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TOWARDS A FEMINIZED TECHNOLOGY

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1. Women in technology

A common observation about women and technology is that women are users but not makers of artefacts and systems.[1] Traditionally, there have been few female inventors and even fewer women doing R&D in science and technology. Historically, science has been a male-dominated area, and efforts was made to keep it that way.[2] Today, official rhetorics welcome women scientists, but it still proves difficult to women to obtain equal opportunities in practice.[3] Even in a country like Norway, which often is taken to be quite progressive in women's issues, the proportion of female scientists is small, about 5-6 %.

The absence of women from science and technology has been interpreted as having its parallel in the absence of reproductive or caring values in this area. In fact, it has been argued that modern science and (by inclusion) technology was developed within an ideological framework emphasizing masculinity, and, more spesifically, a mechanistic worldview, control over nature and distance between observer and observed.[4] The implications of this have been dramatically spelt out by authors like Carolyn Merchant or Brian Easley:[5] Masculinist science and technology has brought us the ecological crisis and the atomic bomb.

The above-mentioned efforts have given feminist critique of science and technology an extra momentum and a broader scope. Feminist are no longer constrained to analyze the dominated situation of women in science and technology and the sexism of traditional scientific knowledge. One can even argue that women - as carriers of reproductive or caring values - represent an important, even necessary, resource to reform science and technology. To increase the number of female scientists and engineers and to give them equal opportunities, may prepare the ground for a necessary - or at least wished-for - transformation of the scientific and technological fields.

This assertion does of course raise a lot of interesting and important questions about the nature of the relations between social interests and science and technology, and what impacts such interests may have on scientific knowledge and the design of technological artefacts and systems. This paper is meant as an effort to explore such issues within value dimensions usually taken to be related to gender. The point is not to test some either-or hypothesis about the impact of values upon science and technology. The assumption of a value-free science and technology has long since been falsified. However, this falsification does not mean that the impact of values is without limits.

The issue of women in science and technology as proponents of caring values has its theoretical basis in the model of women as stereotypically socialized to caring and motherhood, and consequently to be more empathic and other-oriented than men.[6] To Sandra Harding,[7] this model is the backbone of what she calls "the feminist standpoint epistemologies" which privilege women or feminists epistemically. Since women are socialized into a different, more progressive set of values than men, they are in a better position to promote a necessary transformation of the epistemological structure of science and technology.

However, the assumption that caring values in fact are able or allowed to influence science and technology should be questioned. For example may countervailing processes like selection and adaption to the particular environment of science and technology prove to be quite strong. Moreover, my own previous research on men and women working in technological R&D i Norway, suggests that the difference between men and women in terms of research-internal values is small.[8] This invites further inquiry into the matter.

This paper will not address the problem of gender values in science and technology in general. I will in the empirical part make use of data collected through surveys of Norwegian engineering students, of a cohort of young Norwegian engineers, and of scientists of a large Norwegian R&D institute. This means that the focus primarily is on technological R&D, not science and technological development outside R&D nor the uses of technology. The implications of this will be discussed in the conclusion. However, to clearify some of the issues at stake, I will begin by returning to the broader issue of the impact of values on science and technology.

2. Some difficulties with the assumptions of value-laden science and technology

Science and technology are produced through human efforts. Consequently, they are social activities which in principle are as sensitive to values as any other social activity. That means that individual or collective preferences will influence the outcome in some manner. However, historically, scientists have strived to be independent of their "sponsors", and the universities have succeeded in obtaining a considerable social autonomy with regard to political and cultural instutions. Efforts are made to reproduce this autonomy internally by making explicit political and cultural values illegitimate within scientific research. Thus science appear as value-free, at least to the general public. That values really do have an impact, is however difficult to deny when facing much evidence to this fact, but this characteristic is - to a surprising extent - regretted.

The situation of technology in this respect has traditionally been more complex and contradictory. Certainly, technology has been wedded to industrial interests with an explicit understanding that earning profits is a worthy purpose of R&D efforts. Technological R&D is in fact legitimized only through reference to its usefulness, in particular by its ability to serve the ruling elites of society: managers, owners of capital, political leaders, and military leaders. It is not assumed to have any cultural value in itself, like science which e.g. is taken to be a contribution to our general understanding of nature and consequently also to our understanding of "the human condition". In this sense the situation seems quite simple: Technology is embedded in values which direct its development.

