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STS

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STS - Working Paper, no. 9/88

ISSN 0802-3573-12

arbeidsnotat
working paper

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1. Introduction

The issue of gender and technology or, usually, women and technology, is in most cases phrased as how technology will influence or harm women's lives. However, the use of concepts like patriachial technology indicates the assumption that the male gender is dominating the development of technology, and consequently that technological R&D is characterized by "masculine" values and "masculine" relations of work. The hypothesis is usually grounded in two assumptions:[1]

1. The great majority of those employed in technological R&D are men.
2. The application of technology in women's jobs seem to be harmful to women's possibilities.

While these suppositions make it reasonable to argue the hypothesis of a strong "masculine" bias in technological R&D, they do not prove this assertion.

In fact, there are very few studies available which substantiate empirically any "masculine" impact on technological R&D or engineering design. An interesting exception is Sherry Turkle's analysis of the socio-psychology of computers. She argues that it is possible to discern two stereotypical

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*This is a slightly revised version of a paper presented at the Joint Conference of the Society for the Social Studies of Science (4S) and the European Association for the Study of Science and Technology (EASST) Amsterdam, 16-19 November 1988.

[1]An eminent example is C Cockburn: Machinery of domiance, London: Pluto Press 1985.

styles of computer programming: the structured approach, based on preplanned and highly structured programming, that Turkle calls "hard mastery", and a dialogically oriented approach, based on some kind of trial-and-error interaction with the computer. The latter approach is called "soft mastery". Turkle maintains moreover that computers have been constructed as an intimate machine that women fear because they see computers as a technology that make people more occupied with machines than with people.[2]

Norwegian studies of male and female engineering students suggest that the females are more "radical" than the male ones, in terms of techno-political views and career values.[3] This supports the argument that more women into engineering and technological R&D would make a difference. However, when one compares values related to the more strictly "professional" content of engineering work and technological R&D, the gender differences disappear.[4] Consequently, we seem to observe that the socialization of the engineering education make previous differences in values etc. disappear or at least less marked. Nevertheless, we have to careful in generalizing these results to graduates.

This paper reports some research that tries to follow up on these studies of engineering students by studying men and women working in a large technology-oriented research corporation in Norway. The aim has been to compare the opportunities of male and female scientists, doing industrial-technological R&D on a contract basis, and to compare their views on characteristics of the role of successfull scientist. The issues which the study adresses, relate to the abovementioned research, but to develop them further, it seems

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[2]S Turkle: The second self, New York 1984; S Turkle: "Computational retience: Why women fear the intimate machine", in C Kramarae, ed: Technology and women's voices, New York: RKP, 1988.

[3]E Kvande: Integrert eller utdefinert. Om kvinnelige NTH-studenters studiesituasjon og framtidsplaner (eng.: Integrated or excluded. On the conditions and plans for the future among female students at the Norwegian Institute of Technology), Trondheim: Institute for social research in industry, 1984; K H Sørensen and Nora Levold: En rettferdig teknologi? (eng.: A just technology?), Trondheim: Centre for technology and society, 1987.

[4]See Sørensen and Levold, op. cit.; K H Sørensen and A-J Berg: "Genderization of technology among Norwegian engineering students", Acta sociologica, 30, 151-171, 1987.

reasonable to turn to social and philosophical studies of science where there is a fast-growing literature on gender.

2. Gender and science

The discourse on gender and science has grown out of women studies and the experience of women in the academic world. Presently, we can see three main positions in the debates.[5] Firstly, there is what I will call the post-Mertionian approach which is occupied mainly with the (lack of) institutional integration of women in science. Typical areas of interest are differences of scientific productivity and of access to scientific networks.[6] The main orientation of the approach is to critize lack of equal rights to women. Secondly, a weak feminist program can be identified. In addition to problems of integration, it is concerned with the implications of gender to the choice of problems of research. Central concepts to this approach are relations of power in scientific institutions, sexual divisions of labour within scientific communities and coping strategies of female scientists.[7] The issues developed here are based on a more radical understanding of gender relations, being critical to the oppression of women by men.

The third approach that may be called the strong feminist program, is mainly considering how gender relations may affect the practice of science, i.e. the way science is conducted and scientific knowledge constructed. There are important differences also *within* the strong program, between relativists and non-relativists, and between those who emphasize the number of

[5]See E F Keller: "Feminism and science", *Signs*, 7(3), 1982; S Harding: *The science question in feminism*, Itacha: Cornell University Press, 1986.

[6]See e.g. J R Cole: *Fair science*, New York: The Free Press, 1979; I H Frieze and B H Hanusa: "Women scientists: Overcoming barriers" and J R Cole and H Zuckerman: "The productivity puzzle", both in M W Steinkamp and M L Maehr, eds: *Advances in motivation and achievement*, vol. 2, Greenwich, Connecticut: JAI press, 1984.

[7]See e.g. M Rossiter: *Women scientists in America*, Baltimore: John Hopkins University Press,1982; H Nowotny: "Gemischte Gefühle: Über die Schwierigkeiten des Umgangs von Frauen mit der Institution Wissenschaft" and I Wagner: "Das Erfolgsmodell der Naturwissenschaften. Ambivalenzerfahrungen von Frauen", both in K Hausen and H Nowotny: *Wie männlich ist die Wissenschaft?* (eng.: How male is science?), Frankfurt aM: Suhrkamp, 1986.

women scientists and those who are mainly concerned the impact of gender on scientific discourses, e.g. how biology has been biased by sexist assumptions, and more generally, how science has been affected by a "masculinist" philosophy of science.[8]

However, the gender issue is not very well integrated in social studies of science. In fact, the issue seems to represent challenges that standard approaches of the field find difficult to meet. To the Mertonian conception of science, any impact of gender on the scientific undertaking itself represents a violation of the norms of science - in particular the norm of universalism. Consequently, the Mertonian way to treat the issue is to analyze it as a problem of institutional integration. Science will not be any different with more women scientists, but it is unfair and a misuse of talent not to give them equal opportunities.

