

Gender and Disciplinary Cultures: Comparing Mechanical Engineering and Materials Science

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Abstract

Engineering disciplines are still predominantly male areas of education and work; however, there are also notable differences in female representation between different areas of engineering. By comparing the rather classic field of mechanical engineering with the relatively new field of materials science, this paper pays attention to a small, but productive contrast between different engineering cultures in academia.

The contribution is part of a research project addressing the following questions: To what extent are social and epistemic practices and identities in engineering disciplines gendered and / or gendering? How do different disciplinary contexts influence the gendering of practices and identities?

Drawing on ethnographic fieldwork carried out in two departments of a technical university in Switzerland, this paper deals with the group as a relevant social unit in engineering sciences. The first section focuses on the common elements in the group cultures of both disciplines. Some striking differences between the two groups are highlighted in the second section, using field vignettes of daily group practices. These differences are discussed in the last section, drawing on Bourdieu's theory of the scientific field and asking how cultural characteristics are related to the structural position of each discipline in the field. In conclusion, the implications of these findings from a gender perspective are addressed.

Introduction

Engineering disciplines have been strongly tied to forms of *hegemonic masculinity* (Connell 1987) since their institutionalization as fields of higher education in the 19th century. The number of women in these fields started to grow substantially only after World War II, although the situation varies along national and disciplinary lines. Moreover, efforts made in the past few years to attract more women to these traditionally

male areas have proved to be relatively unsuccessful. This raises the question of the reasons for the persisting masculine dominance in specific areas of engineering.

Until recently, female underrepresentation in engineering has mainly been addressed in terms of the position of women in traditionally male fields and from the perspective of the best practices to support women in male dominated environments. In the last few years however, a new line of research has developed in Science and Technology Studies, shifting the focus to the construction of masculinity and emphasizing the mutual shaping of technology and gender (Faulkner 2000; Henwood 1998; 2000; Lohan & Faulkner 2004; Paulitz 2007). While programmes designed to encourage women to enter traditionally male fields continue to address the problem in terms of gender specific socialization, this new perspective focuses on the practices and cultures of engineering itself and raises the following issue: How are social and cultural practices, images and identities in a particular field linked to specific aspects of masculinity, thus contributing to the reproduction of gender segregation in the field?

Following this line of thought, the present paper deals with the culture of engineering in the context of academic institutions, with particular reference to the Swiss case. It is part of a larger research project addressing the following questions: To what extent are social and epistemic practices and identities in engineering disciplines gendered and / or gendering? And how do different disciplinary contexts influence the gendering of practices and identities?¹

In Switzerland, like in other Western countries, engineering is still a predominantly male area of education and work. In the last decades, however, the number of women studying engineering has continually increased, although it still varies notably between different areas of the field. Some disciplines continue to resist feminization, namely electrical engineering and mechanical engineering, with less than 10% of female students in Switzerland. In contrast, other disciplines have experienced a quick increase in female representation in the last 15 years and show a proportion of over 30% of women; this is the case in environmental engineering and materials science. How do these differences between engineering disciplines come about? By comparing the rather classic

field of mechanical engineering with the relatively new field of materials science, I concentrate on a small, but hopefully productive, contrast between different engineering cultures in academia.

My research draws on ethnographic fieldwork carried out at two departments of a technical university.² In this paper, particular emphasis is given to the importance of the group as a social unit in the engineering departments and its influence in shaping social life. I start by describing the common elements of group organization in both disciplines (first section) and then go on to highlight some of the striking differences between mechanical engineering and materials science, focusing on their social and cultural practices (second section). In the final section, I suggest some theoretical lines which might explain these differences and address the question of gendering in these findings.

The group as a social unit

In academic engineering as well as in the natural sciences, institutions are subdivided into research units often called laboratories. These institutional units include one or more groups, each of them headed by a professor. The group represents the relevant institutional entity for the organization of research as a professional activity (Whitley 1982). This type of organization differs to some extent from the organization of scientific work in the humanities and social sciences and, therefore, I start by describing some basic features of group organization that hold true for both disciplinary contexts.