But technology is also an ensemble of academic disciplines which was established in a context where traditional academical autonomy was held in esteem, and an understanding that long-term developments might require some freedom from short-term interests was soon established. This is evident from the establishment of technical universities which were characterized by conflicts between those who argued the importance of practical understanding of engineering work (and implicitly for less autonomy) and those who argued the importance of theoretical efforts (and explicitly for more autonomy).[9] Autonomy does not mean value-free, but it indicates that the influence of values may be more subtle and more difficult to trace.

Our present knowledge about the importance of values in science and technology comes mostly from studies of scientific and technological controversies.[10] In particular, studies of controversies with great political significance, like the debates about nuclear power, show how political and scientific/technological views tend to coincide. Also, work on technological developments with relations to struggles in industrial settings has shown the merging of managerial and engineering interests, or of the interests of male workers and engineers. Here, David Noble's analysis of the development of NC-machinery has been very influential. He shows - in my opinion very convincingly - how this machinery was the embodiment of a fusion of managerial, military, and engineering interests.[11] More explicit about the gender issue is Cynthia Cockburn's equally important and convincing study of the merging of patriarchal interests and technological development in the British printing industry.[12]

However, it is in my opinion severe problems in generalizing from these studies because they make the links between values and particular technological developments too simple and too obvious. Some European experiences with the use of NC-machinery has shown that this technology can be used to strengthen the position of skilled workers and in fact contribute to an upgrading of their skills.[13] The characteristics of this technology which David Noble carefully attributes to managerial interests in deskilling and increased control, turn out to lend themselves to a reinterpretation in terms of upgrading and autonomy. Of course, it cannot be denied that these managerial interests were very much present in the concrete development process of NC-machinery. What is in question here, is the possibility of interpreting this machinery as - in a strict sense - a materialization of these interests.

At least three different problems with this kind of interpretation can be identified. Firstly, we have the *problem of translation*. To what extent can values be translated unambiguously into characteristics of an artefact, and vice versa. Secondly, we have the *problem of overdetermination*. We should assume that technological communities are heterogeneous in terms of values, and consequently that there are more values than options in development and design of technology. Thirdly, we have the *problem of anarchy of decisions*. The development of solutions to technological problems should not be understood in the simplistic, linear terms of engineering textbooks. On the contrary, it seems as the metaphor of "muddling through" is a more accurate description. Thus it is difficult to assume that values explicitly and rationally are used as criterias in a well-ordered situation of technological choice.

These three problems pose two rather different challenges to the assumption of gender impacts on the development of technology. On the one hand, they suggest that the domination of masculine values may be of less importance to technological development than has been asserted. Moreover, they indicate a possibility that female caring values may be less constrained in the context of technology than is assumed. This is due to the suggestion of a more complex and diffuse relationship between values and technology. On the other hand, the three abovementioned problems also pose a barrier to an increased impact of caring values in the same sense that it is difficult to be sure that particular sets of values really are realized in development of technology.

There are several possibilities of approaching this problematic as a challenge to social science. The research strategy that will be employed in this paper, is to look more carefully into the system of values present in technological R&D communities and the conditions that produce this systems. The idea is that if general values are to have an effect on the outcome of the R&D work, these values have to be translated into values which in a more specific way direct the R&D work. This point may be illustrated by the model shown in Figure 1.

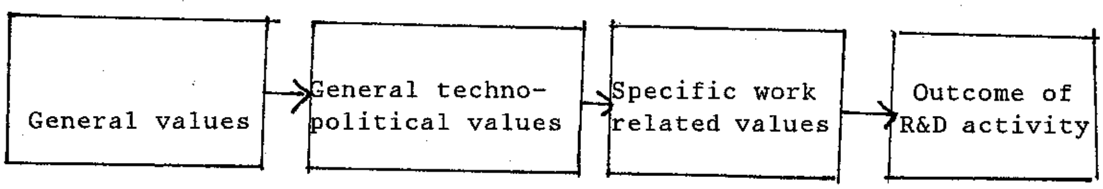

Figure 1.

