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FEMALE GUESTS IN A MANLY WORLD: A PICTURE WITH NUMEROUS SHADES

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Abstract: These studies on female engineers in several countries since the last century show similar processes of integration and marginalization if one considers the major lines of development. But primary and secondary education, the predominance of school culture or of shop culture, the opening of technical schools, the intervention of the state and other factors acted differently at times and across the countries, producing specific patterns concerning the choice of technical fields, as well as affecting the extent and the kind of occupational work. If we cannot discern any uniformity in respect of these dimensions, the results of the historical investigations converge nevertheless on one point: the persistence of the gendered hierarchical order at the workplace.

Résumé: Ces études sur les femmes ingénieurs mettent en évidence des processus d'intégration et de marginalisation dont les caractéristiques sont semblables dans de nombreux pays depuis le siècle dernier. Cependant les facteurs qui interviennent, en ce qui concerne notamment l'éducation primaire et secondaire, la prééminence de la dimension théorique ou de l'aspect pratique dans la formation, l'ouverture d'écoles d'ingénieurs, l'intervention de l'Etat, ont produit des modèles différents dans le temps et selon les pays tant du point de vue du choix des disciplines d'ingénieurs que de celui des emplois professionnels occupés par les femmes ingénieurs. S'il n'existe pas de modéle unique dans ces domaines, les résultats des études historiques convergent néanmoins sur un point: la persistence d'une hiérarchie entre les sexes sur le lieu de travail.

Engineering is not just an occupation, a job distinct from one's personality. Maybe more than others it seems to leave its mark on the inner and the outer person. In his famous *Man without qualities* Robert Musil pictured the protagonist Ulrich who at the turn of the century and in a certain period of his life wanted to become an engineer. He was dreaming of being a man "with resolute features,

a stubby pipe clenched between his teeth, a tweed cap on his head, journeying, in superb riding-boots, between Cape Town and Canada, carrying out tremendous plans for his firm. In the intervals there would always be some time to spare to draw on one's store of technical ideas for suggestions regarding the organization and administration of the world..." But Ulrich also had to observe that real engineers did not wholly conform to this heroic ideal: "Why, for instance,...do they like to stick tie-pins adorned with stag's teeth or small horseshoes in their ties? Why are their suits constructed like the motor-car in its early stages? And why do they seldom talk of anything but their profession? Or if they ever do, why do they do it in a special, stiff, out-of-touch, extraneous manner of speaking that does not go any deeper down, inside, than the epiglottis? This is far from being true of all of them, of course, but it is true of a great many; and those whom Ulrich met when he took up his duties for the first time, in a factory office, were like this, and those he met the second time were also like this."[1]

Musil's description suggests that this profession is bound particularly closely to certain images of maleness. Some recent feminist writings have claimed to find an explanation for this by arguing radically that technology in itself is essentially male. But this all too sweeping assertion has been contested with good reason, and it seems to me that the reports on several countries collected in this volume point to a more promising direction in examining the weight of a bundle of social and cultural factors at different periods. Rather than assuming the invariant existence of substantial qualities of both gender and technology, the authors tend to a historical inspection of these concepts, seeing them as two fields of social construction having many specific intersections which might change over time. So, what are the results of the international comparison?

To start with the long term development of women's participation in technical studies, it looks at a first glance as if there has been a continuous evolution towards steadily growing shares since the last century. Nevertheless the decisive "take-off" occurred in the various countries at different times: in the US, technical colleges were opened to female students from the end of the 1870s on, whereas Germany, Austria and Sweden followed only some twenty years later, accepting women first for single courses, and then as extra-ordinary or guest students. In comparison, France shows an extremely uneven development. Not more than a handful of colleges admitted women before World War I, some afterwards.

Especially striking is the interlocking between the existence of a special women's college, the *Ecole Polytechnique Féminine*, since 1925, and the hermetic exclusion of women by the *grandes écoles*, maintained in some cases till the 1950s or even longer.

