Masculinities in organizational cultures in engineering education in Europe: results of the European Union project WomEng

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The paper describes elements of engineering organizational cultures and structures in higher engineering education from the European project WomEng. Hypotheses, based on state of the art, refer to: women friendly presentation, attractiveness of interdisciplinary teaching methods, single sex education, perceptions of minority status, feelings of isolation, existing discrimination and coping strategies of female students. Quantitative and qualitative methodologies, asking questions of and observing students and faculty are completed by website analyses. The results show that special recruitment and a welcome for women do not exist everywhere and, furthermore, are denied by faculty of some countries. General welcome events are appreciated. Among interdisciplinary subjects, languages and soft skills are preferred, along with people-oriented teaching. Attitudes towards single sex education are controversial. The general male engineering image is combined with negative attitudes and discrimination practices in only some countries. More latent discrimination, like prejudice, jokes and stories, lead to self-confidence coping strategies by female students. The results are reflected on the basis of feminist and men’s studies. The conclusions refer to inherent dilemmas in research on masculinities in engineering education.

Keywords: Gender; Organizational culture; Gendered education; European project; Masculinities

1. Introduction

The European Project WomEng: ‘Creating Cultures of Success for Women Engineers’ (website at http://www.womeng.net) (2002–2005) was participated in by universities and non-profit women’s engineering associations from seven countries (UK, France, Germany, Austria, Finland, Greece and Slovakia). Forming called work packages (wp), WomEng was split into two parts, education in and the profession of engineering, combining a strong quantitative with a complex qualitative methodology. In the first part (now finished) choice of degree course (wp 2) was connected with the experiences, satisfaction and dissatisfaction of students (wp 3) and the organizational culture of degree courses (wp 4). This paper concerns wp 4, it under German responsibility. After a short state of the art, explication of hypotheses and an
explanation of the methodological approach, several results will be presented. Interpretation will be based on different gender theories and focus on understanding and changing masculine organizational structures in engineering educational institutions.

2. State of the art

It is not a deficit in abstract thinking, etc. by women that drives them away from technology, but the content and climate of technical institutions, referred to as an atmosphere of ‘dominant masculinity’ (Connell 1999, Sagebiel and Hoeborn 2004 with reference to McLean et al. 1996, Sagebiel and Dahmen 2005).

2.1 European research on women and engineering

The ETAN report pointed out that in all EU member states women are under-represented in mathematics, computer science, engineering and architecture. Girls seem to prefer sciences linked to nature, human and social matters (Research Directorate-General 2000, p. 58).


The European project curriculum Women and Technology, CuWaT (1998) provided evidence that cross-disciplinary courses and significant elements of group work and project work are effective in retaining women in engineering.

2.2 Non-European research on women and engineering

US research has shown that one of the most powerful influences is a lack of self-confidence in their intellectual abilities, based on a low self-esteem due to female students’ minority status and their feelings of isolation. Men are less affected by poor teaching, poor organization of course material and by dull course content (Adelman 1998). Since women tend to evolve an interest in technology over time, the typical first year ‘killer’ exams may be counter-productive for retaining female students. Etzkowitz et al. (2000) found that

‘critical mass’ is meaningless when women are isolated and unknown to each other, when affiliation with other women is too stigmatising, or the female faculty model available reflects an archaic, male stereotype impossible to emulate or incorporate into a contemporary professional identity. (p. 245)

Australian research stresses the significance of women working with men and of gaining sympathetic men as partners for social change process in engineering education (McLean et al. 1996, Lewis and Copeland 1999).

3. Hypotheses

• First, recruitment measures and welcome events can demonstrate a positive image of engineering degree courses.
• Second interdisciplinary curricula combining engineering with some non-engineering subjects together with people-oriented teaching methods should attract more female students.
• Single sex learning possibilities should be proved, especially in Germany, where some single sex model projects exist in a few universities of applied sciences.
• Their awareness of and feelings about the minority situation of female students in engineering were determined and they were asked whether they met hostile attitudes from their male colleagues and/or from teachers.
• Faculty in departments of engineering education were asked about their awareness of and willingness to change.
• The enduring masculine image of engineering in society and in departments of engineering education was shown to be a possible barrier to female students.
• Possible conflicts between their identity as women and identity as female engineering student were found.
• The study atmosphere, social relations, masculine jokes and stories, could lead to feelings of isolation and marginalization or young female students could feel comfortable and integrated in the organizational culture.