In the dominant versions of relativist studies of science, we encounter a rather different kind of problem. While relativists generally appear as very perceptive of social influences on science, they usually demand - influenced by etnomethodology - that the impact of gender should be observable at the research site, at the laboratory bench. And for some reason, the (mostly male) proponents of relativist/constructivist social studies of science do not "see" any gender at their research sites. At least, gender is not a topic in their publications.

Even to those who are not very interested in gender issues, the ability of an approach to handle such issues is an indication of a more general ability to manage on the one side the challenges of social effects on the production of scientific knowledge, and on the other hand questions related to work organization and working conditions of scientists. Taking that these are important problems, the experience of students of gender in/of science may have more general interest. Anyway, I will return to the body of work of women in science as the basis of my empirical investigations.

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[8]See e.g. E F Keller: Reflections on gender and science, New Haven: Yale University Press, 1985; Harding, op. cit. R Bleier, ed: Feminist approaches to science, New York: Pergamon Press, 1986.

Previous work on women in science suggest that the problem of gender issues fruitfully can be analyzed as two problemsets, one concerning the conditions of women in science, and one concerning the impact of gender upon scientific work and scientific knowledge. While these two problemsets should not be perceived as independent of each other, they nevertheless can be examined seperately. Moreover, it should be noted that the first - "women in science" - raises problems known from both the post-Mertonian approach and the weak feminist program, while the latter leads us right into the strong feminist program.

Contributions to the analysis of the conditions of women in science have raised mainly four sets of questions:[9]

1. Why are there so few female scientists?
2. What are the possibilities and challenges of female scientists? How well are women doing in the scientific system, compared to men?
3. What strategies have been/are accessible to women scientists in their efforts to succeed in the scientific system?
4. What role models can be found among female scientists of previous periods?

Obviously, in this tradition, there is no lack of problems to do research on. To the practically minded, the choice of problems would then depend on which factors or issues one believes have the greatest impact on the possibilities of women to get ahead in science. One great weakness with the this research strategy is its lack of theory or theoretical models on which a more general understanding of women in science can be established. This is evident from the fact that studies of women in science have been quite empirist, observing whatever problem they have chosen to observe.

A more satisfactory approach could be developed from the theories emerging from studies of women in organizations, particularly from the work of Rosabeth Moss Kanter.[10] Kanter's model is based on three elements:

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[9]See L Schiebinger "The history and philosophy of women in science: A review essay", i S Harding og J F O'Barr, red: Sex and scientific inquiry, Chicago: Chicago University Press, 1987; M W Steinkamp and M L Maehr, eds: "Women in science", Advances in motivation and achievement, vol. 2, Greenwich, Conn.: JAI Press, 1984.

[10]R M Kanter: Men and women of the organization, New York: Basic Books, 1977.

1. The opportunity structure,
2. The power structure, and
3. The social composition of groups.

The first element refers to access to challenges, opportunities of learning new skills, and organizational rewards. A good opportunity structure implies high motivation, high ambition, and high orientation towards work as means of satisfaction. The second element - power structure - consists of factors like degree of routine or variation in a job, visibility of a job in terms of important problems to the organization, recognition from persons with high status, access to supporting persons, and access to informal networks. The third element refers to the relative number of women at a particular level of the organization. If that number is low, the risk is high that women become too visible, experiencing a strong pressure towards conformity, becoming more isolated, and having less opportunity to get mentors. A somewhat modified version of Kanter's model might consequently prove fruitful also to a study of women in science.

The analysis of the impact of gender upon science has concentrated on its efforts to critize how different scientific disciplines (erroneously) have studied the characteristics of women and their conditions and uncovering the masculinist bias of modern science. Using a Kanter-inspired analysis of women in science, it seems particularly relevant to follow up some themes raised by Evelyn Fox Keller. These themes concern both the ideology and practice of science, emphasizing in particular the relation between the scientists and their objects of study. Kanter argues that modern science is characterized by a distance between scientists and nature, developed through the socialization of boys to distance themselves from their most accessible object of modelling, their mother. (The argument is based on so-called object relations theory which has developed from psycho-analysis.) This dis-engagement in science and technology could be analyzed through a lot of different measures, as could what is perceived as a traditional "male hardship ideology" of getting ahead in science.

Returning to technological R&D, the question arises whether models of gender in/of science are applicable to technology. This question relates to the more general issue of the relationship of science and technology, indicating that the answer is not a simple one. However, there is little reason to believe that the conditions of women in science are radically different from those of women in technological R&D. Consequently, the critical issue are that of how gender affects the production of knowledge. It might be argued that technology is more "open" or "vulnerable" to external influences. Technological problems may have several solutions, in contrast to science which is usually conveived as a business of one correct answer only. Moreover, technological R&D has a much more complicated interest structure, usually involving a larger numer of people and institutions than science do. However, the application of Keller's argument should not be hampered by this. In fact, if anaything, technological R&D could be supposed to be more suited for this kind of analysis than science.

