
Attracting Women into Engineering through Regional Technology Programmes¹

Christine Wächter

Abstract

Women appear to play only a minor part in technology design and technology politics. It is not women's deficits that drive them away from engineering, however, but grown, patriarchally shaped structures and preconditions of teaching and working climate, content and context in technology fields. Higher education institutions and companies are thus faced with the challenge of adapting their environment and content of training and working to meet women's needs. In order to develop a wide set of measures for a Women-into-Engineering (WIE) Programme, a one-year research project was carried out in 1999 in Villach, Austria. The aim was to integrate and motivate key actors in the main training and education institutions as well as in companies from the very beginning. One outcome of the WIE Programme in Villach is a manual with over 70 suggestions for further activities to encourage girls to enter technical fields.

Introduction

Our understanding of technology is in many cases still dominated by an outdated view of engineering as the work of the 'engineer-inventor'. Technology according to that old-fashioned paradigm is big, powerful, complicated, opaque,—even if the globally dominant computer technology proves the opposite: that it is loud and dirty. Much could be said about the exclusion of women from science and engineering. Recorded history reveals: technological developments, scientific explorations and their applications have been pursued in the most part by men. As in other areas that are also marked by arbitrary, historically grown hierarchies and power structures, women appear to play only a minor part in technology design and technology politics.

Women make up more than half of all Austrian students. In engineering subjects, however, they hardly reach 19%. In chemical engineering

and in architecture, women constitute 30 to 40% of the students, but in traditionally 'hard' engineering subjects like mechanical or electrical engineering, they account for only 5 to 6%. The numbers of female first year students in engineering in general are slowly increasing (for example at Graz Technical University: 1990/91: 19%, 2000/01: 27%). But these numbers must be put into perspective when it comes to considering the higher drop out rate among women engineering students. At Austrian Technical Colleges,² 10% of the students are young women. Seven percent of female but 40% of male Austrian high-school graduates are graduates from these Technical Colleges. Sixty percent of the male Technical College graduates take up engineering studies. Eight out of the ten most often chosen apprenticeships among young men are in the field of engineering, among the girls not a single one.

Women are hardly ever visible as actors in engineering contexts. At the same time the 'realities' of women are not taken into consideration in technology design and development. Different social, cultural, biological experiences, needs and demands of women, their various interests, their knowledge and skills, their differing values are not held to be of value in a technological civilisation that is formed and dominated by basic male-centred knowledge.

Over the past 25 years multiple initiatives and programmes have been set up to change and improve this unsatisfactory situation. The common aim was to bring the minority status of women in science and engineering to an end. In this context, special emphasis must be placed on integrating regional actors, especially institutions of education and training (such as private companies, technical colleges, universities of applied sciences, technical universities), as well as women's consulting and training programmes and organisations. It is important to realise that it is not women's deficits that drive them away from engineering but grown, patriarchally shaped structures and preconditions of teaching and working climate, content and context in technology fields. Higher education institutions and companies are thus faced with the challenge of adapting their environment and content of training and working to meet women's needs. Companies have to play an active part and must signal to the women that they are willing to employ qualified women engineers.

The Women-into-Engineering Programme Villach

Methodological background of the study

The City of Villach in Austria has launched a Micro Electronic Cluster Programme to help it develop a unique market position. Among other activities to promote scientific excellence a centre of competence has been installed. The deputy mayor, being not only in charge of economic affairs but of women's affairs as well, wanted to make sure that special emphasis was put on the integration of women right from the start of the Cluster Programme. Otherwise, she feared, women might once again miss the opportunity to get on board and actively participate in the technological shaping of our future.

In order to develop a wide set of measures for a WIE Programme, a one-year research project was carried out in 1999 (Wächter 1999a). The aim of this research project was to integrate and motivate key actors in the main training and education institutions as well as in the 'cluster firms' from the very beginning. In addition to two workshops 50 qualitative interviews were made at the following institutions:

- At the *College of Technology—Electronic data processing and organisation*: nine teachers of science and humanities (5♂, 4♀), the director, the head of the electronic data processing and organisation branch and 15 girls from various classes (age 14 to 18). In addition, two teachers asked three of their classes (boys and girls age 14 to 16) to write essays on 'Being a girl in a technical school'. Of a total of 70 papers, 15 were written by young women. Thus, this method made it possible to get an idea of the views of 55 male students as well, that otherwise would not have been captured.
- At the *Carinthia Tech Institute—School of Electronics*: two professors of mathematics (♂) and law (♀), the head of the School of Electronics and five female students.
- In three companies of the *Micro Electronic Cluster*: four Human Resources managers (3♂, 1♀) and twelve women engineers.