The self presentation as a group

For a visitor in the buildings of an engineering department, unfamiliar as I was with the localities and trying to orient myself, the group as a unit is evident at first sight. In the corridors of the department, each group presents itself on a poster. On this poster, each member of the group is usually depicted by a photograph, including his or her name, status and room number. The head of group, the professor, figures on the upper left

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side of the poster, followed by the senior scientists, the administrative and technical staff, the postdocs and, finally, the PhD students. Besides the obvious practical function of providing information for visitors, these posters give us a first glance on some relevant categories in the field of observation.

- (1) Symbolically, the group is presented as a *unit*, the poster shows us who belongs to a particular group and who does not.
- (2) The distribution of individuals on the poster directly reflects status differences and the internal *hierarchy* of the group.

Thus, the self-presentation of the group is characterized by a tension between *equality* on the one hand—each member of the group being represented on the same terms—and *hierarchy* on the other hand—the ranking of the group members according to their status in the scientific field being emphasized.

The group as a research unit

The core function of the group is its role as a research unit. Following a sociology of science approach, scientific research is to be considered as work like any other form of work. Thus, one of the purposes of my field investigation was to find out how research activities are organized in the groups I observed. The following points emerged to be typical of the organization of research activities in engineering and the natural sciences as opposed to the humanities and the social sciences.

Research agenda

The topics investigated in a particular research unit are defined by the agenda of the head of the group. In other words, research projects are outlined by the professor or his / her senior scientists. Then, an appropriate candidate is selected to fill in the position as a PhD student. In contrast to the social sciences and humanities, engineering is therefore characterized by a top-down approach to research.

Employment

In engineering, to do research is considered a professional activity and doctoral students are treated as trainees. Hence, they are always employed by the department, usually on the basis of a three-year contract, and they are normally expected to complete their dissertation in this time span. The process of qualification for research in engineering is thus professionalized to a higher degree than in the social sciences.

Supervision

The work of the PhD students is closely supervised by a postdoc, a senior scientist, or even directly by the head of the group. Meetings take place on a weekly basis with the direct supervisor to discuss ongoing problems and ensure work progress. In the case of a larger group, the professor meets with each PhD student and his / her direct supervisor every few weeks. The support of the trainees and the steering of their research by the supervisor is much closer than in the humanities.

Specialization

The topics treated by doctoral students in engineering research are highly specialized; they are closely linked to the work of their direct supervisor and to the findings of previous doctoral students in the group. Conforming to the same division of labour, PhD students define small problems from their own research and supervise the work of graduate students, hence participating in the top-down training process.

From this brief outline of work organization in an engineering research group, two aspects seem particularly worth stressing:

- (1) Research organization in engineering is characterized by specialization and a *hierarchical division of labour*; accordingly it reproduces, or rather, it pre-produces one of the key structural features of the labour market.
- (2) The initiation to the standards of scientific work—the transmission of implicit knowledge—occurs in a *one-to-one relationship* to a person of the next higher status position in terms of hierarchy in the scientific field.

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The social life of the group

Having briefly examined the way the group presents itself as a social unit to the outside world and having sketched out some features of the internal organization of the group with respect to its main activity, namely research, I will now address the informal part of the social activities of the group, its social life.

The units observed, both in mechanical engineering and in materials science, practiced what I call a *strong form of group life*. This means that, besides regular scientific group meetings, a range of informal activities took place in the group, including the following:

- daily routines such as meeting for lunch or for coffee;
- special all-group events like the summer party or the Christmas party;
- a yearly group seminar (a weekend or even a week) that takes place in an outside location (for example in the mountains);
- informal meetings and leisure activities among some members of the group, especially those from abroad;
- sports activities, often performed as a team competing with other group teams, for example in a football cup organized by the department.

