstacle for innovation.

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[158] Margolis, Jane and Fisher, Allan: Unlocking the clubhouse: women in computing, MIT Press, Massachusetts, USA 2003

Even though policies regarding diversity and gender-equality for every kind of educational institution already have been established and enforced for many years the situation in STEM for women had worsened in Germany. The number of female students in engineering and especially female participants in ICT[159] was decreasing for many years. There are already a wide range of excellent and thoroughly investigated examples of good practice and a huge number of concepts for increasing the number of girls and women in STEM. However, we have to reconsider the implementation of strategies and manage and monitor the process accurately for change.[160] Schools need a new quality and innovation management[161]. These process skills are crucial for future progress.

[159] European Commission community research: „She-figures 2006“, p. 23; and „Source: www.destatis.de“ cited by Prof. Dr. S. Ihsen, Genderfaktoren bei der Berufswahl, Fachtag Berufsorientierung, München, 19 February 2008 (symposium gender influences on career choice Munich); and Financial Times, U.K. Special Report Digital Business, May 14 2008, page 1

[160] European Commission: Community research Unit C4: women in science and technology – the business perspective, 2006, p. 25, and cf. „Diversity as Strategy," Harvard Business Review, Vol. 82, No. 9, September 2004.;and cf. Thomas, D: „IBM finds profit in divesity“ http://hbswk.hbs.edu/item/4389.html 15 March 2009; and cf. Desvaux, G and Devillard, S. McKinsey&Company: Women Matter 2 female leadership, a competitive edge for the future, McKinsey&Company 2008

[161] cf. e.g. Cobb, Charles G.: From quality to business excellence: a systems approach to management, Milwaukee, Wisc. 2003.

National Joint Initiative for Women in MINT-Professions "Go, MINT." - New ways of networking

Keywords: MINT, joint initiative, network, women, girls, career, partner

Abstract:

Education and Science Minister Dr. Annette Schavan started the National Joint Initative for Women in MINT-Professions in June 2008. 45 organisations, universities and companies were the first to sign up the memorandum in which the partners committed themselves to special targets with the aim to raise the number of women in MINT-studys and profession and to raise the awareness for women in MINT. During the next 3 years the different partners try to interest more young women with technical skills to study MINT. And they want to promote young women by starting their professional careers. To be successful, it is necessary to work together, to bring together actions, which were successful and can be implemented into other structures. New partners are welcome at any time and will be integrated into the project. There are different additional projects of our partners that still have started or will be started during the next three years. Working together and built up a strong and broad network is therefore another target which is essential for the success of the project.

Barbara Schwarze, Eva Viehoff, Christina Haaf

1. The starting point: The situation of women in MINT

Along every step of the qualification process women in Germany get lost when pursuing potential careers in MINT. Studies show that a large share of women with MINT preferences does not choose a MINT-related field of study when entering university. Nevertheless, due to continuous measures and projects the number of first-year female students in engineering had been steadily increasing until 2003. However, starting then the numbers began to decline: from 2003 to 2006 they dropped by 12%. A similar tendency can be seen in science subjects, where the number of first-year female students dropped by 6% within the same period. The number of female engineering graduates as yet continues to thrive. In the period between 1999 and 2006 their figure increased by 24% (1,793 women). In 2006 22% of the final examinations taken in this subject group were completed by women. The drop in first-year students has not yet influenced the number of female graduates. The number of female

graduates in mechanical engineering has risen by 70% since 1999 and their numbers in electrical engineering even doubled. However, the overall number of graduates remains quite low. In 2006 2,891 women completed their studies in mechanical engineering, whereas 717 women graduated in the field of electrical engineering. With only 22% of female graduates in the field of engineering Germany resides 5% below the average European level. In light of the dropout rate in the field of engineering, it becomes evident that the relatively small percentage of female students in MINT could be increased by reducing the number of dropout students. The arrival of MINT-sector graduates in the economy has barely been investigated. As a result no definitive statements can be made for any of the different fields of study and their final degrees. It is important to note that the percentage of female graduates in engineering amounted to 22% percent in 2006 (8.3% electrical engineering, 18.3% mechanical engineering and 17.1% computer science). However, only 5% of these 22% of female MINT graduates appear in the Federal Employment Agency's labour market statistics. The positive developments and slowly but steadily increasing number of women graduates are not reflected in the MINT professions themselves. The MINT sector loses a lot of vital female potential post-graduation. Furthermore, the Institute for Labour Market and Professional Life Research stated in 2006 that the unemployment rate of female engineers (9.7%) has been two-and-a-half times higher than that of their male colleagues, listed at 3.7%. All this shows a marked need for action.