One outcome of the WIE Programme in Villach is a manual with over 70 suggestions for further activities to encourage girls to enter technical

fields. The main focus here lies on qualitative aspects of improving the learning and working environment and culture (Wächter 1999b).

Women students at a Technical College

All interviewees said they would welcome an increase of women students. Teachers would appreciate a more pleasant class climate (cleaner class rooms, less noise and disturbances). The studying motivation for boys was higher, they said, and it was more enjoyable and relaxed to teach in mixed classes. If boys learnt to deal with women as competent colleagues right from the beginning, professional women in their future employment would be something natural and normal.

Mixed classes not only have advantages for male students and for teachers, girls would profit too. They would no longer have to suffer nightmares in their vacations before school started, fearing to be the only woman in an all-boys class. From the perspective of the women students, however, there should not be too many girls in the class. Otherwise, they fear they might lose contact with the boys. Many of them have deliberately chosen a non-typical environment, thus trying to get away from a 'girlie' culture or atmosphere. Choosing a male institution for them has the advantage of getting away from typically feminine social environments, including gender-specific conflict management, which annoyed them in the female-dominated schools they came from.

The women students would welcome an exchange of experience with girls from the other classes. Younger ones could profit from the support of older ones and thus find it easier to cope with everyday barriers and challenges. Some women would like to add a more friendly touch to the school atmosphere by painting the walls in more friendly colours or by putting more plants in the classrooms and hallways. An infrastructure deficiency causes major trouble: There are far too few wash rooms for women. *'You can really tell from the number of ladies' washrooms that this school initially was built for boys only'*, was a statement made more than once by the interviewed women students.

Several girls talked about discriminatory teachers. They feel either explicitly or inexplicitly that they are not treated equally. Boys and girls are treated differently, was a frequent statement in the interviews and

essays. Some (male only) workshop teachers particularly discriminate against female students, for example by underestimating their capabilities. Some of the teachers allege that girls only enter this school type to find a future husband. The boys mention discriminatory practices in their essays too. In some cases discrimination is, be it consciously or unconsciously, disguised in advantageous treatment of the female students. For example, a teacher who gives a better grade to a girl because she is a girl may imply that women do not have the same intellectual capacities as men. Coping with an unfriendly environment might be easier if the number of women increased. The climate itself might change as well. The support of the director is another important factor to create a women-friendly study environment.

Many boys are not aware of the fact that their insensitive, rude behaviour and language offend, insult and hurt their female colleagues. Those boys that dislike macho behaviour have a weak position in the class and are mostly outsiders themselves (Stadler 1997, 51; BMUK 1999, 7). Being rude seems to be part of a universal pattern of male socialisation that aims at converting boys into 'tough guys' so that they fit into the 'dominant masculinity' (Connell 1995). To achieve positive changes in traditionally male learning environments, it is necessary not only to increase the assertiveness of the girls but at the same time to work on consciousness raising with the boys (Dundler & Himmelbauer 1998).

To paraphrase the girls, they were especially annoyed by the noise and by the low level of hygienic standards and tidiness of some of their male colleagues. The girls reported cases of aggressive behaviour such as food fights, misuse of school property, spreading waste all over the classroom. In their opinion the domineering boys deliberately acted in this manner towards the girls to provoke them, because of the perception that girls are an easier target. Conversely, they would not treat other males as such for fear that they would be confronted with resolute counter-reaction, or more simply: bullying girls means less fear of retaliation.

In addition to technical training, the female students also learn how to survive and succeed in a hostile environment. After a first phase of irritation and orientation they start fighting back and develop a variety of

strategies and tactics. Some become hardened. Some adapt to the situation and try not to lay themselves open to attack or provocation. Others practise active ignoring. Some try to react quick-wittedly. Or they react to the provocation in an unexpected way, thus hoping to put the aggressor's nose out of joint. All the women agreed that they need additional energy and power to cope not only with the contents of training but also with the climate in the institution. In a mono-educational learning environment these energies could be focussed more productively on studying.