In a very simplistic manner, Figure 1 suggests that the relationship between the general values of scientists and the outcome of the R&D activity they are engaged in, is a process of concretization or specification of these values. This process can be studied diachronically or or synchronically. In any case, we should note that both the normative model of scientific work and the traditional professional self-understanding assume that there is a rupture somewhere in the chain of Figure 1. To the professions as well as to the normative theorist of science, the outcome of an activity like R&D is *independent* of the values of the individuals involved. However, from the point of view of the feminist standpoint epistemologies, no rupture occurs in the process depicted in Figure 1. The outcome of R&D is *dependent* of the values of the individuals involved, and consequently dependent on their sex.

Generally speaking, both these models have good arguments to support their conclusion, although there has been little effort to examine the empirical validity of the arguments. This situation should make us sensitive to the possibilities that both models may be correct in the sense that their validity varies according to some characteristics of the context. For example, it seems reasonable to assume that the dependence model is the most accurate in situations characterized by techno-political conflicts which stimulates the translation from general values to specific values to action. Conflict implies debate which obviously increase the need for such translations. On the other hand, situations which are relatively free of conflicts, may make translations un-necessary. Then the independence model may prove to be the most correct.

The empirical material employed in this paper is collected in situations characterized by a low level of conflict. At least from a Norwegian perspective, this is also the most common context of technological R&D. Consequently, I start out by leaning towards the independence model. From this model, one derives the assumption that caring values, which in principle should be present in technological R&D through the presence of women, are not translated into the outcome of R&D work. However, this assumption has to be examined more closely by looking more carefully at some specific aspects of the translation process.

First, we should examine two important preconditions of the translation process: *selection and secondary socialization* of women in technological R&D. Both of these may prove to put out gender differences with respect to caring values, and consequently to weaken very much the basis of the translation process.

Second, we should examine how caring-oriented techno-political values may be transformed into work-related or work-directing values. Here, we need a better understanding of the "mechanics" of such transformations.

Third, we should look into the *organizational climate* of technological R&D. To what extent is the climate such that caring values become illegitimate?

Fourth, it could be suggested that the disciplines varies with respect to the possibilities of impact of caring values. To what extent do the language or *discursive structure of technological disciplines* offer possibilities of expressing caring values?

The rest of the paper is dedicated to analyzing and discussing these four aspects.

3. Does selection and socialization remove caring values?

Women in technological R&D are in principle twice selected, the first time when they choose an appropriate education (engineering or science), the second time when they choose a job in R&D. The popular assumption is that these women are rather masculine, more like men than like other women.

To us, the second of these selections are of less interest. Admittedly, we know little about this selection, but compared to most other options for female engineers and scientists, technological R&D does not seem to be particularly alien to caring values. Consequently, we can concentrate on the first selection process, the choice of an education in engineering or science, and the secondary socialization that takes place, initially through their education and then through working in R&D.

Studies of female engineering and science students, both from Scandinavian and other countries suggest that they can be characterized in the following way:[14]

- they identify more with their fathers and feel closer to them than women usually do.
- they score less on measures of femininity than other women.
- they come from high-status families.
- compared to male students, they are more radical in terms of techno-political values.
- compared to male students, they are more interested in social issues and their potential social usefulness, and less interested in future career prospects.

The fact that female engineering and science students seem to have a stronger identity towards their fathers and that they score less on measures of femininity, suggests that these women are less strongly socialized into caring values than the average woman. However, compared to male students, we still have strong indications that the female engineering students feel more inclined towards caring values. The selection process weaken the position of caring values, but it does not put them out. This assumption is also supported by Table 1 which is taken from a survey of first and second year engineering students at the Norwegian Institute of Technology (NTH). The Table shows the percentage of students expressing agreement with some techno-political statements.

Table 1 indicates that female engineering students are somewhat more progressive that male engineering students in terms of techno-political values. The differences are substantial, but not dramatic. Also, the Table shows that both male and female students agree that technology is mainly a good thing. Can these techno-political differences then be traced in values of a more work-related character? Results from the same survey, shown in Table 2, indicate an answer in the negative. Here the students were asked how important each of a set of criterias for choosing among technological solutions were in their personal opinion. For comparison, the results of a survey of a cohort of Norwegian engineers graduating in 1981/82 (the survey was done in 1985), using the same battery of questions, have been included.