2. Past solutions towards gender equality in the MINT professions

There are already numerous successful measures for attracting more women to MINT careers all over Germany. However, as of yet these measures have often remained independent actions and thus still do not have a broad impact on prospective students or on women's job interests in general. They also have not helped to improve the image of MINT qualifications and studies and its impact on the "female" public. Thus far there is an uneven distribution of measures along the process of qualification. Successful and innovative measures are often found on the school level, starting from middle school, in the fields of professional education and in higher education. Considerably fewer activities can be found in the preschool sector and in primary schools, even though it is important to implement these measures early on to prevent a premature disinterest in the classically technical education and professions on the

part of the girls. Many universities offer a number of different projects and activities for women in the MINT sector. These are predominantly supported and financed by the universities themselves. There are only a few cases of projects being sponsored by companies or corporations. An important part of most of these projects is “mentoring”. Beyond that, the building of professional networks and the relaying of information regarding the organisation and contents of the chosen course of study are also important support measures. Most of the measures undertaken by the federal government and the individual federal states focus on awakening young women’s interest in technology and technical items and do not take into account the situation they might be facing in their professional life later on. However, many young women consider work-life balance to be an important aspect of their future career. Likewise, there is a marked lack of measures for students in their advanced study and career entry periods. Integrated concepts, covering all phases from introducing technology and technical items early on in primary school to supporting the careers of female scientists, are hardly ever implemented. While dedicated companies, research centres and foundations aim to strengthen MINT education, their approaches often lack specific concepts for attracting young women. Adding such concepts would lead to a broader impact of such measures.

3. MINT as an innovative project

Attracting more highly qualified young women to MINT is not possible within the scope of the available activities alone. There is a lack of realisable integrated concepts. Motivating young women to enter an MINT course of studies is not sufficient if at the same time the number of female (and male) dropouts is too high. Furthermore, there is a visible gap between successfully graduating an MINT course of studies and arriving in the economy. Thus far, despite considerable efforts, a national turnaround has not happened and thousands of qualified young talents still keep away from the MINT sector. There is a definite need to bundle and focus the existing measures and projects. This is the starting point for the Joint Initiative for Women in MINT. This broad initiative started in June 2008 with already more than 40 strategic partners from the economy, science and politics and seeks to attract considerably more women to the MINT sector and to effect a change of image. The joint initiative is part of the federal government’s qualification initiative. The Federal Ministry of Education and Research will fund the initiative with three million euros per year. The

MINTup of new projects in cooperation with the partners will be funded parallel to numerous projects already sponsored within the framework of the programme “Women to the Top”. The partners pledge themselves to support the common objectives by implementing their own measures. The institutions of higher education, for example, plan to develop more attractive MINT courses of study and facilitate the study orientation for young women. Companies will undertake a visible effort to promote attractive job chances for women in their MINT sectors. Partner experts are integrated in the planning and shaping of the joint initiative. The initiative itself is flexible and open to many partners. This means:

- Existing projects and initiatives will be placed, bundled together and transferred into the public by joint public relations.
- The transfer of successful measures in different regions and institutions will be facilitated.
- The partners’ new activities will kick off. The planned measures should boost realistic decision-making in occupational orientation, enable an early contact with role models and contribute to more self-confidence with regard to technical and scientific competences.

4. Objectives of MINT

The partners have MINT themselves tangible joint objectives: to raise the share of first-year students in science- and technology-related subjects by an average 5%, to make sure women are included in new appointments in the MINT sector in numbers at least proportionate to their share of graduates, and to considerably raise the number of women in executive positions. A broad alliance between the federal government, the Federal Employment Agency, companies, organisations, unions, universities, research facilities, women technology networks, the media, and public facilities is necessary to achieve these objectives. It is the initiative’s goal to spark more girls’ and women’s interest in MINT courses and professions.

The partners want to make a contribution to:

- particularly appeal to and sponsor the technically gifted and interested female students (about 40% of the women eligible for a place at university)

- raise the percentage of women first-year students in MINT-related subjects to at least the European level: that means an average increase of five percentage points

- increase the percentage of women recruited into the MINT sector to at least the share of women graduates of the corresponding courses of study

- support more women on their way to the top with an eye to raising the share of women in executive positions in universities and research facilities at least one percentage point a year, as well as

- markedly raise the percentage of women in executive positions in the participating businesses in keeping with their self-MINT targets. It is especially important to support talented women and help them to tap their full potential in the process.