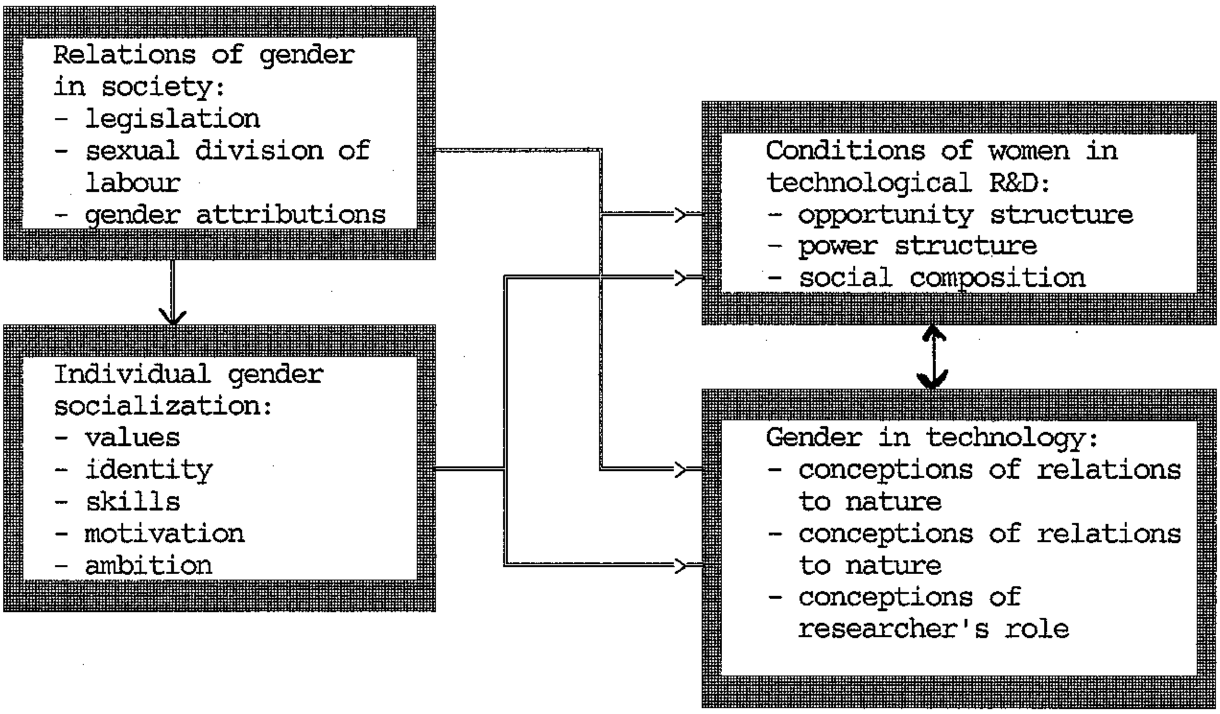

Figure 1. Model.

To conclude, the empirical analysis will be based on the model described in Figure 1 above. This model represents an effort to integrate the points made above about the study of the conditions of women in science/technological R&D versus the issue of gender in science/technology. Two methodological challenges are inherent in the model. The first one is the need to study gender in/of technological R&D in terms of both individual and organizational values and conditions. The second one is the need to differ between the effect of social relations inside and outside the research institute. To what extent are the observed effects of gender the result of gender relations in society versus the result of the spesific relations of the institute(s) under scrutiny. However, these challenges are difficult to meet, and in most cases of empirical analysis we may have to be content with a blurring of such issues.

3. A short note on method

The data presented in this paper comes from a survey of permanently employed researchers in a large Norwegian industrial R&D corporation. The corporation employs (1986) some 960 researchers, supplemented by a considerable number of university employees that are contracted on a part-time basis. The latter group did not participate in the study. The survey was orginally designed to give general information about the organization and the content of its research work. Consequently, it does not by any means supply us with all relevant information for our purposes. Nevertheless, at least some of the themes occuring in Figure 1 may be reasonably covered.

The survey was conducted through the internal post system. We received 635 answers, giving a response rate of 66 %. This should be considered as satisfactory. We believe that there is no substantial difference of the response rates of men and women, but lack of sufficient information has made it difficult to calculate exact response rates according to sex.

Of the 635 responses, only 9 per cent came from women. The comparison of male and female researchers are consequently complicated by a very skewed distribution in terms of the sex of the respondents. This is of course also a very important, though not very suprising, result: <u>There are in general few women in technological R&D</u>. A second problem arose from the fact that there are three social science units within the technological R&D corporation. This lead to the exclusion of 24 responses, leaving 611. A third problem stems from another important fact which is shown in Table 1: There are particularly few women among those over 35 years of age. Comparing men and women could then lead to uncertainty whether differences were due to gender or age.

Table 1. Age distribution of respondents according to sex.

Age	Men	Women
- 25	5 %	20 %
26-30	33 %	40 %
31-35	24 %	27 %
36-40	19 %	2 %
41-50	13 %	7 %
51-60	5 %	4 %
61-	1 %	0 %

To come around this problem, I have chosen to exclude all respondents older than 35 years. This means that the empirical analysis will be limited to young researchers. The drawbacks of this procedure are obvious, but it is simply not meaningful to perform a quantitative analysis of the very few female researchers past 35 years of age. This reduces the number of responses to 380, of which 340 are men and 40 are women.

A fourth problem is produced by the sexual division of labour taking place inside the R&D corporation. These divisions are in themselves important data to which I will return shortly, but the fact that the female researchers are unevenly distributed in the various departments of the corporation does represent a methodological problem. We find for example that 18 per cent of the women work in the department of industrial chemistry (4 per cent of the men work there) and another 18 per cent work in the department of metallurgy (5 per cent of the men work there). In contrast, several departments have no female researchers employed, e.g. the departments of applied thermodynamics, applied materials science, machine design, mining, applied control theory, and applied hydrodynamics. Since the departments are organized somewhat differently, this may explain some differences in the conditions of men and women. On the other hand, it could be assumed that the differences in organizational characteristics somehow are related to the presence of female researchers. Consequently, due to small sample sizes, this issue is assumed to be of less importance.