Table 1. Percentage of NTH-students expressing agreement to the following statement, according to sex of respondents.[15]

Statements	Men	Women	Sign. of diff.
Engineers have a moral responsibility regarding the technology they take part in making	83	94	s.
New technology usually leads to improvements in society	70	71	n.s.
Too little money is spent today in Norway to develop new technology	76	50	s.
Military purposes have too much effect on technological R&D	57	77	s.
Technology is too seldom used to solve problems of common people	39	39	n.s.
Increased automation should be an important goal for the development of technology	24	6	s.

Level of significance is 0,05.

Table 2. Importance of different criteria for choosing among alternative solutions to technological problems. Percentage of students and graduates responding very important or important.[16]

	Students		Graduates	
Criteria	Per cent	Sex diff.	Per cent	Sex diff.
Userfriendliness	94	n.s.	90	n.s.
Economical in use	88	n.s.	76	n.s.
Sturdiness	75	n.s.	72	n.s.
Predictable performance	71	n.s.	76	n.s.
Economic to purchase	69	n.s.	56	n.s.
Fool-proof	44	n.s.	41	s.
Originality, making use of theoretical advances	44	n.s.	25	n.s.
Simplicity and elegance	35	s.	61	s.

Level of significance=0,05.

The results reported in Table 2 suggests that techno-political values have little impact on these, more work-related values. This can also be shown more explicitly by combining the variables of Table 1 with those of Table 2. However, we should note that both students and graduates attach much importance to userfriendliness - possibly the most important expression of caring values in Table 2. Moreover, with a view to educational and workplace socialization, it is interesting to note the similarity of responses of students and graduates. Only in the case of the criteria of "Simplicity and elegance" one can see a substantial change.

Table 2 may be a poor indicator of caring values. Such values are more easily discerned in Table 3. This Table is based on a set of questions formulated to operationalize the otherwise abstract concepts of "masculine" and "feminine" characteristics of science. While the operationalization obviously can be criticized for being too blunt about complicated issues, it should nevertheless be seen as an effort to approach these issues empirically. The dimensions covered are:[17]

- *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/willful),
- *"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).

This set of questions has been used in the previously reported survey of NTH-students and in a survey of scientists in a large Norwegian R&D institute. Since the introduction to the questions were phrased a little bit different in the two cases, I have chosen only to present whether or not male and female respondents gave significantly different answers. To address the point about the (lack of) impact of techno-political values, I have also used an indicator of techno-political radicalness to see whether it had any significant impact on the students's answers (unfortunately, the survey of scientists lacks such an indicator).

The main conclusion to be drawn from Table 3 is similar to the one from Table 2: The effect of techno-political values on values more specifically work-related is rather limited. However, among the students there is a clear tendency that being female and/or being radical in a techno-political sense to some extent increase the support of caring values. This tendency cannot be found among the scientists, a result that support the assumption that socialization make female scientists, relatively speaking, less inclined to bring forward caring values.

Table 3. Sex differences among scientists and students and techno-political differences among students in evaluating different characteristics of what they see as a good technological scientist.[18]

Characteristic	Sex diff. scientists	Sex diff. students	Techno-pol. diff. stud.
Creative, inventive	n.s.	n.s.	n.s.
Skilled at cooperating with others	n.s.	s.	n.s.
Theoretical skills	n.s.	n.s.	n.s.
Practical sense	n.s.	n.s.	n.s.
Patient, perservering	n.s.	s.	n.s.
Accuracy	n.s.	n.s.	n.s.
Ability to withstand adversity	n.s.	n.s.	n.s.
Ability to distinguish matter and person	n.s.	s.	n.s.
Ability to keep deadlines	s.	s.	n.s.
Objective	n.s.	n.s.	n.s.
Intuition	n.s.	n.s.	n.s.
Ability to work alone	n.s.	s.	s.
Ability to realize other people's problems	n.s.	n.s.	s.
Respecting nature's complexity	n.s.	n.s.	s.
Concerned with career	n.s.	s.	s.
Engaged in social/political issues	n.s.	s.	s.
Cool, sober	s.	n.s.	s.
Dexterous	n.s.	n.s.	n.s.
Stubborn, willful	s.	n.s.	n.s.

Level of significance=0,05.

The findings reported in this paragraph is mainly in accordance with the independence model. Selection and socialization seem to put out the difference between men and women in terms of support of caring values. However, one should note that among students, there is still a potential of such support. Is it possible that this potential can be revived in certain situations?