In keeping with this background the partners pledge for at least three years to support the Joint Initiative for Women in MINT by participating in the joint publicity events and activities or through their own materials or measures. They can, for example,

- organise, participate in or finance events and workshops designed to attract more women to the MINT professions, and particularly to the companies and organisations involved in the initiative, or

- find female role models to participate in the occupational orientation events offered within the scope of the initiative's activities, or

- include the topic in their already existing initiatives or campaigns for skilled workers and qualified trainees, or

- offer traineeships for girls and women within the framework of occupational orientation

- offer concerted measures for young women during and after their studies to help with their orientation within their field of study and thus reduce the number of dropouts, or

- develop or advance family-friendly work structures and workplaces for women and men in the MINT sector and promote them through their own public relations activities, or

- develop publicity materials presenting successful women employed in their company or organisation as role models and depicting the MINT professions as modern and attractive, or

- create special media offers and assure the targeted placement of the topic within the scope of the occupational orientation initiative of the Federal Employment Agency, or

- actively cooperate with the agency and the joint projects, as well as provide data and materials for the evaluation of the Joint Initiative for Women in MINT

In cooperation with individual partners the Federal Government will initially start the following joint activities and thus provide at least 20,000 additional offerings for girls and women:

- development, expansion and implementation of events aiming to convey appropriate role-models for the MINT sector

- support of a proper and realistic depiction of the MINT professions in the media, especially in the area of fiction

- development and running of technology camps including as many of the different partners as possible

- development and expansion of a mentoring offer for female students, run through the web and e-mail

- development and implementation of a “gender appropriate” range of services in order to provide information and help with the decision to enter a MINT-related course of studies

5. Best Practice – Examples of MINT

5.1. MINT Role Models

An integrative concept developed to increase the share of women in MINT in a sustainable way. The project MINT Role Models, an initiative seeking to raise the percentage of women in the MINT subjects (science, engineering, technology) with a lasting effect, aims to help female students get past the inhibitions keeping them from entering a course of studies or profession in one of these subjects. The depiction of modern, attractive MINT job descriptions and the implementation of numerous regional and nationwide events are planned in order to accomplish these objectives. Furthermore, the communication and information about the project will be accompanied by and kept up through student magazines, TV ads, Internet forums, etc. The presentation of positive career examples featuring women is emphasised in all these activities. The activities focus on both female school and university students equally and are, for now, expected to run for a limited period of three years. Funding will be provided by the Federal Ministry of Education and Research.

5.2. "Girls in MINT" – A cooperation between the Deutsche Telekom Foundation and the Fraunhofer Society

The Deutsche Telekom Foundation and the Fraunhofer Society are very committed to achieving a higher share of girls and young women in technical professions and to this end offer a joint continuous support programme reaching from middle school to the start of university. For this purpose the partners will interlock their projects Junior Engineer Academy (middle school) and Fraunhofer Talent School (sixth form). The goal is to work together and establish at least ten Junior Engineer Academies and run twenty Talent Schools until the end of 2010. At least half of all participants will be girls. Insights gained during the nationally and internationally successful Fraunhofer project "Roberta – Girls discover robots" will be part of the content taught in these courses.

5.3. tasteMINT – Try Before You Apply!

tasteMINT is an innovative personal potential assessment centre located at the gateway between grammar schools and universities. It is geared towards female pupils who have not yet decided on their field of study, but are interested in MINT subjects (MINT meaning Mathematics, Informatics, Natural Sciences and Technology, in English-speaking countries often referred to as STEM). As the term already implies, the potential assessment centre as an instrument focuses on the girls' potentials and strengths in the MINT-sector, furthering their decision-making processes and encouraging them to choose a suitable subject in MINT. During the three-day assessment centre, the young women perform several tasks simulating typical situations and requirements for their future fields of study or professions in MINT. In the five exercises they work either alone or in teams and are watched by trained observers, who provide individual feedback and advice after each task. The assessor's feedback regarding the participant's competences and strengths is based on precise and transparent criteria and includes advice on whether a university or a university of applied sciences might be the best choice. tasteMINT is currently provided by three German universities and one university of applied sciences. Participation is free of charge for pupils. tasteMINT is being developed by LIFE e.V. in Berlin and the Competence Center Technology-Diversity-Equal Chances in Bielefeld and funded by the Federal Ministry of Education and Research and the European Social Fund of the European Union. For further information please visit: www.tastemint.de or contact the office in Berlin: cordes@life-online.de.