4. Methodologies

Quantitative and qualitative methods have been used in WomEng in all the partner countries and for all work packages (Sagebiel 2006). 100 female and male engineering students in each country were compared with a group of 100 non-engineering students (science, social sciences, humanities and economics). In each country characteristic institutions of higher education were chosen for investigation (sampling). Several complementary qualitative methods were constructed in order to understand more complex and deeply institutional barriers for women engineering students. Faculty interviews with representatives of degree courses and expert interviews with members of steering committees and officials from equal opportunities offices were carried out. The perspectives/views of students came from individual interviews with persistent and drop out students and, especially, from separate focus groups with female and male students.

5. Results on masculinities

5.1 Self-advertising, recruitment and welcome events

Whereas special recruitment measures for women, like open door days, school visits by university teachers, communication campaigns for girls/women only, such as information events, summer universities, girls’ day, etc., are used in Germany, Austria and the UK, these measures are unknown in France and Slovakia, and may even be seen as illegitimate: ‘This should not be’ (Slovakia).

Welcoming events or activities are thought to be helpful in all countries by the students asked (in questionnaires and interviews). In comparison to their female fellow students, except the Scottish ones, men did not rate the importance of welcoming events as high as did women. First contacts with faculty members and fellow students are made on these offers, which form an important step in the integration of new students. For women it is a chance to meet other females and to build something like a social network to cope with the ‘special’ status they have as a minority in a male domain, even though special welcoming events for women only exist in Germany.
5.2 Interdisciplinary curricula with non-technical subjects and teaching methods

Austrian female students gave the highest percentage agreement on appreciating more interdisciplinary subjects, at 64.7%, followed by Greek women at 59%, in contrast to France, where the curricula obviously already included non-technical issues to a higher degree (see figure 1). Asked what kind of non-technical subjects students would like added to their current curriculum, languages, with over 50.0% agreement in all countries, was the most favoured subject, with soft skills coming second. In France especially 77.5% of women would like to be able to take these subjects, followed by Austrian (67.6%), German (57.4%) and Slovakian (55.3%) engineering students. In contrast to these results, female students in Finland, Greece and the UK did not appreciate soft skills. Instead they would prefer to have more technical subjects, which students in France, Germany and Austria would not appreciate. Looking for possible changes, most of the faculty think that interdisciplinary subjects could not be included because indispensable technical subjects would have to be cut.

In evaluating teaching methods all female students asked for more dialogue, more discussion and more projects, with fewer lectures, which are (with the exception of a French woman) not appreciated and are seen as ‘boring’ and without sufficient practical links. An interesting result from the questionnaires is the overall high agreement on all kinds of practical work, e.g. industrial placements, except for Austrian female students.

5.3 Single sex courses

The existence of and necessity for single sex degree courses or lessons was critically discussed in the European partner countries. For most of the interviewees single sex education has the bad ‘odour’ of needing special support or the imputation that females are unable to study engineering in company with men. The vehement aversion of female students in interviews and focus groups produces the conclusion that women do not want to have special status and are afraid to be marked off.

Opponents of single sex education, both faculty and students, think ‘that it is an artificial world’ and that women who want to study engineering must have self-confidence right from the start, otherwise they would not succeed. Without discussing the potential of single sex teaching, French faculty members totally disclaimed mono-education, seeing it as sexist and unnecessary. In Slovakia and Austria male faculty members especially rejected single sex teaching, whereas female faculty saw some positive potential in these models but feared a kind
of ‘positive discrimination’ (Slovakia). Women working together would be more uninhibited, could develop ideas more easily and deepen their knowledge without competing with men.

Members on the single sex degree course in Stralsund/Germany stated that ‘single sex teaching increases self-esteem and self-confidence’ of female students. At the same time the model shows that the traditional and sometimes old-fashioned culture of engineering degree courses, even in a mechanical engineering department, can be changed to a more woman friendly culture.

