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THE GENDERIZATION OF TECHNOLOGY
AMONG A SAMPLE OF CANADIAN ENGINEERING STUDENTS

BY

VALERIE S. NORLEN, B. A.

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of
the requirements for the degree of

Master of Arts

Department of Sociology and Anthropology

Carleton University

Ottawa, Ontario

June, 1989

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Thesis Supervisor

Acting Chairmen, Department of Sociology
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July, 1989

Abstract

Based upon an interest in both gender and technology, this thesis undertook a partial replication of a study of genderized technology conducted in Norway by Knut H. Sorenson and Anne-Jorunn Berg (1987). Survey material from a sample of Canadian engineering students provided evidence consistent with the Norwegians' proposed model of genderized technology, and its symbolic, institutional and behavioural components. At the institutional level, there was a gender division of labour whereby women tended to be least concentrated in departments with high male participation rates. It was argued that this division may partially be the result of the gender-typing of technological artefacts. While largely refraining from gender-typing artefacts, the students did gender-type artefacts linked with traditional male- or female-dominated activities. Minimal evidence consistent with the proposed relationship between symbolic and institutional genderization was found. Our data did not allow a proper test of any relationship between symbolic, institutional and behavioural genderization. At the latter level, evidence was found of a hegemonous 'masculine' style of work and thought valued in technological research. Although the students believed engineers to be responsible for technological developments, and evaluated this positively, others who control the utilization of technology were not always as positively evaluated.

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Valerie S. Norlen
Ottawa, Ontario
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CHAPTER I
INTRODUCTION

Technology pervades every area of our daily lives from the food we eat, to the cars we drive, the TV we watch, the machines we use for cooking and washing, even to the manner in which we determine who shall be the next generation, and when and how they shall be born (Ferguson, 1982: 8).

While we may realize how greatly technology 'pervades every area of our daily lives,' we tend to think of technology as socially neutral, developed autonomously through the application of scientific principles. Technology is part of our culture, however, and as such reflects the social relations in which it is embedded. Hence, technology is shaped by the past and present relations of gender which characterize Canadian culture, such that the concept of genderization of technology is an appropriate designation.¹

Scholars elsewhere have used similar such conceptions and their contributions, particularly that of Knut A. Sorenson and Anne-Jorunn Berg, will be drawn upon in this thesis. In an attempt to explore the applicability of such a concept within a Canadian context, we undertook a partial replication of a study conducted by Sorenson and Berg with Norwegian engineering students. Ninety-seven engineering students at a Canadian university were surveyed using a modified version of the questionnaire developed by Sorenson and Berg. In this thesis, we attempted to document the

¹ It is recognized that relations of race and capital also characterize Canadian society, and thus, the development and use of Canadian technology. In the context of this thesis, however, we will emphasize gender relations, and explore whether technology reflects the gender relations of the society in which it is developed and used.

manifestations of the genderization of technology among engineering students at three levels: the symbolic, the institutional, and the behavioural.

WHAT IS TECHNOLOGY?

Before we can consider how technology is genderized, we must first clarify how we define technology. Definitions of technology are notoriously unclear. Indeed, one of the themes of numerous discussions of technology is an attempt at definition (eg. Abrams, 1976; Mumford, 1967; Ellul, 1964).

Marx was among the earliest to recognize that technology is decisively shaped by the social relations in which it is embedded, and to systematically theorize these relations. Hence, his work provides a point at which to begin the search for a definition of technology. Marx argued that technology discloses

the process of production by which [man] sustains his life, and thereby also lays bare the mode of formation of his social relations, and of the mental conceptions that flow from them (Marx in Rosenberg, 1981: 9).

The method of historical materialism which Marx utilized was one which emphasized the interactions and conflicts of social classes and institutions. The focus of his discussions about technology was thus not upon the individual, but upon a collective, social process in which the institutional and economic environments played major roles. Contrary to his alleged technological determinism,

Marx did not posit some unidirectional chain of causation for technological change. Rather, he offered a far richer mode of analysis, one which emphasized the mutual interactions and feedbacks between the economy and technology (Rosenberg, 1981:11).

Specifically, Marx theorizes technology within the capitalist economy as a 'driver' of economic growth (ie. productivity). Although productivity grows through the exploitation of new and more extensive divisions of labour, a rigid ceiling to the growth in productivity continues to be imposed by the limitations of human strength, speed, and accuracy. Among others, Cooley (1980), Burawoy (1979, 1985), and Rinehart (1975) have noted how workers actively resist employer's attempts to compel them to maintain peak productivity, and how workers find ways to exert control over the labour process. The decisive step, then, is the development of technology which is not heavily dependent upon human skills or volition.

In capitalist society power-holding capitalists choose to design and implement technology according to four prime criteria: to assure (i) the continued existence of society, (ii) the accumulation of profit, (iii) the domination of the working class, and (iv) to repress their resistance to this domination. If capitalists are to prevent a deterioration of profit accumulation they have to assert control over the labour process, and override the human priorities of the

workers by the imperative of productivity (Cockburn, 1983: 87). This never-ending cost-cutting search involves the bringing in of new technology to bypass costly workers and increase productivity. Thus, technology, as a capitalist instrument of production, is constantly engaged in a dialectical interaction between the forces and relations of production: constantly being transformed by these forces and relations and in turn, transforming them; and thus lastly, involved in transforming society. As Marx and Engels (1948: 12) wrote in The Manifesto of the Communist Party,

The bourgeoisie cannot exist without constantly revolutionising the instruments of production, and thereby the relations of production, and with them the whole relations of society.

Marx's analysis, however, is not without its flaws. Although Marx acknowledged power as a major factor in defining technology, there is nothing in his analysis to suggest that men might have a relationship with technology different from that of women. He gives no indication that gender should be another major factor to be considered in any discussion of technology. In other words, his analysis is sex-blind.

In addition, Marx did not distinguish between the terms 'technology' and 'technique.' Because these terms are often used rather loosely, we need to do this carefully. A technique is a way of making or doing something: a particular product or a particular process. Technology

encompasses the knowledge that goes into creating techniques, and this knowledge may be used as a social tool in the course of power struggles. For example, within institutions established to advance technology, such as universities, professional societies, and company research laboratories, power relations operate to manage or control the access of 'outsiders' to that knowledge. Technology, then, encompasses the social relations involved in creating, changing, and sharing (or not sharing) knowledge about techniques (Faulkner and Arnold, 1985: 21). Hence technology is a system of power, of organization and control, not only of tools, knowledge, and procedures, but of people. Lastly, and perhaps most importantly, this power is male-centred. Throughout this paper, then, my working definition of 'technology' will refer to the totality of social relations involved in the production, transmission and acquisition of the knowledge associated with the techniques that are used to accomplish certain tasks in society; this totality most often governed by men's attempts to organize, control, and understand the world.²

WHAT IS GENDERIZATION?

To consider what is meant by the concept 'genderization of technology,' we must consider what genderization means,

² The word 'man' or 'men' and the male pronouns, as they are used in this thesis, are never meant to connote 'humanity' or 'humankind,' but refer specifically to males.

and in what ways technology is genderized.³ Genderization refers to the development of technology over a long historical period in conjunction with the growth of the white male, capitalist hierarchical system of power, such that technology enters into our gender identity:⁴

femininity is incompatible with technological competence; to feel technologically competent is to feel manly . . . (Cockburn, 1985: 12)

Thus by whatever contortions it takes, women are kept non-technological, incompatible with technology -- mentally and physically -- except in the controlled, supervised, guided role of operator. While women work competently and confidently with techniques every day, whether it be a food processor, a cash register, a washing machine, or a word processor, their relationship with technology teaches them nothing of the internal structure and processes of the techniques with which they work. The transferable technical knowledge and skills used in the design, manufacture, marketing, installing, servicing and managing of technology's associated techniques remain almost exclusively

³ The term 'genderization' is preferred over the term 'masculinization' because technological artefacts can be perceived as either 'feminine,' 'masculine,' or 'neutral.' In addition, the use of the term 'genderization' represents the existence of alternatives to the male monopolization of technology which results in the reinforcement of women's oppression. Lastly, it represents the recognition that both gender and technology are socially constructed categories. While they may feel like and are treated as constants, they are, in fact, variable and hence subject to change.

⁴ See Appendix A for a discussion of the term 'gender.'

a male possession. In this context, then, the genderization of technology refers to the monopoly men as a social group have over technology. As 'technopeasants,' those who do not understand technology, women are vulnerable to being used and abused by those who do (Menzies, 1982: 13). As a result men as a social group are in the position to dominate and manipulate women, and thus confirm the relations of sexual and capitalist oppression.⁵

Just as the gendering of men and women into 'masculine' and 'feminine' is a cultural process of immense power, the gendering of occupations and technology is as well. As outlined by the two Norwegian scholars mentioned earlier, Sorenson and Berg (1987: 155), the genderization of technology (i.e. the monopoly men as a social group share over technology) is potentially visible on three levels: the symbolic, the institutional, and the behavioural.

1. Genderized symbols and symbolism in technology ⁶

⁵ It should be noted that the argument presented in this chapter is not one of conspiracy. We are not conceptualizing men as consciously conspiring together to oppress women. Nevertheless, their actions serve to maintain the capitalist, patriarchal system of oppression. It should also be noted that within the context of this thesis, men and women are spoken of in terms of social groups and not as individuals.

⁶ One noticeable omission in the second level is the differential use of language by men and women. An extensive literature exists on the relationship between language usage and gender. There is a general consensus that the style of women's and men's language usage differs. The implications of this for research on genderization of technology at the level of symbolism, suggests that this may be another way to measurably document genderization at this level. In keeping with original Norwegian study and as a thorough investigation would be beyond the scope of this thesis, this subject will be excluded from the analysis.

- The perception of technological artefacts and fields in terms of 'masculinity' and 'femininity.'
 - The use of sex-related metaphors in research and development work.
2. Genderized institutions
- Internal gender division of labour
 - Discriminatory practices of recruitment and in the availability of funding, equipment, supervision, etc.
 - The relation between internal and external gender division of labour and the development of research problems/tasks.
3. Genderized styles of thought and work
- Emphasis on mastery, control, and domination of nature.
 - Emphasis on objectivity, lack of affection, and separation of investigator and the object of investigation.
 - Emphasis on instrumentality and rationalism.
 - Development of artefacts and systems of artefacts that are in accordance with dominant perceptions of probable users, including their gender, and with dominant aesthetical values which in turn may be characterized by notions of 'masculinity' or 'femininity' of the artefacts (eg. ships with female names which are described by the same words as men use to describe the physical characteristics of women).
 - Individualized, instrumental, and manipulative styles of work.

'MASCULINITY' AND 'FEMININITY'

It is advisable at this time to consider what we mean when we use the terms 'masculine' and 'feminine.' These terms are known in the academic literature as exceptionally difficult to define, although we all seem to have an intuitive sense of what these words mean. Consequently, we have to be careful not to suggest interpretations which rely on clearcut definitions of these concepts. As a reminder of these conceptual difficulties, quotation marks are used throughout this paper.

In the context of this academic inquiry, however, at

least a minimal level of meaning must be established. The following is based on the distinctions outlined by Sandra Bem (1974), and which social psychological research has found to be consistent over time and across various cultures. Williams and Best (1982), for example, found a remarkable similarity in conceptions of men's and women's characteristics among adults and young children in research covering thirty countries and five continents. 'Masculine' is used to refer to those psychological and behavioural characteristics that are widely supposed to be developed and displayed predominantly by men, while 'feminine' refers to those psychological and behavioural characteristics that are widely thought to be developed or displayed predominantly by women. In Canadian culture it appears that, very crudely speaking, such traits as self-control, aggressiveness, hardness, separatism, mastery, dominance of nature, objectivity, rationalism, and emotional reticence are widely seen to be qualities either ideally or actually possessed by men. Traits such as passivity, submissiveness, softness, connectedness, receptivity, emotionalism, and the capacity to nurture are widely seen to be qualities either actually or ideally possessed by women (cf. Wilson, 1986; Armstrong & Armstrong, 1978; Jaggar & Rothenberg, 1984). It should be noted that men and women who in no way conform to such cultural expectations are no threat to stereotypes, nor are a few individuals of the 'wrong' sex in any

predominantly one-sexed institutions (eg. women engineers). Kanter (1977: 206-242), investigating the significance of numerical distributions for behaviour, found that the life of women in the corporation was influenced by the proportions in which they found themselves. Those women who were few in number among male peers and often had "only woman" status became **tokens**: symbols of how-women-can-do. Despite their heightened visibility the women suffered from the men's tendency to encapsulate them in specific gender-congruent roles that the men could respond to and understand. Thus, the women's behaviour and characteristics were often distorted to fit pre-existing generalizations about their category/gender as a group. While this may serve to reduce ambiguity about how to behave around the "strange" person and provide a familiar role for the token, it also constrains the token's area of permissible and rewarded action. As a result the token's presence, characteristics and behaviour, while presenting a challenge to traditional expectations, could succeed in breaking neither these forms of social cognizing nor their behavioural antecedents.

It should also be noted that this division between males and females is not a sex-neutral categorization. The mutually exclusive, value-laden qualities associated with the social and economic roles that are prescribed for males and females in Canadian society are part of the capitalist system which privileges men. Ruth Schwarz-Cowan (1979: 62)

pointed to some of the dichotomies surrounding these roles and their relation to technology when she wrote:

While we socialize our men to aspire to feats of mastery, we socialize our women to aspire to feats of submission. Men are hard; women are soft. Men are meant to conquer nature; women irrational; men are practical, women impractical. Boys play with blocks; girls play with dolls. Men build; women inhabit. Men are active; women are passive. Men are good at mathematics; women are good at literature. If something is broken, daddy will fix it. If feelings are hurt mommy will salve them. We have trained our women to opt out of the technological order as much as we have trained our men to opt into it.

IN CONCLUSION

This quotation returns us to our consideration of technology as genderized, that is, as monopolized by men as a social group and hence characterized by their interests and priorities. The following chapter will review relevant literature, both social and feminist studies of technology, in order to demonstrate the legitimacy of the concept 'genderization of technology.' Chapter III will investigate men's and women's experiences as engineers using empirical sources in a further attempt to demonstrate this. The chapters beyond this will discuss the methodology (Chapter IV), data analyses and findings generated (Chapter V-VIII) by the present research into the genderization of technology among engineering students at a Canadian university. In Chapter IX we will conclude by discussing the implications of these findings for future studies of technology.

CHAPTER II
SUPPORT FROM THE FIELD: TECHNOLOGY
AS GENDERIZED

Technology is popularly perceived as a harbinger of progress; its design and implementation decreed by the laws of nature and scientific rationale. Technology, however, does not somehow 'spontaneously emerge' to determine independently the form a particular society takes. On the contrary, "technologies are found because they are sought; and are adopted, designed, released, applied, and controlled by those trying to protect their own interests" (Rowe, 1986: 23). Within the Canadian white capitalist hierarchical system of power those in the position to use technology 'to protect their own interests' are men: Men interested in protecting their privileges as men, and men interested in protecting their privileges as capitalists.

As noted in the previous chapter, both traditional and conventional views of technology conceptualize it as deterministic in its effects on society and socially neutral in its development and implementation.⁷ According to the technological determinism argument, technology [technique] develops not because of its relation to society or any particular class forces, but out of its own inevitable, inescapable logic. This fatalistic acceptance of technological change necessarily involves fatalistically accepting certain social changes and consequences. For

⁷ Note that this argument's definition of technology corresponds to the definition of technique given in Chapter 1. Henceforth, whenever the usage of the term 'technology' corresponds to the definition of technique, this will be represented as follows: technology [technique].

example, power driven machinery requires the use of a central power source, and thus also central workshops, factory production, repetitive work, and central supervision (Clawson, 1980: 42). The new organization of work -- the shift from home to factory production -- was not the result of particular interests; it was only the necessary but unintended consequences of technological progress. For this view to be valid, technology [techniques] would have to be independent of social forces, and, thus, in some way inevitable.

Marxist analyses, however, reveal that technology [techniques] is selected according to certain criteria and to serve certain purposes. These analyses argue that organizational change precedes technological change. Thus, the transitions from handicraft to manufacture to modern industry are social, not technological changes. To understand why these transitions occurred the interests of the capitalist class must be examined, not some independent technological force.

SOCIAL STUDIES OF TECHNOLOGY

In Labor and Monopoly Capital Harry Braverman (1974) uses a Marxist perspective to explain why production technology [techniques] has developed with an orientation around the issue of control. As discussed in the Introduction capitalists are ruled by the imperative of capital accumulation, a process which requires that the

workers' labour power be geared to this objective (p. 53). Workers, however, have a fundamental interest in not surrendering complete control over their labour power to capitalists. In this setting of antagonistic relations the problem for the capitalist becomes one of realizing the "full usefulness" of the labour power which has been purchased (p. 57). New systems of control which simply reorganize the work place by divorcing conception from execution cannot solve this problem entirely because the workers retained "their grip on the actual processes of labour" (p. 100).

Capital uses technology [techniques] to further control and dictate every step of the labour process, until the worker is reduced to the level of an instrument and is treated as a machine (p. 172- 173). In his analysis Braverman reveals that the effect of technology [techniques] on the worker is the product of the antagonistic relations of production between capital and labour, not of some immovable, rational force.

Braverman, like David Noble (1977), succeeds in lifting the 'technological veil' of determinism to reveal that ⁸

technology must inescapably reflect the contours of that particular social order which has produced and sustained it (Noble, xxii).

⁸ Others who have succeeded in revealing that technology is not 'value-free' include Marcuse, 1964; Ellul, 1964; Ferkiss, 1969; McDermot, 1969; Leiss, 1974; and Muller, 1970.

Thus far, we have used a Marxist framework which arguably explains the power relations associated with the capitalist mode of production, to examine the logic of technological innovation. As noted in the Introduction regarding Marx, however, there is nothing in these analyses to suggest that men might have a different relationship with technology [techniques] than women. For example, in Noble's American by Design one finds no indication that, as important as the division of technology [techniques] into conception and execution is, the question of **who** is conceiving and **who** is executing this technology [techniques].

As is evident from the previous discussion, the tradition of placing technology within its social context dates back to Marx. Although Marx and others have rightly perceived that technology became a tool of the new capitalist class in their struggle with workers, they failed to notice that the new capitalists were men and that, because of the new economic role of technology, capitalist technology is more inherently 'masculine' than any previous technology (Faulkner & Arnold, 1985: 47).

FEMINIST STUDIES OF TECHNOLOGY

Most pre-1980 studies of technology neglect the issue of gender, although emerging feminist analyses are increasingly addressing this omission. In her review of the

journal Technology and Culture⁹, Joan Rothschild (1983: xiii-xxii) documents this omission by conducting a content analysis. She found that despite having published ninety-three issues between 1959 and 1982, only four articles on 'women's subjects'¹⁰ have appeared in T&C (eg. Cowan's "From Virginia Dare to Virginia Slims"). Only twenty-three book reviews on "women's subjects" have appeared, less than the average number than generally appear in a single issue. As Rothschild points out, this is a particularly telling inditement against technological scholarship for the study of technology emerged from the Society for the History of Technology (SHOT) which established the journal. Writing in the initial issue, editor Melvin Kranzberg explained and supported the choice of the title, referring to the journal's commitment to publishing "general articles dealing with the relations of technology with society and culture as well as more specialized articles on the history of technological processes and devices" (ibid., xiii). Rothschild (1987: xv) concludes that although some individual women have gained professional recognition for their feminist contributions to this field within the last

⁹ Referred to hereafter as 'T&C' or 'the journal.'

¹⁰ The phrase "women's subjects" does not imply that other published articles on technology are not of interest to women. This designation refers to only those articles which specifically take note of women's relation to technology or of technology of particular relevance to women in, for example, its effects on women's employment in job ghettos.

few decades, this has yet to translate itself into any serious recognition that women and technology and feminist perspectives on technology are legitimate concerns.

It is these contributions which have provided the impetus to consider technology as genderized. Feminist studies of technology argue that technology (and techniques, as I define them) are characterized by 'masculinity' and influenced by 'masculine' interests. This 'masculinity', men's proprietorial grasp of technology, is a product of social history.

The manifestations of this are potentially visible on many different levels. In Britain, Cockburn (1983, 1985, 1986) has documented how men have acted to exclude women from the domain of technology through a variety of mechanisms, including union efforts, discrimination, and sexual harassment. She (1986: 93-113) argues that as capital developed forms of technological products and processes to break down workers' residual control of the labour process, trade societies and later unions used men's technical effectivity (relative familiarity with and control over technology) to resist the initiatives of capital in the context of the gradual industrialization of their trades. When, for example, a machine (ie. the linotype) was invented that could bypass the labour-intensive process of hand typesetting in the printing industry, compositors (those who set the type) demanded the absolute, exclusive right to the

machine (p. 100-101). In 1909-1910 the compositors' societies succeeded in achieving a ban of female apprentices and an agreement for natural wastage of women compositors and operators. The men's socio-political power enabled them to extend their technical effectivity from manual typesetting to control of the technique that replaced it (p. 102). Since the development of microtechnology and the electronic photo-composition it makes possible, the compositors' union, the National Graphical Association (NGA), has again fought to retain the right to the new equipment as it did to the old (p. 103). Attesting to their success is the fact that females in the closed-shop NGA until recently amounted to no more than two percent of its membership (p. 104). Hacker (1981: 341) has also found that a strong, predominantly white male union in the United States has retained control over photo-typesetting for its members. In her conclusion, Cockburn (1986: 98) argues that the appropriation of muscle, capability, tools and machines by men is an important source of women's subordination, and indeed, that it is part of the process by which females are constituted as women.¹¹

Reinforcing the exclusionary practices of unions is the discrimination and sexual harassment women face once they

¹¹ The argument briefly discussed here is fully articulated in Cockburn's Brothers: Male Dominance and Technological Change, Pluto Press, 1983.

have entered the 'forbidden sanctuary' of male technical training and employment, both white- and blue-collar. As a challenge to the stereotypes concerning what constitutes appropriate 'feminine' behaviour and 'female' work, these women are acting in direct opposition to the assumptions of a patriarchal society. Hence, all women employed in non-traditional occupations, whether it be blue-collar, working class (eg. Walshok, 1981) or white-collar professional employment (eg. Ross, 1979), suffer similar repercussions.

The sexual harassment which operates to further ghettoize women ranges from a general derision of women's competence, through tactical use of 'tits and arse' conversation, to actual physical molestation (Cockburn, 1985: 203). While most experiences of harassment were not considered 'severe' by the women, they had to endure, among other behaviours, "noisy belches, farts, and blue language . . . pin-ups . . . and direct passes" (Braid, 1979: 15-16). Walshok (1981: 236) found that "all women faced some form of negative reaction or initial harassment" when entering male dominated, blue-collar, technical jobs. Carothers and Krull (cited in Cockburn, 1983:203) have found that the form of harassment varies depending on whether one is employed in traditionally female jobs or male jobs. Harassment of women in male dominated work settings is typically more overtly hostile than harassment within traditional work settings which appears more often as hints and requests for dates.

Numerous researchers (eg. Walshok, 1981; Braid, 1979; Cherry, 1984; Cockburn, 1985) have suggested that the problems women face in non-traditional, technical work stems from the contradiction these women represent to society's assumptions regarding 'feminine' behaviour. As Cockburn (1985: 190) notes, when women step into the male work world they upset a widely accepted order of being characterized by a hegemonic ideology, that is, a broadly understood and accepted body of masculine ideals. Sexual harassment is the expression of the male workers' desire to maintain their technical effectivity (Cockburn, 1985: 203). By relating through obscenity, sexual stories and innuendo that directly objectify women, men effectively exclude women, and reinforce both bonds between themselves and the appropriation of the technological sphere for 'masculinity.' The exclusion of women from the technical sphere by men is one of the reasons feminists speak of the "gendered character of technology" (Cockburn, 1986: 112).

Experiences of sexual harassment are accompanied by other typical experiences among women in non-traditional, technical areas of employment. These include perceptions of themselves as 'oddities,' feelings of social and work-related isolation, and re-evaluations of self. These are all linked to the identification men share with technology and the conjunction of technology with 'masculinity.' The contradictions they feel between their socially defined

'feminine' selves and their lived 'masculine' roles result in their sense of themselves as workers and women changing.

As one mechanic told Braid (1979: 18)

It has taken me a long time to get to this point but my attitude towards femininity, now, is not that the external trappings make the person feminine or masculine, as much as simply that I am female. Therefore I am feminine and nothing that someone else can say is going to change that.

The antagonism between 'femininity' and technology which must be resolved if one is to function within the technical sphere, and the feelings of 'oddness' and isolation it accompanies contributes to the exclusion of women from the technical sphere. Clearly, by contributing to their exclusion, it also contributes to the appropriation of the technical sphere for 'masculinity.'