In all these countries we can observe that the proportion of women in technical schools rose temporarily during World War I and World War II, but dropped afterwards. In Western countries, it attained a ceiling of 20% in the last decade and now seems to be stagnating on this level. This development contrasts sharply with the figures from the former GDR which achieved a maximum share of much more than 30% in the seventies. Even though falling afterwards slightly, they remained significantly higher.

These numbers show that changes took place at a relatively slow pace everywhere. The opening of institutions was not followed by an invasion of female students, waiting impatiently at the gate to be accepted at last. Obviously there were other factors impeding them. Also, we should keep in mind that the share of female students is not identical with the share of women working as engineers. One would expect deviations especially in the way that women with technical diplomas would not make use of them later, but would retire home or work in other fields. Nevertheless deviations could occur as well in the other direction. The example of the US census data of 1890 confirms that more than a hundred women answered that they were working as engineers, whereas records of engineering schools of this time mentioned not more than one woman graduate. This points to the fact that, similarly to men, a significant number of women at this time acquired technical knowledge by other, informal ways, probably mainly in family firms which they sometimes continued to manage after the death of their husband. This could have happened in other countries and later on in the 20th century as well. Even if formal education has gained a much higher weight since then, the ties between the content of studies and the content of later jobs are often extremely loose – for men as well as for women. Especially in small firms which still have much more importance in economic life than is often believed, the boundaries of job definitions can prove to be very malleable and dependent on practical experience or informal learning.

After this *tour d' horizon* on the longterm development of women's involvement in technical studies, I would like to consider this lifespan in more detail, as well as what precedes it, and what possibly comes after it, in order to discover in the studies presented

the main factors influencing the participation or exclusion of women in the technical field. The three relevant spheres are therefore: education prior to the academic level – especially secondary education – higher academic education, and occupational work.

Certain concepts of secondary education could act as effective and nearly prohibitive barriers against higher technical education of women. This is the conclusion one can draw from the French case where until 1924 girls were not allowed to obtain the specifically natural-science oriented *baccalauréat*, the school leaving examination required for technical studies. Further obstacles consisted in the 2-year preparatory programs for the *grandes écoles*. Nevertheless, where coeducation existed, this could prove to be a necessary, yet not at all sufficient condition for encouraging girls to develop technical interests. As we have known for some years, girls who not only followed the same curricula as boys, but who were also sitting in the same class-room with them, often became apathetic, whereas the chance to develop their talents proved to be much better in separate classes.

On the other hand, the fact that women sometimes showed a pronounced interest in mathematics and natural sciences was not necessarily followed by an opening of technical studies for them, as is demonstrated by the Swedish and Austrian examples. In Sweden, we find women attending lectures at the Technological Institute in Stockholm prior to the 1850s, and in Austria a lecturer of mathematics organized in the 1870s a "Mathematisches Damen Collegium" at the Polytechnical Institute, forerunner of the Viennese Technical University. In Vienna, though the courses were attended by several hundred women, this initiative had almost no impact on subsequent discussions and policies. Besides, things should not only be regarded from the angle of supply, but also from that of demand. An inclination to mathematics, physics or chemistry did not lead directly to technical studies. Rather, middle- or upper-class-women in the US preferred to choose studies in natural sciences which were surrounded by an aura of purity, whereas engineering was often seen as a vehicle for social promotion for young men of the lower-classes.

When we change now to the sphere of academic studies we will find a similar complex relation between the formal framework and the real processes. First, we need to ask what pressures led to the reinforcement or to the removal of hindrances to women. Following the common opinion, derived from other similar experiences, one

would expect that women usually failed because they confronted a solid front of male resistance against admitting female students to technical colleges. But if the women's movement in several countries campaigned for the opening of all spheres of activity to women, it nevertheless took no particular interest in technical studies. On the other side, the stance of professors and bureaucrats cannot be reduced to an overall conspiracy aimed at undermining any potential competition from women. As historical evidence shows for Austria and Sweden, there existed inside the colleges different fractions pleading for the exclusion or inclusion of women. One reason for this could lie in finances, given that universities wanted to attract students who would have to pay fees. Also, colleges and universities did not act in a social vacuum and had to adapt to economic and technological changes. In France – where possibly the conspiracy model fitted best for a certain time – these changes led after World War II to new curricula which broke up traditional structures and allowed the intrusion of women.