4. Can caring values be transformed into technology?

The results of the preceding paragraph suggests that care-related techno-political values are not or only to a small extent translated into work-related or work-directing values, at least when one uses the sex of the respondents as an indicator of the strength of individual caring values. However, some caution should be exercised before accepting this conclusion. To begin with, we have to consider the contradictory ranking of care-related values i Tables 2 and 3. In Table 2, the care-related value of userfriendliness is ranked above all the other criteria. In Table 3, the care-related values are ranked medium-to-low. This is most pronounced among scientists, while students rank some of the care-related values more highly.[19] However, this seemingly contradictory finding may be interpreted as a reminder of the importance of differing between the impact of values on *choice of problems* and on *solving problems*.

Do female technologists choose different problems from those that interest their male colleagues? To answer this question, one has first to take into consideration the fact that problems in technological R&D are not generated freely. In most cases, new ideas about interesting problems have to be sold to research councils or private companies to make them finance the project (see e.g. Sørensen 1987). The best option for choosing problems is concequently in choosing discipline, research speciality, and department.

In this respect, women act differently from men. Female Norwegian technologists are concentrated in chemistry and related fields.[20] Consequently, they choose problem-fields that are different from the stereotypical male technologist. The question is whether this can be interpreted as being related to caring values or not. To give an answer would be to demand a careful analysis of chemistry, compared to other technological fields. However, intuitively, there are some arguments to support the assumption of a relation between caring values and chemistry. Having in mind that such a relation has to be considered as a social product anyway, there are good reasons to believe that chemistry has been more closely related to caring activities than most other technological disciplines. In this context, it should be sufficient to remind that chemistry - compared to other technological disciplines - has played and still plays a very important role in medicine and nursing, in control of food and development of better nutrition, and in making housework and similar chores easier, less demanding and providing higher quality.

Whether women, given discipline, have a problem-developing behaviour which is different from that of men, remains an open question. Available evidence is contradictory. Pertinent in this respect is a very heated discussion that has been taking place in Norway around an alternative science policy report which was produced by four feminist social scientists.[21] This report argues the necessity to develop an alternative science policy, to a substantial extent based on caring values, and it assumes that this alternative is in accordance with women's interests in general. It is also taken for granted that feminist perspectives is relevant in all scientific and technological fields, consequently implying a different choice of problems of female scientists.

The report has been severely attacked by some senior female scientists who feel appalled by the assumption that they should be different as scientists, compared to their male colleagues. To the extent that their arguments indicates their own experiences as scientists, they suggest that there is no sex differences in terms of problemchoice. A recent study by Elisabeth Piene suggests otherwise.[22] She has examined male and female scientists in two different organizations, one small universtiy department doing bio-physics and one medium-sized contract-research institution, specializing in computer science and related fields. Piene finds that female scientists tend to be less interested in the purely technological dimension than their male colleagues. In bio-physics, this leads the women to choose problems related more to biology and organic matters than to the construction of instruments that interest several of the male scientists at the department. In the computer science institution, several women argued that they had chosen problems of a less technical character than their male colleagues. This did not mean that the problems necessarily were more "social", but that they were conceived as less conventional and in a way more "meta-technological".

Piene's results - together with the previous points made about chemistry - support the assumption that caring values, socialized into female scientists, are transformed to direct the choice of problems. This leads to a conclusion which is somewhat different from that of the preceding paragraph: A support of the dependence model. This support is nevertheless limited to problemchoice. Certainly, Piene does find that male computer scientists say they emphasize development criteria like efficiency and elegance more often than their female colleagues, but the difference is small. Moreover, she does not find any differences on other indicators of technological practice like style of work.[23]

Consequently, the material presented in this paragraph turn out to give some support the dependence model, in contrast to the material from the preceding paragraph. This contradiction may at least partly be resolved by pointing to the difference between arguing that values have impact on problemchoice and that they affect the ways problems are solved, i.e. the scientific practice of technology. Moreover, some of the results of paragraph 3 suggest that among female engineering students, there is a limited, but nevertheless important, potential for change in the direction assumed by the feminist standpoint epistemologies. Thus, it remains important to examine the conditions of realizing alternative values in technological R&D, in particular the organizational culture and the nature of technological discourses.