5.4. CyberMentor

CyberMentor is an e-mentoring program for female high school students (grades six to twelve) who are interested in Science, Technology, Engineering, and Mathematics (STEM). The aim of the program is to increase female participation rates in STEM. Each girl exchanges via email with a female mentor, who is studying or working in the field of STEM. Mentors support their mentees for one year by giving advice, answering questions, and providing insights into their job. Furthermore, a community platform with discussion forums, a chat room and profile pages allows getting to know other participants who share similar interests. Here, participants can discuss STEM topics, school, study courses and more. In

addition the CyberMentor team organizes meetings as well as excursions to universities and research institutes. Interested girls and woman can apply online at www.cybermentor.de.

6. International connections and connectivity

There are several aspects that mark the joint initiative as important for other initiatives around the world. Not only Germany faces a lack of engineering and science experts. It is also felt by other industrialised countries. Hence several other European countries also proclaim a need for specialists in science and engineering. This shows that the joint initiative cannot simply confine itself to working on a national level. The building of a strong national network is crucial but it is also important to establish connections to comparable initiatives in other countries, e.g., Great Britain. As a first step towards this international integration an international congress was held at the Hannover Industrial Fair in April 2009.

Authors

Mostafa Akbari has studied computer science at the RWTH Aachen University. Now he has a doctoral fellowship for investigating how mobile Web 2.0 access via small-screen devices can be designed in a way that it enables all students to integrate continuous learning in their lives, regardless of their gender and diversity.

Nina Bessing is Programme Director Business at the EAF. She has studied Economics, Business Administration and Education at the Freie Universität and Technische Universität Berlin. Since 2000 she works for the EAF. Nina Bessing is leading the research project "Gender and Diversity in innovation processes". Her research interests are: gender and diversity in innovation processes, career building for women, work life balance and human resource development.

Isabel Beuter holds an M.A. (Magistra Artium) in Sociology, Political Science and English. After shorter experiences at VW Coaching GmbH Wolfsburg, at the Federal Employment Services Agency in Nuremberg and at the Department of Sociology, University of Bonn, she took up a position at the Center of Excellence Women and Science CEWS in Bonn, Germany. From 2002-2008 her areas of work at CEWS included women in industrial research, equal opportunities in human resources management and networking. After finishing her M.A. (Master of Arts) in Staff Development (a long-distance study course) she moved on to her current position in staff and organisation development at the Translational Centre for Regenerative Medicine, TRM Leipzig.

Elke Breuer is a research associate at the department "Integration Team – Human Resources, Gender and Diversity Management" at RWTH Aachen University and the coordinator of the international mentoring programme TANDEMplusIDEA. Her research focus is on women in academia, human resources development and international relations.

Barbara Burr became a teacher for higher education after finishing her studies in French and Russian literature in 1984. After her change to the University of Stuttgart in 1988, she became member of the scientific staff of the computer center (RUS). As a head of the department "Information Services", she was responsible for the Internet presentation at the University of Stuttgart. Her focus in the early 90ties was on the development and deployment of web-services. Since 1995, she was responsible for several large information projects in the EU-Frameworks Esprit and ACTs and served as evaluator of EU and BMBF Projects. As the Head of the Department Infrastructure, she was responsible for national multimedia and eLearning projects as well as for development and implementation of eLearning. In 2006 she became deputy director at RUS; actually she is serving as executive manager.

Judith Ebach is a psychologist and the leader of the coordinating office of the Ada-Lovelace Project in Rhineland-Palatinate which is situated at the University of Applied Sciences, Koblenz, Campus Remagen. She develops, implements and evaluates mentoring strategies to motivate female pupils for studying science and technology.

Martina Endepohls-Ulpe is a psychologist and academic director at the University of Koblenz-Landau in Koblenz, institute of psychology. She teaches educational and developmental psychology to teacher students and has been doing research on the topics of giftedness, gifted education, gender differences and girls and technology.

Sharron Frillmann is a PhD candidate at Purdue University. Organizational leadership, College of Technology.