Technology is also linked with gender in the way in which men and women use different kinds of technological products, and use these differently. Traditionally and currently women are assigned responsibility for home and child care. In this way their involvement with technological products (eg. washing machines, vacuums) around the home differs from mens' (eg. car, lawnmower). Based on this gender ideology the labour force is also highly segregated. In 1983, seventy-seven percent of all female employees worked in just five occupational groups -- clerical, sales, service, teaching, and medicine and health. The non-professional categories -- clerical, sales and service --

are the largest of the 'female' occupational groups, accounting for sixty-two percent of all female workers in 1983 and fifty-seven percent of the overall growth in female employment between 1975 and 1983 (Statistics Canada, 1985: 43). Accompanying this occupational segregation are proportionately more women than men operating machines, being exposed to machines that have alienating effects, and suffering from the negative effects of technological change, utilization, and implementation.

In the United States, for example, Form and McMillen (1983: 147-175) found that the sexes are technologically separated. More women than men work with machines, but more women use either simple handtools or operate machines that perform repetitive tasks and restrict their physical mobility. More men are involved with technology [techniques] that requires skill and encourages work autonomy. Women also suffer more from technological change than men, particularly in the three areas of (i) interesting work, (ii) steadiness of employment, and (iii) opportunity for advancement. Although this study was carried out in the United States, because American women and men share a similar pattern of occupational segregation with Canadian women and men, we can tentatively suggest that these findings also apply to the Canadian labour force. Technology is genderized, then, because men and women use different kinds of technological products.

Technology, however, may also be viewed as genderized if women and men use these products differently. In her study of computer cultures Turkle (1984) found that female and male elementary-school-age children exhibit different relational styles in computer programming. Males and females tend to develop distinctive styles of mastery: hard and soft, respectively. Turkle (1984: 104-105) defines hard mastery as the imposition of one's will over the machine through the implementation of a program, an instrument of premeditated control. While hard mastery is comparable to a monologue, soft mastery is more like a conversation. It is an approach which allows the overall shape of a program to emerge through an interaction with the computer. She (1984: 117-119) also notes evidence of these styles among graduate students in computer science. Soft mastery, as Turkle describes it, is reminiscent of the style of scientific inquiry Barbara McClintok described using in her work on genetic transposition. When asked by her biographer, Evelyn Fox-Keller (1983: 197-198), what enables her to see further and deeper into the mysteries of genetics than her colleagues, her answer is simple.

. . . she tells use one must have the time to look, the patience to "hear what the material has to say to you," the openness to "let it come to you." Above all, one must have "a feeling for the organism."

Both Turkle's and Keller's investigations provide evidence of the way gender may be linked to different styles of work

and thought. In as far as approaches to technological work may be characterized by a similar division, we find further indications of technology as genderized.

Others have documented the disproportionately harsh impact the implementation of technological developments, primarily 'microchip,' both have had and will have on women's employment. As a result of the mass production of low cost computers and computer components in 'chip' form,

. . . there have been increasing developments in the use of microelectronic technology in robots, computer-aided design, electronic mail handling systems, electronic fund transfer systems, satellite systems for low-cost communications, improved traffic control systems, and a general and rapid trend in the use of computers in automating the storage, manipulation, and retrieval of vast quantities of information (Science Council of Canada, 1981:9).

It is this automation within the 'information (service) sector' which many predict will have a disproportionately harsh effect on women's employment and job conditions. Recall from previous discussion that this is the sector in which women's employment is concentrated. In addition, it is the sector which has absorbed women's rising labour force participation in the past, and is expected to do so in the future. Hence, any reorganization involving new techniques in this sector will disproportionately effect women. The literature which looks at the effects of microtechnology on women's employment within the service sector has found three general trends. First, there is a consistent decline taking place in labour requirements at the level of clerical and

sales workers and low-level supervisory, administrative staff. Second, the skills gap is growing between two levels of work -- information handling versus the use of information in analysis, decision-making, design, etc. Third, an increase is occurring in the fragmentation and routinization of service sector work.¹² Thus the differential impact of technology and its associated techniques on men and women is another factor which suggests that technology may be genderized.

IN CONCLUSION

To review briefly, the emerging feminist literature on technology suggests that the concept 'genderization of technology' may be appropriate because:

- Men act to exclude women from the technical sphere, for example, through discrimination and sexual harassment.
- Men use technology to dominate and control women.
- Men and women use technological products and processes differently.
- Men and women use different kinds of technological products and processes.
- Women suffer from more negative effects of technological developments than men.

The following chapter will examine empirical research done on men and women in engineering in an attempt to determine the extent to which the concept receives support

¹² These trends were documented in an unpublished paper (Norlen, 1987, Carleton University). Published documentation can be found in Armstrong, 1984; Arnold, Birke & Faulkner, 1981; Faulkner & Arnold, 1985; Hacker, 1982; Huws, 1982; Kuyek, 1979; Labour Canada, 1982; Manchee, 1984; Menzies, 1981 & 1982; Mirabelli, 1982; Neice, Snider & Zureik, 1982; Participatory Research Group, 1985; Peitchinis, 1982; Rothschild, 1983; Science Council of Canada, 1980 & 1981; Steid & Tiffin, 1986; Stinson, 1981; and Werskett, Stinson & Mathers, 1981.

from studies of this technical field.

CHAPTER III
PRELIMINARY INDICATIONS: THE GENDERIZATION OF
TECHNOLOGY AMONG ENGINEERS

Ours is a technological age and, as a result, we interact with technological products and processes in an innumerable number of ways every day. The gender related constructs of personal identity and of technology result in men and women having a different relationship with technology. Women's relationship with technology, the essence of which may be characterized by a 'lack,' is not inconsequential for their experiences with technology. More specifically, men's and women's differing relationship with technology has significant consequences for their experiences as technical workers, in this case, as professional engineers.¹³ In order to investigate how the genderization of technology may effect women's experiences within a male dominated technical profession, men's and women's experiences as engineers will be compared using empirical research.

CONCEPTUAL SPECIFICATION

Before reviewing men's and women's experiences as engineers to justify the use of the concept 'genderization of technology,' we must briefly specify the usage of certain terms. Terms such as 'technology,' 'masculine,' 'feminine,' 'relationship,' and 'experience' are problematic when left undefined because they elicit numerous, even contradictory

¹³ Throughout this chapter whenever the term engineer is used it refers to someone who is a member of one of the professional associations of engineers.

connotations. 'Technology,' 'masculine,' and 'feminine' are defined in the Introductory Chapter. The meanings of the terms 'relationship' and 'experience' have not as yet been clarified. A relationship may be defined as any connection or association that prevails between two or more persons and/or things (Oxford English Dictionary, 1971: 2478). Within the context of this paper, then, it refers to the cultural connection or association that prevails between women as a social group and technology as a result of the genderization of technology. Experience, in the context of this chapter, is defined as the personal participation, observation, and/or perceptions by men and women of any external event or activity.

WHY ENGINEERS?

Another point that deserves clarification concerns the choice of engineers to demonstrate the impact of genderized technology on men's and women's experiences as technical workers. Professional engineering, as opposed to other technical occupations, is particularly well suited to demonstrate this impact for one primary reason. This reason concerns the unique position engineers occupy as **generators** of techniques, that is, particular products and processes, and also technology, the knowledge that goes into creating techniques. While there are four possible ways men and women may relate to technology and/or techniques -- they can be 'generators,' the engineers and scientists who conceive new

technological developments; they can be 'constructors,' the skilled and semi-skilled craft workers who build machines, roads, etc.; they can be 'assemblers,' the unskilled workers who, for example, manufacture technological components, and they can be 'consumers,' using cars, trains, hair dryers, fridges, etc. For the most part women are neither the generators nor the constructors; many are assemblers but all are consumers.¹⁴ Men, on the other hand, encompass all the possibilities outlined above.

Consequently, while most paid and unpaid work now relies heavily upon techniques, they do so in ways that involve applying, utilizing, manipulating, and even exploiting these techniques. Producing, designing, developing, inventing and creating, however, are all tasks of the engineer. Hence, any effect that men's and women's relationship with technology may have on their experiences as technical workers is likely to be accentuated in the engineering profession, and thus observable and measurable. In other words, they are particularly well suited to making visible the uneven gender impact of genderized technology.

THE RELATIONSHIP BETWEEN MEN, WOMEN & TECHNOLOGY

Feminist theory has made it clear that we cannot allow gender to be treated as a "natural" category. Gender is neither simply the manifestation of sex, nor simply an

¹⁴ This breakdown is based on the one used by Griffiths (1985).

easily dispensable artefact of culture. It is, instead, what culture makes of sex -- it is the cultural transformation of males and females into men and women. While all cultures do this somewhat differently, how they organize the human attributes around sex has a significant impact on the world beyond sex -- on technology. The same cultural process that names objective and rational as male and subjective and irrational as female, also, and simultaneously names 'technology' as male and 'nature' as female. The same sexual division of intellectual and emotional labour that frames the maturation of males and females into men and women also, and simultaneously, divides the practices and bodies of knowledge we call technology from those we call 'not-technology.' Modern technology has been constituted around a set of exclusionary oppositions in which that which is named feminine is excluded, and that which is excluded -- be it subjectivity, nature, intimacy, or relatedness, is named female. The transferable technical knowledge and skills used in the design, manufacture, marketing, installing, servicing and managing of techniques remains almost exclusively a male possession.

Despite the fact that between 1970 and 1983 the number of women engaging in some form of paid work almost doubled, in 1983 seventy-seven per cent of all female employees worked in just five occupational categories --- clerical, service, sales, medicine and health, and teaching

(Statistics Canada, 1985: 41-43). These occupations generally involve low-prestige, low-paying, repetitious, routine jobs with little opportunity for advancement. Men, in contrast, are engaged in a far wider range of occupations and monopolize the highest ranks of both the occupations they dominate and the ones women do. The technologists, with few exceptions, are men. Women play the support role of office secretary to the professional engineer. Women continue to be rarities in those occupations that involve knowing about what goes on inside the machine. The flexible, transferable skills of engineering are still the property of men. In 1983 out of a total of approximately 115 000 engineers in Canada, there were only just over 1400 women -- 1.2% of the total population of engineers (SECOR Inc., 1983: 1-2). Hence technological competence is a factor in the segregation of occupations by gender: Women clustering in jobs that require little or none, men spreading across a wider range of occupations which include those that call for technological competence. There is nothing 'natural' about this affinity of men to technology. It has, like gender itself, been developed in a social process over a long historical period in conjunction with the growth of hierarchical systems of power. In this context, then, the genderization of technology refers to the appropriation of technology by men as a social group with the result that technology is an aspect of the 'masculine' gender identity

and is in opposition to the 'feminine' gender identity.

This genderization culminates in men and women having a different relationship with technology. As defined near the beginning of this chapter, relationship refers to the cultural connection or association that prevails between all women and technology as a result of the genderization of technology. As implied in the above discussion of men's and women's involvement with technology in the labour force, women's relationship with technology is characterized by a 'lack' --a lack of access, of familiarity, of control and of knowledge. It is one of separation, estrangement, isolation, exclusion, and prohibition --- the essence of which may be characterized by the use of the term 'lack.'

While women's individual contacts with technology do vary, because 'masculinity' and 'femininity' are exclusionary categories and technological competence is allied with 'masculinity,' all women share the same relationship with technology. Similarly, all men regardless of individual variation, because of a cultural tradition that assigns them technical competence, share the same positive relationship with technology. And while it is self evident that not all men are technologically skilled or knowledgeable, by virtue of what they are (ie. men) technological skill and knowledge accrues to them. On the other hand, women whether they possess technological skill and knowledge or not, are denied this capacity and even the

opportunity to develop it. Technology remains a male domain, whether it is as male capitalists who manage technology, as male workers who design, manufacture, market, install, and/or service techniques, or as men who feel comfortable 'tinkering' with a car engine. Hence, all women share the same 'lack', the essence of their relationship with technology.

While the term 'lack' may imply that women's relationship to technology is actually a 'non-relationship,' I refrain from using this term for two reasons. First, women use techniques every day in an unaccountable number of ways, despite our society's failure to recognize this. Second, and most importantly, 'non-relationship' implies that women's lack of access, of familiarity, of control, and of knowledge is inconsequential. On the contrary, the effect on women as people and as workers of their relationship with technology is of immense proportions. Including the occupational segregation mentioned above, it results in a critical problem of identity for any women technologist since "to feel technologically competent is to feel manly" (Cockburn, 1985: 12). Their femininity may even be called into question by others.

Just how inconsequential this relationship is **not** will be explored by comparing men's and women's experiences as technical workers, in this case as engineers, in order to identify evidence of the genderization of technology at the

levels of the institution, the symbolic, and the behavioural.¹⁵

EVIDENCE FOR INSTITUTIONAL GENDERIZATION AMONG ENGINEERS

If technology is genderized then women are more likely to choose and/or be allocated to fields of engineering that are less threatening in terms of their identification of artefacts as masculine, and their orientation towards research styles centred on competition, aggression, and domination of nature. Hence this level of genderization may be revealed by the internal gender division of labour, as well as discriminatory practices of recruitment, promotion, availability of funding, supervision, etc.

As previously mentioned, in 1983 women comprised less than 2% of the total population of professional engineers in Canada (SECOR Inc., 1983: 1-2). In 1988 they comprised 2.6% of professional engineers (Canadian Engineering Manpower Board, 1988: 7). Hence in 1988 there were a little over two times the number of women professional engineers in Canada than there were in 1983. While this constitutes a significant increase over five years, 97.4% of professional engineers are men.¹⁶ Clearly, the engineering profession is

¹⁵ Refer to the Introduction (p. 8-9) for a breakdown of these three levels.

¹⁶ It is important to note that these statistics refer only to professional engineers, ie. engineers who are members of any of the twelve provincial/territorial professional engineering associations. Therefore, there is no data available on the numbers of men and women who have graduated with engineering degrees, either in or out of the labour force, but who are not registered professional engineers. There

highly male-dominated.

This is also true of countries other than Canada. At the Norwegian Institute of Technology the percentage of women remains in the minority despite the increase among first-year students from 5.4% in 1972 to 26.8% in 1985 (Sorenson & Berg, 1987: 153). In Britain although women constituted about 22% of all employees in the engineering industry, they comprised only 2.6% of the scientists and technologists (Cockburn, 1983: 16). Similarly, in the United States in 1985 women comprised 6% of those in the engineering work force (Estrin, 1985: 181).

Consequently, women studying engineering are breaking with the traditional gender division of labour. Thus it is interesting -- and a bit disconcerting -- to notice that a gender division of labour is reproduced also within the engineering profession. Women engineering students tend to be concentrated in a limited number of specializations, specifically within the 'traditional' ones. About a third of all women are civil engineers, the branch with the largest number of women. Chemical, electrical and electronic, and mechanical engineering each contain about 10% of the total number of women engineers (Ellis, 1986: 59). There are

is reason, however, to suspect that the numbers are considerable. The 1988 Salary and Opinion Survey conducted for the Electronic Engineering Times (Oct. 17, 1988) found that only half of its readers belonged to any professional society. There is no information on whether men are more likely than women to belong to professional associations, or vice versa.

almost no women in the more recent or specific specialities, such as computer engineering, systems engineering, or fuels and material engineering. The gender division of labour within engineering education will be discussed at length in Chapter VII.

The most recent survey of professional engineers conducted by the Canadian Council of Professional Engineers (1988: 4-5) compiled information under the following five headings:

1. BIOGRAPHY - Surname, Date of Birth, Area of Residence, Birthplace, Sex, Language Skills, Year of Entry to Canada (if applicable)
2. REGISTRATION - Association Membership (Category), Status of Membership, Year of Initial Registration, Process for Registration
3. EDUCATION - Degrees Received, Discipline of Study, Degrees by Country, Degrees by Year
4. EMPLOYMENT - Employment Status, Industry
5. OCCUPATION - Nature of Job, Skill Speciality, Level of Responsibility

Clearly, this provides a wealth of information about the 130,000 professional engineers in Canada. Unfortunately, although the Council included gender as a variable, they did not use it to investigate whether, for example, men and women are distributed differently among industries, receive different degrees or numbers of degrees, and/or differ in the nature of the job performed, skill speciality, or level of responsibility. This is a problem which plagues much research on engineers. Therefore, we can not draw conclusions from this data source concerning women's division of labour either between or within engineering

fields. Similarly, the data do not lend themselves to a discussion of discrimination.

Numerous studies document the existence of discrimination in recruitment, hiring, training, supervisory responsibility, and salary. Jagacinski (1987), for example, found that increases in job status, supervisory level and salary with experience were greater for men than women. In a recent study by the United States' National Research Council, academically employed women in all fields of science and all age levels were less often tenured than men faculty (Malcolm, 1985: 193). In the twenty-five leading U. S. universities, women faculty in engineering were twice as likely as their male counterparts to be hired for positions without a future (Hornig, 1984: 40). Merringer and Rose (1980) found that a disproportionate number of women in science and engineering are in the lowest ranks of American academia, particularly in short-term, non-tenured research positions. When looking at graduate science (including engineering) students, Lasvergnas-Gremy (1983) found that women have only half the chance of men to be involved in research project teams. Though women are engaged in scientific study they are discriminated against by not being co-opted for research teams.

We can conclude, then, that women's and men's experiences of education and employment in engineering are differentiated along gender lines. In other words, there is

research which indicates that the genderization of technology is visible at the level of the institution. There is also evidence which suggests that this may be linked to genderized styles of work and thought among engineers.

EVIDENCE FOR BEHAVIOURAL GENDERIZATION AMONG ENGINEERS

Sally Hacker (1981), based on research at a technical institute, argues that there is a 'culture of engineering' which includes an extension of the profession's formal objectification of the natural world to an informal objectification of women. Engineers exhibited a persistent mind/body dualism, subordinating sexuality and the body, and elevating scientific abstraction. They valued social hierarchy on a continuum giving most prestige to this abstraction and least to feminine qualities. She suggests that women's under-representation in engineering may be linked in part to a dislike of the field's culture. Hacker's engineering culture corresponds to the genderized styles of work and thought outlined by Sorenson and Berg (1987: 155) as emphasizing the domination of nature, objectivity, separation of investigator and the object of investigation, and rationality. Another indication that the engineering culture is genderized is found in Robin (1969). He found that the introduction of 'feminine' norms into the student engineering role reduced performance in grades, while the reduction of 'reminine' norms yielded an increase.

Cockburn (1983: 17) argues that the absence of women in

engineering is linked not simply with a 'dislike' of the technical field: women are being repelled by it. When women enter a technical profession a conflict occurs between two series of polarized characteristics, those associated with masculinity and those associated with femininity.

There is a variety of research which supports both Hacker's discovery of a 'culture of engineering' and the conflict it engenders for women engineers. Bailyn (1987) probed the experiences of technical work for men and women engineers, and the differences between them. She suggested that women experience conflict over the role technical expertise plays in their careers. Female engineers had lower self-confidence than men, and their self-confidence was more strongly related to perceived success in their lives outside of work. It was negatively related to the importance attached to the opportunity to develop technical expertise. The reasons for this seemed not to lie in complications stemming from women's multiple roles, but rather to the singular, more 'masculine' way that technical work is defined (Bailyn, 1987: 299). The findings of Cooper and Robinson (1987) also indicate the value women place on their lives outside of work. They found that among engineering students females experience greater conflict between the importance of their work and home values than do males.

This research also suggests that the genderization of technology is related to the division of labour within the

engineering work world. If women attach less importance to the opportunity to develop technical expertise, they may be less oriented towards strictly technical jobs or technical ladders of advancement. Bailyn (1987), however, does not provide information on this possibility. It is also possible that women whose self-identity is not in conflict with the 'culture of engineering' and the 'masculine' way in which technical work is defined, may have different work experiences than women who are experiencing significant conflict.

Jagacinski's (1987) research provides some support for this speculation. She investigated the relationship of sex-typed traits to performance and satisfaction in engineering. She found that both males and females high in instrumentality (androgynous and masculine) reported greater levels of supervisory and technical responsibility, salary, involvement in professional activities, and satisfaction than those low in instrumentality (feminine and undifferentiated).

The research reviewed above indicates that engineering is characterized by genderized styles of both thought and work. Because there is a continuum between the attitude one takes toward the material one studies, to the methodology one selects as ideal for one's studies, to the kinds of theories and explanations one considers appropriate, styles of thought and work are inextricably linked. All of the

research discussed suggest explanations for their findings based on a view of technical work as 'gender alien' for women. Thus, there is some evidence to justify the use of the concept 'genderization of technology' at both the level of the institution and the behavioural. But is there any evidence, other than Sorenson and Berg's, of genderization at the symbolic level?

EVIDENCE FOR SYMBOLIC GENDERIZATION AMONG ENGINEERS

Analyzing language codes, Lakoff (1983) argues that technical codes can be understood as exaggerations of masculine distancing, a power-based strategy involving impersonality and non-emotionality. Since the code is based upon an exaggeration of a male style of interaction, it is relatively easier for men to assimilate. Because of the hidden implication that anyone who cannot use the language is unworthy of membership in the 'club,' the burden is on women to prove their worth. This involves two choices for the woman, neither of them comfortable, regarding use of the technical code. On the one hand, she can accept the male model. The model's formal technical vocabulary, however, tends to drive out normal -- that is, emotionally punctuated -- discourse, the form of discourse with which she is most familiar. On the other hand, she may use her own 'native language,' one centred on emotional expression and which is invariably devalued as imprecise, unscientific and subjective. If she chooses this option, she is unlikely to

be taken seriously since lack of competence with the technical code deems her incompetent. Thus, the 'fit' between a man's language and the technical code and the lack of 'fit' women experience operates as an exclusionary mechanism. In other words, a gendered system of technical symbolism operates against the inclusion of women.

Although not mentioned by Sorenson and Berg (1987), another indication of genderized symbolism in technology is the use of jokes which transmit certain values. Within the engineering institute, Hacker (1981) found that wives, students and others with relatively less power were frequently the butt of jokes. This apparently harmless humour exalts sophistication, technical competence, and abstraction while devaluing those experiences and qualities gender-linked with females -- intimacy, sensuality, the body, and social complexity.

In Hacker's and Lakoff's research we find evidence of genderized symbolism in both formal vocabulary and informal humour. Currently, there are few studies of engineers which suggest that artefacts are genderized. Although Hacker (1981) does not deal with it in depth, she does speak of the 'sexualization' of technology. She found that machines and devices, as well as styles of interaction, jobs, and bodies of knowledge were often characterized as having 'masculine' or 'feminine' properties appropriate to men or women (Hacker: 342). Benston (1983) also suggests that tools and

activities may be gender-typed. Hence, we find some limited evidence for the genderization of technology at the symbolic level.

IN CONCLUSION

In this chapter we have conducted a review of the relevant research on male and female engineers for signs of the genderization of technology at three levels: (i) the institution; (ii) the behavioural; and (iii) the symbolic. Readers should be cautious, however, in interpreting the research presented here as evidence of the genderization of technology. Virtually all of the available research has neglected women's experiences as technical employees and the studies which have been done often do not provide a male comparison sample. In addition, although we know a great deal about the technical careers of men, social studies of technology are still in their infancy so what research does exist does not consider how the social nature of technology has an impact on the experiences of male technical employees. The lack of specifically Canadian analyses is also problematic. These limitations culminate in a body of research which largely does not consider the impact of the genderization of technology on men's and women's experiences as technical workers.

Nevertheless, current research did provide some indications of genderized technology at the three postulated levels. Hence, probing the available research for

indications of the genderization of technology has been a worthwhile endeavour. The following chapters will review the evidence produced by the current research into the genderization of technology among engineering students.

CHAPTER IV
METHODOLOGICAL CONSIDERATIONS

In the previous chapters the problem of this thesis, that of identifying the genderization of technology, has been approached in the context of both social and feminist studies of technology, and empirical research on engineers. In this chapter we will introduce the study that was performed to investigate this problem. First, a brief discussion of the questionnaire development will be presented, followed by a review of the students' reactions to the questionnaire. The students' response rates and sample sizes by gender and engineering department are then examined. An outline of the thesis's basic survey methodology reviews the strategy of analysis implemented, the nature of the data generated, and both the exploratory and confirmatory statistical procedures used. Lastly, we consider the contradiction presented to knowledge production by the paradigm governing survey analysis and its restriction of analysis to only those responses prompted by specific questions.

QUESTIONNAIRE DEVELOPMENT

The data to be drawn upon in this thesis was generated by a partial replication of a study performed by Knut H. Sorenson and Anne-Jorunn Berg for the Institute for Social Research in Industry in Trondheim, Norway. In response to a request for the questionnaire they had utilized, a copy was promptly received. As it was in Norwegian, the first task

entailed having it translated into English.¹⁷ This was performed by a professional translator. An initial reading of the questionnaire revealed that only minor modifications were required: (i) the paragraph of introduction required revision to make it appropriate for use with engineering students at a Canadian university (Carleton University); (ii) questionnaire item no. 2 was divided into two items, one referring to professional engineering associations of relevance to Canadian engineering students, and the other referring to relevant labour organizations; (iii) two questionnaire items (no.'s 12 and 13) were inserted to measure the gendered division of labour; (iv) item no. 14 was added to investigate genderized styles of work and thought; and (v) because problems of translation left the meaning of questionnaire items no. 7, 8 and 9 unclear, their wording changed from, for example:

7. Can you with the help of 3 to 6 cue words describe what for you is characteristic for a type of technology which you associate with manly or masculine?

to:

Please list from three to six words (adjectives or nouns) which describe a type of technology that you think is manly or masculine.