5. The organizational culture of technological R&D - a Procrustean bed of alternative values?

To assert that R&D institutions are creative, seems a banality. However, in practice, R&D balances creativity with discipline, order, and conservatism. This balance may vary substantially between institutions, in response to different environments and different traditions. To give a general account of the organizational culture of Norwegian institutions of technological R&D, is thus fairly difficult. The institute from which the survey data in paragraph 3 originates, consists of a host of departments that are quite different in terms of hierarchy, openness to new ideas, and possibilities to non-senior scientists of generating their own research agendas.[24]

Survey data from the junior scientists of this institute show no difference between men and women with respect to self-reported influence on the development of new projects, but male scientists have more frequent contact with clients that their female colleagues. Probably, they also have better access to financial possibilities of funding new projects, although that is not clear from the data.[25] The over-all picture of women's possibilities of realizing caring values is unclear. Some indicators suggest a positive view, but I think the majority are more negative. Here, it seems pertinent to remind of the following, potential obstacles:

- Technological R&D is funded mostly by private industry, eventually in collaboration with the research council for industrial affairs. This does not exclude the possibility of initiating projects characterized by caring values, but it does not make it very probable either - unless, of course, it should turn out that such projects should hold great industrial promise.
- Technological R&D is characterized by being mainly problemsolving in a very specialized manner. The transformation problem of caring values (or any social values, at that) is thus very striking. How does these values translate e.g. into the analysis of mono mood optical fibers or properties of fires in closed rooms? In fact, most scientists - men and women - experience substantial difficulties in relating their work to any social values. Probably, the organizational culture lacks the linguistic resources to produce such relations.
- In some departments, senior scientists - all male - dominate the formulation of new projects. Even in rather egalitarian departments, the process of developing sizable new projects involves a lot of networking where female scientists are handicapped. In nearly all departments, female scientists constitute a small minority. They thus face all the problems of tokenism, to use the concept of Kanter.[26] Gender relations thus pose important obstacles to the realization of alternative values.

Judging from standard accounts of technological R&D, very few believe that such institutions are favorable to alternative social values. It is not customary to believe them to be very favorable to women either. In this view, the argument that women (or feminists) should be able to impress the alternative values of caring upon R&D activities appears as fairly optimistic. However, we should be sensitive to the possibility that external changes may so-to-speak turn the cards or at least reshuffle them. A very pertinent example in this respect is the current environmental concerns. Such concerns may not necessarily pave the way for alternative values like caring, but they may produce a situation where values may be discussed more explicitly. This may improve the possibilities of caring values to influence R&D. Given the industrial environment, these possibilities will in the final analysis be dependent on whether caring values can be linked to a future of profits or not. In the management field, this has to some extent proved possible. Technology may however be tougher to break because its discourse is more homogeneous and less easy to change.

The obstacles to alternative social values posed by the structure of technology's discourse have probably been seriously underestimated. Of particular relevance here is the way that concepts of humans, human activity, and work gradually have been removed from the vocabulary offered by technological texts. A small study of texts on pulp and paper making which I made some years ago, show that even before the turn of the century, such texts consisted mostly of references to non-human elements: Machinery, raw materials, chemicals, chemical or mechanical processes, and so on. However, in older texts, the nature of necessary human efforts was an important subject.[27]

Today, the typical technological text describes only relations between the non-human elements of the particular process or artefact. Moreover, the text exhibits an inherent drive towards predictability and thus towards control.[28] The lack of reference to humans may be interpreted as the engineering utopia, realized in the text if not in reality. To change this historical transformation should be considered as fairly difficult, in particular since there is scant evidence of alternatives.

However, in those technological fields which for various reasons are forced to conceptualize human activities, the situation is different. The most prominent examples are probably ergonomics and information systems, the latter referred to previously. Ergonomics exhibit very visible expressions of the technological drive to make humanity extinct in its texts. In a textbook on man-machine systems, Sheridan and Ferrel expresses this in the following way:[29]

> "People may show grace, imagination, creativity, or feeling even in narrowly constrained tasks; but these qualities are too fine for the nets we cast in modeling and experiment. We have to be content to describe and predict at a more mundane level. Our frequent use of terms such as *operator* and *performance* instead of *person* or *behaviour* is meant to emphasize the engineering context and the relatively narrow range of human experience which it encompasses".