Women students at the University of Applied Sciences

Most of the female students interviewed have not entered this University of Applied Sciences (UAS) directly after their high school diploma like their male colleagues but have made detours via office jobs or stays abroad. This extra time and additional experience seems to make it easier for them to pursue their favourite training and enter 'a man's world'. Their various post-school occupations have broadened their horizons and have added an extra amount of self-confidence that facilitates a more relaxed and self-assertive relationship with their male colleagues, who, coming directly from high school were younger, less experienced and still at the height of their adolescence.

The majority of female students (six out of a total of seven) have no technical background whatsoever, whereas most of the male students come from technical colleges. This brings about problems especially for the young women but also for the lecturers. All interviewees emphasised that handicaps mainly in the first year are not grounded in the sex of the students but in the different school types that provide more or less basic technical knowledge. In the future, this lack of technical and practical experience will be compensated for through means of additional voluntary courses in programming for beginners. Certainly consciousness raising programmes and training in non-sexist teaching for the teaching staff would, furthermore, contribute to creating a supportive work and study environment for female students.

The head of the School of Electronics favours a stronger heterogeneity of students. He wishes to address especially logically gifted and mathematically interested girls from women dominated school types, e. g. domestic

science colleges, in order to attract more students from non-technical schools. One engineer from a big company appreciates this intention since he has had good experience in working with young women interns from that school type. He regrets that most of these girls do not consider a career in science and engineering. In his opinion, one should focus more strongly on this group of talented young women, thus trying to win them as qualified employees.

The female students in the electronics course were a little tired of the fuss that had been made about them lately. They do not like being in the limelight but want to simply pursue their studies like their male colleagues. They also do not want to be put on a pedestal or get special treatment just because they are female but expect to be treated as equals. As long as they are so few, this dilemma will not be solved. They suggested that female students should visit school types they themselves had attended and thus encourage girls to get interested in technology related jobs. Furthermore, the female students would welcome possibilities to get in contact with women engineers.

The students criticised the strong orientation to computer programming. This increases the amount of studying time required dramatically, especially for those students with less technical backgrounds. Some even considered signing up for computer classes offered by adult education organisations during their summer vacations. They argued that they had chosen to study electronics and not computer programming. They would appreciate a higher degree of creativity and self-determined working and learning in projects. In addition, they would approve of a stronger emphasis on the environmental aspects of technologies. The head of the School of Electronics is working on an improved curriculum with a higher degree of project oriented courses. According to his plan, a project should be elaborated each year considering aspects and solutions of various disciplines. Thus, by encouraging inter-disciplinary and teamwork the students would also gain experience and knowledge in project management as well as social and communicative skills.

When asked about the necessary prerequisites for women to study engineering, the students interviewed mentioned an interest in mathematics, taking pleasure in solving technical problems, diligence, industry,

perseverance, and stamina. In their opinion, the public should be made aware of the fact that apart from the above-mentioned features no special prerequisites are necessary. A degree in engineering from a UAS can also be obtained by students without a technical school background as well as by latecomers. A female professor interviewed at the UAS stated that in her view the female students are more determined to pursue their technical education. They participate and co-operate to a higher degree than their male colleagues. This observation was confirmed by an Australian investigation by McLean et al. (1996, 37) who also concluded that the girls were much more serious about their studies than the boys.

Women engineers in high-tech companies

A frequent message from business was, 'We would employ women but they don't apply for vacancies'. All interview partners from management and human resources confirmed their willingness to employ women in non-traditional professions. They were, however, uncertain about the best measures to adopt to make the companies' work climates agreeable and pleasant to women.

Women in non-traditional professions are confronted with a variety of barriers. This is true for engineers, scientists and technical professionals in a broader sense. After having successfully negotiated the cliffs of technical training and education they are confronted with heavy storms on the sea of the job market. The interview partners no longer used the pseudo-argument 'A woman could become pregnant'. The so-called 'clonal effect' (Josefowitz 1983) and the 'pressure to reproduce homo-social and homo-sexual structures of management' (Kanter 1977), however, are still prevalent in company hiring practices. Decisions in favour of a woman will only be made for a very good reason, such as a noticeably better performance, since there are enough average men available. Whoever chooses a woman must justify her or his decision to do so even more profoundly. Female human resources managers are in the same, if not a more stressful situation as their male colleagues. They may react even more severely since they are observed more closely and because of their sex must face a higher pressure to legitimise their decisions.