To conclude, there are obvious weaknesses in the data. Firstly, it is not possible to meet properly any of the two challenges mentioned in the discussion of Figure 1. The data has to be analyzed as primarily as expressions of individual experiences and characteristics. Secondly, the small sample size of female researchers calls for care in the interpretation of the results, in pariticular since the sample size of male researchers is so much larger. Moreover, the sample size do not allow multivariate analysis, a tool that otherwise might have proved valuable. Thirdly, the exclusion of researchers past 35 years of age implies that we cannot hope to analyze effects that will appear later in a scientist's career. Nevertheless, with a view to the lack of empirical material about gender in/of technology, these data may still prove interesting - if nothing else, at least as a basis for further inquiries.

4. Sexual division of labour?

The majority of our respondents have a masters degree in engineering (77 per cent), while 7 per cent have Phds in engineering. In this respect, the differences between male and female researchers are negligible. However, as we have seen, there is a distinct sexual division of labour in terms of women being concentrated in a few departments. This is of course due to the fact that men and women differ in terms of type of engineering degree. 43 per cent of the women have their degrees in chemistry, compared to 8 per cent of male researchers. 17 per cent of male researcher have degrees in electronics and 22 per cent in mechanical engineering. The parallell figures for female researchers are 5 per cent in both cases. The number having degrees in civil engineering is, however, close to 17 per cent for men as well as for women.

The implications of this disciplary specialization of women are unclear. I have, however, more detailed data that allows for an analysis of other possible aspects of a sexual division of labour. The survey contains information on the following important issues:

- the work content of the in terms of time spent on different tasks,
- the distribution of men and women according to position,
- the possibilities of generating ones own projects.

Table 2 shows how much time male and female respondents report using on different tasks occuring frequently in technological R&D. The emerging pattern shows some interesting differences between men and women. Some of these are accountable in terms of the previously observed differences of educational background, i.e. women are clustered in fields related to chemistry.

Table 2. Per centage of responding scientists spending more than 5 per cent of working hours on different tasks, according to sex of respondent. Per cent.

Type of task	Male researchers	Female researchers	Sign. diff.*
Design/build/assemble measuring equipment and other instruments or models for experiments or tests	14	11	n.s.
Run experiments and/or collect data	35	60	s.
Other laboratory work	13	26	s.
Development/design of mathematical or logical models related to calculations, simulation, etc.	40	20	s.
Calculation, plotting, curvedrawing	44	58	s.
Design, prototyping, drawing	16	3	s.
Development and/or testing of computer programs	63	31	s.
Read scientific literature related to spesific project	49	69	s.
Read scientific literature to keep up professionally and to be informed about new fields	28	30	n.s.
Writing of reports	67	81	n.s.
Professional discussion with colleagues	55	53	n.s.
Lecturing	8	0	n.s.
Coaching/teaching	18	11	n.s.
Project administration	30	14	s.
Other adminstrative and office work	16	8	s.
Acquisition of new projects, writing of grant applications, contact with sponsors	22	17	n.s.

*The test of significance of difference between responses of men and women is based on the Kruskal-Wallis one-way analysis of variance, performed on a three level score of time spent on the various tasks. Level of significance = 0.05.

More specifically, we note that male researchers spend more time in developing mathematical models and computer programs, a finding substatiated by the fact that male researchers spend about twice as much time using computers (a median of 12 hours a week, compared to 6 hours for female respondents) and that the males experience themselves as far more competent users of computers than the females (39 of the men consider themselves "advanced users, compared to 3 per cent of the women). These findings are evidence of a different pattern of specialization among women, but they do not in themselves suggest that there is any difference in the quality or rewards of these patterns.

However, there are also some indications of a vertical differentiation. While there is no significant difference in time spent on writing, on having professional exchanges with colleagues, on coaching/teaching or on trying to acquire new projects, we find that male researchers spend significantly more time on administrative tasks. This suggests that male researchers - as one would expect - are moving faster towards managerial positions than their female colleagues. Consequently we would also expect to find that they to larger extent than the female researchers get managerial responsibilities.

The available data give two kinds of information concerning managerial responsibilities. One is based on information from respondents on whether or not they had responsibilities in terms of managing projects. 62 per cent of male researchers said they managed projects involving at least one other researchers, compared to 44 per cent of female researchers. In terms of titles, a similar, but less marked picture appears: Of 14 respondents working as group managers, only one is a woman. However, the difference in terms of percentages is small, due to the fact that also very few of the men have reached the position of a group manager. This usually happens later in the career.

So far, the data presented suggests that we can observe a sexual division of labour in the vertical as well as in the horisontal sense. The horisontal differentiation is probably related to a more general gender-typing of different technological specialities, making women choose subjects like chemistry or biotechnology.[11] This can of course be interpreted as an

[11] See Sørensen and Berg, op. cit.

expression of women wanting to research different problems from what men want, an interpretation to which I will return later in the paper. The vertical differentiation is not as clearcut, but the symptoms are obvious. Becoming a researcher in a technological field is no garantee that a woman will get the same career pattern as men. I will pursue this issue in the next section by turning to indicators of opportunity and power structure.

5. Equal opportunities?

According to the tradition of women's studies in organization theory which is examplified by the work of Kanter, explanations of differences in terms of ambition and career progress are to be found in the organizations and not in the women themselves. Does the structure of opportunities that emerges from my data support the abovementioned result that female researchers seem to be getting less managerial responsibilities than their male colleagues?

Before proceeding with the analysis, it should be noted that in terms of quite important indicators on <u>the quality of projects</u>, there are no significant differences between men and women. Such indicators include whether a project is considered to be R or D, usual size of projects, and usual number of people involved with projects. Female respondents report the same level of influence in the development of projects as the male ones.