Minor modifications were also performed on questionnaire items no.'s 4, 6, 10 and 11 to make it unlikely that participants may misinterpret them. Space for comments was

¹⁷ Refer to Appendix B for a copy of the translated questionnaire.

provided as a final questionnaire item.

In October of 1988, the revised questionnaire was pre-tested using eight fourth-year students, two women and six men, at Carleton University, Faculty of Engineering. Third-year engineering students could not be used since it was the intention of this study to survey the entire third-year population. On the basis of the pilot study a small number of changes were made to the questionnaire. Instructions for questionnaire items no. 1, 6, 10, 11 and 12 were altered to further clarify what it was they requested. As a result of an oral consensus reached by these students after they had completed the questionnaire, a last item (no. 18) was added. This allowed the students to indicate if they would be willing to be interviewed briefly at some later date. Additionally, it provided an excellent option for the researcher in regards to future studies. These alterations resulted in the final draft of the questionnaire.¹⁸

FIELD METHODS

On November 10, 1988, the questionnaire was administered to third-year engineering students at Carleton University. Engineering students were used as in the original Norwegian study. The Norwegian study used second-year students who were close to finishing their second school year. As this survey was to take place early in the

¹⁸ Refer to Appendix C for a copy of the questionnaire utilized in the study.

school year, it was decided that third-year engineering students would provide a better comparative sample than students just beginning their second year. As noted by Sorenson and Berg (1987: 152) there were several reasons for choosing engineering students:

First, they appear to have quite strong beliefs in the autonomy of technology, and they have a quite close relationship with and knowledge about technology. Second, the perceptions of engineering students are of particular interest because their viewpoints may be important to future developments in the technological fields. Third, the present, steep increase in the number of female engineering students makes it important to analyse the possibility that genderization of technology may affect their choice of speciality and their career patterns.

In Canada the numbers of women entering and graduating from engineering faculties has not risen as rapidly as in Norway. At the Norwegian Institute of Technology the percentage of women among first-year students has increased from 5.7% in 1972 to 26.8% in 1985 (Sorenson and Berg, 1988: 153). At Carleton University the percentage of women among first-year students changed from 6.0% in 1978 to 5.9% in 1988.¹⁹ Although this did not indicate a perceptible increase, the number of women enrolled overall in engineering at Carleton University increased from 5.6% in 1978 to 7.3% in 1988. The failure of a steep increase to occur formed part of the motivation for the current study. Since it was believed that

¹⁹ These percentages were calculated on the basis of enrolment numbers provided by the Office of Planning and Statistics at Carleton University.

the genderization of technology also occurs outside the engineering institution, it may affect not only their choice of speciality but also their decision to enter engineering.

On the basis of logistical considerations and with the cooperation of members of the engineering faculty, the questionnaire was group administered to each of the classes of students which then comprised the population of third-year engineering students at Carleton University. Students completed the questionnaire in a classroom during two sections of a regularly scheduled class with the assistance of Dr. Holtz and Dr. G. Suter. After each professor had introduced the researcher to his class, the following (pre-memorized) address was given:

Thank you Professor [Sutter/Holtz]. I am a graduate student doing research towards my Master's degree in sociology. My work involves a replication of a study done with engineering students in Norway by the Norwegian Institute for Social Research in Industry. Basically I am interested in your views about technology and its function within society. The questionnaire should take you 15-20 minutes to complete. Please remember there are no right or wrong answers. I am interested only in your opinions. And please note that no one, except myself, will have access to any of your individual replies. To ensure confidentiality, please do not write your name on the questionnaire. Also, although your cooperation would be appreciated your participation is completely voluntary. You are under no obligation to complete the questionnaire.²⁰ Thank you.

The questionnaire was then distributed to the students. No

²⁰ It was felt that the voluntary nature of participation had to be stressed given that the students' past experience with test-taking, the class room atmosphere, and the format of the questionnaire may undermine their ability to refuse.

students asked for any clarifications during the time allotted for questionnaire completion. After all questionnaires were completed students deposited them in a box placed on a desk at the front of the classroom. The last page of the questionnaire was collected separately by having all students remove this page and place it face-down on a corner of the desk. Lastly, they were thanked again and informed that the findings would likely be available from the Department of Sociology and Anthropology during the first half of 1989. The researcher then left the room with the box of questionnaires in order that the regular class may resume.

STUDENTS' REACTIONS DURING QUESTIONNAIRE COMPLETION

Sally Hacker (1981) in her study of the 'culture of engineering' found a persistent mind/body dualism exhibited, subordinating the soft, the physical and the socially scientific, and exalting the hard, the mental and the scientifically abstract. Consider, for example, the disdain she (1981: 347) found expressed towards the social sciences in the following 'joke:'

Scientist and engineers stand on the shoulders of giants. Social scientists stand on their faces.

Suspecting that the engineering students surveyed may share this disdain, it was felt this may interfere with serious responses to the questionnaire. As a result of the previous years negative interactions between some parts of the

engineering student body and the Women's Centre at Carleton University, it was also felt that the students might be particularly sensitive to and thus sceptical about any questions mentioning gender. As a result of these concerns, both the verbal and nonverbal reactions of the students during questionnaire completion were casually monitored. It was believed that this would both relieve the researcher's reservations about facing over one-hundred potentially distrustful males, and help in the later comprehension of the students' written responses.

Generally, the two classes were widely interspersed by a variety of smirks, giggles, grins, laughter, quizzical looks at fellow students, bemused glances at the researcher, and quiet self-directed muttering. These behaviours supported the researcher's anticipation of a sceptical reaction to the questionnaire. In both classes, however, only four comments were made loud enough to be heard (as intended, presumably) by the researcher and other students present.

- (i) Male - "it's (the questionnaire) not about technology"
- (ii) Male - "talk about stupid"
- (iii) Female - "this doesn't measure anything"
- (iv) Male - "its about men's attitude towards women"

These remarks also indicated the scornful attitude among some students towards sociology in general and issues specifically related to gender. No students, however, attempted to disrupt the completion of the questionnaire. On

the whole both groups quietly, attentively and thoughtfully answered the questionnaire. This impression was supported by later data analysis. Only one individual, a male, refused to complete the questionnaire, writing "RIDICULOUS" on the first page. Very few non-serious responses were detected and these occurred primarily on those questionnaire items (ie. no.'s 6,7,8,12 & 13) designed to measure any association between gender and technology or gender and engineering.²¹ Despite indications of disdain and scepticism, the willingness of the students to complete the questionnaire and the thoughtfulness of both their answers and comments led the researcher to conclude that the students' responses could be treated as reliable.

STUDENTS' RESPONSE RATES AND SAMPLE SIZE

The total number of students completing the questionnaire during class time allotted included eighty-six males and six females. As only one male refrained from completing the questionnaire, this represented a response rate of 99% for those males attending the class. The eighty-five useable questionnaires represented 53% of the total number of third-year males at Carleton University.²² The six

²¹ These responses are discussed in greater detail when appropriate in the following chapters.

²² Although it had been arranged with the engineering department that a core course be used which all third-year engineering students were required to take, in March of 1989 it was discovered that systems and computer engineering students were not required to take this course. These students did not respond to attempts to contact them through a notice posted outside the Faculty of Engineering Registrar's Office. As

women participants represented 50% of all female third-year students.

As the sample size for females was so small, attempts were made to contact more women by posting a notice outside the Faculty of Engineering Registrar's Office which requested those who had not completed a questionnaire to please do so. They were also notified of the voluntary nature of their participation. In this manner six more questionnaires from female engineering students were obtained. The twelve women who were surveyed, then, represented 86% of the total number (ie. 14) of third-year female engineering students.

The Norwegian students who responded to the initial questionnarire distributed by Sorenson and Berg (1987: 157) represented 92% of the total number of registered engineering students. Of the 232 valil responses, 53% were from the school of chemistry and 47% were from the school of electronics. Sixty-two percent were men and 38% were women. For their second survey, the response rate in terms of the total number of students registered was lower than that of the first survey -- 56%. Of the ninety-nine engineering students responding to the second survey, 70% were male and 30% were female and all were from the school of civil engineering. The table below shows the Canadian students'

a result twenty-one males enrolled in systems and computer engineering were not surveyed.

response rates broken down by gender and department.

TABLE 4.1
STUDENT RESPONSE RATES BY GENDER & DEPARTMENT

Department	Number of Males	Number of Females	Males as % of 3rd-year Students in Department	Females as % of 3rd-year Students in Department
Mechanical/ Aeronautical	37	2	63	100
Electrical	33	5	58	83
Civil*	15	-	65	-
Systems & Computer	0	5	0	83
Total	N=85	N=12		

* There were no women enrolled in this department. This may partially be related to the overall low level of enrolment in this department. For 1988-89 civil engineering had the lowest level of enrolment. The low percentage enrolled in civil engineering at Carleton University is consistent with low enrolments at other Canadian universities.

Source: Norlen Survey, Carleton University, 1988

As can be seen in the table the males' response rates for the three departments surveyed varied by only 7%. The women's response rates for each department were uniformly high. Hence, there was no one subsample surveyed which dominates the responses. As noted previously, however, due to non-coverage error part of the intended population

(systems and computer engineering students) was omitted. The data were carefully examined, therefore, for any significant differences between the responses of students in various departments. As no such differences emerged, however, there was reason to expect that systems and computer engineering students would not exhibit many, if any, differences from the other students.

Of course, logically we could only tentatively extrapolate our research findings to this population. The principles underlying survey analysis meant that we must restrict ourselves to making generalizations about that specific population whose members share an equal probability of being included in the sample. As the ninety-seven students surveyed represented a large percentage of the universe of third-year engineering students (minus those unintentionally omitted), generalizing to the remainder of this sample did not constitute a problem. For the same reason, however, we could not logically make generalizations to the first, second or fourth-year engineering students at Carleton University. Nevertheless, these students may be expected to exhibit orientations similar to the third-year students given the combined effectiveness of recruitment and socialization within the engineering institute in reproducing homogeneous orientations. There was a logical basis, then, for making tentative generalizations beyond the confines of the study's sample. Confirmation of such

speculations would require replications, that is, the systematic re-study of a given problem within different contexts. Generalizations would be even more speculative in regards to professional engineers. As Sorenson and Berg (1987: 157) note, similar surveys among professional engineers might yield different results.

Making appropriate generalizations about the female students was even more problematic because their small sample size undercut the reliability of drawn conclusions, and thus also any generalizations. Care also had to be taken when comparing two such discrepant sample sizes. As a result measures (to be discussed later in the chapter) were taken to enhance the validity of any comparisons. When examining differences between our two samples, we had to consider a potentially confounding factor: that the differences did not reflect actual differences but were the result of sampling or measurement errors. In other words, any observed differences might have vanished if those males and females who were either absent or omitted had been surveyed. While it was unlikely that all significant differences would disappear, there was no absolute way to assess the extensiveness of this effect. The high sample representation of third-year students, however, decreased the probability of this effect undermining all significant differences between the males and females.

SURVEY METHODOLOGY

(i) The Strategy of Survey Analysis

The flow of analysis in this thesis did not follow that of the model of scientific procedure which involves the testing of preformulated hypotheses derived from strict deductive reasoning and general theoretical considerations. Much can be learned, however, from survey analysis which is not based on the explicit testing of stated hypotheses. Hence, as may already be apparent, this thesis did not propose to test specific hypotheses in the sense of assessing a specific symmetrical, reciprocal or asymmetrical relationship between independent and dependent variables, followed by an elaborate search for intervening, antecedent, extraneous, component and/or suppressor variables.

The thesis, however, did begin its investigation with a specific interpretation from which inferences were drawn, and which were then followed by testing to determine whether the data was consistent with them. From the interpretation of technology and its genderization, as outlined in Chapters I-III, it was inferred that this genderization may be manifest at the three levels proposed by Sorenson and Berg: the symbolic, behavioral, and institutional. The thesis was an attempt to test this inference and also to replicate the Norwegian research findings. By focusing on the concrete manifestations of the genderization of technology, we hoped to deduce both theoretical and descriptive generalizations.

Based on Rosenberg's (1968: 222-223) definitions, a descriptive generalization involves extrapolating a finding based on a small number of cases to a broader population, while enunciating a principle which encompasses a variety of situations constitutes a theoretical generalization. A descriptive generalization, for example, may state that female engineering students are more likely than male engineering students to score lower on a scale designed to measure 'masculine' styles of work and thought, and higher on a 'feminine' scale. One might interpret this finding to suggest, however, that the differential socialization of males and females leads them to develop different cognitive styles and hence different styles of technical work and thought. This would be an example of a theoretical generalization. While the nature of both our sample and our data logically restricted us to descriptive generalizations, tentative theoretical generalizations were made.

As suggested by the limitations the sample imposes, and the survey strategy just outlined, this thesis was largely exploratory. Consequently, it relied heavily upon the process of exploratory data analysis developed by John Tukey.²³ His procedures provided efficient ways of searching for patterns in response and exceptions to these patterns. Having arranged the data into batches of related numbers,

²³ As represented by B.H. Erickson and T. Nosanchuk in
Understanding Data, Toronto: McGraw-Hill Ryerson Limited, 1977.

five major features of each batch were extensively explored: (i) the level, or where the data were centred; (ii) the spread, or the amount the batch could be expected to vary about the centre; (iii) clumping, or the clustering of the batch into groups of numbers; (iv) the shape, or how the numbers were distributed; and (v) extreme or unusual numbers.²⁴ These procedures allowed an in-depth exploration of two aspects of the students' orientation to technology and engineering. The first, the overall orientation of the students, indicated the "direction" of this orientation. The second, the degree of consensus among the students, indicated the "dispersion" of such orientations.²⁵ This assessment of direction and dispersion was tempered by a consideration of clumping, shape, and extreme values.

A reliance upon exploratory procedures, however, did not prevent us from using complementary confirmatory procedures. These procedures were designed to test the observations and interpretations produced in the exploratory analysis. To be accurate in our inferences we used agreed-upon statistical procedures with established advantages and disadvantages to confirm or disconfirm these inferences.

²⁴ Minitab, Version 5.1, was used to conduct the statistical manipulations utilized in the thesis because it was an easy-to-use, flexible and powerful general purpose computing system with which the researcher was already familiar.

²⁵ Note that these two aspects correspond largely with level and spread, respectively.

Depending upon the formal procedure used, adherence to a variety of conditions was required.

(ii) The Nature of the Data

The first assumption upon which confirmatory procedures were based was that the data be unbiased and comprised of universe elements having an equal chance of being selected for the sample (ie. be a random sample). As discussed previously, the sample of engineering students utilized in this thesis may more accurately be termed a 'universe' since it was the intention to survey the entire third-year population of engineering students. Both the size of the universe and the response rates of males and females in each department were relatively high. These two factors support a treatment of the data as unbiased. Sources of bias, however, did include the omission of male systems and computer engineering students, and the small sample size of female students.

Another potential source of bias involved the assumption that specific confirmatory procedures be used upon data characterized by certain properties.²⁶ Most confirmatory statistical procedures are intended for analyses using numeric data, that is, data with both order and interval properties. The data generated by the survey,

²⁶ Exploratory techniques do not share this dependency on specific data properties.

however, was either ordinal or categorical.²⁷ Ordinal data were generated by categories of response with intrinsic order properties but without intrinsic numerical properties because there was no way to ascertain that the differences between the successive categories was the same. Questionnaire item no. 1, for example, offered the following response categories: agree wholly, agree a bit, neither agree nor disagree, disagree a bit, and disagree wholly. Although these categories exhibited an order, we could not know that the difference between 'agree wholly' and 'agree a bit' was interpreted as the same as that between 'agree a bit' and 'neither agree nor disagree.' Categorical data exhibit neither order nor interval properties. For example, although questionnaire item no. 2(b) has five possible response categories, there was no way of assigning a logical order to them or of concluding that the differences between the successive categories was the same.

Despite the lack of correspondence between the data properties and the requirements of confirmatory procedures, certain procedures were utilized: Why? Ordinal data can be treated like numeric data when the data have a fairly normal distribution, the sample size is large and the procedure

²⁷ Ordinal questionnaire items include no.'s 1, 4, 5, 6, 10, 11 & 14, while categorical items include no.'s 2, 3, 7, 8, 9, 12, 13 & 15.

robust (Erickson & Nosanchuk, 1977: 167).²⁸ In statistics, 'robust' means that the data being examined do not need to completely satisfy the assumptions upon which confirmatory procedures are based. We will review, in turn then, each confirmatory statistical procedure whose assumptions may not have been totally satisfied.

(iii) Confirmatory Procedures Utilized

After exploring the direction and dispersion of the students' responses, the significance was determined by using both t-tests and confidence intervals. They were used to assess, for example, whether or not 'agreement' responses with a technological theory stated in questionnaire item no. 1 were significantly different from responses of 'neither agree nor disagree'.²⁹ Both measures of significance were used because analysis revealed that in some cases a t-test might indicate significance while the confidence interval included the value the t-test had measured as significantly different from another value. Both procedures were based on two prerequisites: (i) normality, and (ii) random sampling. As the male sample was large (N=85), the data were often characterized by a normal distribution. For females,

28 By a normal distribution we mean that the data exhibits a standard shape, symmetric and single-peaked: , other distributions might look like , or or even .

29 As their design dictated, the following four techniques to be discussed were used only with ordinal data.

however, the sample size ($N=12$) meant we had to ensure that the data had a fairly normal distribution by using the appropriate transformation (eg. square root) when necessary. Transformations were also performed as needed on data relating to the male sample. The second criterion, random sampling, need not concern us greatly as the entire universe of third-year engineering students was our intended sample. In addition, the t-test is a robust confirmatory procedure. To determine whether the responses of the male and female samples were significantly different from each other, analyses of variances (anova) were conducted. Basically, this procedure measured whether the variation in responses about the mean between the two samples was significantly greater than the variation within each sample. The three assumptions governing the use of this procedure included normality, equal variances and independence. The first has already been discussed above.. The second assumption meant that each of the two samples should be drawn from populations with equal variations about the mean. As our sample sizes were so discrepant, it was important to equalize variances by using transformations when appropriate. The largest variance, however, was always less than three times the smallest, so it was unlikely that misleading results were produced. The third assumption, independent observations, implied that the data should be gathered in such a way that each value was a separate piece

of information, not affected by the others. While random sampling guarantees this, our two samples were comprised of high response rates by the universe of third-year students. As a result we did not need to be overly concerned with this assumption. Fortunately, anova is a robust confirmatory procedure. This procedure was also used to assess significant differences between Norwegian and Canadian responses to questionnaire items no. 4 and 6. Again, care was taken to ensure that the relevant assumptions were satisfied.

To determine whether the patterns of responses between females and males and between Canadian and Norwegians were similar or not and how strong this similarity was, rank correlations were performed. As the assumptions above were adequately satisfied, they will not be repeated here, and the test was deemed appropriate. As this procedure is not resistant to unusual values, the data were always plotted and transformations performed as necessary. This procedure provided a measure of how well one set of values (or responses) predicted another. But it should be noted that if, for example, the Norwegian females' responses were very different from the males,' correlating their combined responses with the Canadian females' or males' responses may give a distorted impression of their similarity. Nevertheless, the correlations provided an exploratory indication of the similarity between the students' responses. In the

context of this thesis, they were not utilized to measure the proportion of the variance of one variable (Y) explained by a linear fit of one variable (X) to another (Y). This was consistent with our survey analysis which was not based on the explicit testing of stated hypotheses. Consequently, no confirmatory measures were utilized to test the significance of any correlations. This would have been inappropriate since we were not hypothesizing that one variable (eg. male responses) explain, in a linear relationship, any other variable (eg. female responses).

As the above confirmatory procedures were not appropriate for categorical data, the chi-square test was utilized to determine whether certain male and female responses were significantly different. This test examined the data for any possible relationship between two variables (eg. gender and whether engineering duties are perceived as unsuitable for women), without making any assumptions about which variable was independent. As with any confirmatory test, chi-square was only appropriate when the assumptions about the data on which it was based were satisfied: (i) the sample should be a random one; and (ii) the expected values for 2 X 2 tables should be 10 or more, while for tables larger than 2 X 2 the mean of the expected values should be six or more for tests at the 5% level (Erickson & Nosanchuk, 1977: 255). As our sample consisted of the universe of students the first assumption need not concern us. The small

size of the female sample, however, meant that the expected values did not tend to be large enough. This was countered by 'correcting for continuity,' a process which counteracted the tendency of the chi-square value to be increased by arithmetic constraints (caused by small expected values) that had nothing to do with the relationship between the two variables (1977: 255).

A CONTRADICTION IN TERMS

Despite the variety of disciplines (eg. sociology, political science, economics) which have used questionnaires, this form of survey analysis has been focused on one goal: that of obtaining information about the topic in question by wording questions so that they actually measured the concept of interest and evoked consistent responses by participants. This paradigm which viewed the respondent as a 'data producer' meant that non-numerical information (eg. comments written in the margins) was not considered a valued part of the knowledge producing process. This was a practice which subverted the goal of information gathering by disregarding and disallowing the **active** participation of the **subjects**. Hence there was a lack of fit between the theory and practice of survey analysis.

To resolve this contradiction we recognized that the subject/subjective could not be excluded and hence, we did not limit ourselves to statistical analyses while ignoring the information conveyed by the comments and questions of

the students. The problem, then, was that of qualifying these analyses by the students' commentary. This orientation was based on the premise that the researcher is first and foremost accountable to those who participated in the study and who the researcher claims to represent. As accountability encompasses accessibility, both the methods used to analyse the data and the data's manner of presentation was organized to promote comprehension among the engineering students, and thus, also, their criticism. As a result an attempt was made to use percentages and other forms of response summaries which allow the data to be accessible to a non-sociological readership. They were also used to avoid the confusion caused by comparing absolute numbers when the samples are of three such discrepant sizes: three hundred and thirty-one Norwegians, twelve Canadian females and eighty-five Canadian males.

IN CONCLUSION

In this chapter, and those that have preceded it, we have attempted to provide the reader with a framework by which to evaluate the findings generated by the current research. Through reviews of the literature, conceptual specification and theoretical discussion, we developed a model of technology as genderized. Technology was conceptualized as the totality of social relations involved in the production, transmission, and acquisition of the knowledge associated with the techniques used to accomplish

certain tasks in Canadian society. As 'technocrats,' those who organize and control this totality, men as a social group are in the position to dominate and manipulate women. Thus, the relations of sexual and capitalist oppression are confirmed.

The genderization of technology is potentially visible at many different levels. In the remainder of this thesis manifestations of this genderization are documented at three levels: the behavioural, the institutional, and the symbolic. This documentation, however, is preceded by a chapter which examines those aspects of the engineering students' beliefs about technology not explicitly linked with genderization. In Chapter VI we begin exploring genderization by investigating the students' perceptions of technological artefacts in terms of 'masculinity' and 'femininity.' In Chapter VII we suggest that these artefacts may be part of a signification process that contributes to the production and maintenance of a gender division of labour among students within the engineering educational institution. These chapters prepare the reader for the discussion in Chapter VIII of genderized styles of work and thought in technological research. We conclude in Chapter IX by both reviewing and summarizing the findings from the current study of the genderization of technology, and by discussing the implications of these findings for future studies of technology.

CHAPTER V
MIXED MESSAGES: STUDENTS' PERCEPTIONS OF
TECHNICAL RESPONSIBILITY AND PROGRESS

Before considering engineering students' perceptions of technology as genderized, we will investigate some other dimensions of their belief-system surrounding technology. This examination is organized around two themes: first, technological determinism versus technological causality; and second, technology as progressive versus technology as hazardous. The purpose of this analysis is to answer a number of questions regarding the engineering students' conception of technology and its relation to their role as (future) engineers: To what degree do engineering students view technological developments and the manner in which they are utilized to be the inevitable consequence of a logic decreed by scientific rationale? Do they believe themselves to be causal agents, responsible for technological developments and/or their utilization? If so, do they feel this responsibility is shared with certain others, such as the military or the banks? Do they regard these developments and modes of utilization, for which they may share responsibility, to be progressive or potentially hazardous? Are new technological developments by their very 'nature' (ie. newly developed) progressive? Or does their impact upon society depend upon who is responsible for their implementation? What criteria do engineering students think should be emphasized when choices are made about the development of new technology?

Throughout this chapter we will also consider whether

any of the answers to these questions differ depending upon the gender of the respondents. For example, do female engineering students express a more negative evaluation of technology's effect on people, given that (as discussed in Chapter III) women more than men suffer from the negative effects of technology. Regrettably, it is not possible to perform a similar comparison between the Norwegian and Canadian samples. Despite the inclusion of the survey items relating to the above questions in the Norwegian study, results of any analyses are not yet available.

WHY THESE TWO THEMES?

A review of the translated questionnaire revealed that the questionnaire items could be divided into two broad categories: (i) those intended to explicitly measure the genderization of technology, and; (ii) those not meant to measure it. Those items which did not explicitly investigate genderization were concerned with other aspects of the engineering students' beliefs about technology and its relation to society. Specifically, the items were geared to determine whom students did or did not ascribe responsibility for technology, and whether they evaluated this technology and those that may share responsibility for it in positive or negative terms. Hence, it was decided to categorize these questionnaire items under two themes: (i) technological determinism versus technological causality, and; (ii) technology as progressive versus technology as

hazardous.