Several interview partners referred to their concerns of not finding a job after graduation. Companies must take on the active role and make a clear statement that they are ready and willing to hire technically qualified women. Furthermore, they should include women engineers into their presentation staff at congresses, recruitment fairs, etc., so that young women (and their teachers and parents) can get in contact with them.

The statements of the women engineers interviewed confirmed the findings in previous studies (Collmer 1997; Janshen, Rudolph et al. 1987). They described their professional lives in science and engineering as a succession of hurdles. They felt trapped in a 'beginners forever' status where they must prove their competence anew each day and also that 'being female' and 'being technically competent' is compatible. While male engineers are perceived as competent from the start, women do not get such confidence in advance. Even highly qualified women engineers felt they must work harder than their male colleagues to get the same recognition and appreciation. This was confirmed by several interview partners. The appearance of women in traditionally male dominated areas leads to irritation among men since they have not acquired ways of interacting with and relating to them. Their register encompasses mother, sister, girl friend, and buddy. But how should they treat a female colleague in engineering,—as a woman or as a colleague? (Janshen, Rudolph et al. 1987, 230) Engineers with the same degree on the same hierarchy level in particular have big difficulties, as Janitha Molvaer and Kira Stein (1994, 44 f.) have shown. To co-operate with women means a potential loss of prestige because in the eyes of the others a man's performance is devalued by the success of a woman. The 'feminisation of professions' has been observed in several fields, such as clerical or educational work. When women enter a job field the male myth of the speciality and difficulty vanishes, which results in a decline of prestige and income.

Probably every woman has had the experience that statements coming from men are valued more highly. This communicative asymmetry was confirmed in the interviews as well. In addition, to gain acceptance or to prevail, women not only need rhetorical skills, they also should have the appropriate voice prerequisites such as volume and endurance, as the report of one engineer illustrates: *To assert yourself can become quite a problem*

when it comes to basic biology. You must be loud to be heard. Sooner or later the civilised culture of meetings comes to an end and then you must raise your voice. Men are louder by nature. And I sometimes really suffer from a sore throat after such an occasion. Pitch, vocal range and rhetoric can be trained individually but the communicative interaction across cultures (be they geographical, ethnic or gendered ones) needs consciousness raising and practice of all parties involved. Women will otherwise end up adapting to the male culture of engineering only and not bringing out their full potential.

The economic profit of mixed teams is meanwhile unquestioned in organisational development. The human resources managers interviewed agreed that women improve the social climate within the teams as well as with regard to customer contact. They contribute a broader and more holistic view and integrate isolated singular problems in a wider context.

Various women engineers stated that one reason why they chose to go into this non-traditional field was their rejection of the traditional female gender role. But even women engineers cannot escape the socially attributed expectations put forward towards women in a hierarchic, gender-segregated society (Harding 1986). They must combine professional duties and chores of the reproductive sphere like all other working women as well, a mechanism Regina Becker-Schmidt (2000, 57) calls 'doppelte Vergesellschaftung'. It comes as no surprise that the problem of how to combine job and private life was a topic for the female students and engineers interviewed in this project as well. Most of them think of having a family in the future but at the same time do not want to stop their career. They have gone through a long and intense training and education process and do not want to end up as 'highly qualified mothers and housekeepers'. There is no doubt about the fact that flexible working hours make life easier for both women and men who have children. But to combine career and family life, women—and men—also need appropriate child care facilities and a partner who shares the responsibilities and the work involved in both child care and household chores. In Austrian companies there still is a high demand for regulations and programmes that go beyond individually negotiated agreements. Especially the phase of re-entry after parental leave is of crucial importance here, since to stay away from the job for too long would have negative effects

on progression and career options. In this case again, measures should not only focus on women but on men as well since '*father*-friendly companies' would really make a difference.