Several authors have previously studied the access of male and female scientists to <u>networks</u> of information, finding that women are less integrated than men in professional networks.[12] The results of Table 2 show that among our respondents, men and women spend about equally much time on professional exchange with colleagues. However, the measure is rather rough. Other questions supply us with more detailed information about the use of networks which gives a somewhat different picture.

At the outset, it should be noted that the importance of networks is at least twofold. Firstly, it gives access to professional and scientific

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[12] See e.g. Frieze and Hanusa, op. cit.; J R cole: "Women in science", <u>American Scientist</u>, 69, 1981, B Reskin: "Sex differentiation and the social organization of science", <u>Sociological inquiry</u>, 48, 1987.

information which may be very useful, even critical, to the research work and to the acquisition of new projects and new positions. Secondly, it may be a support structure, in terms of supplying mentorship, emotional support, etc. My respondents were asked how often they were in contact with different categories of people to have professional exchanges. The answers are shown in Tables 3 and 4.

Table 3. Percentage of male and female respondents having professional exchanges with different categories of "insiders" of the corporation, daily/weekly or monthly/less than monthly.

	Male researchers		Female researchers		
Categories of contacts	Daily/ weekly	Monthly/ less	Daily/ weekly	Monthly/ less	Sign. diff*
Co-workers on common project	94	6	86	14	s.
Other colleagues in same group or section	78	22	67	33	n.s.
Researchers at the department, outside own group or section	34	66	14	87	s.
Manager of group or section	51	49	35	65	s.
Leader of department	13	87	3	97	s.
Reseachers in other departments	9	91	3	97	n.s.
University employees	31	69	27	73	n.s.

*The test of significance of difference between responses of men and women is based on the Kruskal-Wallis one-way analysis of variance. Level of significance=0.10.

Table 3 reports findings that confirm expectations, but only to some extent: Female researchers have less frequent professional exchange inside own organization than their male colleagues. This indicates lesser integration in the organization, or to put it differently, that female reseachers have less easy access to information and support than their male collaborators. However, the exceptions to the rule are notable: The frequency of exchange with researchers in other departments and with university employees are not significantly different. From Table 4 we also learn that this is the case in the matter of exchange with researchers outside the R&D corporation and the local university. It is in their relations to internal, departmental networks that women in the present study seem to be worse off, in addition to, as shown in Table 4, the relations with clients and suppliers. Contact with clients should be acknowledged as potentially very important, and this result indicates that female researchers may have less resources to obtain new grants or contracts.

Table 4. Percentage of male and female respondents having professional exchanges with different categories of "outsiders" of the corporation and the local university, monthly or more frequent or less than monthly.

Categories of contacts	Male researchers Monthly or more	Male researchers Less than monthly	Female researchers Montly or more	Female researchers Less than monthly	Sign. diff*
Researchers/scientists outside local networks	20	80	14	76	n.s.
Clients	71	29	51	49	s.
Suppliers	25	75	3	97	s.

*The test of significance of difference between responses of men and women is based on the Kruskal-Wallis one-way analysis of variance. Level of significance=0.10.

We also asked the R&D scientists about the frequency of informal contact with people in the same categories as in Tables 3 and 4. The results from these questions show less difference between male and female reseachers, but the tendency is the same. Supporting the conclusion of lesser integration in professional networks of female researchers is also the fact that female respondents report significantly less frequently that they have projects in common with researchers from other departments than do male respondents.

In a recent, qualitative study of another, smaller, Norwegian computer science laboratory, a somewhat different pattern of gender differences was observed: Women had fewer contacts outside the laboratory, and inside, they compensated for lack of informal exchange by establishing a women's network.[13] Comparing this result and the results of Tables 3 and 4 to US

[13] E Piene: Vilkår og verdier. Om kvinner og menn informasjonsteknologisk orientert forskning ("Conditions and values. On women and men in research oriented towards information technology"), report 7/88: Trondheim: Centre for technology and society, 1988.

studies,[14] it seems reasonable to suggest as an overall conclusion that female scientists in general have greater difficulties in getting integrated into professional networks than their male colleagues. This is also in accordance with Kanter's theory and with the fact that men dominates these networks. However, the reported findings should also be interpreted as a need of more careful analysis of the different kinds of network that are available, and in particular, how women cope with local networks. We may come to experience that there are differences in the degree of integration of women into professional networks, in terms of diffence with respect to bort local and disciplinary cultures. Moreover, the establishment of networks of female scientists only, to counter the problem of lack of information and support, is an old, but well-proven strategy.[15]

Information, mentors and emotional support are not the only relevant resources of researchers. It could also be assumed that female researchers would have less access to material resources needed to do good work. However, as previously indicated, we have no indications that time and money are more sparse to our female respondents, compared to our male ones. In particular, the survey gives information about the individual access to different kinds of computers and computer equipment: terminals, PCs, printers, plotters, etc. Bearing in mind that male researchers report doing more computer-based work and having greater computer skills than female, one would expect that they also would have better access to relevant equipment. Nevertheless, according to the survey, there is no significant difference between men and women in this respect.

Besides studies of access to networks, the analysis of sex differences in scientific productivity measured by the output of has been one of the most frequent approaches to study men and women in science. The findings of such studies are quite consistent in reporting that women are less productive than men, although the differences become smaller when controlling for

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[14]See note 12.

[15]See M Rossiter: Women scientists in America. Struggles and strategies to 1940, Baltimore: John Hopkins University Press, 1982.

differences in position.[16] The data on professional exchanges from my material suggests that similar results would be obtained from the group I study. However, surprisingly, my data on publications - which are based on self-reports - shows no significant differences between male and female researchers in terms of publication frequencies.