Both social and feminist studies have revealed a tendency among people to think about technology deterministically. We tend to conceptualize it as having its own *modus operandi*. We speak, for example, of automating technology as putting people out of work. As those who have an intimate relationship with technology, engineers may be particularly likely to exhibit this frame of mind. Conversely, as 'generators' of technology they may possess a more sophisticated conception of who is responsible for technological development and implementation. As members of an engineering institution which serves as a major point for the transmission of engineering culture, students may express aspects of either orientation or both. They may, for example, perceive technological change to be unstoppable and yet view themselves as causal agents, part of that set of circumstances which must exist for a particular technological change to logically occur. This, then, is the focus of the theme 'technological determinism versus technological causality.'

Additionally, it is reasonable to expect that those being socialized into the ranks of the technical elite may share a positive evaluation of technology before arriving at the educational institution, and have this positive evaluation reinforced during the period of education. Hence, engineering students are likely to share a progressionist

view of technological change, that is, a view of technological change as part of an advancement towards a higher state of technology in value, quality and condition, and perhaps, by extension, of human society. This stance is also suggested by the engineering community's concern with technological obsolescence (Electronic Engineering Times, 1988). As those who share an intimate relationship with technology, however, they may be particularly aware of the potentially negative implications of specific technological change for society. This is the focus of the theme 'technology as progressive versus technology as hazardous.'

TECHNOLOGICAL DETERMINISM VERSUS TECHNOLOGICAL CAUSALITY

In order to provide answers to the questions posed, we will begin with a consideration of the first theme: technological determinism versus technological causality. The questionnaire items, however, do not always distinguish between the development and utilization of technology. As a result, it is possible that when students were asked to indicate their perceptions of responsibility their responses may confuse both issues. For example, while they may feel a responsibility for the development of certain technological products and processes, they may not feel responsible for the manner in which they are utilized. Hence, we may find unexpected and/or contradictory results.

(i) Engineers

Responses to the questionnaire, particularly item no.

1, indicated that the engineering students believe themselves responsible for technological developments (Tables 5.1 and 5.2). Eighty-three percent of the male and female students agreed that "engineers have a moral responsibility for the technology they help to develop."¹ This perception of causal agency is also reflected in the strong agreement among the students, all of the females and 98% of the males, that engineers in industry both have and ought to have a very important influence on the development of technology (10 & 11).² Similarly, ninety-five percent of the males and all of the females report that researchers both have and ought to have a very important influence on the development of technology. Four females and twenty-six males mentioned that their responses apply only in those cases when the researcher is an engineer. Since these numbers reflect a significantly large portion of both the male and female sample (ie. a third), it is reasonable to assume³ that other respondents may have based their

¹ T-tests (one-tailed, $p < 0.01$) and confidence intervals revealed that agreement and disagreement with the technological theories stated in item no. 1 of the questionnaire to be significant. Categories 'agree a bit' and 'agree wholly' were collapsed into one category, as were the two 'disagree' categories prior to significance testing. Ratings of influence in response to items no. 10 and 11 were also found to be significant through the use of t-tests (one-tailed, $p < 0.01$) and confidence intervals. It should also be noted that although differences in percentages between men and women will be reported, they are not significant unless specified.

² Questionnaire items will be indicated by placing the appropriate number within (brackets).

TABLE 5.1
TECHNOLOGICAL DETERMINISM VS TECHNOLOGICAL CAUSALITY -
PERCENTAGE OF CANADIAN FEMALES AND MALES AGREEING,
DISAGREEING OR NEITHER AGREEING NOR DISAGREEING WITH
STATEMENTS ABOUT TECHNOLOGY

STATEMENTS ABOUT TECHNOLOGY	AGREEMENT, DISAGREEMENT, OR NEITHER	
	FEMALES	MALES
Engineers have a moral responsibility for the technology they help to develop	83% agree	83% agree
Technological developments ought to be directed by political authorities	100% disagree	87% disagree
Technology ought to be developed independently of political & economic interests	88% agree	54% agree
There is too little emphasis on engineers and their technical knowledge in political decisions in Canada today	82% agree	77% agree
Military aims have too large an emphasis on technical research	68% agree	68% agree

Source: Norlen Survey, Carleton University, 1988

TABLE 5.2
TECHNOLOGICAL DETERMINISM VS TECHNOLOGICAL CAUSALITY -
PERCENTAGE OF FEMALES & MALES ANSWERING THAT CERTAIN GROUPS
HAVE AND/OR OUGHT TO HAVE VERY IMPORTANT, IMPORTANT OR
LITTLE & NO INFLUENCE ON THE DEVELOPMENT OF TECHNOLOGY

GROUPS	FEMALES			MALES	
	HAVE	ought to have		HAVE	ought to have
Engineers in industry	100%	100%	very impt	98%	98% very impt
Researchers	100%	100%	very impt	95%	95% very impt
Banks	70% impt	75%	little	75% impt	68% little
Federal government	75%	75%	impt	80%	80% impt
Provincial government	70%	70%	impt	75%	75% impt
Government employees	83%	83%	little & no	76%	83% little & no
Unions	100%	100%	little & no	87%	87% little & no
Business leaders	75%	75%	impt	89%	89% impt
* Canadian Consumer Council	50%	42%	impt	44%	40% impt
	25%	38%	little & no	25%	32% little & no

* For only this group do we indicate the percentage of females and males answering important, and little & no influence.

Source: Norlen Survey, Carleton University, 1988

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judgements on a similar stipulation.

(ii) Political Authorities & Economic Interests

While students perceive themselves responsible for the development of technology and evaluate this in positive terms, they do not attribute sole responsibility to themselves. The causal role they assign to others, however, is not always evaluated as favourably as their own. Eighty-seven percent of the males and all of the females disagree with the statement that "technological development ought to be directed by political authorities" (1). Similarly, fifty-four percent of the males and eighty-eight percent of the females agree that "technology ought to be developed independently of political and economic interests" (1). An analysis of variance revealed the male and female responses to be significantly different ($p < 0.05$). The lower level of agreement among the males may be a reaction to the inclusion of both 'economic' and 'political' interests in the statement. This possibility is suggested by the double-peaked nature of the data, that is, by the clustering of responses on the categories 'agree a bit' and 'disagree a bit.' In other words, some male students may agree that technology ought to be developed independently of political interests, but not that it ought to be developed independently of economic interests.

The converse is also possible but not as likely given the comments by eleven of the male respondents to this

effect and the strong agreement with the statement concerning 'political authorities.' In addition, while seventy-five percent of the males and seventy percent of the females indicate that although the banks have an important influence on the development of technology, sixty-eight percent of the males and seventy-five percent of the females felt that they ought to have little influence (10 & 11). This decrease in rating of importance is significant ($p < 0.01$). While 'the banks' are not synonymous with 'economic interests,' the responses do lend support to the interpretation suggested above. Had the female sample been larger we might have also found their responses to be characterized by the same double clustering. Alternatively, we might have found that female engineering students share a greater negative evaluation of the impact of economic interests on technological development. While only a separation of 'economic' and 'political' interests in the questionnaire would provide confirmation of such speculation, it is suggested by the greater (but nonsignificant) percentage of women indicating that the banks ought to have little influence on technological development.

Nevertheless, it is apparent from the students' responses that they negatively evaluate the influence political authorities and interests might have on technological development. This finding is further

reinforced by the agreement among eighty-two percent of the females and seventy-six percent of the males that there is "too little emphasis on engineers and their technical knowledge in political decisions in Canada today" (1). It also underscores the important influence they attribute to themselves regarding technological development.

(iii) Military Aims

As in the case of political authorities, engineering students assess the role the military plays in the development of technology negatively. Sixty-eight percent of both the male and female students agree that "military aims have too large an influence on technical research" (1). Technical research is an integral part of technological development, and as such, we may presume that this unfavourable evaluation extends to development as well as research. Additionally, since the military may be viewed as an extension of political authorities, the responses may also reflect the negative evaluations of these authorities.

It should be noted that the students' statements concerning 'political authorities' and 'political and economic interests' can not indicate whether the students perceive these to currently occupy a causal role in technological development. Certain responses, however, do indicate an attribution of responsibility to political authorities and those with political interests. Moreover, this responsibility seems to be evaluated positively in the

sense that it 'ought' to occur.

(iv) The Federal & Provincial Governments

This evaluation, however, may be contradicted by certain responses to items no. 10 and 11. Specifically, eighty percent of the males and seventy-five percent of the females agree that the federal government both has and ought to have an important influence on the development of technology (10 & 11). The provincial government is similarly rated by seventy-five percent of the males and seventy percent of the females (10 & 11). If federal and provincial governments are viewed as political authorities, this may represent a contradiction of the students' negative evaluation of political authorities and interests as they relate to technological development. Alternatively, since the government is likely equated with providing funds for research and development, and 'political' with decisions regarding the curtailment of such projects, there may be no contradiction as government funding would be positively evaluated while political curtailments would be negatively evaluated. Hence, it is plausible that the students' personal definitions of the 'government' and the 'political' do not conflict with each other. A greater degree of specification within the questionnaire would be required to determine whether a contradiction does exist.

Items no. 10 and 11 also reveal other aspects of the students' perceptions of responsibility for technological

development. The majority of students, just over seventy-six percent of the males and eighty-three percent of the females, agree that government employees have little or no influence, while eighty-three percent of the females and males agree that it ought to have little or no influence. Comments were made by six males and one female consistent with one student's statement that "they know nothing about technology but their ignorance may have an unfortunate influence." We may conclude that the students attribute little causal influence to government employees and what influence is attributed is not regarded as beneficial.

(v) Unions

Similar negative sentiments were expressed towards unions with most students, eighty-seven percent of the males and all of the females, stating that unions both have and ought to have little or no influence. This derogatory appraisal of unions is also expressed in the responses to item no. 3. Seventy-two percent of the males ($N=50$) and all but one of the females responded with a 'no' to the question: 'Do you think it is important that engineers are members of labour organizations, such as the Canadian Union of Professional and Technical Employees?' The significantly greater negative response ($\alpha = .05$) on the part of females may be related to the broad nature of the choices given, as well as the difference in sample size. The primary reason given for this response, chosen by forty-

three percent of the males and fifty-five percent of the females³², was that this type of organization was unnecessary in the type of position the students thought they would get. The reason chosen next most often, by twenty percent of those who gave reasons, was that membership in this type of organization does not give any results. These reasons were complemented by a variety of comments made by eighteen males and two females to the effect that "unions were often too concerned with money," "did not have engineering interests wholly in mind," "were bad for ethical companies (ie. engineering firms)," and "had the potential to restrict choice of research topics and influence goals away from the business decisions which choose product developments for society." Both the responses and commentary suggest that engineering students perceive union membership to be inconsistent with the role of the engineer (ie. inappropriate for a professional), despite their recognition of probable future employee status.

Responses to item no. 2 also support this interpretation. Ninety-four percent of the males and all of the females responded that they believe it is important that engineers are members of professional organizations. The

³² Percentages refer only to those students who indicated reasons. However, as only 11 males and 1 female responding with a 'no' did not indicate any reasons for their response, it is reasonable to conclude that the percentages adequately reflect the engineering students' beliefs.

reason cited most often in support of membership, by forty-one percent of the males and fifty-four percent of the females,³³ was that "it is necessary to have an organization that takes care of the employee interests of engineers." The reason chosen next most often, by twenty-four percent of the males and twenty-nine percent of the females, was that "it is important to be organized, to be in solidarity with others." While these two reasons might also be used in support of union membership, engineering students clearly disparage this form of representation.

(vi) Business Leaders

As evident in the students' comments pertaining to unionism, they are also aware that economic 'business' decisions effect technological development. In response to items no. 10 and 11, eighty-nine percent of the males and seventy-five percent of the females agree that business leaders both have and ought to have an important influence on the development of technology. Hence, as in the case of engineers, researchers, the banks, and the federal and provincial governments, business leaders are perceived as causally influencing technological development, and this influence is positively evaluated. Government employees and unions are viewed as ideally having little influence. What

³³ Percentages refer only to those students who indicated reasons. Only 2 females and sixteen males did not give reasons for their response, and as previously, responses may be assumed to reflect the beliefs of the majority of the students.

little influence they are perceived as exerting is evaluated negatively.

(vii) The Canadian Consumer Council

The only "group in society" that does not receive a relatively uniform response is the Canadian Consumer Council (CCC). While forty-four percent of the males and fifty percent of the females indicate that the CCC has an important influence on technological development, thirty-eight percent of the males and twenty-five percent of the females report that it has little influence. In addition, while forty percent of the males and forty-two percent of the females agree that the CCC ought to have an important influence, thirty-two percent of the males and twenty-five percent of the females agree that it ought to have little influence. This lack of consensus may be the result of a confusion among the students concerning what this council is, who its members are, and what role it plays in the Canadian economy. Nine males and one female verbally communicated their uncertainty.

TECHNOLOGY AS PROGRESSIVE VERSUS TECHNOLOGY AS HAZARDOUS

(i) Technology as Positive

As future technical workers who see themselves as sharing responsibility for the development of technology, it is probable that one aspect of the engineering students' belief system concerning technology revolves around this theme (Table 5.3). It was found, as expected given the

students' commitment to technical work, that technology tends to be evaluated positively. Eighty-eight percent of the males and all of the females agreed that "new technology leads mainly to improvements in society"(1). The same proportion of male and female students agreed that "too little money is used today in Canada to develop new technology" (1). Since this statement may be translated as meaning that more technological development needs to be occurring, it also suggests an attitude on the part of the students that technology (or at least its development) is progressive. However, this perspective is not absolute.

(ii) Technology as Negative

It is in regard to technology's potential negative consequences for society/people that the engineering students are less positive. As noted previously, sixty-eight percent of both the male and female students agree that "military aims have too large an influence on technical research" (1). Arguably, this concern with the control of the military over technical research may be presumed to extend to the implications this research, and any technological developments, may have for society.

This concern is also reflected, though less strongly, in the students' responses to the statement "increased automatisisation ought to be an important aim for the development of new technology" (1). Although a majority of

TABLE 5.3
TECHNOLOGY AS PROGRESSIVE VS TECHNOLOGY AS HAZARDOUS -
PERCENTAGE OF CANADIAN FEMALES & MALES AGREEING,
DISAGREEING, OR NEITHER AGREEING NOR DISAGREEING WITH
STATEMENTS ABOUT TECHNOLOGY

STATEMENTS ABOUT TECHNOLOGY	AGREEMENT, DISAGREEMENT, OR NEITHER	
	FEMALES	MALES
New technology leads mainly to improvements in society	100% agree	100% agree
Too little money is used today in Canada to develop new technology	100% agree	100% agree
Military aims have too large an influence on technical research	68% agree	68% agree
* Increased automatisisation ought to be an important aim for the development of new technology	67% agree 25% neither 8% disagree	51% agree 25% neither 25% disagree
* Technology is used too infrequently to solve ordinary peoples' problems	37% agree 24% neither 39% disagree	37% agree 24% neither 39% disagree

* For only these two statements about technology did we indicate the percentage of females and males who agree, disagree and neither agree nor disagree.
Source: Norlen Survey, Carleton University, 1988

the students, fifty-one percent of the males and sixty-seven percent of the females, agree with the statement a consensus does not exist. Twenty-five percent of both the male and female students neither agree nor disagree with the statement, while twenty-five percent of the males and eight percent of the females disagree. Compared to the responses to statements already discussed, there is a much wider distribution of responses.

This may be a result of the statement's failure to specify where or how this automatisation may occur. Hence, students may be unsure of its potential consequences for people. This is reflected in the comments of eight males and two females who communicated a concern with the possible effects of automatisation on workers in terms of both employment lost and lowered work satisfaction. Given the engineering school's orientation towards management and their traditional problem-solving paradigm (cf. Perruci & Gerstl, 1969; Rosenbrock, 1981), it is unlikely that this concern is shared by the majority of the students.³⁴ This interpretation is supported by the majority of the students' agreement with the above statement.

A wide distribution is also particularly evident in the

³⁴ This traditional problem-solving paradigm is geared towards creating and sustaining economic efficiency through job fragmentation and the reduction of job content. Hence, it is not a paradigm oriented towards the development of technological systems and/or products well matched to human ability or which fosters skill and makes it more productive (Rosenbrock, 1981: 167-169).

students' responses to the statement "technology is used too infrequently to solve ordinary peoples' problems" (1). In both the male and female samples, thirty-seven percent agree with the statement and thirty-nine percent disagree, while twenty-four percent neither agree nor disagree. Clearly, the engineering students do not concur in their appraisal of the application of technology to the solution of peoples' problems. This may partially be the result of some confusion over what type of 'problems' were being referred to. Six of the males wrote a question mark beside this part of the statement indicating that its meaning may not have been apparent. It does provide evidence, however, of a concern among some engineering students with how technology is being used and implemented.

(iii) Societal Advancement

Although the basic definition of 'progress' may be limited to a "moving forwards or onwards," the term also refers to an "improvement and advancement towards desirable ends, particularly in human society" (Oxford English Dictionary, 1985: 3489). The students' responses to the statements about automatisisation, military aims, and peoples' problems reflect a concern with these consequences. Although slightly more women than men disagree with the statement about automatisisation, no other responses indicate a greater concern on the part of women pertaining to the possible hazardous effects technology might have on society/people.

Hence, we have found no evidence of a gender difference in perceptions of technology as progressive or hazardous. It can be concluded, then, that despite their agreement that technology is progressive in that it leads mainly to improvements in society, the students do not evaluate technology in unequivocally positive terms.

CRITERIA EMPHASIZED IN SELECTION OF TECHNOLOGY

Having inferred that engineering students positively value technology, we can consider what specific criteria they employ in the selection of technology to be developed. Item no. 5 was designed to measure what degree of emphasis students would assign to various criteria used in the selection of technology to be developed. The students were asked to indicate on a seven-point scale what weight, in their personal opinion, ought to be ascribed for each criterion.³⁵

(i) Degree of Emphasis Assigned Criteria

Both exploratory and confirmatory analyses reveal that relatively high emphasis is given to most criteria. Greatest emphasis is given to the criterion 'serviceable and user friendly,' with a median response of seven (ie. very high

³⁵ Refer to Chapter Four for a discussion of methodological limitations.

emphasis).³⁶ Three criteria, 'economical in procurement,' 'robust against stress and strain,' and 'predictable contribution and functionability,' received a median emphasis of six. The remaining criteria, 'idiot proof,' 'simplicity and elegance,' and 'originality, level of exploitation of new theoretical inventions,' obtained a median emphasis of five. However, significance testing does not confirm this pattern of emphasis. T-tests and confidence intervals ($p < 0.05$) were used to discover at what level ratings of emphasis were significant. No significant differences were found between males' and females' rankings. All of the criteria, except 'idiot proof' and 'originality,' have ratings that are significantly greater than 'medium emphasis.' In other words, the emphasis given these criteria is significant at the level represented numerically by a '5,' but not by a '6' or '7.' Although t-tests indicate that the two exceptions noted above are also significant at this level, their confidence intervals include the 'medium emphasis' category, '4.' Hence, it cannot be concluded that the emphasis given these two criteria is significantly greater than this category. The emphasis given these criteria, however, is significant at the 'medium' level.

³⁶ As these data are ordinal, that is, characterized by order but not interval properties, the median is a better indicator of the level or centre of the data than the arithmetic mean. In addition, the median is much less sensitive to erratic values, and thus gives a better impression of the overall level of the data.

(ii) Methodological Inadequacies

The results of these statistical manipulations confirm the methodological problems noted in Chapter IV. The combination of the format of the seven-point scale and the criteria listed prevents the satisfactory ascertainment of what item no. 5 was designed to measure. We can discern neither the criteria given most emphasis when choosing between technological options, nor the subtle differences in emphasis that may be ascribed to these criteria during this process. While one might surmise that the students believe all criteria need to be emphasized, it seems more prudent to reserve judgment until this issue can be further studied.

The standard deviation, however, may provide some clues as to how the engineering students weigh the criteria. As a measure of how much the batch values vary from their mean, it also indicates the degree of agreement among the students. This means that the lower the standard deviation, the greater the agreement on the emphasis ascribed to a certain criterion. Both the males and females displayed greatest agreement on the following criteria: 'robust against stress and strain,' 'serviceable and user friendly,' 'predictable contribution and functionability, and 'economical in procurement.' All remaining criteria had standard deviations which indicated that their values varied more than one response category away from their means. This translates into a lower degree of agreement among students

regarding the emphasis given these criteria. Not surprisingly, the criteria, 'idiot proof' and 'originality,' shared the largest standard deviations, and thus also the least agreement among engineering students. As noted earlier, they were also given the least emphasis. This lesser emphasis might be a reflection of the students' doubt regarding what these criteria meant. Although no students refused to respond, thirteen males and one female indicated confusion with the criteria 'idiot proof' through various comments. Similarly, eight males questioned what was meant by 'level of exploitation of theoretical inventions.' If the lesser emphasis is a consequence of this uncertainty, it further reinforces the inadequacy of this measure to discriminate among the criteria used or the weight given these criteria during the selection process.

SEPARATION OF RESPONSIBILITY FROM UTILIZATION

In this chapter we have begun to explore certain aspects of the engineering students' constellation of beliefs surrounding technology. This investigation was centred primarily around two themes. Although the relevant questionnaire items (no. 1, 2, 3, 10 & 11) provide only a minimal indication of the students' beliefs, the general content of these is evident. There is a general consensus among the students that they share the responsibility for technological development with a variety of entities who have differing economic, political and/or military agendas.

There is evidence, however, of a cognitive separation in their assessment of technological responsibility depending upon whether it is the development or utilization of technological products and processes that is being considered. This cognitive separation is also linked to their evaluation of technology as positive (ie. progressive) or negative (ie. hazardous). Thus, although the students agree that they have a moral responsibility for and a very important influence on technological development, this does not extend to the manner in which, for example, political authorities or the military may use them. While technological developments tend to be evaluated positively, the manner in which they are utilized or implemented may be evaluated negatively.

DEVELOPMENTAL RESPONSIBILITY & POSITIVE EVALUATIONS

The analysis reviewed in this chapter provides evidence of two series of linkages. One series exists between self-responsibility, technological development, and the progressive consequences of technology, and one between others' responsibility, utilization, and the potentially hazardous consequences of technology for society. Note that this does not translate into an assessment of all others' influences on technology as negative, as the positive evaluation of the federal and provincial governments attests. Rather, it points out the connection between the positive assessment of engineers' influence and its

restriction to technological development.

A DETERMINISTIC VIEW OF TECHNOLOGY

Despite the students' perceptions of technological responsibility, a somewhat deterministic view of technology is not completely absent. Greater evidence of this orientation is present in the students' voluntary commentary than was garnered in response to the questionnaire items. Five females and thirty-three males wrote statements to the effect that a "higher power which I don't understand governs technological changes," and that "one can't fight the wheels of technological progress." Hence, although they attribute responsibility to themselves for technological development, they are but one causal agent in a series which must exist for an effect logically to occur. As only one element in a series of precipitating antecedents, they are responsible neither for the utilization of technology nor any potential hazardous effects.

IN CONCLUSION

No gender differences were found regarding the students conceptualization of technological responsibility or progressivism. There was a significantly greater agreement among the females with the statement that "technology ought to be developed independently of political and economic interests" {1}. However, since this may have been a methodological artefact and no other significant gender differences were found, no conclusion can be drawn. In the

chapters that remain we will explore what evidence exists for a genderization of technology among engineering students, and whether this genderization is itself gender linked.

CHAPTER VI
GENDERIZATION OF TECHNOLOGY AT THE SYMBOLIC LEVEL

In the previous chapters, we reviewed relevant studies in the areas of women and technology, women and work, and women and engineering, in an attempt to document support for the concept of genderized technology. By supplementing this with an investigation of the engineering students' beliefs about technology and its relation to their role as future engineers, we have set the stage for our study of the genderization of technology. In this chapter we began our study by focusing on the symbolic level of genderized technology. Specifically, we examined whether and to what extent the students would assign a gender to technological artefacts. In addition, we examined whether the students would make associations to 'masculine,' 'feminine' and advanced technology, and whether they would restrict the performance of any engineering duties on the basis of gender. In this manner we hoped to elucidate the properties the students used to gender-type artefacts.

When asked to make gender associations to engineering or technology in questionnaire items no. 6, 7, 8, 12, 13 and 14, many of the students reacted negatively to the notion of linking gender to either of these. Eighty-three percent of both the female and male students made at least one comment to the effect that one cannot link gender to either of these. For example, one student said that "although there are more male engineers this does not mean that certain technologies are masculine." Only 17% of the women and

18% of the men, however, consistently made no gender associations.³⁷ While 31% of the men consistently made gender associations, 52% made inconsistent associations. Fifty-eight percent of the women also made inconsistent associations, while 25% consistently made gender associations.