5.4 Experiences and feelings of a minority situation, attitudes and discrimination

Being a male domain, engineering studies are less attractive to women, most of all because young females fear being lonely among a vast majority of young men. The results of the WomEng project show that this is only true for students in countries in which female engineering students feel discriminated against. While in the UK, Austria and Slovakia female students feel lonelier, at the same time they described experiencing negative attitudes to them. In Slovakia and Austria they felt open discrimination, not being attractive to their colleagues, being seen as masculine women (Austria) and experiencing male remarks about their ‘female logic’ (Slovakia). Additionally, 38.8% of the Slovakian female students reported discriminatory remarks about women by professors or instructors. This was also applicable to 21.2% of Austrian and 20.0% of Scottish female students, where demeaning comments by teachers are not unknown. More open discrimination in Austria is shown by descriptions of sexist professors, of not being taken seriously, of often being taken as a secretary instead of an engineering student, of being excluded from men’s groups (described in a male focus group) and of being discriminated against by their boyfriends. As a reaction female students wanted more female fellow students’ (over 50%) and Austrian and Scottish female students would also prefer more female teachers/professors.

The opposite seems to be true for France and Germany. Females feel acceptance overall (and even appreciate their exotic status) and relate that, because of the open atmosphere with their male colleagues they do not feel any isolation. Elite students from a very prestigious technical university in Germany even liked the anonymity during the first cycle of their studies. Only a few students interpreted their high visibility and the attention paid to them in as a form of discrimination. At the same time they got more support and were pressed to work harder. Many of them were told: ‘It is fantastic, that you as a woman are an engineer’.

5.5 The male image of engineering and femininity (data from WomEng on femininity is covered in Genin and Pinault 2006)

The image of engineering in society is still a masculine one in the view of female students (Germany, France, Austria and Slovakia): machine-oriented, with less communication, rational but not creative, not positive, but combined with high earnings. In Austria attitudes towards engineering have changed from trusting to criticism.

Departments of engineering degree courses reflect this masculine image, especially in the view of female faculty. Results from website analyses of the departments investigated in all of the partner countries (except Slovakia) confirm this masculine image: highly text-oriented, with fewer pictures, these dominated by machines and technical equipment, and if people appear they are mostly male. Even though the atmosphere seems to be inviting, overall the needs and presence of women are neglected.

Female students see a conflict between the image engineering and the image of femininity, most of all in the eyes of other women (Germany, France). This conflict could discourage
other women from studying engineering (Germany, France and Austria). A similar result was found in the Athena project (Etzkowitz 2000, p. 58).

5.6 The perception of masculinity and coping strategies

Female students are conscious of their studying in a male domain (Germany, France, Austria and Slovakia) and they see their study content as male-dominated. But asked in the interviews about changes, they cannot tell about alternatives. In questionnaires female students from Austria and Greece, who felt more discriminated against (see above) than females from the other partner countries, would prefer more non-technical subjects in comparison with students from the other partner countries. It seems that the dichotomy between hard technology and assumed ‘soft’ nature of women (Austria) is more radical in the more traditional engineering education culture.

A special male-oriented culture, of language and humour, is present in all countries, and women adapt, behaving in the same way. Stupid jokes are common (Germany, France and Austria). As this is a crucial element of the masculine culture of engineering degree courses and departments, the question is how the way women adapt to this behaviour can be interpreted. In the questionnaire only 33.3% of Greek female engineering students assessed their study atmosphere as positive concerning ‘a healthy mixture of jokes and stories’. As an expression of the traditional culture, the jokes about gender-sensitive language by some Slovak faculties can be seen. In Austria, students and faculty related that stories and jokes changed in the presence of females.

In France and Slovakia (Hudec et al. 2004) interviews with non-engineering and drop out students brought out masculinities which female engineering students did not describe. So the apparent non-existence of discriminatory practises in France and Germany must be interpreted with caution.

The predominantly competitive and masculine climate of engineering degree courses is one deterrent factor putting women off taking up technical degree courses. Greek female students suffered most from a competitive atmosphere (50.0%), followed by the UK (38.0%) and Slovakian female students (25%), while it seems to be no problem in the other partner countries. To cope with this competitive male behaviour

- some women adopt the competitive imperative, and learn how to compete in male terms. Men are often not comfortable with this. It is their game, and there is no place in their prestige system for a woman who competes successfully with them. (Etzkowitz 2000, p. 55)

- Generally, female students are ‘playing with gender prejudices’ (Germany and France) or ‘making sex invisible’ (Austria).

5.7 Interpretation and theoretical reflections

Female engineering students seem to be very pragmatic and professionally oriented in their choices of interdisciplinary subjects, preferring languages and soft skills, but faculty seem to fear that with more interdisciplinary subjects the ‘pure’ and ‘hard’ techniques would lose importance. The integration of more practical work is valued differently in the different countries. Austrian female students, being aware of their minority situation and still suffering some discriminatory practices, don’t want more practical work. Mostly negative attitudes to single sex education show the still missing ‘normality’ of females on engineering degree courses in engineering departments and in society.