Sabrina Gebauer, sociologist, research assistant at Gender Studies in Engineering at TU Muenchen, Germany. Research fields: diversity in teams and organizations, personnel development, innovation research

Miretta Giacometti is professor of “Economics of Innovation” at the Faculty of Economics of the University of Bologna and Italian representative in the WiTEC Association (www.witec-eu.net). As manager of the UETP AlmaMater she carried out activities aiming at fostering university-industry links both in Europe and in Latin America (http://ilo.unibo.it). As WiTEC member she is involved in EU funded projects focused on gender issues.

Helene Götschel is visiting researcher at the Centre of Gender Research at Uppsala University/Sweden in the Excellence Programme <GenNa - Nature/Culture Boundaries and Transgressive Encounters>. She has been working as an assistant lecturer for <Gender & Science> at faculties of natural and social sciences both in Germany and abroad since 1997, recently as Maria-Goeppert-Mayer guest professor at the ‘Center for Interdisciplinary Research on Women and Gender’ at Oldenburg University/Germany. Her main fields of research are Gender and Physics as well as Technology and Gender in Houses of Correction in 18th century Europe.

Peter Göhner was appointed professor at the IAS at the University of Stuttgart in 1995. His research interests include component-based software development, dependability of technical systems, agent technologies in industrial automation and web technologies. He was dean of the faculty Electrical Engineering and Information Technology from 1998 to 2000. From 2000 to 2003, he served as vice president for education and training.

Marieke Gonschior, studied sociology, linguistic communication and pedagogy at the University of Rostock and is now an academic employee in the research project “Academic careers in political science and chemistry: orientation, planning and consulting in transition to the post-doc-phase” at the Institute of Sociology and Demography at the University of Rostock (Germany).

Christina Haaf in History, French and German Literary Studies, Responsible for the Public Relations of the National Joint Initiative for Women in MINT-Professions, since 2000 responsible for the Public Relations in different projects of the Competence Center Technology-Diversity-Equal Chances. Former scientific employee at the Interdisciplinary Center for Women and Gender Research, University of Bielefeld.

Victoria Hantschel, sociologist, Scientific Assistant at Gender Studies in Science and Engineering at TU München, especially for the gender issues of the TUM-Excellence program.

Clem Herman is a Senior Lecturer in the Department of Communication and Systems at the Open University. She runs a pioneering online course for women returning to Science, Engineering and Technology and her recent research has been focused on the impact of career breaks for women in SET.

Ester Höhle, sociologist, research assistant at Gender Studies in Engineering at TU Muenchen, Germany. Research fields: Sociology of Technology, Gender, Student Surveys in (Higher) Education, Modernization, Individualization, Social Structure Theory

Susanne Ihsen, sociologist, Professor at Technische Universität (TU) München for Gender Studies in Science and Engineering , Department for Electrical Engineering and Information Technology; experienced in gender and diversity in Engineering Education, Professions, Organizations and in technical research and development.

Sabina Jeschke received her M.Sc. in Physics at the Berlin University of Technology in 1997, graduating with distinction. Sabina Jeschke worked as an assistant teacher at the Department for Mathematics and Natural Sciences and earned her doctorate in 2004. Holding a scholarship from the German National Academic Foundation, she spent several months of research at the NASA in Moffet Field, CA. In 2000 and 2001, Sabina Jeschke worked as an instructor at the GaTech (Georgia Institute of Technology, Atlanta). Since 2005, Sabina Jeschke has been associate professor for "New Media in Mathematics and Natural Sciences" and director of the MuLF Center (Multimedia Center for "New

Media in Education and Research") at Berlin University of Technology. Starting in 2001, her Berlin group has been a driving force behind the development of multimedia technologies at the university, implementing multimedia educational elements in the education of undergraduate students, in particular for engineering students. In May 2007, Sabina Jeschke has taken over a full professorship for "Information Technology Services" at the University of Stuttgart and is also acting as scientific and executive director (CEO) of the "Center of Information Technologies" of the University of Stuttgart. Additionally, she holds a co-professorship at the TU Berlin, in particular targeted towards the co-ordination of the design of new curricula in technology-oriented studies and the coordination of several eLearning and eResearch projects.

Heike Kahlert, sociologist (diploma at the University of Hamburg, promotion at the University of Bielefeld); currently Maria-Goeppert-Mayer-Guestprofessor for international women's and gender studies at the Centre for Interdisciplinary Women's and Gender Studies at the HAWK University of Applied Sciences and Arts Hildesheim/Holzminden/Goettingen and University of Hildesheim (Germany); head of the research project "Academic careers in political science and chemistry: orientation, planning and consulting in transition to the post-doc-phase" at the Institute of Sociology and Demography at the University of Rostock (Germany).