In the course of my field work, I directly participated in some of these activities as an ethnographer, such as having lunch with people or attending a party. Other events, such as sports or the yearly group seminar, were reported to me in the interviews. Now, a closer examination of the ethnographical field data reveals that, besides their common characteristics, relevant differences emerge between group cultures in mechanical engineering and in materials science. These differences in disciplinary culture are elaborated in the next section.

Group life: mechanical engineering versus materials science

In this second section, I will argue that characteristic features of group culture in mechanical engineering can be systematically contrasted with those in materials science. To illustrate this point, I will use a field vignette of the daily routines in both groups. First, the routine of lunch in the group of mechanical engineering is described; this picture is then compared with the practices in the group of materials science before elaborating on the most salient contrasts.

Group life in mechanical engineering

The group I observed at the department of mechanical engineering uses German as its language of communication, even though there are several doctoral students from abroad. In this group, lunch takes place every day at 11.20 in the canteen of the technical university. Lunch is scheduled early in order to avoid the crowd of students coming in at 12 o'clock. Doctoral students as well as postdocs and senior scientists gather for lunch, even one of the professors joins the group.

The first time I went to lunch, I had an appointment with one of the PhD students in the morning in order to get information about his research. At ten past eleven, he told me that people would go to lunch now and that we should get ready soon. And so we went to the canteen, which is in the main building. People of this group always sit at the same two tables in the canteen. When we arrived, six young men were already seated and eating their meals; they seemed to eat very quickly. As I was much slower, people waited until I finished my meal; having eaten half of my plate, I felt that this was enough and said that we could get up and go.

After lunch, one part of the group usually goes to the snack bar for coffee, while the other goes back to the institute for coffee. On the way back, my informant, who came from Italy, told me that when he first arrived, he also ate very slowly. In Italy, he explained to me, people take their time to eat their meal and they drink their espresso very quickly; here, he said, it's just the other way round. But he had rapidly adapted to the culture of the group, as he felt uncomfortable when people were waiting for him.

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What can we learn about the culture of the group from this vignette? Obviously, the practices associated with lunch in this group are defined to a large extent: time and location of the meal are precisely fixed. As a newcomer, this was the first thing that surprised me. Of course, this rule allows people to join in on a regular basis without having to confer with each other before going to lunch, but on the other hand, this leaves not much space for flexibility. Moreover, the terms of this informal meeting seem to have quite a dominant impact on the schedule of group members. In the case described above, the ongoing activity (of the interview) was interrupted in order to join colleagues for lunch. The second aspect that struck me goes beyond the formal setting of lunch, it refers to the very practice of eating. It was performed in a speedy, somewhat hurried way, as if people were eager to get it done quickly. Even though people were friendly, I could feel the pressure to adapt to the group's tacit rules. The exposure to the rhythm of activity at lunch disclosed the extent to which the group culture has to be individually incorporated. Finally, my experience as an outsider was confirmed by the PhD student coming from another cultural background. He, too, had experienced a conflict between his own habitual practice and the practice of the group and he was aware of the fact that he had adapted to the group culture.

To summarize this brief discussion, the following points can be emphasized:

- the lunch practices of the group are formalized to a certain degree;
- the group culture has to be incorporated by the members of the group;
- in this process, individual cultures get subordinated to group culture.

Group life in materials science

Let me contrast this account with a second vignette, drawing from my experience at the department of materials science and focusing again on the daily habits associated with lunch.

The materials science group uses English as its language of communication. To begin with, it was more difficult for me to join people for lunch in this

group. When I had an appointment with someone in the morning at 10 o'clock, the interview usually lasted for two hours and by the time I asked whether I could accompany my informant to lunch, we had missed the lunch time of the group. Furthermore, my informant quite often had a private appointment or sports practice.

In this group, too, people go for lunch before 11.30 and they do so for the same reason, namely to avoid the crowding by students at 12 o'clock, but the attendance of people seems to fluctuate more. Moreover, there is one favourite canteen, but it is not unusual for smaller groups to go to another canteen. The signal to go usually comes from one of the offices shared by a dozen doctoral students. Due to the size of the group, people form into subgroups of peers, hence postdocs, who share office space, usually go on their own.