In Slovakia, Greece and to some extent in Austria the more traditional masculine engineering culture can still be seen as an existing explicit link between the social construction
of masculinities and engineering. Hints at a structural marginalization of female students in combination with feelings of isolation due to their minority situation were rarely expressed openly. However, this can indirectly be concluded in those countries in which the culture is biased by masculinities (Austria, Greece and Slovakia).

Women who are successful in their studies, especially in France and Germany, show self-confidence and are active in the engineering culture, with its jokes and stories. Apparently they don’t miss other women, not as fellow students nor as teaching role models.

Can feminist research and theory be disproved by these results or does the ‘softer’ appearing masculine culture in some of the countries investigated (e.g. France and Germany) produce an illusion of feeling integrated into the community? Are women rejecting engineering studies just for those who are qualified but who stand outside and refrain from entering a male domain and/or only for those who fail? Or can the presented self-confidence of female engineering students partly be interpreted as ‘social desirability’, as an adaptation to male norms of ‘toughness’? Or are doubts which do not fit with the self-image suppressed in order to create inner psychical balance? Future research should focus on these masculine connotative processes of adaptation on engineering degree courses.


6. Theoretical reflections on masculinity in organizational cultures of engineering education

Even though reality has changed in both engineering and gender, gender segregation and engineering and gender stereotypes still exist.

One frequent explanation for the small number of women in engineering was the female socialization process, which holds girls back from playing with tins and machines in early childhood, but less technical competence is not a reason seen in research on the subject.

The definition and construction of gender differences seem to be more promising, as during puberty girls are anxious to adapt to the female image and to not be excluded from their reference group. One characteristic of this period is to pretend not to like the natural sciences, mathematics and technology, as these fields seem to be male terrains. So girls learn to adapt to what they think is the prevalent female image and to avoid behaviours that deviate from these images.

Two central elements in fighting against gender and engineering stereotypes are interdisci- plinary subjects (Beraud 2003) and single sex education. Both can be interpreted as approaches to weaken gender segregation. As a quasi ‘paradox intervention’ (Kahlert and Mischau 2000, Jordanov 2002, Gransee 2003) single sex education of female students can hypothetically deconstruct gender differences. Instead of gender differences, differences between female students become visible. The positive significance of single sex educational environments on female students’ self-confidence could be high (Metz-Goeckel 1996).

Popular images of science and technology have strong connotations concerning the masculine sides of dualisms such as hard – soft, abstract – concrete, people-centred – technology-centred, mind – body, rationality – emotionality. ‘Sexual ideologies and stereotypes are diverse and fluid, but such opposites as ‘male/female’ and ‘reason/emotion’ are central to Western culture (Sagebiel 2005a, with reference to Wajcman 1991, 1996, p. 145) are extremely persistent and change only very slowly.
The feminist perspective on women’s studies and gender studies parallel the perspective of critical men’s studies’ (Connell 1999, Sagebiel 2003 with reference to Höyng and Puchert 1998). Bob Connell saw so-called ‘hegemonic masculinity’ as central. The bond between hegemonic masculinity and engineering lies in the social construction of engineering as a masculine issue in the female–male polarization. Elements of this dominant masculinity (Connell 1999) are a male culture of stories, jokes, leisure sports and similar informal strategies, all constructed explicitly or implicitly to exclude women, consciously or and unconsciously (Faulkner 2000, Sagebiel 2003 with reference to McLean et al. 1996).

Though exclusion of women by gender segregation can be interpreted at the macro-societal level, feelings of being excluded could be a source of deeper insecurity feelings, with a negative influence on self-confidence. The feelings of technical incompetence arising during puberty or/and from a narrow definition of technique reduces their self-confidence (Erb 1996, Sagebiel 2003 with reference to Wajcman 1996).

7. Conclusions

The issue of masculinities in engineering produces several dilemmas. First, everywhere being rooted in societal traditions and having grown historically, it will take a long time to overcome these organizational cultures. Second, in looking at masculinities one has to define gender differences and these are in danger of reifying enduring processes of doing gender. On the other hand avoiding looking at gender differences will not skip still existing masculinities and discriminating practices in the field.

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