The strongest motive to remove old barriers was surely the longterm growth in the importance of engineering for industrial production and the hope of achieving economic growth by fostering technological innovations and technological studies. In this respect, the experience of the GDR is most interesting, as it demonstrates the limits of technocratic planning. Even when new incentives were combined with strong political and social pressure, the results did not for years fulfill the expectations of the regime. Whereas in western countries some vested male interests were pushed back as they conflicted with economic and institutional aims, here on the contrary economic and institutional aims could only partially be realized as they collided with vested male interests. An example of this was the foundation of new colleges with an orientation paradoxically rooted in the bourgeois tradition, continuing to cherish the ideal of the great engineer-inventors, an ideal dear to male engineers but informally discriminatory against women who generally in the sphere of occupations were thought to be confined to routine work. Other problems arose from the resistance of the educational institutions where men dominated and were reluctant to accept women as students or as colleagues. Deepseated prejudices as well as the fear of losing power could not be defined away by technocratic planning targets. Eventually, these could only be met by installing quotas for women's attendance. Several other contradictions were added to this. Thus, the official aim of mobilising the potential of human

resources to the full could often be inconsistent with the demand to promote especially those showing conformity and loyalty to the regime and who were participating in those so-called "social activities" which it encouraged.

Apart from this, the formal framework of educational opportunities was also filled with different contents when one looks at the disciplines chosen by women. It seems remarkable that in no country can we find an even distribution of male and female students over the single fields of technology. There appear clear-cut gender patterns which – so far as they can be compared – show some similarities, but also striking differences. We cannot unequivocally discern special fields as typically male or female. Specific patterns existed, but these did not always and everywhere have the same shape.

In Sweden, in Austria, in Germany until 1945, and in the GDR, one of the favorite disciplines at any time was architecture. Also, we can find that chemistry enjoyed great popularity in most of our countries. By contrast, civil and electrical engineering belonged to the most neglected fields in Germany and Austria, and to the preferred ones in the US. In Sweden too, electrotechnics were considered as particularly suited for women. This points to the fact that these options cannot be explained by some technical content of a discipline qualifying it for ever as male or female. Rather, a specific context relating to culture or economy seems to be important. So specializations opening the way to laboratory or office work were often – probably by men as well as by women – judged more suitable for women than those leading to work on the shop-floor or "in the field". But to declare certain fields as particularly feminine could also be related to wider ideas regarding the assignment of men's and women's spheres, e.g. when a Swedish feminist considered architecture to be especially close to the natural "motherliness" of women, because these would create a socially oriented housing.

These expectations restricted the possible professional areas, and also established additional boundaries within them. For instance at the French *Ecole des Ponts et Chaussées* – the National School for Bridges and Roads – women were supposed to be confined, following these widely accepted tacit agreements, to work in urban planning and not to be sent out for road construction jobs.

Cultural and economic factors influenced not only the choice of certain disciplines, they also shaped the very decision of female students to take up and to continue with technical studies. A most