Most previous studies of publication output have been based on material from universities and institutes doing basic research. The R&D corporation which is the source of my data, is different in at least two respects. Firstly, publications are not considered as important as it is in more purely academic settings, and the rates of publication are lower than in the universities. Secondly, most of the publications are internal reports, the writing of which should be considered mandatory. This is due to one inherent characteristic of contract research: The pressure to keep time schedules. In contrast to basic research where there may be a real choice of when to publish what, much of this choice is eliminated in the context of contract research.

In particular, the last argument represents a possible explaination of my deviant results, an explaination locating the sources of possible gender differences in productivity within the research organization and its culture. Moreover, it should be noted as an additional argument that when my respondents evaluate local support for publishing efforts, there is no significant differences between male and female researchers. Both sexes consider the support to be so-and-so. My results could consequently also be produced by a more equal opportunity structure in terms of publishing.

This conclusion rests upon the assumption that male and female researchers put in a similar amount of working hours. This contention is not quite supported by Table 5 that shows a significant difference between male and female researchers in terms of lenght of work-week. However, in terms of actual hours, the difference is quite small. The average female researcher works 38 hours per week, while her average male colleague works 41 hours per

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[16]Cole and Zuckerman, op. cit.; S Kyvik: Vitenskapelig publisering blant kvinnelige og mannlige universitetsforskere ("Scientific publishing among female and male university researchers"), Oslo: NAVF's utredningsinstitutt (in press).

week (self reports). The conclusion of a more equal opportunity structure as an explaination of equal publication patterns is thus supported.

Table 5. Usual number of working hours per week, according to sex of respondents. Per cent.

Working hours	Men	Women
Part-time	4	18
Normal hours	74	76
More than normal hours	22	5

In sum, the data presented in this and the preceeding paragraph paint a somewhat ambigous picture of the conditions of female researchers working with technological R&D. On the one hand we find a sexual division of labour which seems to lead to relatively more men than women in managerial positions. Moreover, we find that women have somewhat poorer access to professional exchanges with other groups of researchers and managers. On the other hand, there is little evidence to support assumptions of women having less access to material resources or having projects of lesser quality. The differences in terms of average hours of work are small, and no difference is found in publishing activity. My data consequently indicate a somewhat more favorable position of Norwegian women working with technological R&D than is found in studies of women in science from other countries. However, there is still no equality.

6. Gender and the practice of research

One weakness of the data reported above is the focus on quantitative characteristics of the relations of research work only, ignoring the quality of these relations. In section, I will start by presenting briefly some data on how research work is experienced (see Table 6). Women are usually believed to be more demanding of social relations. The results of a survey among Norwegian engineering students suggest that female engineers may be more concerned with users and useful problemsolving than male engineers.[17] Similar arguments are made on the basis of North American studies of female scientists and engineers.[18] This indicates that female researchers should

[17]Kvande, op. cit.

[18]Frieze and Hanuse, op. cit.

have better contact with clients and value views of clients more than male researchers do.

Table 6. Per cent agreeing to statements about different qualities of R&D work, according to sex of respondent.

Statement	Per cent of male researchers agreeing	Per cent of female researchers agreeing	Diff. sig.*
I communicate well with clients	47	29	s.
Steering committes seldom contribute constructively to projects	26	28	n.s.
Clients often have important scientific contributions to projects	39	13	s.
I solve problems most efficiently when having the opportunity to be alone several days in a row	50	41	n.s.
It is stimulating to work with practical problems	90	82	s.

*The test of significance of difference between responses of men and women is based on the Kruskal-Wallis one-way analysis of variance. Level of significance=0.10.

However, the results shown in Table 6 are not consistent with these hypothesises. In fact, they are turned around. We see that male researchers - compared to female - feel that they communicate better with clients, they have a greater appreciation of clients' contributions, and they place greater value upon practical problemsolving. Moreover, isolated problemsolving which theoretically should be a "masculinist" practice, is looked upon as favorable by women as by men.

On the other hand, Table 6 should be interpreted having in mind that the clients with which the researchers communicate probably in most cases are men. Female R&D scientists may experience this as difficult, feeling for example that they are not taken seriously. Anyway, it is difficult to refer to Table 6 as supporting the idea of a more "soft" style of work and thought of female researchers. Moreover, as we shall see, this conclusion is also supported by the results presented in Table 7.

Table 7 is based on a set of questions formulated to operationalize otherwise abstract concepts of "masculine" and "feminine" characteristics of science. While the operationalization obviously can be critized for being to blunt about complicated issues, it should nevertheless be seen as an effort to approach these issues empirically. The dimensions covered are:[19]

- traditional, "neutral" qualities of skilled scientists (creativity, theoretical skills, practical sense, accuracy, dexterous)
- "masculine" qualities relating to distance between scientist and object of research (ability to distinguish matter and person, objective, cool/sober),
- traditional values of "masculine hardship ideology" (patient/perserving, ability to withstand adversity, ability to keep deadlines, ability to work alone, concerned with career, stubborn/wilful),
- "feminine" values related to caring aspects of research (skilled at cooperating with others, intuition, ability to realize other people's problems, respecting nature's complexity, engaged in social/political issues).

There are three set of expectations which could be presented to such data:

1. One could expect gender differences in terms of female researchers having a different value system from male researchers. This argument could be sustained by much feminist research into such value systems.[20]

2. Also, the opposite argument could be made, based on the assumed effective selection and socialization process of engineering education.

3. One would expect to see the domination of perceived "masculine" values over "feminine" values, in concert with the theories of gender and science developed by e.g. Keller.[21]

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[19]The primary source of inspiration here is Keller, op. cit. See also Harding, op. cit. and C Merchant: The death of nature, San Fransisco: harper & Row, 1980.

[20]See e.g. C Gilligan: In a different voice, Cambrigde, Mass: Harvard University Press, 1982.