GENDER-TYPING OF ARTEFACTS

(i) Measurement of Gender-Typing

Questionnaire item no. 6 requested each student to indicate in 'your own personal opinion' what degree of 'masculinity' or 'femininity' each technological artefact possessed.³⁸ Degrees ranged from 'clearly feminine' to 'neither feminine nor masculine' to 'clearly masculine.' In an attempt to have the intervals between the degrees perceived as equal by the students, the degrees were represented numerically as ranging from one up to four and down to one again. But as the printed lines between the

³⁷ Gender associations were considered consistent when the student linked gender to technological artefacts, engineering duties and abilities. The students' responses were also considered consistent if they linked gender only to artefacts but not to engineering duties or abilities, or vice versa. A lack of gender associations was considered consistent if gender was not linked with either artefacts, duties or abilities. Responses were considered inconsistent if, for example, s/he gender-typed artefacts, reported that s/he did not think of technology as 'masculine' or 'feminine,' indicated that certain engineering duties are unsuitable for men and others for women, and rated all abilities as applying equally to males and females in engineering.

³⁸ Three male students refused to answer this question stating that gender is irrelevant to technology. Statistical manipulations were carried out on the basis of 82 male and 12 female valid responses.

degree options rendered the categories visually unequal, the intervals may not have been interpreted as equal.

Consequently, this may have had the effect of leading the students to choose the response option 'neither masculine or feminine' since this category became visually the widest.³⁹ For all technological artefacts the response that occurred most frequently (ie. the mode) was 4 or 'neither masculine or feminine.' To what extent this may have been attributable to the category's visual wideness, if at all, was impossible to ascertain. Nevertheless, ratings of artefacts were often widely distributed. When gender-typing all the artefacts except four (ie. melting oven for ore, excavator, typewriter, and cement mixer), the students' responses were characterized by numerous outliers. Outliers were judged to be those values (ie. responses) that were at least one-and-a-half midspreads above the upper quartile or below the lower quartile. As a result of the small response range, however, only four artefacts had responses that may be considered unusual. These responses were far outliers, that is, those values at least three midspreads above the upper quartile or below the lower quartile.⁴⁰ The few unusual values which did emerge in the ratings of the

³⁹ It should also be noted that hereafter the response category 'neither masculine nor feminine' will be referred to simply as 'neither' or the neutral category.

⁴⁰ Consult Appendix D for a further clarification of these concepts.

thermometer, the electrical drill, the soldering iron and the telephone exchange may represent non-serious responses on the part of some students. As in the case of the Norwegian ratings, this 'noise' was revealed as artefact ratings that were in opposition to the normative response. The rating of the thermometer as 'masculine,' then, by six male students may reflect non-serious responses. Alternatively, the association of the thermometer to the traditionally male-dominated occupation of doctor may explain these responses. The ratings of the electrical drill and soldering iron as 'feminine' and the telephone exchange as 'masculine' lacked obvious gender linkages. As a result, they may represent non-serious responses.

(ii) Similarities in Response

Despite the clustering of responses on the neutral category certain similarities emerged between both the female and male ratings, and the Canadian and Norwegian ratings. Some of these similarities are visible in Figure 6.1 and Table 6.1. Figure 6.1 gives a visual depiction of the direction of the Canadian male and female responses by showing the mean gender-typing scores for each of the sixteen artefacts.⁴¹ Although using means is not considered appropriate when the data are ordinal, means were used

⁴¹ Ratings of 'masculinity' and 'femininity' were constructed by collapsing each categories' respective degree options (ie. 1, 2, 3).

FIGURE 6.1

MEAN SCORES OF GENDER-TYPING
OF TECHNOLOGICAL ARTEFACTS

SOURCE: NORLEN SURVEY, CARLETON UNIVERSITY, 1988

TABLE 6.1
PERCENTAGE OF MALE AND FEMALE STUDENTS RATING EACH ARTEFACT
AS 'MASCULINE' COMPARED WITH RATINGS OF NORWEGIAN STUDENTS

ARTEFACTS	MALE	FEMALE	NORWEGIAN
MELTING OVEN FOR ORE	61	33	85
EXCAVATOR	60	58	86
CEMENT MIXER	57	42	86
ELECTRICAL DRILL	57	42	69
SOLDERING IRON	38	25	56
DENTIST'S DRILL	20	17	16
WEIGHT	18	8	4
CENTRIFUGE	18	0	4
ARTIFICIAL FIBRE	15	0	10
FISH FILLET PACKING MACHINE	15	8	6
GAS ABSORPTION-CHROMATOGRAPH	12	0	15
REFLEX CAMERA WITH MIRROR	9	0	25
MICROSCOPE	7	0	5
THERMOMETER	7	0	4
FIBRE OPTICS	6	0	25
TELEPHONE EXCHANGE	1	0	4
TYPEWRITER	0	0	2

Source: Norlen Survey, Carleton University, 1980

because they provide the greatest level of specificity when responses are highly similar, and thus, when median or modes would not indicate any variation. It was immediately apparent when one looked down the list of the artefacts in Table 6.1 that the means of both groups increased from below to above four. In other words, those artefacts near the top of the list (eg. typewriter) tended to be perceived as less 'masculine' than those near the bottom of the list (eg. excavator). Despite the similarity between the men's and women's pattern of gender-typing, the female students were more restrained. Whereas the women's responses differed by only .83 across all seventeen artefacts, the men's responses differed by 1.87. It should be noted that in both cases the variation is small, with the ratings centring around the 'neither' category.

A consistent pattern in the way artefacts were gender-typed is also visible in Tables 6.1, 6.2 and 6.3. These tables present the dispersion of the students' responses by listing the percentage of male, female and Norwegian students labelling artefacts 'masculine,' 'neither masculine nor feminine,' or 'feminine,' respectively. As one gazes down tables 6.1 and 6.3 artefacts tend to become increasingly rated as less 'masculine' and more 'feminine'

TABLE 6.2
 PERCENTAGE OF MALE AND FEMALE STUDENTS RATING EACH ARTEFACT
 AS 'NEUTRAL' COMPARED WITH RATINGS OF NORWEGIAN STUDENTS

ARTEFACTS	MALE	FEMALE	NORWEGIAN
MELTING OVEN FOR ORE	29	50	13
EXCAVATOR	38	33	11
CEMENT MIXER	38	58	11
ELECTRICAL DRILL	40	58	26
SOLDERING IRON	59	75	36
DENTIST'S DRILL	72	75	64
WEIGHT	70	83	54
CENTRIFUGE	68	92	22
ARTIFICIAL FIBRE	80	100	60
FISH FILLET PACKING MACHINE	70	75	21
GAS ABSORPTION-CHROMATOGRAPH	74	83	68
REFLEX CAMERA WITH MIRROR	81	83	60
MICROSCOPE	78	58	54
THERMOMETER	67	58	52
FIBRE OPTICS	91	83	62
TELEPHONE EXCHANGE	67	67	18
TYPEWRITER	48	50	24

Source: Norlen Survey, Carleton University, 1988

TABLE 6.3
 PERCENTAGE OF MALE AND FEMALE STUDENTS RATING EACH ARTEFACT
 AS 'FEMININE' COMPARED WITH RATINGS OF NORWEGIAN STUDENTS

ARTEFACTS	MALE	FEMALE	NORWEGIAN
MELTING OVEN FOR ORE	9	17	3
EXCAVATOR	2	8	2
CEMENT MIXER	5	0	3
ELECTRICAL DRILL	2	0	5
SOLDERING IRON	4	0	9
DENTIST'S DRILL	9	8	21
WEIGHT	12	8	42
CENTRIFUGE	13	8	76
ARTIFICIAL FIBRE	5	0	31
FISH FILLET PACKING MACHINE	16	17	73
GAS ABSORPTION-CHROMATOGRAPH	13	17	17
REFLEX CAMERA WITH MIRROR	10	17	15
MICROSCOPE	15	42	43
THERMOMETER	26	42	44
FIBRE OPTICS	2	8	14
TELEPHONE EXCHANGE	32	33	78
TYPEWRITER	52	50	74

Source: Norlen Survey, Carleton University, 1988

by the male, female and Norwegian samples.⁴²

Again, women were the most restrained when gender-typing, exhibiting the highest percentages of neutral ratings. The Norwegians displayed a pattern of gender-typing similar to that of the Canadian male students, except that it was more pronounced. Although the percentage of students rating each artefact as neutral was often greater than percentages rating artefacts as 'masculine' or 'feminine,' the Norwegians gave the lowest percentage of neutral ratings.

(iii) Neutral Rating of Artefacts (Table 6.2)

Only eight artefacts were rated as neutral by a percentage of the Norwegian students larger than the percentages rating the same artefacts as 'masculine' or 'feminine.' The dentist's drill, for example, was rated as neutral by 64% of the Norwegians, as 'masculine' by 16% and as 'feminine' by 21%. All of the artefacts, except the excavator, were rated as neutral by higher percentages of Canadian women than percentages rating them as either 'feminine' or 'masculine.' On twelve artefacts a greater percentage of the men gave neutral responses than 'masculine' or 'feminine' responses. The men, then,

⁴² Data concerning Norwegian female and male responses were not available, and thus comparisons could not be carried out between Norwegian male or female responses and Canadian male or female responses. Comparisons were conducted between the Norwegian students and the Canadian male students, the Norwegian students and the Canadian female students, and the Canadian male and female students.

occupied a middle position as regards the gender-typing of artefacts.

The correlations between the students' neutral ratings also indicated that the men were more reserved than the Norwegians, but less restrained than the women when gender-typing artefacts. Spearman's rank correlation between the Canadian men's and the Norwegians' neutral ratings gave a value of 0.60, while the value between the women's and Norwegians' neutral ratings was 0.52. In other words, knowing the Norwegian's neutral ratings allowed one to predict 60% of the men's and 52% of the women's neutral ratings. Although both correlations were relatively strong, the correlation between the men's and Norwegians' neutral ratings was higher indicating a greater similarity between them than between the women's and the Norwegians' ratings. It was also stronger than the correlation between the men's and women's neutral ratings (0.56). This meant there was a greater degree of similarity between the Norwegians' and men's neutral ratings than between the men's and women's, and between the men's and women's neutral ratings than between the Norwegians' and women's.

Basically, this review of percentages and correlations indicates that while all three samples had a strong tendency to refrain from gender-typing technological artefacts, this was most pronounced in the female sample, followed by the male, and lastly by the Norwegian sample. Sorenson and Berg

(1987: 164) also found that the female students gave more neutral ratings than their male counterparts, although they did not find any significant differences between the Norwegian men's and women's 'masculine,' 'feminine,' or neutral ratings. Similarly, we did not find any significant differences between the Canadian men's and women's neutral ratings. Analyses of variance ($p < 0.05$) revealed significant differences between the neutral ratings of four artefacts by the Norwegian students and the Canadian male and female students. This meant that the Canadian students gave significantly higher neutral ratings to the cement mixer, the centrifuge, the packing machine for fish fillets, and the telephone exchange. The Canadian women's neutral ratings were significantly higher than the Norwegians' on an additional three artefacts (ie. the melting oven for ore, the soldering iron, and artificial fibre).

(iv) 'Masculine' Rating of Artefacts (Table 6.1)

As Sorenson and Berg (1987: 159) noted, while technology [techniques] in the singular probably would be characterized as 'masculine,' technological artefacts were not massively experienced as 'masculine.' There was only one artefact, the excavator, rated as 'masculine' by the majority of students in all three samples. In addition to this artefact, the melting oven for ore, the cement mixer and the electrical drill were rated as 'masculine' by the majority of Canadian men and Norwegians. The deviation

from the neutral category for the men was significant for all four of these artefacts (one-tailed t-test and confidence intervals, $p < 0.01$). Sorenson and Berg did not report which artefacts emerged as significantly 'masculine' or 'feminine.' They (1987: 159) did state, however, that many ratings were significantly different from the neutral category. Hence, it is reasonable to expect that those artefacts which a majority of the Norwegian students rated as 'masculine' or 'feminine' would have emerged as significantly different from the neutral category.⁴³ It is likely then, that the same four artefacts which emerged as significantly 'masculine' among the male sample had similar significant ratings among the Norwegian students.

Despite these similarities in the 'masculine' gender-typing of artefacts, analyses of variance ($p < 0.05$) indicated that the Norwegians' ratings of the excavator and the cement mixer were significantly more 'masculine' than the men's ratings of these artefacts. While the men's ratings of these two artefacts were not significantly more 'masculine' than the women's ratings, the men's ratings of the melting oven for ore were significantly more 'masculine' than the women's. It was not surprising, then, that the Norwegians' 'masculine' ratings were significantly more

⁴³ This majority must have been at least as large as the majority of Canadian males' ratings that was determined to be significant (ie. the Norwegian majority must be at least 57%).

extreme than the women's ratings of the melting oven for ore, the cement mixer, and the excavator, in addition to the electrical drill and the soldering iron.

Although the Norwegians' rating of the soldering iron was found to be significantly more 'masculine' than the women's rating, the percentage of Norwegians (57%) rating it as 'masculine' was not large enough to be safely judged significant. The similar significant 'masculine' ratings between the Canadian men and Norwegians was also suggested by the correlation, 0.58, between these ratings. This correlation indicated that the similarity in ratings between these two samples was greater than that between the Norwegians' and the women's 'masculine' ratings, which had a correlation of 0.50. The similarity between the men's and women's 'masculine' ratings, however, was much greater than that between either of the two aforementioned sample sets. The correlation between the men's and women's ratings was a very large 0.77. This meant that knowing one set of ratings gave one the power to predict 77% of the other set of ratings. A consideration of the dispersion of the students' responses, in conjunction with these correlations, indicated that the women and men shared a greater similarity than the women and the Norwegians or the men and the Norwegians. This reflected the greater shared tendency among the Canadian women and men to refrain from gender-typing artefacts than the Norwegians, although

this tendency was most acute among the Canadian female students.

(v) 'Feminine' Rating of Artefacts (Table 6.3)

While three artefacts (ie. the packing machine for fish fillets, the telephone exchange, and the typewriter) were rated as 'feminine' by the majority of the Norwegian students, only the typewriter was rated this way by the majority of the Canadian male and female students. The Norwegian students, then, gender-typed more artefacts in a 'feminine' direction than the Canadian male or female students. While the men tended to give stronger 'feminine' ratings on a few artefacts (eg. the centrifuge) than the Canadian female students, the opposite is true for more artefacts (eg. the microscope). This pattern of findings was also suggested by the correlations between the three samples' 'feminine' ratings. There was a higher correlation between the women's and Norwegians' ratings (0.54) than between the men's and Norwegians' ratings (0.41). The correlation between the women's and men's ratings (0.31) was substantially lower. This indicated that there was a higher degree of similarity between the female sample and the Norwegian sample than between the male sample and the Norwegian sample, and between the male sample and Norwegian sample than between the male and female sample. As the moderately low correlations between the Norwegian and Canadian samples indicated, the Norwegians exhibited a much

greater tendency to label certain artefacts as 'feminine.' These artefacts and the percentage of Norwegians labelling them as 'feminine' include: (i) dentist's drill, 21%; (ii) weight scales, 42%; (iii) typewriter, 74%; (iv) artificial fibre, 31%; (v) packing machine for fish fillets, 73%; (vi) centrifuge, 76%; and (vii) telephone exchange, 78%.⁴⁴ The greater tendency of the Norwegians to gender-type in a 'feminine' direction than the Canadians was also indicated by their significantly greater 'feminine' ratings of the last four of these artefacts.

Despite the greater similarity between the Norwegians' and the Canadian women's 'feminine' ratings, both the male and Norwegian samples were characterized by a greater tendency to gender-type artefacts than the female sample. Only two artefacts were gender-typed by the majority of women, the typewriter as 'feminine' and the excavator as 'masculine.' Neither of these ratings, however, deviated significantly from the neutral category. Five artefacts were gender-typed by the majority of male students: the melting

⁴⁴ When conducting final revisions to the questionnaire an error was made such that a word was omitted. The result was that instead of the technological artefact in questionnaire item no. 6 reading as 'weight scales,' it was listed only as 'weight.' Since numerous students questioned what this term referred to and then rated it as neutral, it was reasonable to expect that the high neutral rating of this artefact reflects their confusion. Had the error not occurred we may have found that the Canadian students shared the Norwegians' 'feminine' rating. The cultural connection which presides between women and "diet" in both Canada and Norway might have contributed to this manner of gender-typing. Overall, however, this error did not alter the general order of gender-typing among the three samples.

over for ore, the excavator, the cement mixer and the electrical drill as 'masculine,' and the typewriter as 'feminine'. Like the men, greater percentages of women rated artefacts as 'masculine' than as 'feminine.' Except in the case of the excavator and the typewriter, these percentages were lower than the percentages rating the same artefacts as neutral. These findings were consistent with the expectation that as a whole technology [techniques] would be characterized as 'masculine.' While there was a stronger tendency to rate artefacts as 'masculine,' the women showed a greater tendency than the men to rate certain artefacts as 'feminine.' This was reflected in the low correlation, 0.31, between the men's and women's 'feminine' ratings, as was the men's higher 'feminine' ratings of the electrical drill, the centrifuge and artificial fibre. These ratings may have been partially the result of non-serious responses. While approximately the same percentages of men and women rated the packing machine for fish fillets (17%), the telephone exchange (33%), and the typewriter (51%) as 'feminine,' greater percentages of women than men rated the following four artefacts as 'feminine:' (i) the thermometer (42% & 26%, respectively), (ii) the microscope (42% & 15%, respectively), (iii) fibre-optics (8% & 2%, respectively) and (iv) the reflex camera with mirror (17% & 10%, respectively). This tendency, however, was very slight and

not statistically significant.

(vi) Significant Differences in Artefact Gender-Typing

An analysis of variance ($p < 0.05$) revealed that only the men's and women's ratings of the melting oven for ore was significantly different. In other words, although the women were substantially more restrained than the men when gender-typing, the men's and women's rating of artefacts were not significantly different except in the case of the melting oven for ore. This was not surprising given the high correlation, 0.77, between the men's and women's 'masculine' ratings. The correlation, 0.56, between their neutral ratings was also relatively high. While the low correlation (0.31) between the men's and women's 'feminine' ratings may now seem surprising, the differences between the percentages rating artefacts as 'feminine' were small enough to produce no significant differences but large enough to collectively generate a low correlation. These correlations reiterate the statement made earlier concerning the greater similarity between the Canadian samples in the rating of artefacts as 'masculine,' than between them in the rating of artefacts as 'feminine.' The degree of correspondence was also higher between the Canadians' and Norwegians' 'masculine' ratings than between their 'feminine' ratings. Having clearly represented how these three samples gender-type artefacts, we must now consider what qualities of an artefact contribute to it being

labelled as 'masculine' or 'feminine.'

QUALITIES CONTRIBUTING TO GENDER-TYPING OF ARTEFACTS

(i) 'Masculine' Artefacts

A review of those artefacts which were gender-typed in a 'masculine' direction by the Norwegians and the Canadian men and women revealed that all five artefacts are strongly associated with male-dominated occupations and stereotypical male activities. The excavator, cement mixer and electrical drill are associated with the blue-collar occupation, construction; the melting oven for ore with smelting and mining; and the soldering iron with welding. Additionally, the electrical drill is associated with men's home role of "handyman." Thus, those artefacts used mainly by men and/or in male-dominated occupations tended to be labelled in a 'masculine' direction.

(ii) Neutral Artefacts

There were a number of artefacts, however, which may be used more by men than women but which were rated neutrally. For the Canadian samples, these artefacts included the dentist's drill, the centrifuge, artificial fibre, the reflex camera with mirror, the microscope and the gas absorption-chromatograph. As these artefacts may be considered more 'modern,' and hence more advanced than the industrial artefacts, this may have contributed to their neutral rating. More notably, unlike the artefacts rated as 'masculine,' they were neither linked with any traditionally

male-dominated industrial occupations nor are they clearly associated with any male-dominated activities. The dentist's drill may be linked to the female-dominated occupations of dental hygienists, assistants and technicians; the centrifuge, gas-absorption-chromatograph and microscope to that of medical laboratory technicians and technologists. While these artefacts may have connoted male professional users as doctors and dentists, they may also be associated with female users. The increased numbers of women working as doctors and dentists may have also increased their association. The linkage, then, of artefacts with both male and female users may have contributed to their neutral rating.

It is also plausible, however, that certain artefacts were rated neutrally when students were unfamiliar with either the artefact itself or its specific use and purpose. A large number of the male and female students, between 20-30%, were unfamiliar with the reflex camera with mirror and the gas absorption-chromatograph, placing a question mark beside these artefacts in the questionnaire or writing "what is it?" in the margin. This may explain the high neutral rating of these two artefacts. This possibility is supported by the high neutral rating of "weight" given by fifty-one male and six female students who indicated their uncertainty with this artefact.

(iii) 'Feminine' Artefacts

As in the 'masculine' rating of artefacts, the artefacts labelled 'feminine' by all three of the samples were artefacts used mainly by women. These artefacts included the thermometer, the telephone exchange and the typewriter. They can be associated with the female-dominated occupations of nurse, telephone operator and secretary, respectively. In addition to these, certain artefacts were rated in a much stronger 'feminine' direction by the Norwegians than by the Canadian men or women. Although the packing machine for fish fillets may be linked with processing jobs dominated by women in both Canada and Norway, the 'feminine' rating of this artefact by 73% of the Norwegians may be related to the greater visibility of the fishing industry in this country. Had the current research been conducted in Canada's coastal provinces, we might have found a higher 'feminine' rating.

The dentist's drill may have received a stronger 'feminine' rating because of the much greater concentration of women in this profession in Norway. As long ago as 1964 23% of all dentists in Norway were women -- at that time only 2% of all dentists in Canada were women (cf. McFarlane, "Dental Manpower in Canada," Chapter II). Although medical laboratory technicians and technologists are overwhelmingly female in both Canada and Norway, this has been the case for a longer period of time in Norway. It may be viewed more as

a "woman's job" in Norway, and hence the technological artefacts associated with these jobs, such as a centrifuge or a microscope, may be more likely to be labelled as 'feminine.' Unlike the above interpretations, it was much more difficult to ascertain why artificial fibre might have been rated as 'feminine.'

(iv) Qualities Associated With Technology

A clue may be provided by investigating what artefact qualities students named when they were asked to list words (adjectives or nouns) which described a type of technology [techniques] they thought of as 'masculine,' 'feminine' and 'advanced' (questionnaire items no. 7, 8 & 9). As in the Norwegian study, although the students' wording was somewhat dissimilar, certain patterns of association emerged. These are set out in Tables 6.4, 6.5 and 6.6 where the most frequently mentioned qualities are itemized.

In the current study a large number of the students did not respond to these three questionnaire items, either leaving them blank, stating that "technology cannot be categorized in this way," or giving non-serious responses. In the male sample there were forty non-responses and four non-serious responses (eg. steel toe boots) to item no. 7, fifty non-responses and four non-serious responses (eg. fashion) to item no. 8, and twenty-nine non-responses and one non-serious response (ie. sexy) to item no. 9. This

TABLE 6.4
 QUALITIES ASSOCIATED WITH 'MASCULINE' TECHNOLOGICAL
 ARTEFACTS. PERCENT OF NORWEGIAN, CANADIAN FEMALE AND
 CANADIAN MALE RESPONDENTS.

'MASCULINE' ARTEFACTS	NORWEGIAN	MALE	FEMALE
LARGE, HEAVY, BIG, ETC.	32	25	50
MANUAL WORK	18	na	na
MALE USER, MALE JOBS, ETC.	18	na	na
DIRTY, NOISY, ETC.	13	6	8
COMPLICATED, ADVANCED, ETC.	13	7	na
MACHINE-LIKE, MECHANICAL, ETC.	13	9	17
RUGGED, ROBUST, ETC.	7	6	na
HARDWARE	na	6	na
CONSTRUCTION, BUILDING, ETC.	na	21	17
COMPUTERS, ETC.	na	9	na
ELECTRONICS	na	7	na
DESTRUCTIVE, FOR WARFARE, ETC.	na	6	na
	114	102	92

Source: Norlen Survey, Carleton University, 1988

TABLE 6.5
 QUALITIES ASSOCIATED WITH 'FEMININE' TECHNOLOGICAL
 ARTEFACTS. PERCENT OF NORWEGIAN, CANADIAN FEMALE AND
 CANADIAN MALE RESPONDENTS.

'FEMININE' ARTEFACTS	NORWEGIAN	MALE	FEMALE
SMALL, EASY, NEAT, ETC.	26	11	na
TRADITIONAL WOMAN'S JOB, SEX ROLES, ETC.	14	15	see below
ACCURATE, DEXTEROUS, FIDDLING WORK, ETC.	13	6	na
SIMPLE, NOT VERY ADVANCED	11	na	na
ROUTINE, REPETITIVE, ASSEMBLY LINE, ETC.	10	na	na
HOME, KITCHEN, ETC.	9	7	na
CHEMISTRY, BIOLOGY, MEDICINE, LABORATORY, ETC.	9	11	na
PHYSICALLY LIGHT	8	9	33
CARE, SOCIAL, HUMANLY ORIENTED, ETC.	8	7	na
CLEAN	7	2	na
SOFT, SENSITIVE, DELICATE, AESTHETICAL, ETC.	5	9	na
ADVANCED, THEORETICAL, NEW TECHNOLOGY	3	na	na
SOFTWARE	na	8	na
	123	83	33
CANADIAN WOMEN: THINGS IN AN OFFICE, EG. TYPEWRITER, COFFEE MACHINE, PHOTOCOPIER			75

Source: Norlen Survey, Carleton University, 1988

TABLE 6.6
 QUALITIES ASSOCIATED WITH 'ADVANCED' TECHNOLOGICAL
 ARTEFACTS. PERCENT OF NORWEGIAN, CANADIAN FEMALE AND
 CANADIAN MALE RESPONDENTS.