When I was watching practical training in the laboratory, I managed to join a group of PhD students for lunch. We went to one of the canteens on the campus. People dispersed to queue for their preferred meal and then sat down at a free table. There, they waited until everybody had joined the table before they started to eat. During lunch, a lively conversation developed; people were talking in English, but quite a few were also trying to speak in each other's language, an American PhD student practicing his German, a Swiss one practicing Italian or explaining a German idiom to a colleague from abroad.

Again, what are the features of group culture displayed in this vignette? In contrast to the lunch culture observed in the mechanical engineering group, the practices in the materials science group are obviously less formalized; moreover, there is more individual flexibility in attending lunch. On the one hand, the ad hoc character of meeting for lunch made it more difficult for me as an outsider to join in; on the other hand, socializing with the members of the group turned out to be more relaxed, once I had succeeded in joining them. Actually, those who go for lunch together form an ad hoc group, which has temporarily a binding character. Thus, in contrast to the practices in the mechanical engineering group, to have lunch together formed a sequence with a common beginning and end. Finally, the specific cultural background of single members was positively recognized in the social space of the group. People referred to each other's culture in a playful way and clearly enjoyed the plurality of cultures present in the

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group. Cultural differences were not only acknowledged, people also demonstrated their readiness to bridge cultural boundaries.

To summarize this second vignette, the following points can be emphasized:

- lunch practices are quite informal and give people individual flexibility;
- ad hoc groups for lunch are considered socially binding;
- group culture is open to the diversity of individual cultures.

Contrasting group cultures

Typically, to develop a strong group life is part of the disciplinary cultures in science and engineering. In the context of the interview, the heads of the materials science and mechanical engineering groups both stressed the importance of a friendly group atmosphere to prevent competition among group members. Thus, in order to strengthen the group as a research unit in the struggle for reputation in the scientific field, the unity of the group has to be emphasized and norms of social behaviour have to be established and practiced. This occurs in the formal and informal settings of daily group life. Nevertheless, the groups in mechanical engineering and materials science differ in the type of tacit rules and norms established in their social life.

Drawing from the short descriptions of my field experience at lunch, group cultures in the two disciplines can be contrasted along the following lines:

- Formality – informality (in relation to time and location),
- Discipline – flexibility (in relation to individual—particularly bodily—needs),
- Uniformity – diversity (in relation to individual culture).

The disciplinary culture in mechanical engineering emphasizes formality, even with respect to informal daily practices. Furthermore, it encourages the subordination of individual needs to group discipline, thereby shaping

bodily practices. This is associated with the promotion of uniformity over diversity of cultures. The tradition of this type of culture can historically be traced back to the male worlds of military institutions, as has been shown by several authors (Berner 1997; Marry 2004; Zachmann 2004). On the other hand, the disciplinary culture in materials science turns out to be more informal. It allows for more individual flexibility in daily group life, with regard to participation as well as to actual practices. Nevertheless, a tacit commitment to group norms is enacted, thereby strengthening social ties among group members and stimulating diversity within the group. This type of culture could be associated with the *clan*, a form of organization characterized by the interconnection of social norms and economic principles (Weber 1998). In both disciplines, informal social life is thus regulated to a certain extent, but the practices clearly differ in the specific form of governance at work in each field.

In this section, daily lunch practices have been used as an exemplary site for contrasting group cultures. I have done so in order to generate codes and theoretical concepts, thereby following the idea of grounded theory (Glaser & Strauss 1967). Of course, these concepts should prove their validity for other domains of group and disciplinary culture as well. The analysis of my field data so far tends to confirm their relevance, but further investigation will be needed.

Theoretical discussion

In the last section, differences between disciplinary cultures in mechanical engineering and materials science are discussed from a theoretical perspective, with reference to Bourdieu's theory of the *scientific field* (Bourdieu 1976; 1998). In particular, I ask how cultural characteristics might be related to the structural position of each discipline in the scientific field. Finally, the potential of each disciplinary context for gendering / degendering practices is addressed.