Both ergonomics and information systems are on the boundaries of the social and behavioural sciences, and these disciplines have a much higher risk of facing theoretical alternatives than do more traditional technological disciplines. This possibility of alternatives probably make these two technological disciplines more open to criticism, for example for not being in accordance with caring values. Such values translates more easily into the concepts and problems of these two disciplines, and moreover, the existence of alternative discourses facilitates the concretization of for example the meaning of caring values in relation to the discipline in question.

However, neither the organizational culture of technological R&D nor the impact of the discursive structure of technology should be assumed as a monolithic bulwark against alternative values. The organizational culture is complex and changing, and it gives at least some small openings for alternative views. The discursive structure of technology does make it difficult to conceptualize other relations to humans than control and automation, but practical and cultural demands may nevertheless support alternatives.[30]

6. A caring technology?

This paper has aimed at a closer examination of the validity of claims that an increase in the number of female technologists may change some characteristics of technology. The conclusions are by no means clearcut, but the evidence which has been presented, justifies neither the extreme feministic optimism nor pessimism. The women who are educated as engineers, although a select group, prove to give more support to values related to caring than the male students do. Although the differences becomes smaller when we look at values directly related to engineering work, design or development of technology, they do not totally disappear.

When we analyze the situation in the more exclusive field of technological R&D, there is considerable support of the hypothesis that work experience and the organizational climate socialize women to become very much alike their male colleagues. However, in the matter of problemchoice, there still seem to be an impact of women's caring values. This is by no means a small accomplishment, although the range of this impact is not clear.

Consequently, the independence model as well as the dependence model proves to be too simplistic. Since we may find independence in some instances, and dependence in others, we need better models.

One of the reasons that the conclusions remain diffuse, is that the subject matter - the possible relation between caring values and technology - is both slippery and very far-reaching. It is slippery because the relation is negotiable. As far as I can understand, it is not possible in an objective and universalistic manner to describe this relation. On the contrary, as the idea of what constitute caring values and how these values relate to characteristics of either artefacts or knowledge-producing structures may be transformed, the nature of the relation will also change.

Our problems in translating caring values into artefacts and systems of artefacts may also relate to the lack of technological conflicts that are focussed around such values. This is at least partly due to the way the women's movement has approached technological issues. Compared to the ecological movements, the women's movement has treated technology as a non-issue. The movement was generally critical, but very seldom was any concrete criticism raised. Consequently, from advertisements of houshold technology, we can see that the ecological movements have been far more successful in influencing the technological conditions of what mostly is women's work than the women's movement.

One could assume that technology would be able to change its appearance through substantial efforts in the environmental field. By bringing solutions to problems of pollution, changing climate, or scarce natural resources, the associations of technology might change from the hard and strong, to the soft and kind. We would probably conceive of technology then as being far more impressed by caring values, and it is reasonable to assume that this would lead to a substantial increase of the number of women interested in working with technological issues.

The problem is that this change could be brought about without any extensive transformation of the knowledge-producing structure of technology.

Technology could remain control-oriented, automative, highly specialized, etc. - in Merchant's and Keller's terms, still masculine. This brings out the far-reaching feature of the issue of technology and caring values: The necessity of an anti-positivist revolution in technology. The practical difficulties of bringing about such a revolution are evident. However, there are also great theoretical problems which can be hinted at by a brief look at the relation between ecology and caring values. Merchant argues that ecology is impressed by caring values, and in this matter, she is supported by the ecological movements as well as some parts of the women's movement. This attribution of progressiveness and caring to ecology is quite problematic, as is evident from some ecologists' efforts to model human societies. Indeed, there is very little substance to the argument that ecology is radically different from other sciences with respect to cognitive structure and style of work.

The environmental scenario of new attributions of technology is not the most probable one. In the fact, the 1980'ies have marked a revival of values like profits and competition, at the cost of caring. Technological innovation is much more aggressively oriented towards increasing productivity and surviving in the world market today than it was 15-20 years ago. If women continues to be stronger socialized into caring values than men, it may prove that fewer women will try a career in technological fields than we have experienced the last few years. This reduction will not by itself necessarily mean that caring values will have lesser impact, but it will signify a situation where this impact factually has been reduced.

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