[21]Keller, op. cit.

The set of questions were formulated to map out perceptions of what characterized a prolific, skillful researcher. The main impression of the results shown in Table 7 is that they support the engineering education socialization hypothesis. There is no meaningful pattern of differences between the responses of male and female researchers, except perhaps that the male respondents tend somewhat more towards a heroic picture of research. The way the question was phrased, could be a barrier to voice alternative opinons, but this seem doubtful in the light of the results of Table 6.

Table 7. Per cent emphasizing strongly different characteristics according to their importance to identify a prolific researcher, in groups of male and female respondents and total sum.

Characteristic	Total	Male researchers	Female researchers	Diff. sign.*
Creative, inventive	76	76	77	n.s.
Skilled at cooperating with others	75	76	71	n.s.
Theoretical skills	71	71	69	n.s.
Practical sense	57	57	62	n.s.
Patient, perservering	55	54	58	n.s.
Accuracy	52	52	58	n.s.
Ability to withstand adversity	45	43	59	n.s.
Ability to distinguish matter and person	39	38	44	n.s.
Ability to keep deadlines	36	33	58	s.
Objective	34	33	40	n.s.
Intution	29	30	21	n.s.
Ability to work alone	27	27	29	n.s.
Ability to realize other people's problems	25	26	15	n.s.
Respecting nature's compexity	12	11	17	n.s.
Concerned with career	11	11	15	n.s.
Engaged in social/political issues	9	9	11	n.s.
Cool, sober	6	6	5	s.
Dexterous	5	5	5	n.s.
Stubborn, wilful	4	5	0	s.

*The test of significance of difference between responses of men and women is based on the Kruskal-Wallis one-way analysis of variance. Level of significance=0.10.

What then about the Keller hypothesis? In Table 7, the characteristics have been ranked according to their popularity among the respondents. Those characteristics that come out on top, are mostly those that are difficult to place in the "masculine" - "feminine" duality. Moreover, we see that cooperation skills - usually perceived a "feminine" trait, are valued highly by both men and women. However, moving further down the ranks, we do find some support for the Keller hypothesis. "Masculine" characteristics like "patient, perserving", "ability to withstand adversity", "ability to distinguish between matter and person", "ability to keep deadlines" and "objective" are ranked above "feminine" characteristics like "intuition", "ability to realize other people's problems", "respecting nature's complexity", and "engaged in social/political issues". That some more "heroic" features are ranked below these, does not change that conclusion, since these features are not included in the Keller hypothesis.

This does not mean that Table 7 gives unequivocal support to Keller's theory of a genderized science (or, in this case, of a genderized technological R&D). While we can see that the "masculine" features with which Keller has occupied herself dominates over the "feminine" alternative which she also has formulated, in accordance with her theory, to assume a clearcut polarity between "masculine" and "feminine" science appear nevertheless as problematic. Firstly, the difficulties of interpreting important characteristics of a skillfull researchers in terms of gender should warn us that there are a <u>common ground</u> of "masculine" and "feminine" science. Secondly, the domination of "masculine" over "feminine" values are not total. This reflects at least some of the problems of developing theories based on ideal types. While it may be true, as is asserted by object relations theory, that the stereotypical male is socialized to separate himself from others, a male population may nevertheless show conciderable variation in terms of this kind of socialization. There will always be a considerable proportion of males with more "feminine" values, and vice versa. Consequently, science and technology may thus be characterized by a less homogeneous value system than is assumed in some feminist (and other) theories of science.

Anyway, Table 7 represents a support of the assumptions of genderized technology, and thus some support of a part of the strong program. What is not supported by my data is the belief that the presence of women automatically make a difference. To be able to conclude on the latter issue, however, one would need data on choice of problems and such information cannot be presented here. One indicator that female researchers do make somewhat different choices is found in paragraph 4 in the fact that they specialize differently from men. The indicator is weak, but it may be taken as an encouragement to take the issue further.

7. Universalism and feminism in technology and science

The present study set out to compare the conditions of male and female researchers, working with technological R&D, and to analyze the possible impact of gender on technology, particularly in terms of conceptions of researcher's role. The empirical findings may briefly be summarized this way:

1. There is a sexual division of labour also inside technological R&D. This division of labour occurs both horisontally, men and women choosing different specialities, and vertically, men getting somewhat more managerial responsibilities than women. The horisontal division of labour may be interpreted as an indication of gender differences in the formulation of interesting research problems, but more research is needed to substantiate this interpretation.

2. There are differences in the opportunity structure of male and female researchers, primarily in terms of use of networks for professional exchanges. In most other respects, we find small, non-significant differences when we compare indicators of quality of projects, of access to material resources, and - surprisingly - of scientific productivity. The latter result suggests that the R&D corporation with a less clearly developed hiearchy, compared to universities, in fact gives women better opportunities than the universities. However, it is neccesary to inquire into the possible costs to women - in terms of stress and pressures - to keep up with male colleagues to be able to draw more general conclusions in this respect.

3. The results concerning gender and the practice of research does not sustain the idea of female researchers being more user-oriented and having different ideals of R&D work, compared to male researchers. However, some support of the hypothesis of a more general domination of "masculine" values

over "feminine" was found. The results are - at least to some extent - in accordance with the assumption of genderized science/technology, but the support is not very strong. Again, more empical work is needed.

Looking back on the model outlined in Figure 1 (p. 7), I will still argue that it seems to represent a fruitful basis for the intepretation of the results presented in this paper as well as for continued work in the same direction. The model is, as previously stated, an effort to to integrate important points from the weak and strong feminist programs. In particular, it tries to reflect the integration of an organization theory-based angle developed from the work of Rosbeth Moss Kanter and the social study of science-based approach of Evelyn Fox Keller. Such an integration seems necessary to be able to analyze gender with respect to both the theoretical and the instutional level of scientific and technological undertakings.