Conclusions and recommendations

The WIE Programme Villach was situated in a supportive general set-up given the fact that the deputy mayor of the city was in charge of both economic and women's affairs in the municipal government. The real problem, however, turned out to be gaining a strong commitment of the local companies. A broad support is indispensable for the success of such an ambitious project. Equally important is continuous co-operation and involvement of representatives of the various institutions participating in the extended project team.

The results of the WIE Programme research project for the Austrian municipality of Villach and its Micro Electronic Cluster have proved that both universities and educational institutions as well as firms are interested in recruiting more women. Special emphasis in this process should be placed on a close co-operation between institutions of training and education and companies, integrating both female and male key actors and decision makers. Activities within the organisations should aim at strengthening the position and at increasing the number of women at all levels.

Various studies have shown that what drives women away from technology are not women's deficits in abstract thinking but the content and climate prevalent in technical institutions, this field of 'dominant masculinity'. Therefore, universities and other training institutions are called upon to contribute to this process by improving curricula, thus making both the climate and content of teaching appropriate to attract and satisfy men and women. Changes must cover curriculum reforms as well as further developments on methodological and didactic levels. The social embeddedness of technology, its roles, consequences, frameworks, or alternatives must become part of the general training in schools and universities. Examples must be taken from the everyday life experiences of both sexes, thus integrating young women's knowledge, skills, and reference frames as well.

A stronger emphasis should be placed throughout technical education, on the social and environmental aspects of technologies. This could be done, e. g., by providing inter-disciplinary courses which examine the use and impact of technology on societies, including gender and culture and differences in experience. This analysis should furthermore be implemented in core engineering subjects, thus offering students inter-disciplinary subjects that critique gender and technology. Engineering departments can work with humanities, social sciences and women's studies, encouraging students to cross their disciplines' borders and work co-operatively together. This will not necessarily require new courses to be established, but existing courses and materials could be scrutinised and evaluated to make supplements that integrate these topics into regular courses. These curricular changes would lead to an overall improvement in engineering education so that not only women but students in general, and so-called 'non-typical males' in particular, would profit from this development.

The WIE Programme Villach has shown that much more information must be disseminated among young women about careers in non-traditional fields such as engineering. Networking and mentoring programmes are important ways to bring women in technical fields in contact not only with each other but also with interested young women. In contrast with young men, young women seldom know female engineers in their surroundings. Role models, however, are an important source of information, motivation, affirmation, and support. They must be made aware of the fact that jobs in engineering offer challenging, fascinating, and interesting perspectives and that there is no need to worry about being 'the only woman' in a male environment. There also is a need for further education for teachers and trainers in kinder gardens, schools and in adult education. Parents, students, employers, media professionals of both sexes must be sensitised likewise, to contribute to equal opportunities.

In summary it must be pointed out that the fact that engineering still is a male dominated field is not the fault of women. Consciousness raising programmes may increase girls' interest and motivation to pursue careers in science or engineering and can make their 'getting in' less difficult. A quantitative feminisation through increasing the number of women in

science and engineering is an important step but not the only one necessary to increase female participation in technology design and development. Apart from the above mentioned change in teaching contents and contexts, a stronger focus must be placed on how career paths, working lives and job profiles are presented and that these appeal to both sexes as well as to target groups that do not correspond to 'traditional male standard biographies'. This is a factor that could support the 'staying on' of women in minority positions. To ensure a qualitative, vertical feminisation, it is necessary to foster the 'getting on' of competent women in greater numbers at all hierarchy levels in companies and universities likewise (Glover 2000). In addition to implementing gender-sensitive recruitment policies, their outcomes must be scrutinised and evaluated. Governmental affirmative action programmes in the USA and the UK have proved successful by means of coupling equal opportunity policies with government contracts or public funding. Annual reports on employment equity and their outcomes should be established as standard procedure like environmental reports. This would also contribute to more comprehensive, gender-specific company data, something that has not been available up to now, and this not only in Austria.

Notes

- ¹ Paper presented on June 24th 2002 at the Work-in-Progress-Workshop of the Institute for Advanced Studies on Science, Technology and Society, Graz.
- ² HTL = Höhere Technische Lehranstalten, students aged 14 to 19 study for five years at this kind of a high-school. With the school leaving exam they are entitled to enter higher education at university level.

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