'ADVANCED' ARTEFACTS	NORWEGIAN	MALE	FEMALE
RELATED TO COMPUTERS	26	19	17
COMPLEX, DIFFICULT, ETC.	24	9	na
ELECTRONICAL, MICROPROCESSOR, LASER, ETC.	17	24	42
SMALL, FRAGILE, ETC.	8	11	na
COMMUNICATION TECHNOLOGY NEW, WITH A FUTURE, DEVELOPING, ETC.	8 7	na 18	8 25
SPACE RESEARCH THEORETICAL, DEMANDING KNOWLEDGE, ETC.	7 7	9 na	8 na
AUTOMATIC, DIGITAL, ETC.	6	8	8
RELATED TO OIL BIOLOGY, MEDICINE, BIOCHEMISTRY	6 6	1 na	na na
PHYSICS HUMAN, SAVING NATURAL RESOURCES, ETC.	6 4	na 11	na 17
ACCURATE	4	6	8
OVERPRICED UNPREDICTABLE, UNRELIABLE, ETC.	na na	2 4	na na
DANGEROUS, FRIGHTENING, FOR MILITARY PURPOSES	na	5	na
	136	127	133

Source: Norlen Survey, Carleton University, 1988

meant that the percentages of men giving usable responses to the three questionnaire items were 48%, 36% and 65%, respectively. For the female sample, there were three non-responses for item no. 7 and 8, and one for no. 9. The percentages of women giving usable responses were 75%, 75% and 92%, respectively. The women's substantially higher response rates was likely an artefact of their small sample size. In both samples, then, the students had the least difficulty naming qualities they associated with 'advanced' technology. Given the larger number of associations made to 'advanced' technology by the Norwegians, it seemed they shared this tendency with the Canadian students. Sorenson and Berg, however, did not report any non-responses or non-serious responses.

(v) Qualities Associated with 'Masculine' Technology (Table 6.4)

As in the Norwegian study (Sorenson and Berg, 1987: 161), gender associations to technological artefacts reflected two main properties: how they looked and who they were used by. The latter property has already been suggested by the patterns of gender-typing apparent in the students' responses to questionnaire item no. 6. It was also evident in the 21% of the men and 17% of the women naming "construction" as associated with 'masculine' technology [techniques]. Fifteen percent of the men, like 14% of the Norwegians, named "traditional women's jobs, sex roles,

etc." as qualities associated with 'feminine' technology [techniques]. This 15%, however, included only the jobs "clerical, word processing and secretary." While no women made associations to traditional women's jobs, a large 75% named "things in an office" such as a "typewriter," a "coffee machine" and a "photocopier." Although the women made no associations concerning who the artefacts were used by, this property was reflected in the naming by the Norwegians and Canadian men of the "home, kitchen, etc." and "chemistry, biology, medicine, laboratory, etc." While 9% of the Norwegians made both these associations, 7% of the men made the first and 11% made the latter.

The remainder of the associations referred to the physical characteristics of the artefacts (eg. how they looked) and reflected the type of user attributes these artefacts were presumed to require. Thirty-two percent of the Norwegians, 25% of the Canadian men and 50% of the women named qualities such as "large, heavy, big, etc." While 13%, 6% and 8%, respectively, named "dirty, noisy, etc.," 13%, 9% and 17% named "machine-like, mechanical, etc." as descriptive of artefacts they thought of as 'manly' or 'masculine.' An additional 7% of the Norwegians and 6% of the men named "rugged, robust, etc." These associations may represent the reason why large percentages of the women and men named "construction, building, etc." as descriptive of 'masculine' technology [techniques]. Construction may

have been perceived as involving dirty, rugged work that requires physical strength and the use of various machinery, and hence male workers.⁴⁵

(vi) Engineering Duties Associated with Gender

This interpretation was supported by the students' responses to questionnaire items no. 12 and 13. These items asked the students to report which of nineteen engineering duties, if any, they considered particularly **unsuited** for men or women, respectively. They were also asked to specify the reasons for their responses.

Like the large number of students who refrained from making gender associations to technology, a large number answered that there were no engineering duties unsuited for either women or men. While 60% of the men responded in this manner, a larger percentage of the women, ie. 67%, gave this response. Again the women seem to be somewhat more reluctant than the men to link gender with engineering or technology. Similar percentages of the women and men, however, made statements such as "a qualified engineer is capable of performing tasks and duties regardless of sex," or that "the ability to perform duties depends upon the individual."

Despite the numbers which did not link engineering

⁴⁵ We are not suggesting that these artefact and work characteristics necessarily require a male user/worker, only that this may typify the assumptions that guided the engineering students' gender-typing of artefacts.

duties with gender, some students did report that certain duties were unsuitable for either women or men. It is, perhaps, not surprising that a larger number of engineering duties were judged unsuitable for women than men, given the male domination of this profession and the cultural association between men and the world of work. While three duties were chosen as least once as unsuitable for women by the male students, seven duties were chosen at least once as unsuitable for men. This resulted in a total of sixty-one times that the male students indicated duties were unsuited for women, and forty-eight times that duties were indicated to be unsuited for men.

Unlike the male students, the female students reported more duties as unsuited for men than for women. While they chose three abilities at least once as unsuited for women, five duties were chosen at least once as unsuited for men. This resulted in a total of five times that the female students indicated duties were unsuited for women, and nine times that duties were chosen as unsuited for men. Although the female students judged more engineering duties as unsuitable for men than for women, these five duties can all be associated with female-dominated occupations or traditional female activities. Had the female sample size been larger, we might not have found that they answered in a manner opposite to that of the male students.

(vii) Duties Judged Unsuitable for Women

Despite this difference between the female and male students, there were similarities between which duties they judged unsuitable for women, and those they judged unsuitable for men. Of the duties judged unsuitable for women, only two were chosen enough times to reflect any degree of agreement among the students. 'Construction' was chosen by 32% of the male students and 17% of the female students, while 'installation, erection' was chosen by 12% and 17%, respectively (Table 6.7). Although a larger percentage of the male students than the women indicated that the former duty was unsuitable for women, a slightly larger percentage of the female students chose the latter duty as unsuitable for women. As already noted, these small differences may be the result of different sample sizes.

Similar percentages of the female and male students, 8% and 9% respectively, chose 'maintenance' as unsuitable for women. This duty was only judged unsuitable for women by those male students who had also judged the two duties, 'construction' and 'installation, erection,' as unsuitable for women. Only one female student indicated that all three duties were unsuitable for women. The only other female student who indicated that any duties were unsuitable for women chose the two duties just noted.

TABLE 6.7
ENGINEERING DUTIES CHOSEN AS UNSUITED FOR WOMEN &/OR MEN -
PERCENTAGE OF CANADIAN FEMALE & MALE STUDENTS

DUTIES	UNSUITED FOR WOMEN		UNSUITED FOR MEN	
	% F	% M	% F	% M
Writing, information services	0	0	25 N=3	12 N=10
Library work, patents	0	0	25 N=3	18 N=15
Personnel	0	0	17 N=2	14 N=12
Purchasing, marketing, sales & service	0	0	0	5 N=4
Finance, accounting, & budgetary control	0	1 N=1	0	5 N=4
Teaching, instructing	0	1 N=1	8 N=1	1 N=1
Other (ie. "janitorial," & "work that requires patience")	0	1 N=1	0	2 N=2
Construction	17 N=2	32 N=27	0	0
Installation, Erection	17 N=2	12 N=10	0	0
Maintenance	8 N=1	9 N=8	0	0
Supervision of Department, District, Floor or Section	0	4 N=3	0	0
Administrative, Management & Executive Positions	0	1 N=1	0	0
Field Exploration	0	4 N=3	0	0
Testing, Inspection	0	4	0	0
Layout, Location	0	1 N=1	0	0
Research	0	1 N=1	0	0
Development	0	1 N=1	0	0
TOTAL	5	61	9	48

Source: Norlen Survey, Carleton University, 1988

(viii) Reasons Why Duties Were Unsuitable for Women

Previously it was found that the students gender-typed in a 'masculine' direction those technological artefacts that could be linked with industrial, traditionally male-dominated occupations, and that the students named "construction," "rugged" and "heavy" as descriptive of 'masculine' technology. On this basis it was suggested that if an occupation was perceived as involving dirty, rugged work that required physical strength and the use of machinery, it would also be assumed to require a male worker. This interpretation was reinforced by the responses of many of the students that 'construction,' 'installation, erection' and 'maintenance' are unsuitable for women. It is also possible, however, that these duties were judged unsuitable not simply for women, but for engineers regardless of their gender. But the students did not, as we would have expected, also chose these duties as unsuitable for men. Not one student indicated that any of these three duties were unsuitable for men.

The reasons the students gave for their responses also reflected the one-sided nature of their choices. Twelve of the twenty-seven male students and both of the women who chose 'construction' made statements such as, 'women lack the strength needed' or "women don't have the physical capability." Four male students also made comments to the effect that "women are not suited to mechanical things."

Eight of the ten male students and three of the eight male students who chose 'installation, erection' and 'maintenance,' respectively, also gave as their reason women's lack of physical strength. The two women who chose these duties as unsuited for women also cited women's physical inability. Unlike the female students who gave no other reasons for their choices, some male students commented on women's general incompatibility with the duties. Six of the eight male students who chose all three duties as unsuited for women, also made comments to the effect that they were "not nice" or "not ladylike."

(ix) Duties Less Consistently Judged Unsuited for Women

Although other duties were also judged unsuited for women by the male students, they were chosen much less often and with much less consistency. These, and the number of male students making such choices, included: (i) administrative, management and executive positions, N=1; (ii) finance, accounting and budgetary control, N=1; (iii) teaching, instructing, N=1; (iv) research, N=1; (v) development, N=1; (vi) supervision of department, district, floor or section, N=3; (vii) layout, location, N=1; (viii) field exploration, N=3; (ix) testing, inspection, N=3, and; (x) other, ie. "janitorial," N=1.

While some of these choices may be non-serious, the choice of 'field exploration' and 'testing, inspection' by three male students is likely linked with their choice of

'construction,' 'installation, erection' and 'maintenance' as unsuited for women. This is also likely the reason why 'layout, location' was chosen as unsuited for women, as it was one of these three male students who made this choice. These students also made comments about women's general incompatibility with "physically-taxing" duties.

The choice of the first six duties listed above as unsuited for women may largely represent non-serious responses. For example, the first five duties (ie. administration, finance, teaching, research, and development) were each chosen only once by one male student who commented that "women lack the intelligence and common sense to perform these duties." The duty 'supervision, management and executive positions' was also chosen by this student as unsuited for women. The other two male students who chose this duty may also have been responding non-seriously. One of the students, however, may have been serious, as indicated by his comment that "guys might not give any respect to a woman supervisor, even though its not her fault." Considering the hostility with which a minority of the students seemed to regard the questionnaire (eg. "what a stupid questionnaire"), it was not surprising that some students may have responded in a non-serious manner.

Again, it is unlikely that these responses reflected a belief on the part of the students that the duties are unsuited for engineers regardless of gender. If this was the

case, we would expect that the same duties would be chosen as unsuited for both women and men. Only three duties, however, were chosen as unsuited for women and men, and these were the choices of only one individual. It is likely, then, that this student regarded 'teaching, instructing,' "janitorial [work]" and 'finance, accounting and budgetary control' to be duties inappropriate for an engineer. This was also suggested by his comment that the three duties were "not related to an engineer's work."

Given the degree to which the students refrained from linking gender with engineering duties, it is possible that many of their choices represent non-serious responses. Conversely, it is possible that students refrained because of the disapproval behaviours labelled as "chauvinistic" or "sexist" often garner. Despite any constraints this might have imposed, there was a clear trend which led duties associated with traditional male activities to be judged unsuited for women.

(x) Engineering Duties Judged Unsuited for Men

In a similar manner, duties associated with traditional female activities tended to be duties chosen as unsuited for men. The seven duties chosen by the male students as unsuited for men included 'writing, information services,' 'library work, patents,' 'personnel,' 'teaching, instructing,' 'purchasing, marketing, sales and service,' 'finance, accounting and budgetary control,' and 'other'

(eg. "janitorial" and "work that requires patience"). The duties chosen by the female students were limited to the first four of the duties listed above. While the duties 'writing, information service,' 'library work, patents,' 'personnel,' and 'teaching, instructing,' were chosen by 12%, 18%, 14% and 1% of the male students, respectively, these duties were chosen by 25%, 25%, 17% and 8% of the female students, respectively. Although larger percentages of the female students judged the four duties unsuited for men, we could not make the generalization that female engineering students are more likely than the male students to perceive these four duties as unsuited for men. Their small sample size may have helped to create a distorted image of what duties the female students viewed as unsuited for men.

(xi) Reasons Why Duties Were Unsuited for Men

The reasons the students gave for their choices tended to repeat the wording of questionnaire item no. 12. Fourteen of the fifteen male students who chose 'library work, patents,' and eight of the ten who chose 'writing, information services' as unsuited for men, made comments to the effect that these duties "did not suit men." One of the three female students who chose both of these duties, as well as 'personnel' and 'teaching, instructed' as unsuited for men, also made this comment.

Three of the eight male students who chose the former

two abilities expanded upon this comment, saying that "women are more attracted to these positions" or that "men are not interested in these positions." Two of these male students also remarked that such "work requires patience." One of these students listed "any work that requires patience" in the responses category of 'other.' Presumably, they meant that women are better suited for these duties because women have greater patience than men. One male student who chose these two duties, as well as 'personnel,' 'teaching, instructing,' and 'purchasing, marketing, sales and service,' gave the reason that "women have better interpersonal skills." Another male student who also chose these duties as unsuited for men, except 'teaching, instructing,' similarly commented that "women seem to communicate better with people." One woman who chose three duties as unsuited for men, ie. 'writing, information services,' 'library work, patents' and 'personnel' wrote that "women are better at dealing with people."

These students responses may be interpreted as indicating that the students believed that information services, library work, personnel, teaching, sales and service require interpersonal skills. Their responses also indicated that these are the skills they believed women possess. It seems, then, that it was not that men were judged incapable of performing these duties, as much as it was that they were perceived as less interested in them and

that women were better suited for them by virtue of the skills they possess. Despite this pattern of findings, it should be remembered that most students, eight of the women and fifty-one of the men, refrained from associating any engineering duties with gender. In addition, significance tests revealed that few of the students' responses linking gender with duties were significant.

(xii) Duties Significantly Related to Gender

Chi-square tests ($p < 0.05$) were used to determine whether there was any relationship between the gender of the persons indicated in the question (ie. women or men) and whether a duty was judged unsuitable. By this measure, we found that the female students' responses concerning which duties were unsuited was not significantly related to the gender of the persons in question. This was also true of the male students' responses, except those pertaining to 'construction.' Although the chi-square test did indicate their responses about 'construction' were significantly related to the gender of the persons in question, a measure of association (ie. fee-square) indicated that the relationship was weak. As fee-square was only 0.18, it indicated that knowing the gender of the persons in question (ie. women or men) would allow one to predict only about 18% of the students's responses concerning whether the duty 'construction' was unsuited.

Although a significant relationship ($p < 0.05$) was

found for the male students, a chi-square test did not find any significant differences between the responses of the female and male students. This may be due to the weakness of the observed relationship between the persons in question (ie. women) and the duty judged unsuited (ie. 'construction'). As no other statistically significant relationships were found within either the female or male sample, this reflected the students' tendency to refrain from linking duties with gender. Specifically, it indicated that the male students were no more likely than the female students to judge that any duties were unsuited for women or men.

It seemed, then, that when the students did chose duties as unsuited for women or men, they tended to chose the same duties. Duties perceived to require physical strength, such as 'construction' and 'installation, erection,' were judged to be unsuited for women. Duties perceived to require interpersonal skills, such as 'writing, information services,' and 'library work, patents,' were judged unsuited for men. Thus, as when gender-typing technological artefacts and making gender associations to technology, the students used the gender of the dominant perceived user, and the attributes this user is believed to possess, on which to base their judgements. As when asked to perform the former two tasks, however, many of the students refrained from making gender linkages.

(xiii) Qualities Associated with 'Feminine' Technology
(Table 6.5)

The characteristics associated with 'feminine' technological artefacts were in direct opposition to those outlined in connection with 'masculine' technology. Hence, 26% of the Norwegians and 11% of the men named "small, easy, neat, etc." as descriptive of artefacts they thought of as 'womanly' or 'feminine.' While 13% and 6%, respectively, named "accurate, dexterous, fiddling work, etc.," 5% and 9% also associated "soft, sensitive, delicate, aesthetical, etc." with 'feminine' artefacts. Although the women made no similar associations, 33% named "physically light" as a quality descriptive of 'feminine' technology [techniques]. Eight percent of the Norwegians and 9% of the men also made this association. Again, one can see this association as being related to the large percentages citing "construction, building, etc." as descriptive of 'masculine' technology [techniques]. It might have also contributed to the 6% of the men associating "hardware" with 'masculine' artefacts, and the 8% associating "software" with 'feminine' artefacts.

(xiv) Patterns of Association

While it was difficult to compare three such discrepant sample sizes, certain patterns of association were evident. As in the gender-typing of artefacts, the Norwegians were

the least restrained when making gender associations.⁴⁶ Although the men did make more gender associations to technological artefacts, we could not state conclusively that they were less reserved than the women. Nevertheless, given the women's much greater restraint when gender-typing artefacts in questionnaire item no. 6, it is likely that a larger female sample would have exhibited this tendency. As in the Norwegian sample, the gender-typing of artefacts was organized around the properties of who they were used by and how they looked. In the Canadian sample, however the property 'how they looked' was expanded to include both the physical characteristics of the artefacts and the user attributes these were presumed to require. The Norwegians' associations also supported this reclassification. "Large, heavy" artefacts, for example, were viewed as requiring physical "strength" and thus a male user. Analysis of the associations revealed that, as in the Norwegian study (Sorenson and Berg, 1987: 161), 'masculine' artefacts were large, dirty, noisy and rugged, in contrast to the 'feminine' ones, which were small, neat, accurate and physically light. As when gender-typing artefacts in item no. 6, most of the associations made to 'masculine'

⁴⁶ We cannot know whether the increased number and variety of associations to 'masculine,' 'feminine' and 'advanced' technology [techniques] is a result only of the Norwegians' larger sample size, or whether it also represents a greater tendency to make gender associations. Given their greater degree of artefact gender-typing, it is likely that both contributed to this trend.

artefacts referred to traditional, industrial technology and traditional blue-collar industrial jobs. Like the Norwegian responses, the number and variety of associations made by the Canadians to 'feminine' artefacts was larger than those made to 'masculine' artefacts.

(xv) Qualities Associated with 'Advanced' Technology (Table 6.6)

Given that it required no controversial gender associations, it was not surprising that 'advanced' technology [techniques] received the greatest number and variety of associations. The largest percentage of these associations referred to specific types of technological artefacts, such as computers, microprocessors, and lasers, in addition to those related to electronics, telecommunications, space exploration and fuel production. Large percentages, 25% of the women and 18% of the men (but only 7% of the Norwegians), made associations linking the "new, improved, creative, innovative, progressive and pioneering" with 'advanced' technology. While all these associations carried positive connotations, 17% of the women, 11% of the men and 4% of the Norwegians specifically linked 'advanced' technological artefacts to positive outcomes for society. These included "saving natural resources," "improving the lifestyle of society," and "solving environmental problems." Eleven percent of the men, however, connected negative qualities with 'advanced'

artefacts: 4% mentioning "unpredictable, unreliable;" 2% listing it as "overpriced;" and 5% labelling it "dangerous, frightening, and for military purposes." Eight percent of the men also made the negative association, "destructive, for warfare or military combat," to 'masculine' artefacts.

(xvi) Similarity Between Associations to 'Masculine' & 'Advanced' Technology

These negative associations provided the first hint that when comparing the list of associations of 'advanced' artefacts to ones of 'feminine' and 'masculine' artefacts, we would find greater similarities between the 'masculine' and 'advanced' associations. While the physical characteristics of 'advanced' artefacts were not commented upon as frequently as they were in the case of 'feminine' and particularly 'masculine' ones, the 'masculine' and 'advanced' artefacts shared associations relating to complexity and specific new technological products. While 24% of the Norwegians and 9% of the men made the associations of "complex, difficult, etc." to 'advanced' artefacts, 13% and 7%, respectively, made similar associations (ie. "complicated, advanced, etc.") to 'masculine' artefacts. Since the association "new, with a future, developing, etc." to 'advanced' artefacts by 7% of the Norwegians and 18% of the men, may be interpreted as consistent with the associations to 'masculine' artefacts, there was further evidence of a correspondence between the

associations of certain 'masculine' and 'advanced' artefacts. This was also suggested by the 19% of the men associating "computers" with 'advanced' artefacts, and the 9% associating them with 'masculine' artefacts. Similarly, 7% of the men associated "electronics" with 'masculine' artefacts, while 11% associated them with 'advanced' artefacts.⁴⁷

(xvii) Similarity in Associations to 'Feminine' & 'Advanced' Technology

The few similarities between the qualities associated with 'feminine' and 'advanced' artefacts focused around their smallness, fragility and humane purposes. While 8% of the Norwegians and 11% of the men associated "small, fragile, etc." with 'advanced' artefacts, 26% and 11%, respectively, associated "small, easy, neat, etc." with 'feminine' artefacts. An additional 5% and 9%, respectively, associated the related category, "soft, sensitive, delicate, aesthetical, etc." with 'feminine' artefacts. While 8% of the Norwegians and 7% of the men associated "care, social, humanly oriented, etc." with 'feminine' artefacts, 4% and 11%, respectively, associated "human, saving natural resources, etc." with 'advanced' artefacts. Unlike the Norwegians, associations to the 'living' sciences were not shared by both 'feminine' and 'advanced' artefacts.

⁴⁷ While this 11% does not appear in Table 6.3, it was calculating by disaggregating the responses represented by the category "electronical, microprocessor, laser, etc."

(xviii) Third Property Effecting Artefact Gender-Typing

Based on these similarities, however, we could discern, as did Sorenson and Berg (1987: 161), a third set of properties by which artefacts may be gender-typed. These properties resembled certain characteristics outlined in both Keller's (1985) model of genderized science and Hacker's (1981) 'culture of engineering.' Both Keller and Hacker made note of a mind/body dualism which gave most prestige to scientific abstraction, and least to 'feminine' qualities. This was reflected in the student's gender associations to 'advanced' artefacts which exhibited a greater similarity with associations to 'masculine' artefacts, than those to 'feminine' artefacts. The 'masculine' and 'advanced' artefacts shared associations relating to complexity and new technological products, while associations to 'feminine' artefacts were focused around their smallness, fragility and humane purposes. Hence, those technological artefacts viewed as modern or advanced may be more likely to connote 'masculinity' than 'femininity.' These "new" artefacts, then, which lack a cultural association with traditional male occupations or with activities requiring physical strength, may still be gender-typed as 'masculine.'

(xix) Status and Artefact Gender-Typing

On the basis of this dualism we would expect that the degree of 'masculinity' attributed to an artefact would be positively related to the status also attributed to it. 'Masculine' artefacts, then, would tend to be rated higher in status than 'feminine' ones. Although this thesis did not attempt to measure the status of technological artefacts, Sorenson and Berg did this in their initial survey. They (1987: 163) found that the associations to 'advanced' artefacts had little in common with those of 'masculine' artefacts. Although all artefacts labelled 'feminine' were rated as low-status, the neutral and 'masculine' ones showed a substantial variation in their status ratings -- from quite high to rather low. This suggested that the relationship between gender-typing and status ratings was rather more diffuse than originally expected. Had a similar investigation been conducted in this thesis we might have found similar results given the similarities in the way artefacts were gender-typed and the correspondence between certain association made to 'advanced' and 'masculine' artefacts.

(xx) Why Artificial Fibre was Rated 'Feminine'

Having investigated the qualities students associated with 'masculine,' 'feminine' and 'advanced' technology [techniques], we can now return to the problem of why artificial fibre was rated as 'feminine' by the Norwegian

students. Although the Norwegians were less restrained when gender-typing artefacts than the Canadian women and men, all the engineering students were remarkably compatible in what qualities they named as 'masculine,' 'feminine' and 'advanced.' Their associations to technological artefacts reflected the same two properties: (i) the physical characteristics of the artefacts, and (ii) who they were used by. Due to the small sample size of women, and hence the number of responses, however, we cannot assert as reliably that their associations reflected these properties. Nevertheless, the direction of both their artefact gender-typing and their associations to 'masculine,' 'feminine' and 'advanced' technology [techniques] were consistent with those of the men and Norwegians.