important factor turns out to be the backing by the family. Whenever biographical material was used in the reports, it can be seen that most of the women who started engineering studies had fathers, brothers or uncles working in this field. For instance in Germany women who were students at the Munich Technical College mostly reported, when asked, that especially those fathers who belonged to the protestant middle or upper class, had acted as their promoters. Fathers might have different reasons for this. One could be a need for achievement which they wanted to transmit to their children and which, if strong enough, could supersede traditional role expectations towards a daughter. In other cases, as in the US, fathers owned small manufacturing family firms. When sons were lacking, daughters could fill the gap. The interest in the continuity of a family's business was then stronger than considerations about the appropriate men's and women's sphere. Also, a woman's technical interest and work could help her husband to establish a firm of his own, and to realize the dream of independence shared by many engineers. The new enterprise would often use the money that the wife had brought in as a dowry, as well as her social connections. For Austria, too, it is reported that some of the female students entering technical colleges gave the reason that they wanted to take over the family firm. So, not only the family of descent, but also the family a woman founded with her husband could be connected with engineering. It is astonishing how often in Germany and in the US women with a technical diploma chose a colleague as partner for their life. Maybe it was just love, but probably it constituted for them also the only perspective for following their technical interests further.

When we turn now to the sphere of occupation, we discover a structure which is not only typical for technical professions. Irrespective of special technical fields, women mostly occupied (and still occupy) lower positions in the hierarchy than men. Responsible functions counted not only in the US, but also in the other countries, as a central feature of professionalism – and this capacity was closely associated with manliness, in east as in west, during the last century as during ours. Women therefore found themselves working in drafting or calculating, in design departments or laboratories. The male engineers succeeded in establishing boundaries between the male occupations comprising supervisory responsibilities – for instance chemical engineering – and the female occupations reduced to executive work – for instance chemical analysis. Similarly

in the GDR, although management functions were not completely denied to women, they were restrained to certain, already feminized fields. However, most of the female engineers in the GDR too were employed in secondary functions in laboratories. But the US experience reminds us also that the apparent absence of female engineers in certain fields, for instance on the shop floor of factories, is often a matter of definition. Especially during World War II many thousands of women were impelled to follow a different kind of engineering programs, and to become technical assistants, designated at this time "engineering aides". This for them meant, doing the work of engineers without being called engineers.

The question of managerial responsibility is obviously extremely difficult to answer. Partly it is a social construction which helps to confer on men's jobs a halo of importance which they often lack in practice. But partly it means that men really were more closely connected to positions of power.

Explanations for the nearly universal existence of gender hierarchy in the professional world has often been sought in women's life course or in female socialization. We know now that this is only part of the truth, whereas gender stereotypes – shared by men and by women – and concrete behaviour and activities of men in trying to keep women at arm's length play a decisive role. This could happen especially in unions or professional organizations, the latter constituting sometimes very effective old boy's networks for perpetuating a "male engineering fraternity" founded during one's studies at colleges or universities. Often women were explicitly denied membership in professional engineer's organizations, sometimes even when this involved violating the rules, or they obtained a second-class membership without voting rights, as used to be the case in the US. But in the GDR too, women's participation in networks and paraprofessional fraternities remained minimal. Generally, efforts to keep women out were paralleled by a general interest among engineers in striving for neatly defined professional fields excluding not only women, but also other men with lower qualifications. These ways of handling or mishandling the admission of women to these societies also impressively refutes the self-image of male engineers in terms of rational behaviour and of values based on merit and achievement.

We find in these papers a lot of information about women engineers and their special position in the male world of engineering, a position characterized by marginalization and discrimination, by

the necessity to mobilize energies and to overcome barriers. In the final analysis, there is no single factor which would explain the evolution since the 19th century. And even some of the possible agents of change could play very different roles, according to their historical shaping and orientation as well as to specific situations. As candidates for such agents we can discern especially the state, the women's movement, different concepts of qualification and the formal framework of secondary and higher education.

If we examine the importance of the state in market economies, its institutions could help just as well as hamper women's education and employment in technical fields. In the US, for instance, state owned schools often showed a relatively favorable attitude towards women's higher education in engineering, while in France and Austria for a long time it worked the other way round. Nevertheless, differences in policy-patterns which can be observed for these countries in times of peace got blurred in times of war. Everywhere World War I and World War II resulted in fundamental redefinitions of female capacities and duties which made women enter in technical fields formerly strictly closed to them. In planned economies, however, where the state played a much more predominant role, as was the case in the GDR, even when the policy was directed towards the mobilization of women for technical occupations, this did not lead at all to a straightforward realization of such plans. As in many other domains, the state's interference was marked by contradictory motives, as it was torn between the will to promote this mobilization, and the need to assure the collaboration of the traditional elite of engineers.