The model has not been tested in any strict sense through the data which I have presented. However, one important addition or correction could be made. My data suggest that "relations of gender in society" is a more important set of influences than "individual gender socialization". This suggest the modification of the model shown in Figure 2.

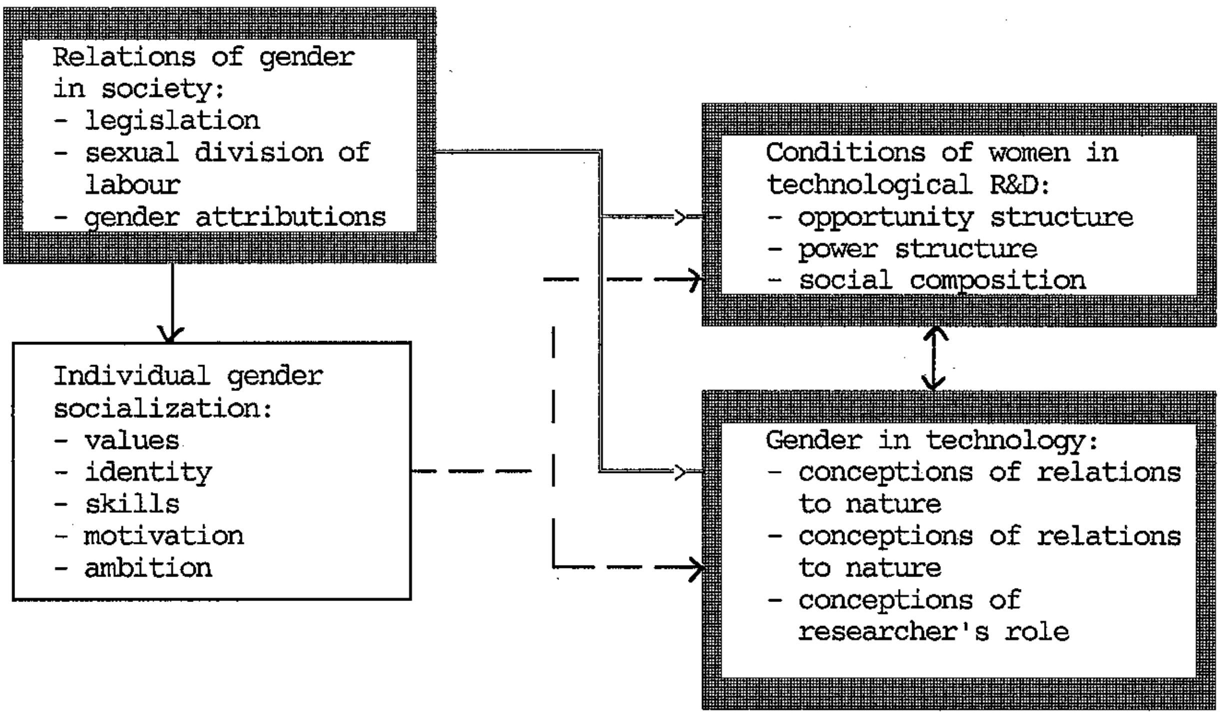

Figure 2. Model, version II.

This correction is not quite as innocent as it looks because the resulting model differs from all the three alternative theoretical approaches presented in the second paragraph of this paper: the post-Mertonian approach versus the weak feminist program versus the strong feminist program. While most of the findings reported previously may be accounted for by the post-Mertonian conception, there are (at least) two important exceptions: The horisontal division of labour and the ranking of values reported in Table 7. Consequently, we may defend the idea of gender _in_ technology which is fundamental break with the post-Mertonians. To both the weak and the strong feminist program, the small influence of the set of factors of "individual gender socialization" raises some problems, but they may not be as critical. The tentative conclusion would be that the weak program is "too weak", while the strong program seems a little "too strong".

When Merton formulated his famous four basic norms of science, he would outlaw the direct entry of politics and racism in the realms of science. Reflecting on the experience of Hitler and notions like "jewish physics" or the infamous case of Lysenko, the norm of universalism appears as necessary and beneficial. In a way, universalism could be considered to be beneficial also to women in technology and science. If this norm was followed, women should be treated on an equal footting with male R&D scientists - at least in terms of the perhaps most important characteristics of a scientist: his or her _credibility_.

However, to feminist critics, to march forward under the umbrella of universalism have proved unattractable, for at least two reasons. Firstly, historical experience has warned women against relying on the norm of universalism because there has been to much particularism.[22] Moreover, the etnographic surge in the social studies of science has shown that the evaluation of scientists' credibility undertaking by other scientists is a social process that _is not_ and _cannot_ be based on an abstract norm like universalism.[23] At best, some forms of particularism may be held at bay. Secondly, the ambition of feminist criticism goes further than equal opportunities. At least the strong program argues no less than the need for

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[22]See e.g. Rossiter, op. cit.

[23]See B Latour and S Woolgar: _Laboratory life_, Beverly Hills: Sage, 1979, in particular chapter 5.

reconsidering the basic value systems found in science and technology. Moreover, they would not acknowledge the usual liberal claim that socialization and experience are without impact on scientific work. On the contrary, differences in terms of socialization and experience is thought to produce different research problems, different conceptions of nature and society, and different methods to approach and solve scientific problems, and these dissimilarities may prove fruitful to the development of human knowledge.

While some of the results presented in this paper does not support the latter set of assumptions, they cannot be used to dismiss a more general argument that a greater consideration of values related to caring and caring activities is needed. They do, however, suggest that just to increase the number of female scientists and engineers is insufficient to produce this change of values.

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