To reiterate briefly, both exploratory (ie. direction and dispersion) and confirmatory (eg. t-tests, anovas) analyses indicated that the Norwegians were less restrained when gender-typing artefacts than the Canadian women and men, and that this gender-typing occurred more often in a 'masculine' direction. When making associations, the greatest number and variety were linked with 'advanced,' then 'feminine' and lastly 'masculine' technology [techniques] by all three samples. Both the Norwegians' and the men's 'masculine' ratings were significant for the melting oven for ore, the excavator, the cement mixer and the electrical drill. Although none of the women's ratings

were significantly 'masculine,' their ratings were in the same 'masculine' direction as the males and the Norwegians. Similarly, none of the women's or men's 'feminine' ratings were significant. The Norwegians' ratings were strongly 'feminine' for artificial fibre, the packing machine for fish fillets, the centrifuge, the microscope, the thermometer and the telephone exchange. The last three of these artefacts were also rated in a 'feminine' direction by the Canadian students.

The artefacts rated as 'feminine' corresponded to the gendered qualities of small, physically light, delicate, and dexterous, as well as the associations of traditionally female-dominated medical and clerical occupations. 'Masculine' artefacts reflected the associations made to 'masculine' technology [techniques] as heavy, dirty and mechanical, and involved in industrial jobs, such as construction. Duties judged to be unsuited for women, eg. 'construction' and 'installation, erection,' were consistent with these associations to 'masculine' technology. We may speculate, then, that artificial fibre was perceived as 'feminine' by a substantial number of the Norwegians because they conceptualized it as neither large, dirty nor mechanical. As these were engineering students, associations to artificial fibre may have consisted of possible industrial and mechanical uses. Artificial fibre used in these contexts, for example, include structural materials

used in roofing and ceiling products. They are also used in the construction of car bodies and, most recently, in car engines. Development of this kind is primarily concerned with combining product strength and weight in such a way as to yield stronger yet lighter materials.⁴⁸ As an important new technological product, it was not likely to be associated with any traditionally male-dominated industrial jobs.

Conversely, artificial (or synthetic) fibre may have connoted the traditional garment industry, a large employer of women, and the widespread use of "man-made" fibres in clothing production. As this connotation may have extended to home sewing, it was likely to also connote the woman/wife/mother producing for home consumption. These connotations, then, may have combined to yield a 'feminine' rating by 31% of the Norwegians.

As suggested by the use of artificial fibre in the production of strong yet light structural products, this artefact may have also prompted associations of "pioneering," "innovative," "new," and "revolutionary." For the Canadian students, then, the connotations may have corresponded primarily to the associations they made to 'advanced' technology [techniques]. This may account for the neutral rating of artificial fibre by 80% of the men and

⁴⁸ The industrial and mechanical uses of artificial fibre were suggested by three professional engineers during separate interviews.

all of the women.

IN CONCLUSION

As evident from the above discussion, the gender-typing of artefacts, gendered associations to technology, and duties linked with gender differentiated male and female domains of activity: The male was linked with mechanical and often industrial work involving large, heavy and complicated technological artefacts, while the female was linked with caring, service-oriented work involving light, small and accurate artefacts. There were also indications that these associations to 'masculine' artefacts were more closely linked with associations to 'advanced' artefacts, than were those to 'feminine' artefacts. 'Masculine' artefacts, then, may be more highly valued than 'feminine' artefacts. These same patterns of gender-typing and gender-associations were evident in the Canadian and Norwegian samples, although this was not as pronounced among the Canadian men as it was among the Norwegians. Similarly, the patterns exhibited by the Canadian women were not as strong as those exhibited by the Canadian men, despite their overall correspondence.

If there was an apparent gender division of labour within engineering, this might be partially related to the gender-typing of artefacts. With the gradually increasing numbers of women in engineering, this might conceivably affect their choice of department, and later their

employment 'choices.'⁴⁹ The possibility of a link between a gender division of labour and gender-typed artefacts will be explored in Chapter VII. Chapter VIII will expand upon the possibility by following this linkage into the realm of genderized styles of work and thought.

⁴⁹ 'Choices' is placed in quotations because where one is employed is rarely only the result of one's preferences. Rather, whether others decide to employ you and where they choose to employ you, both geographically and topically, affects it. In other words, one is both 'chooser' and 'chosen.' The gender-typing of technological artefacts may also influence these employer decisions.

CHAPTER VII
GENDERIZATION OF TECHNOLOGY AT
THE INSTITUTIONAL LEVEL

In the previous chapters we presented evidence of the dominance of men over technology and of gender differences in men's and women's relation to technological artefacts. Based on the students' associations to certain artefacts, it was argued that qualities of artefacts such as heavy, dirty and advanced were labelled 'masculine,' while qualities such as light, clean and accurate were labelled 'feminine.' We also argued that a correspondence emerged between certain sets of qualities which resembled some of the characteristics of Keller's (1985) model of genderized science and Hacker's (1981) 'culture of engineering:' the exaltation of objectivity, separatism and emotional reticence, and the derogation of subjectivity, emotionalism and interactionism. Technological artefacts may act as signs, signifying elements, behaviours and values to be 'masculine' or 'feminine.' Such processes of signification may have contributed to the production and maintenance of a gender division of labour among students within the engineering educational institution.⁵⁰

Women, then, may tend to be concentrated in those departments of engineering that coincide with the identification of artefacts as 'feminine.' In order to make

⁵⁰ While it can be logically argued that a gender division of labour within this institute would be replicated to some degree within the workplace, this issue will not be addressed in this chapter. As we have no data concerning the genderization of artefacts within the workplace statements would be speculative at best.

this inference, four issues had to be addressed. First, we had to determine whether technological artefacts were gender-typed, and then whether this involved the use of 'feminine' as well as 'masculine' labels. Third, we had to determine if a gender division of labour existed at the site of engineering education. Lastly, we had to ascertain whether the artefacts associated with the departments in which women were concentrated were more often gender-typed in a 'feminine' direction than were artefacts of other departments. The first two of these issues were dealt with extensively in Chapter VI. The third and fourth issues will be examined within the confines of this chapter, beginning by situating the distribution of Carleton University engineering students within the Canadian context.

As pictorial presentations and comparative statistics were used extensively, we will begin with a brief explanation of the statistics computed and terms used. For our sample of third-year engineering students, the female participation rate indicated the proportion (or percentage) of students which was female.⁵¹ Hence, the value was always less than one when it represented a proportion (or less than .10 when it represented a percentage).

⁵¹ The following discussion of the female participation rate and the comparative female-representation index was based on Micheal's (1988) use of these terms in her detailed analysis of female under-representation in the training of engineers in twenty-three countries.

Example:

$$\begin{array}{lcl} \text{Female Participation} & & \text{The Number of Female Students} \\ \text{Rate Among Students} & = & \text{Enrolled in Engineering} \\ \text{Enrolled in Engineering} & & \text{-----} \\ & & \text{The Total Number of Students} \\ & & \text{Enrolled in Engineering} \end{array}$$

For 1978-79 at Carleton University, the female participation rate was calculated as follows: 58 divided by 944 = 0.061. In other words, 6.1% of the students enrolled at Carleton University during the school year, 1978-79, were female.

The (absolute) female participation rate, however, did not provide a sense of the role played by women in a given sector in relation to female participation in all educational sectors. This remark is all the more applicable when we try to draw comparisons among countries (ie. Norway and Canada). In this respect, the comparative female-representation index makes it possible to refine the analysis because it took into account existing differences among overall female participation rates in the countries of interest. Similarly, it allowed one to compare the departmental enrolment of women in engineering relative to their overall participation in engineering, and against that of men at Carleton University and in Canada. For our sample, the comparative female-representation index corresponded to the ratio of the sample's female participation rate to that of the total reference population. As the ratio of two values, the index X was: (a) if less than 1 -- relative under-representation of women; (b) if greater than 1 --

relative over-representation of women; or (c) if equal to 1
 -- equal representation of women and men.

Example:

$$\frac{\text{The Comparative Female-Representation Index Among Students Enrolled in Engineering}}{\text{Female Participation Rate Among Students Enrolled in Engineering.}} = \frac{\text{Female Participation Among All Students Enrolled}}{\text{Female Participation Rate Among Students Enrolled in Engineering.}}$$

where, the female participation rate among all students = $\frac{\text{the number of female students enroled}}{\text{the total number of students enroled}}$

For 1978-79 at Carleton University, the comparative female-representation index was calculated as follows: 0.061 divided by (6014 divided by 12885) = 0.131. This translated into meaning that the female enrolment in engineering education at Carleton University during the school year 1978-79 was about seven-and-one-half times lower than the overall female enrolment rate at Carleton University. In addition to the above two measures of women's participation in engineering education, simple statistics were utilized, such as the percentage increase or decrease in the numbers of women and men enroled in engineering between any given school years, and the ratio of men to women enroled in engineering or a certain department during any given school year. To begin our investigation into the gender division of labour among engineering students, we examined how enrolment has changed at Carleton University since 1978.

CARLETON UNIVERSITY ENROLMENT, 1978-88

(i) Total Undergraduate Enrolment

Total undergraduate engineering enrolment declined only marginally in this ten year period. Specifically, it declined by 9%, ie. from 914 to 830 (Figure 7.1). When we looked at how enrolment changed relative to the total number of students enrolled, we found that while in 1978-79 undergraduate enrolment in engineering was 7.1% of the total undergraduate enrolment, by 1988-89 this had declined to 5.6%. We could not, however, consider this as evidence of a strong decline in enrolment given that it was such a small percentage, and that minor fluctuations in enrolment have occurred during the ten year period considered.⁵² Conversely, we may be seeing the first evidence of declining enrolment because of the passage of the 'wave' of the members of the post-war baby-boom generation (ie. the children of returning Second World War veterans) which raised enrolments in the 1970's in the engineering and technology institutions to unprecedented levels. As Morris (1988: 80) noted, with the passage of this 'wave' through the educational system, enrolments can be expected to either remain constant or subside gradually during at least the next two decades.

⁵² The school year 1986-87 is the last year for which Statistics Canada has published enrolment figures. More recent years are not yet available.

FIGURE 7.1
TOTAL FULL-TIME ENROLMENT IN ENGINEERING

Source: Norlen Survey, Carleton University, 1988

(ii) Undergraduate Enrolment by Gender

Enrolment, however, differed considerably by gender: total male enrolment in engineering at Carleton University decreased by 12%, from 859 in 1978 to 756 in 1988 (Figure 7.1). In other words, while in 1978 94% of those enrolled in engineering were men, by 1988 this had decreased to 91%. Women's enrolment, then, increased by 150%: from 6.0% in 1978 and 9.0% in 1988 (ie. from 55 to 74) (Figure 7.2). Between 1978 and 1988, male enrolment across Canada has increased by 115% (from 28 944 to 33 249), while female enrolment has increased by 219% (from 1 920 to 4 217). Although this may be interpreted as a dramatic increase in the number of women enrolled in engineering, a clear picture of their under-representation was illustrated in Figures 7.3 and 7.4. It is apparent from Figure 7.3 that the number of men for each woman enrolled at Carleton University gradually declined from about sixteen in 1978, levelling off near eleven in 1983. In Canada in 1978 there were fifteen men enrolled for every woman, and this stabilized around ten men in 1983. From the line indicating women as the percentage of students enrolled (Figure 7.4), we saw a fairly stable, though small, increase from 6.4% to 9.8% between 1978 and 1988. Canada experienced an increase from 6.2% in 1978 to 11.3% in 1986.

UNIVERSITY ENROLMENT & GRADUATION AT CARLETON UNIVERSITY & IN CANADA, 1970-88

(i) B. Eng. Graduates by Gender

To look earlier than 1978 we had to use statistics on graduation (Figure 7.5 and 7.6), the only available data broken down by gender for Carleton University. Figure 7.5 represented the number of women graduating from Carleton University with a Bachelor of Engineering (B. Eng.) as a percentage of the total number of students graduating with a similar degree between 1972 and 1987.⁵³ While women comprised only 1% of all such graduating students in 1972, by 1987 this had increased to 7.1%. Although this was a 1100% increase in just fifteen years, it represented an increase of only ten women over the one woman graduating with a B. Eng. in 1972. In this year (see Figure 7.5) there were one-hundred men for the one woman graduating, but by 1983 this had declined to eleven men for each woman graduate. Since 1983 the number of men graduating for each woman has stabilized, fluctuating between eleven and fourteen. In Canada in 1970 there were sixty-five men for every woman graduating.⁵⁴ By 1985 this had gradually decreased to ten. This represented an increase of 1585% in

⁵³ Although all engineering degrees are not referred to as a Bachelor of Engineering, for the sake of consistency and simplicity, it will be referred to as such within this thesis.

⁵⁴ Statistics concerning graduation for the school year 1972-73 were not published by Statistics Canada. Figures for the nearest appropriate year, 1970-71, were substituted for comparison purposes.

FIGURE 7.2
TOTAL FULL-TIME ENROLMENT IN ENGINEERING FOR WOMEN

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.3
NUMBER OF MALE FULL-TIME ENGINEERING STUDENTS FOR
EACH FEMALE FULL-TIME ENGINEERING STUDENT

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.4
FEMALE FULL-TIME ENGINEERING STUDENTS AS A
PERCENTAGE OF FULL-TIME ENGINEERING STUDENTS

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.5
NUMBER OF MALE ENGINEERING GRADUATES FOR EACH
FEMALE ENGINEERING GRADUATE

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.6
FEMALE ENGINEERING GRADUATES AS A PERCENTAGE OF GRADUATES

Source: Norlen Survey, Carleton University, 1988

the numbers of women graduating in Canada with Bachelor degrees in Engineering between 1972 and 1985 (ie. from 66 to 1046). In Canada, while women comprised only 1.5% of all Bachelor degrees in Engineering in 1970, by 1986 this had increased to 10.0%.

(ii) Women's Participation and Representation

The number of women both enrolled in and graduating from engineering indicated that a gradual increase has occurred at Carleton University and in Canada. It should be noted that in both enrolment and graduation, Carleton University lagged slightly behind the overall rates in Canada. While the Canadian female participation rate for enrolment increased from 2.0% to 11.3% between 1972 and 1986, Carleton's rate increased from 1.5% to 8.6% (Table 7.1). The comparative female-representation index (Table 7.2) indicated the same trend during all years examined, except the school years 1975-76 and 1978-79. These were also the years when the female participation rates at Carleton University and in Canada were virtually identical: 4.0% for both during 1975-76, and 6.1% and 6.2%, respectively, during 1978-79. The female-representation index, which climbed from 0.038 in 1970 to .191 in 1986, indicated that while the female representation among engineering B. Sc. graduates in Canada was twenty-six times lower in 1972 than their representation among all B. A. and B. Sc. graduates, in 1986 it was only five times lower. This

TABLE 7.1
FEMALE PARTICIPATION RATES FOR FULL- AND PART-TIME
ENGINEERING STUDENTS COMBINED - AS A PERCENTAGE

A. ENROLMENT

	70-71	72-73	75-76	78-79	80-81	85-86	86-87	88-89
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Canada	1.3	2.0	4.0	6.2	7.4	10.6	11.3	NA
Carleton University	0	1.5	4.0	6.1	5.6	8.9	8.6	9.0

B. BACHELOR OF ENGINEERING GRADUATES

	70-71	72-73	75-76	78-79	80-81	85-86	86-87	88-89
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Canada	1.5	NA	NA	5.3	5.7	9.6	10.0	NA
Carleton University	0	1.0	NA	3.5	4.4	8.1	7.1	6.7

Source: Norlen Survey, Carleton University, 1988

TABLE 7.2
COMPARATIVE FEMALE-REPRESENTATION INDICES FOR FULL- AND
PART-TIME STUDENTS COMBINED

A. ENROLMENT

	70-71	72-73	75-76	78-79	80-81	85-86	86-87	87-88
	—	—	—	—	—	—	—	—
Canada	.033	.056	.073	.127	.143	.197	.214	NA
Carleton University	0	.042	.091	.131	.118	.187	.186	.194

B. BACHELOR OF SCIENCE GRADUATES

	70-71	72-73	75-76	78-79	80-81	85-86	86-87	87-88
	—	—	—	—	—	—	—	—
Canada	.038	NA	NA	.108	.113	.181	.191	NA
Carleton University	0	.028	NA	.080	.098	.166	.149	.134

Source: Norlen Survey, Carleton University, 1988

decrease was independent of the intervening increase in female representation in overall university enrolment. For Carleton University, the index climbed from 0.028 to 0.149 . In other words, while female representation among engineering graduates was thirty-six times lower in 1972 than among all B. Sc. and B. A. graduates at Carleton University, by 1986 it was only six-and-a-half times lower (also independent of intervening increase).⁵⁵ It was clear, then, that despite the small differences between the numbers for enrolment and graduation at Carleton University and in Canada, both exhibited a similar trend of gradual increase.

DEPARTMENT DISTRIBUTION AMONG FOURTH-YEAR STUDENTS, 1978-88

While the numbers of women enrolling and graduating varied somewhat from year to year, they also varied by engineering department. Breakdowns by department were only available for enrolment in 1978-79 for fourth-year engineering students because the registration records kept by the Office of Planning and Statistics (OPAS) at Carleton

⁵⁵ Note that both the participation rates and indices for B. Eng. graduates were consistently lower than those for enrolment. This difference in female representation between enrolment and graduates, which was greater than that between male enrolment and graduation, may indicate that women were less likely than men to complete engineering studies successfully. In a review of engineering education in twenty-three countries, Micheal (1988) found a similar pattern in seventeen countries (ie. Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, Finland, The Federal Republic of Germany, Greece, Hungary, Ireland, Italy, Romania, Spain, Sweden, Turkey, the United Kingdom, and Yugoslavia) as well as Canada and Norway. She concluded that women were less likely than men to successfully complete their undergraduate engineering education.

University did not record departmental enrolment for first, second or third years. To create a picture of how departmental enrolment changed between 1978 and 1988 we will use statistics available for the years 1978-79, 1983-84 and 1988-89.

(i) Changes in Departmental Enrolment by Gender

In all departments (Figures 7.7, 7.9 and 7.10), except systems and computer engineering (Figure 7.8), enrolment declined. The largest decline, however, occurred in civil engineering. While the male enrolment in this department decreased by 78%, the female enrolment increased by 150%. While this increase seems dramatically large, it represented an increase of only three more women in fourth-year in 1988 than in 1978. Total enrolment also declined in the department of mechanical and aeronautical. Unlike civil engineering, both male and female enrolment in this department declined over the ten year period: for men by 26%; for women by 50% (ie. 6 women enrolled in 1978, but only 3 in 1988). Although electrical engineering experienced minor fluctuations in enrolment, it did not decline significantly between 1978 and 1988. While male enrolment in year IV decreased by 12%, female enrolment increased by 200% (ie. from only 4 in 1978 to 12 in 1988). The department, systems and computer engineering, was the only one to exhibit dramatic increases in enrolment. As this department was not established until the school year 1983-84,

FIGURE 7.7
FOURTH YEAR FULL-TIME ENROLMENT IN
MECHANICAL AND AERONAUTICAL ENGINEERING

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.8
FOURTH YEAR FULL-TIME ENROLMENT IN
COMPUTER AND SYSTEMS ENGINEERING
NB: Enrolment Axis Is 2x That Of Other Graphs

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.9
FOURTH YEAR FULL-TIME ENROLMENT IN
ELECTRICAL ENGINEERING

Source: Norlen Survey, Carleton University, 1988

FIGURE 7.10
FOURTH YEAR FULL-TIME ENROLMENT IN
CIVIL ENGINEERING

Source: Norlen Survey, Carleton University, 1988

comparison could only take place over a five year span. It was not surprising, then, that since the establishment of this new department, the total enrolment in fourth-year increased by 138% (ie. from 13 in 1978 to 31 in 1983). While the male enrolment increased by 125% (ie. from 12 to 27), this department showed the greatest increase in female enrolment: 400%. Nevertheless, this represented an increase of only three women over the number of women (ie. one) in 1983.

(ii) Departmental Concentration by Gender, 1978-79 & 1988-89

For women in 1988, then, the greatest numbers could be found in electrical engineering followed by civil, then systems and computer, and lastly by mechanical and aeronautical. For men the pattern was somewhat different. While they were also concentrated in the greatest numbers in electrical, this was followed by mechanical and aeronautical, then systems and computer, and lastly by civil. In 1978-79 the greatest number of fourth-year women were enroled in mechanical and aeronautical, followed by electrical and lastly civil (ie. 6, 4 and 1, respectively). ⁵⁶

Consistent with the overall decline in mechanical and aeronautical, this indicated a concentration of women in electrical and civil engineering in 1988-89. For men, the

⁵⁶ In 1978, no women were enroled in the department, 'Materials,' and by 1984 this department had been incorporated into other departments.

pattern of concentration was the same as in 1988-89, with the exception of systems and computer engineering. By 1988-89 both men and women were most concentrated in electrical engineering. While the lowest concentration of women was in mechanical and aeronautical, the second highest concentration of men was in this department. The second highest concentration of women and the lowest concentration of men were in the civil engineering department. This pattern reflected the decreasing enrolment of men in civil, and the increasing enrolment of women in all departments except mechanical and aeronautical.

(iii) Preliminary Indications of a Gender Division of Labour

These numbers represented the first indication of a gender division of labour among engineering students at Carleton University. Unfortunately, as we have no information on the departmental distribution of students in first, second or third year, we cannot determine whether this reflects a consistent gender division of labour across all four years of engineering studies. In addition, since we have enrolment breakdowns by gender and department only for the school years 1978-79, 1983-84 and 1988-89, it is difficult to create a valid image of how the gender division of labour may have changed as increasing numbers of women entered engineering. Lastly, as the numbers of fourth-year women in each department (ie. 11 in 1978-79 and 24 in 1988-89) were so small, we could not draw valid conclusions.

DEPARTMENT DISTRIBUTION AT CARLETON UNIVERSITY, 1980-1988

(i) Men's and Women's Departmental Distribution

To try and judge whether the pattern described above was valid, we reviewed the departmental distributions of men and women in engineering at Carleton University for the school years 1983-84, 1986-87 and 1988-89.⁵⁷ Participation rates, comparative female-representation indices were used, as well as the absolute numbers of students enrolled in engineering. Consistent with earlier discussions, male enrolment declined across all years (ie. from 850 to 811), while female enrolment remained fairly stable (ie. 72, 69 and 74).

In all years examined the highest concentration of both men and women was in electrical engineering. The participation rates (Table 7.3) were greatest in this department, ranging from 23.6% to 35.1% for the men and from 2.4% to 3.9% for the women. This meant that although total male enrolment declined, the male representation in electrical department experienced an overall increase. In 1983-84 the male students in this department comprised 23.6% of all students enrolled in engineering, but by 1988-89 this had increased to 33.0%. Similarly, while women enrolled in this department represented approximately 2.4% of all

⁵⁷ The school year 1983-84 was the first year departmental enrolments by gender were recorded for all four years of engineering studies. The statistics to be discussed were computed from registration records provided by OPAS.

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TABLE 7.3
CARLETON UNIVERSITY MALE AND FEMALE PARTICIPATION RATES IN
ENGINEERING BY DEPARTMENT - AS A PERCENTAGE, 1983 TO 1989

Dept.	1983-84		1986-87		1988-89	
	Male	Female	Male	Female	Male	Female
Electrical	23.6 N=218	2.4 N=22	35.1 N=304	3.9 N=34	33.0 N=294	3.9 N=35
Mechanical & Aeronautical	17.1 N=158	1.3 N=12	32.9 N=285	1.0 N=9	29.6 N=263	1.2 N=11
Civil	14.2 N=131	1.4 N=13	10.4 N=90	1.5 N=13	10.6 N=94	1.1 N=13
Computer & Systems	7.6 N=70	0.54 N=5	9.9 N=8	1.3 N=11	11.8 N=105	1.5 N=13
Total Male	577		765		756	
Total Female		52		57		69
Undeclared*	273	20	33	2	60	5
Dept. Total	922		867		890	

* Indicates the number of students who had not yet selected a department in which to specialize.

Source: Norlen Survey, Carleton University, 1988

students enrolled in engineering in 1983-84, this increased to 3.9% by 1988-89.

(ii) Women's Enrolment by Department, 1983-1989

To put the gender distribution in a different context, while 90% of those enrolled in this department were men, 10% were women. Compared to the other departments, electrical engineering had a much higher concentration of women students. In the other three departments, the concentration of women varied between only 0.54% and 1.5%. When we examined the absolute number of students, this discrepancy in concentration was clearly apparent. The number of women enrolled in electrical, civil, computer and systems, and mechanical and aeronautical engineering were: (i) In 1983-84, 22, 13, 5 and 12, respectively; (ii) in 1986-87, 34, 13, 11 and 9, respectively; and (iii) in 1988-89, 35, 10, 13 and 11, respectively.