The relevance of the women's movement proves to be similarly equivocal. When middle-class dominated, the women's organizations demanded free access to all professions. But this general claim conflicted with images of female behaviour limiting the range of professional activities to those which seemed to converge with the assumed nature of women – and this mostly was not to be refined in the world of machine-tools and slide-rules. Nevertheless the Austrian example does not fit into this picture, since women's organization there campaigned especially for the access of women to technical schools. Besides, looking at women working as engineers we find that in several countries they had a particularly weak connection with the women's movement: they advocated the free access to the professions for themselves, but usually did not extend this claim to their female companions at all.

As to the third agent of change, the shifting concepts of qualification, we can refer here to the well known discussion on the substitution of shop-culture by school-culture to ask if this shift meant to narrow or to enlarge the scope of women for entering the technical field. In fact, shop-culture could encompass the participation of women in those areas where the assumed normality of male technical competence was thwarted by norms of family business. On the other hand, school-culture could mean an invitation for women to acquire technical formation in those cases where it was bound to ideas of equal chances of education for both sexes – at least for members of the bourgeoisie. But shop-culture as well as school-culture could also produce the contrary effect, unveiling therewith a tacit agreement between them. In both cultures we find cases where the exclusion of women is legitimized by vague "inconveniences" which could not at all be referred to a lack of women's capacities to learn or to execute technical tasks, but rather to a social factor acting in the world of oily machines on the shop-floor and of drawing-boards in clean offices: the existence of a "community" of male technicians – even if this community of course was characterized by a lot of inner divisions. Nevertheless its members shared usually the conviction that women engineers could and should never become "one of the boys", a conviction which left a deep mark on daily exchanges, manners of speaking and of joking and on the self-image of male engineers.

Finally, the formal framework of secondary and higher education reveals itself to be important, but likewise not unequivocally determinant of men's or women's spheres. Rather, the relevance of this framework depended on the wider cultural setting, especially the women's movement (as just described), family networks, and male professional networks.

Whereas all these factors led to variations in different times and countries, one feature is seen to occur irrespective of the type of society: the stability of the gendered hierarchical order at the workplace.

Vivid pictures of gender segregation should nevertheless not tempt us to create new myths. After having destroyed the picture of the heroic male engineer – remember Musil's Ulrich seeing himself traveling between Cape Town and Canada – we should not replace it with a new picture of the heroic female engineer, a danger which I see in often attributing to women what Margaret Rossiter has called the Madame Curie-strategy: over-qualification,

personal modesty, self-discipline, and stoicism – a strategy which was aimed at explaining the need and ways of assimilation for women in a world where they had a status of foreigners or guests. As the image of Marie Curie which emerged from the previous number of this journal made only too clear, we should be aware that such descriptions may reflect legitimized images used in autobiographies or drawn by others, rather than picturing the possible contradictions and internal fractures within real personalities.

But there is still another point. If we stress the centrality of gender segregation we risk losing sight of other main characteristics of a society, as well as of lines of differentiation and opposition running through the sub-world of male engineers. Depicting this latter world from the perspective of the women engineers makes it look sometimes all too bright, all too homogeneous and privileged as a whole, exaggerating features of engineers' idealized self-portrait as pioneers or as adventurers at the expense of the sometimes musty and small-scale reality which many of them faced and still face in their daily work. Let's not forget those with the "tie-pins adorned with stag's teeth" and the "small horseshoes in their ties."

Notes

1. Robert Musil: *The Man Without Qualities*, Vol. 1 (New York, Perigee, 1980), p. 38.