In Bourdieu, the scientific field is regarded as a relatively autonomous field. Like any social field, it is structured by hierarchies and social struggles. However, these struggles follow the specific rules and mechanisms of

the field. The relative autonomy of the scientific field depends on its capacity to refract demands from outside and to translate them into its own logic. Consequently, the degree of autonomy varies between different types of disciplines.

Historically, namely in the German speaking parts of Europe, engineering had to struggle for its recognition as a science and its integration into the scientific field. The institutionalization of engineering disciplines in higher education by the end of the 19th century occurred with reference to a professional field outside science and it is still to a higher degree subject to requirements from outside than are the sciences (Gilbert 2006).

As a result, in terms of the standards of the scientific field itself (*cultural capital*), there is a hierarchical relation between natural sciences and engineering sciences, the former being considered the 'pure sciences' and enjoying a higher status. On the other hand, in terms of the dominant values in society as a whole (*economic capital*), the relation is reversed: engineering disciplines are closely connected to the professional field of industry and have access to economic resources outside the scientific field.

Drawing from this theoretical frame, the following issues can be addressed: What elements define the structural position of mechanical engineering and materials science in the scientific field? And, furthermore, how do characteristic elements of disciplinary cultures relate to the structural position of each discipline in the field?

Mechanical engineering was one of the first engineering disciplines to be integrated in academic institutions: in Switzerland, it has existed from the beginning of the technical university in the 19th century and, moreover, it is strongly linked to the development of a national machinery industry and the concomitant professional field. In the controversial relation between engineering and science, mechanical engineering is clearly positioned close to the engineering pole.

Materials science, on the other hand, is a very young discipline: in Switzerland, it was established as such in the early 1980s. Initially, it grew out of mechanical engineering and chemistry and today combines physics, chemistry, biology and engineering. Materials science tends to

challenge traditional disciplinary boundaries. In the controversial relation between engineering and science, it is clearly positioned close to the science pole. Its interdisciplinary character, however, makes it a hybrid in the scientific family.

Bearing in mind the characteristic features of group cultures in mechanical engineering and materials science as described in the previous section, I suggest that these features are closely related to the specific position of each discipline in the scientific field: the structural position of materials science, with its proximity to the science pole and its interdisciplinary character, is reflected in a group culture that supports individuality and diversity, that is, the ability to bridge—disciplinary as well as cultural—boundaries. Whereas the structural position of mechanical engineering, an engineering discipline with a long-standing tradition and strong connections to industry is reflected in a culture informed by elements of hierarchy and discipline, rewarding the ability to conform to instructions from above.

In conclusion, I will briefly address the implications of these findings from a gender perspective. To start with, it seems obvious that the openness to diversity in the daily practices of the materials science group also provides more scope for gender diversity. This includes not only the challenging of male dominance by the growing presence of women, but also indicates the emergence of a diversity of masculinities. In contrast, the group culture in mechanical engineering tends to reproduce features of homosocial male worlds and to link up with specific aspects of male socialization, like military education, thereby supporting masculine uniformity.

The findings presented in this paper support the hypothesis that disciplinary cultures in engineering, namely group cultures, are gendered and have a gendering effect (Gilbert et al. 2006). This is clearly a two-way process: on the one hand, engineering cultures in academia are gendered insofar as they incorporate and reproduce aspects of gendered socialization; on the other hand, engineering cultures have a gendering effect, inasmuch as they have a selective effect on potential newcomers into the field along the lines of gender identities.

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Notes

- ¹ The results presented in this paper are part of the research project *Gender and engineering cultures in academia* which ran from 2005 to 2008 and was funded by the Swiss National Science Foundation. An extended version of this paper is published in *Equal Opportunities International*, Vol. 28, issue 1, 2009.
- ² The methods included participant observation in formal and informal settings as well as in-depth interviews with a dozen professors and doctoral students in each field. Data collection was carried out in 2006 and 2007. I spent one term in each of the selected research units.

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