Panagiota Katsakiori is a Mechanical Engineer, Phd candidate in Technical University of Patras. Works in the Occupational Safety Body of Attika Municipality.

Theodora Kokla is a Electrical Engineer, Msc., Coordinator of the project 'Creating cultures of success for women engineers' (Womeng) for the part of the Greek Women's Engineering Association, ex. International Affairs Secretary of the Greek Women's Engineering Association. Member of the Board of the Center for Research & Action for Peace (KEDE).

Carmen Leicht-Scholten is head of department "Integration Team – Human Resources, Gender and Diversity Management" at RWTH Aachen University. She is responsible for the realisation and scientific evaluation of a coherent gender and diversity management at RWTH Aachen and has developed the mentoring concept of the university. She has a background in political science, sociology, gender and diversity studies. Over the past 15 years she has developed numerous interdisciplinary and applied research projects in the field of gender and science.

Thiemo Leonhardt completed his studies in computer science and history at the RWTH Aachen University in 2008 with the teaching degree for secondary schools. Since October 2008 he has a MINT-doctoral fellowship. Thereby he investigates new access to teaching computer science at school by following the principles of interdisciplinarity, gender mainstreaming and explorative learning.

Katharina Nieter, studied sociology, public law and English/American Studies at the University of Rostock and is now an academic employee in the research project "Academic careers in political science and chemistry: orientation, planning and consulting in transition to the post-doc-phase" at the Institute of Sociology and Demography at the University of Rostock (Germany).

Hale Oner-Keifer is a PhD Assistant Professor at Purdue University. Organizational leadership, College of Technology.

Dillip Pattanaik is a member of IRMA from India, on its mission on development, promotion and dissemination of Information and Communication Technology for empowering the rural communities both men and women as a whole and strengthening the rural livelihood system.

Tanja Paulitz is an Assistant Professor in the Department of Sociology (Sociology of Gender & Gender Studies) at the University of Graz.

Anne-Christien Pielka graduated at RWTH Aachen University in the Master's study "Technical Communication". She currently has been working at the Center for integrative teaching and learning concepts of the RWTH Aachen University. Her doctoral project is encouraged by a gender-doctoral

fellowship. Her main skills are in the fields of eLearning, computer science, communication design and gender research.

Yvette Ramos is a member of the Association Française des Femmes Ingénieurs.

Nadja Ramsauer is head of the department gender studies at Zurich University of Applied Sciences and is responsible for bringing gender studies into teaching and research. She is a historian and here interest is in: gender and technology / gender-sensitive teaching / gender and welfare states.

Wolfram Ressel finished his doctoral degree at the Bundeswehr University Munich. Subsequently, he was employed as managing partner in a Munich engineering company responsible for the planning of engineering work and traffic systems. In January 1998, Wolfram Ressel has been a full professor of the Institute of Road and Transportation Science at the University of Stuttgart. In research and education, he is responsible for transportation and road planning, with emphasis on development and use of methods to the simulation of processes in design, construction and operation of traffic systems. Since October 2006, Wolfram is the rector of the University of Stuttgart.

Barbara Roth studied Architecture, Construction Engineering, Pedagogics, Psychology and Sports, finished with a so called “Staatsexamen für "Höheres Lehramt an beruflichen Schulen in Bayern (Bautechnik)"” (state exam to become a teacher at special vocational schools in Bavaria); Postgraduate courses: Diploma in Public-Relations (BAW), Gender -Studies, business administration and law (Fernuni Hagen und LMU Munich). Business activities: Director of a not for profit organisation, Business Plan Competitions, Director of an adventure and experimental-learning training centre; Teacher at vocational schools; Director of the Department of social education and prevention at the Pedagogical Institute, City of Munich.

Panagiota Rouni is a Mechanical Engineer, Phd., General Secretary of the Greek Women’s Engineering Association. Member of the Board of the European Federation of Mentoring for Women and Girls. Works in the Technical Univeristy of Atrhens.

Helene Schiffbaenker, is Senior Scientist at JOANNEUM RESEARCH in Vienna and head of FEMtech scientific department (www.femtech.at). Her research in science and technology and creative industries focuses on working conditions and gender specific career aspects like reconciliation of work and private life, part-time work, research culture.

Wolfgang Schlicht finished his doctoral degree at the University of Giessen in 1987. Since 2000, he has been a professor at the Department of Sport and Exercise Science. In education and research, the main focus is the prevention and the physical-active behavior in daily routine. The workgroup studies the condition that prevents or facilitates a physically active daily routine. The main research concerns the effects of daily routine activity on the subjective well-being and self-contentment of aging (50+) humans as well as ambulatory assessment.

Ulrik Schroeder is a full professor at the RWTH Aachen University. He is head of the Research Group "Computer-Supported Learning" and also head of the Center for integrative eLearning & eTeaching (CiL) of RWTH Aachen University. His main skills are in the fields of eLearning, Web Technologies, Web 2.0, Software Engineering, Usability, Computer Science Education and Didactics.

Barbara Schwarze is a sociologist, Head of the Competence Center Technology-Diversity-Equal Chances, Inc. Member of the executive board of the German IT Initiative D21, member of the VDI, the Association of German Engineers, member of the International Society of Engineering Education (IGIP). Professor for Gender and Diversity Studies at Osnabrück University of Applied Sciences (main topic engineering and informatics). Expert in commissions, associations, international and national boards. Numerous publications and reports on the topics of the internet, information society, equal chances for women, diversity, study reform in engineering and science, women and technology.

Stephanie Stein works as research associate at the EAF since July 2008. After graduation (Diplom-Kauffrau) in Business Administration at the Freie Universität Berlin in 2007 she worked at the Institute of Management as research associate in a diversity-project which was co-financed by the European Social Fund. Stephanie Stein's research interests are: gender and diversity aspects in organisations, domination and pluralistic interests in organisations and employee suggestion schemes.

F. Fulya Tepe was born in 1974 in İstanbul, Turkey. She got her Ph.D. degree in sociology in İstanbul University in 2008. During her doctoral education, she received scholarships from the Swedish Institute, Nuffic, DAAD and found the opportunity to make research in Sweden, Holland and Germany. She works in the Faculty of Education in İstanbul Aydın University as an assistant professor since November 2008. Her recent research interests remain in the fields of gender studies and oral history.

Elke Van den Brandt has a broad expertise on 'gender and science'. Since 2004 she has been working at the Centre for Gender and Diversity of the Vrije Universiteit Brussel (RHEA) on projects on women in science. As a member of the Network of Excellence on Micro-Optics, she was responsible for a study on the careers of men and women in photonics. She is also member of the Diversity Forum of the Vrije Universiteit Brussel, the counselling body for the academic diversity policy. Elke studied Communication Sciences at the Vrije Universiteit Brussel and the Universidad Compultense de Madrid. After graduating, she worked as a gender expert for the University Centre for Development Cooperation (UCOS), where she organised several trainings and educational activities on gender and development.

Eva Viehoff is an Engineer of agriculture, Co-Ordinator of National Joint Initiative for Women in MINT-Professions, Member of Strategy Board "MINT – Zukunft schaffen", Former Gender Equality Officer of the Alfred-Wegener-Institute for Polar and Marine Research, former Chair of akfifz (working committee women in research centres of the Helmholtz Community). Several voluntary commitments.

Janine von Zabern studied science of education at the University of Koblenz-Landau in Germany. After her graduation she started her doctor's degree at the faculty for psychology at the University of Koblenz. As a scientific officer she is assigned with the European research project UPDATE. Furthermore, she works as a graduated educationalist with young people at a youth welfare office.

Thea Weiss Sampietro is a sociologist at Zurich University of Applied Sciences, Institute of Sustainable Development (INE) and her interest is in: gender aspects in organisational cultures, engineering and environmental science. The Institute of Sustainable Development combines application oriented research, consulting and training in a synergetic way. The wide range of competences in our multidisciplinary university (www.zhaw.ch), and particularly within our institute (**http://www.ine.zhaw.ch/**), combining knowledge in engineering, environmental science, humanities, social sciences and economy, enables us to perform transdisciplinary projects in the interfaces of environmental sciences, social sciences and economics.

Ines Weller is a Professor at the University of Bremen, Director of the Research Centre for Sustainability Studies (artec) and Co-Director of the Centre for Gender Studies; experienced in the field of sustainability research, especially in the field of sustainable production and consumption patterns, gender and environment, gender and sustainability, gender and technology.