(iii) Patterns of Distribution for Women

The small number of women enrolled in the last three departments made it difficult to discern patterns of distribution. Nevertheless, certain patterns were observable. As already noted, the greatest concentration of women was enrolled in electrical engineering. Although the absolute number of women enrolled in civil (ie. 13) did not alter in any of the years examined, the degree of concentration shifted from the second highest in 1983-84 and 1986-87, to the lowest in 1988-89. Since the establishment

of computer and systems engineering in 1983, the concentration in this department has increased from the lowest to the second highest. Women's concentration in mechanical and aeronautical engineering remained consistently low, shifting between third and last position.

The comparative female-representation indices (Table 7.4) for 1983-84 and 1986-87 also exhibited the above pattern. In addition, they illustrate the increased representation of women in electrical and computer and systems engineering, and their decreased representation in civil and mechanical and aeronautical engineering (relative to the increase in the absolute numbers of women enrolling at the university). In other words, in 1983-84 women in electrical engineering comprised 7.5% of all women enrolled at the university, in civil 4.5%, in mechanical and aeronautical 4.1%, and in computer and systems 1.7%. By 1986-87, women had increased their representation in electrical to comprise 8.6% of all women enrolled at the university, 2.7% in systems and computer, while their representation decreased to 3.3% in civil and 2.3% in mechanical and aeronautical engineering.⁵⁸

⁵⁸ Comparative female-representation indices for 1988-89 could not be computed because total enrolment figures at Carleton University were not yet available.

TABLE 7.4
COMPARATIVE FEMALE-REPRESENTATION INDICES FOR CARLETON
UNIVERSITY BY DEPARTMENT, 1983-84 AND 1986-87

Dept.	1983-84	1986-87
Electrical	.075	.086
Mechanical & Aeronautical	.041	.023
Civil	.045	.033
Computer & Systems	.017	.027

Source: Norlen Survey, Carleton University, 1988

(iv) Correspondence Between Distribution of All Enrolled Women & Fourth-Year Women

The pattern of concentration discussed above corresponds strongly with those noted in connection with the distribution of fourth-year women. Their concentration in 1983-84 corresponded with the pattern of their overall departmental distribution in this year. The distribution of fourth-year women in 1988-89 matched the overall pattern of concentration in 1986-87, although not precisely with that of 1988-89. While electrical engineering retained the highest concentration of women, the decreasing degree of female enrolment in first, second and third year in civil engineering and the increasing degree in computer and systems resulted in a different overall pattern of concentration in 1988-89 than that exhibited by fourth-year women.

(v) Correspondence Between Distribution of All Enrolled Men & Fourth-Year Men

The pattern of distribution of fourth-year men also corresponds strongly with their overall distribution. Their distribution in 1983-84 and 1986-87 coincides with that of fourth-year men for 1978-79 and 1983-84. The fourth year mens' distribution in 1988-89 also corresponded to their overall concentration in 1988-89. Male enrolment, then, is characterized by a consistent pattern of concentration in electrical, followed by mechanical and aeronautical, with the lowest concentration shifting from computer and systems

to civil engineering. Given the recent entry of women into engineering and their continuing under-representation, it is to be expected that men display a more uniform pattern of concentration.

A GENDER DIVISION OF LABOUR AT CARLETON UNIVERSITY

The degree of correspondence noted above supports the validity of the image developed of the gender division of labour among male and female engineering students at Carleton University. The differences were focused around the lower tendency of women to enrol in mechanical and aeronautical engineering than any other department, while male enrolment was second highest in this department. Women's enrolment also differed from the mens' in that their degree of concentration in both civil and computer and systems engineering tends to be higher. These patterns are summarized below:⁵⁹

Carleton University:

Men ---	Women -----
1. Electrical	1. Electrical
2. Mechanical and Aeronautical	2. Civil
3. Civil	3. Computer and Systems
4. Computer and Systems	4. Mechanical and Aeronautical

Although a gender division of labour is visible in the

⁵⁹ These patterns were based on the average overall male and female enrolment for the years 1983-84, 1986-87 and 1988-89. Departments were then listed in order of greatest to least concentration.

enrolment figures, the total number of women enrolled in each department is so small it is difficult to make definite claims. Hence, we have evaluated the emerging division of labour in the light of that exhibited by the total enrolment figures for engineering in Canada. It would have been appropriate to use departmental breakdowns by gender for Ontario, but Statistics Canada did not publish such provincial breakdowns. As only aggregate figures for Canada were published, these were utilized. We could not compare enrolment in chemical or computer and systems engineering because of the different categorization schemes used by Carleton University and Statistics Canada. Whereas the latter department was categorized under the listing 'other' used by Statistics Canada, chemical engineering was not offered at Carleton University during the years examined (ie. between 1980 and 1987).

DEPARTMENTAL DISTRIBUTION OF ENGINEERING STUDENTS IN CANADA

(i) Departmental Distribution of Male Students

To get a picture of the differentiation in enrolment between men and women in engineering, participation rates were used (Table 7.5). As at Carleton University, although total male enrolment declined, men in Canada increased their representation in both electrical and mechanical engineering. In 1980-81 male students in electrical engineering comprised 17.1% of all students

TABLE 7.5
MALE AND FEMALE PARTICIPATION RATES IN ENGINEERING FOR
CANADA - AS A PERCENTAGE, 1980 TO 1987

Dept.	1980-81		1983-84		1985-86		1986-87	
	Male	Female	Male	Female	Male	Female	Male	Female
Chemical	7.6	1.4	6.4	1.8	6.0	1.9	5.8	2.0
	N=3002	538	2630	747	2448	779	2188	738
Electrical	17.1	0.67	20.5	1.3	21.5	1.6	21.5	1.7
	N=6740	264	8451	517	8797	647	8057	652
Mechanical	13.9	0.60	17.8	1.0	18.0	1.3	18.4	1.5
	N=5475	236	7346	432	7347	522	6899	546
Civil	11.9	0.87	11.2	1.2	10.2	1.3	10.0	1.5
	N=4676	342	4639	521	4168	549	3749	554
Other	35.7	3.3	34.5	4.2	33.7	4.5	33.0	4.7
	N=14050	1313	14245	1727	13784	1819	12356	1727

Source: Norlen Survey, Carleton University, 1988

enrolled in engineering in Canada, but by 1986-87 they represented 21.5%. In mechanical engineering in 1980-81 male students comprised 13.9% of all engineering students, but by 1986-87 this had increased to 18.4%. Also like the male students at Carleton University, male civil engineering students across Canada decreased both in absolute numbers and in their representation relative to the total number of students enrolled in engineering. While they comprised 11.9% of all engineering students in 1980-81, by 1986-87 this had decreased to 10.0%. Male representation in chemical engineering also declined: from 7.6% of all engineering students in 1980-81 to 5.8% in 1986-87.

It should be noted that the greatest concentration of men was listed as 'other.' It gradually declined from 35.7% in 1980-81 to 33.0% in 1986-87. This should not be taken to represent the concentration of men in one or two additional departments. Rather, it represented the conglomeration of men in the following departments: Agricultural, computer, physics, geological, industrial, metallurgical, mining, petroleum, mineral and materials. The four departments listed by Statistics Canada constituted the main sectors of engineering as greater numbers of educational facilities provided degrees in these areas than in any of the others, and as these four departments shared the longest history. Hence the departments subsumed under the 'other' category had lower rates of participation,

although collectively they contained the largest.

Although the rates changed between the years, male students were characterized by the same pattern of concentration across all years. Between 1980-81 and 1986-87, the greatest quantity was concentrated in electrical, followed by mechanical, then civil, and lastly chemical engineering. This pattern was also characteristic of the total enrolment in engineering for Ontario between 1980-81 and 1986-87.

(ii) Departmental Distribution of Female Students

Like the female Carleton University students, female engineering students across Canada exhibited a pattern of enrolment different from that of their male counterparts. In all years the highest concentration occurred in chemical engineering. While the men's representation in this department decreased, the women's increased as it did in all other departments. In 1980-81 women in chemical engineering comprised 1.4% of all students enrolled in engineering, but by 1986-87 they represented 2.0%. In 1980-81 women in electrical were 0.67% of all engineering students, and by 1986-87 this had increased to 1.7%. Their representation in mechanical also increased: from 0.60% in 1980-81 to 1.5% in 1986-87. Although the women's concentration in civil also increased from 0.87% to 1.5%, consistent with the men's decline in enrolment in this department, this department had the lowest rate of increase.

In 1980-81 while women were concentrated in chemical, followed by civil, electrical, and lastly mechanical, by 1985-86 this had altered to the most concentration occurring in chemical, followed by electrical, and then by civil and mechanical which had equal rates of participation. This pattern of concentration was duplicated in the comparative female-representation indices (Table 7.6). For all years, the comparative female-representation index was lowest for mechanical engineering except during 1985-86 and 1986-87 when it was equal with that of civil.

A GENDER DIVISION OF LABOUR IN CANADA

Women, then, were concentrated in the department with the lowest rate of male participation: chemical engineering. Prior to 1983-84 they were also concentrated in the department characterized by the second lowest rate of male participation: civil engineering. Since 1983-84 both genders, however, tended to be concentrated in electrical engineering. This was the department which had the highest participation rate for male students and the second highest for female students across Canada. The number of educational institutions offering an undergraduate degree in this department was second only to the number offering degrees in civil engineering. This was followed by mechanical and then chemical. Although it undoubtedly had an effect, it was clear that the number of institutions granting a particular degree did not determine the overall rates of participation

TABLE 7.6
COMPARATIVE FEMALE-REPRESENTATION INDICES FOR CANADA,
1980-1987

Dept.	1980-81	1983-84	1985-86	1986-87
Chemical	.025	.034	.036	.037
Electrical	.012	.025	.030	.031
Mechanical	.011	.019	.024	.026
Civil	.016	.023	.024	.026
Other	.060	.080	.084	.086

Source: Norlen Survey, Carleton University, 1988

of men and women in engineering. Women were continually least concentrated in the department of mechanical engineering, which had the second greatest rate of male participation. There is evidence, then, of a strong gender division of labour within engineering in Canada:

Men	Women
-----	-----
1. Electrical	1. Chemical
2. Mechanical	2. Electrical
3. Civil	3. Civil
4. Chemical	4. Mechanical

When we compared this pattern with that of Carleton University's engineering enrolment, excluding chemical engineering, we found that both male and female patterns of distribution concur. In other words, the gender division of labour which characterized Carleton University engineering students also characterized Canadian engineering students. This meant that women were more likely to enrol in chemical engineering than were men, but were much less likely to enrol in mechanical engineering. While men were much more likely to enrol in any department than women because of the vast under-representation of women in engineering, men's and women's tendency to enrol in different departments is apparent given relative comparisons. Although women at Carleton University had a slightly greater tendency to concentrate in computer and systems engineering, we could make no statements concerning this on a national basis. As a result of the few institutions which currently have such a

department and the brief length of time any have been in existence, separate enrolment figures have not yet been tabulated by Statistics Canada. If female engineering students in Canada as a whole are characterized by this same tendency, however, it might explain their increased concentration in electrical engineering. Prior to the establishment of computer engineering departments in Canada, this specialization was offered as part of the electrical engineering department. As a result, those women opting for this engineering stream would be contained within the statistics representing enrolment in electrical engineering.

AN INTERNATIONAL GENDER DIVISION OF LABOUR IN ENGINEERING

(i) Evidence of a Gender Division of Labour in Fifteen Countries

The gender division of labour noted above was also shared by seven European countries, as well as the United Kingdom and the United States.⁶⁰ All of the following countries were characterized by a pattern wherein the greatest concentration of male engineering students were in electrical, followed by mechanical, civil and lastly, chemical engineering: Austria, Belgium, Finland, Greece, Italy, the Netherlands, and Switzerland. While the order of concentration in the first three departments varied in an additional five countries (ie. France, the Federal Republic

⁶⁰ The following discussion is based on Micheal's (1988) and Van der Berghe's (1988) cross-national studies of engineering education.

of Germany, Norway, Spain and Japan), chemical engineering always had the lowest male concentration. In the thirteen countries for which female participation rates in engineering were available, women's enrolment was the highest in chemical engineering and the lowest in mechanical. In addition to Canada, these countries included Austria, Belgium, Denmark, Finland, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and the United States.

(ii) Evidence of a Gender Division of Labour in Norway

In Norway the male participation rate was such that the most men were concentrated in electrical, followed by mechanical, civil and lastly by chemical engineering. Conversely, women were most concentrated in chemical, with lower participation rates in electrical and mechanical engineering.⁶¹ Norway, then, displayed a gender division of labour in engineering studies similar to that in Canada, and hence to a certain degree with Carleton University students. The Norwegians, however, had a much higher representation of women in engineering than Canada. While in 1970 women represented 2.9% of the students enrolled in engineering in Norway, in Canada women represented only 1.3%. By 1980 the representation of Norwegian women had increased to 11.4%, while that of Canadian women had increased to 7.4%. When

⁶¹ Specific statistics on women's concentration in these departments in Norway were not available.

using comparative female-representation indices, we found that in Norway in 1960 female enrolment in engineering was ten times lower than the overall enrolment rate of women in higher education. By 1980 it was only four times lower. As gender breakdowns in engineering were first recorded for Canada in 1970, we used this year for comparison purposes. In 1970 Canada had a female enrolment rate in engineering that was thirty times lower than the female enrolment rate in university. By 1980 this was seven times lower, and by 1986 it had risen to just under five times lower. Despite the greater numbers of Norwegian and Canadian women enrolled in engineering, women remain vastly under-represented in both countries.

ARTEFACT-DEPARTMENT ASSOCIATIONS

As we have determined that engineering studies were characterized by a gender division of labour, the fourth issue noted at the beginning of the chapter must be addressed. In order to make the inference that technological artefacts, as signs, may have contributed to the production and maintenance of a gender division of labour, we had to ascertain whether the artefacts associated with the departments in which women were concentrated were more often gender-typed in a 'feminine' direction. Based on the gender division of labour we expected that technological artefacts associated with chemical engineering would be more often labelled in a 'feminine' direction, while those artefacts

associated with electrical and mechanical engineering would be more often labelled in a 'masculine' direction. The gender-typing results discussed in Chapter VI were partially in accordance with our expectations concerning the relationship between gender-typing and the emerging division of labour within engineering education.

(i) Determination of Artefact-Department Associations

Ten professional engineers, nine men and one woman, were individually interviewed and asked to name technologies [techniques] they thought of as characteristic or representative of the primary engineering fields. They were then asked to associate seventeen technological artefacts, if possible, with these fields.⁶² Six men and one woman were electrical engineers, two were mechanical engineers and one was a civil engineer. The woman's responses were neither systematically nor significantly different from the men's. These engineers consistently named four fields: (i) electrical; (ii) mechanical; (iii) civil; and (iv) chemical. Three male engineers, all electrical, noted that computer engineering should probably be added to the list in the near future as it was a "flourishing" field. These men also noted that it was currently encompassed by electrical engineering.

⁶² These are the same seventeen artefacts used in the questionnaire, the gender-typing of which is analyzed extensively in Chapter VI.

(ii) Technology Named as Representative of Engineering Fields

The technologies [techniques] the engineers named as representative of the four fields are summarized below:

Electrical	Mechanical	Civil	Chemical
-----	-----	-----	-----
-microprocessors N=10	-machinery, ie. "the mechanical"	-materials N=6	-fuel refining,
-digital N=8	N=10	-structures N=6	developing equipment
-control systems N=5	-materials N=6	-stress analysis	N=6
-integrated circuits N=4	-thermodynamics N=2	N=5	-synthetic fibre N=4
-solid state/ transistors N=4			
-communications N=4			
-fibre-optics N=3			
-high voltage N=1			

Given that seven of the engineers were electrical, it was not surprising that the majority of technologies [techniques] named were connected with electrical engineering. As no chemical engineer was interviewed, it was also not surprising that the minority was mentioned in connection with this field. The technologies [techniques] named by the engineers were reflected in the technological artefacts they assigned to various fields. Of these artefacts, six were not linked with any field: dentist's drill, reflex camera with mirror, weight (scales), thermometer, centrifuge and typewriter.

(iii) Technological Artefacts Associated with Engineering Fields

The melting oven for ore, cement mixer, electrical drill, soldering iron and excavator were all linked with mechanical engineering by the ten engineers. The last four artefacts were also connected with civil engineering, but in a less direct manner. While mechanical engineering was viewed as involved in the development of all five artefacts, civil engineering was mentioned as using four in the construction of, for example, "buildings and bridges." The packing machine for fish fillets was also linked with mechanical engineering by six engineers as this field is responsible for "machine development."

Three of these engineers and two others also linked it to electrical engineering. It is this field which is responsible for the development of mechanical control systems, and hence automatic processing machinery. One engineer did not link it with any field. Fibre-optics were associated with electrical engineering by all ten engineers. They also assigned the telephone exchange to this field. Four electrical engineers specified what they interpreted a telephone exchange as being. They explained a telephone exchange as being that piece of technology [technique] which controls "switching" or the conveying of a voice across telephone lines from its point of origin to its destination. This involves the use of microprocessors which control the

integrated circuits that convey voice signals (ie. sound waves which have been transformed into digital representations). It is likely that the other six engineers who associated the telephone exchange with electrical engineering made similar interpretations. One electrical engineer also mentioned artificial fibre in connection with electrical engineering, stating that they were starting to be used in this field.

Two other engineers, one mechanical and one civil, linked it with both mechanical and civil engineering noting its possible structural uses. All of the engineers linked artificial fibres with chemical engineering, citing this field's role in research and development. One engineer noted that the gas-absorption chromatograph may be used in laboratory work in chemical engineering. None of the other engineers, six of whom said they did not know what it was for, linked it with any field. One electrical engineer suggested that the microscope may be linked with laboratory analysis in chemical engineering.

ARTEFACT-DEPARTMENT ASSOCIATIONS & THE GENDER DIVISION OF LABOUR

(i) 'Masculine' Artefact-Department Associations

The technologies [techniques] the engineers named and the artefacts they associated with specific engineering fields bore a relation to the associations the engineering students made to 'masculine,' 'feminine' and 'advanced'

artefacts. The five artefacts (ie. melting oven for ore, excavator, cement mixer, electrical drill and soldering iron) which were rated in a 'masculine' direction by the engineering students were connected with mechanical engineering by all of the professional engineers when naming and making associations.⁶³ This was the department with the lowest female participation rate in Canada and the lowest at Carleton University, although the enrolment at Carleton currently equals that in civil engineering. These results, then, were in accordance with the proposed relationship between gender-typing and the emerging division of labour within engineering education.

(ii) 'Feminine' Artefact-Department Associations

Only one artefact, the telephone exchange, labelled in a 'feminine' direction by the students was associated with any engineering field by the professional engineers. The technologies [techniques] the engineers named in connection with this field shared a similarity with the students' associations to 'masculine' and 'advanced' artefacts: ie. electrical, microprocessors, digital, communication, and integrated circuits. Whereas the professional engineers responded to the telephone exchange in terms of its component parts, engineering students associated it with the

⁶³ Although only the males' ratings of the melting oven for ore, the excavator, the cement mixer and the electrical drill and the females' rating of the melting oven for ore were significant, all five artefacts were labelled in a more 'masculine' than 'feminine' direction.

female-dominated occupation of telephone operator. This technological artefact was rated in a 'feminine' direction and was associated with a department with the second highest concentration of women. The association of this artefact to electrical engineering, however, hinged on its connotations of microprocessors, digital signals and integrated circuits. These technological products were linked with 'masculine' and 'advanced' technological artefacts by the students. We could not conclude, therefore, that this result supported the suggested relationship between gender-typing and the gender division of labour.

There was one artefact which was strongly associated with chemical engineering, the department in which women are predominately concentrated both in Canada and Norway. Although artificial fibre was gender-typed in a 'feminine' direction by 31% of the Norwegians, only 5% of the Canadian men also rated it in this direction. Both Canadian men and women overwhelmingly rated it as neutral. This artefact was not gender-typed in a direction that conformed with the gender division of labour. Only one artefact, the microscope, was rated in a 'feminine' direction by the students and was associated with chemical engineering. There was only one professional engineer, however, who made this association.

(iii) Relationship Institution & Symbolic Genderization

Hence, we did not have a basis by which to make valid generalizations about the proposed relationship between gender-typing and the division of labour within engineering education. As no other artefacts rated in a 'masculine' or 'feminine' direction were associated with a particular field of engineering, we could not draw any conclusions based on them regarding this relationship.

Sorenson and Berg (1987: 160) found that their gender-typing results were partially in accordance with the relationship between gender-typing and the emerging division of labour within engineering. They reported that while all artefacts relating to chemical engineering were seen as neutral or 'feminine,' artefacts of fields such as construction and metallurgy were labelled 'masculine.' In these fields the numbers of women were much lower than in chemical engineering. The strongest evidence found in the current study for the proposed relationship centred around women's vast under-representation in mechanical engineering and the strong 'masculine' ratings of artefacts associated with this department. This suggested that the gender-typing of artefacts may have contributed to the multiple causation of the gender division of labour in engineering. While the above discussion implies that women were not choosing to enrol in certain engineering departments, they may also be less easily admitted to certain departments. The necessity

of being both chooser and chosen is a causal factor in the gender division of labour in engineering.

IN CONCLUSION

While we could not conclude that women were concentrated in those engineering departments that corresponded to the identification of artefacts as 'feminine,' they were least concentrated in that department, mechanical and aeronautical, with the strongest 'masculine' artefact associations. As previously noted, the under-representation of women in this department is a trend shared by the thirteen countries for which female participation rates were available. Williams and Best (1982) found a remarkably similar pattern of male-female stereotypes in thirty countries, including these thirteen, which linked 'masculinity' with the rugged, the heavy, the dirty, and the mechanical. This provided reason to speculate that the gender-typing of technological artefacts may also contribute to the gender division of labour within engineering in these countries. As a sign an artefact may signify those behaviours and values attributed to men and women as part of that gender's stereotype. As stereotypes are types of knowledge structures that aid people in the simplifying and organizing of complex information about others, ourselves, roles and events, decision-making pertaining to education and occupation may be partially processed in these terms. Signs such as gender-typed artefacts, then, which act

to trigger such processing may contribute to the gender division of labour in engineering.

As Sorenson and Berg (1987: 164) noted, these results must be interpreted with care as they are sensitive to the population of artefacts on which the study was based. As a result of the small number of artefacts gender-typed and hence the lack of variety, we could not ascertain whether the artefacts associated with the departments in which women were concentrated were more often gender-typed in a 'feminine' direction than were artefacts of other departments. Valid conclusions would require a much more extensive artefact basis for gender-typing, as well as a much broader identification of artefacts with particular engineering fields. Nevertheless, both the distribution of women in engineering and the gender-typing of artefacts was partially in accordance with the proposed relationship between gender-typing and the emerging division of labour within engineering education.

Women may be concentrated in those fields that were less identity/self-threatening in terms of their identification of technological artefacts as 'masculine.' The model of genderized technology developed in this thesis, then, suggested a relationship between genderization at the institutional and symbolic levels. The model also suggested, however, that genderization may also be apparent within engineering at the behavioural level. In the

following chapter we will try to determine the styles of work and thought the students value in technological research. If we discern systematic differences between the male and female students' ratings of technical researcher qualities and in their attributions of specific abilities to men and women in engineering, we may have evidence supporting the proposed existence of genderized styles of work and thought in technological research.

CHAPTER VIII
GENDERIZATION OF TECHNOLOGY AT THE
BEHAVIOURAL LEVEL

In the past two chapters evidence was presented of the genderization of technology at both the levels of the symbolic (ie. artefact gender-typing) and the institutional (ie. a gender division of labour). Concomitant with these manifestations, behavioural modes observable as genderized styles of work and thought in technological research may occur. A growing literature, exemplified by Keller (1985), has begun to unveil the mystification of science as a process governed by the exigencies of empirical evidence and theoretical necessity. These studies demonstrate how the basic categories of modern science are a series of dichotomies -- reason versus intuition, mind versus matter, culture versus nature, object versus subject -- congruent with the mutually exclusive dichotomy between 'masculinity' and 'femininity,' respectively. Hence, both science and 'masculinity' personify rationality. Technology as an instance of applied science, then, may embody the same cultural association between science, 'masculinity,' and rationality.

MEASUREMENT OF GENDERIZED TECHNICAL BEHAVIOUR

The implication of this claim is that genderized technology at the behavioural level may be measured as the hegemony of 'masculine' styles of work and thought in technological research. This measurement was attempted by having the students indicate which abilities related to the research they deemed most important. On another

questionnaire item they were also asked to link the same abilities, if possible, with either females or males in engineering. In this chapter, then, we will attempt to document the hegemony of 'masculine' styles of work and thought by measuring whether those abilities most valued by our respondents are those associated with 'masculinity.'

Questionnaire item no. 4 asked students to indicate what abilities they thought ought to be emphasized in a person who is engaged in technological research. From a list of nineteen abilities, students were asked to use an "x" to assign a value ranging from 'very little emphasis' to 'very high emphasis.' As with item no. 6, an attempt was made to have the categories perceived as equal by the students. Hence, the categories ranged from one (very little emphasis) to seven (very high emphasis) with four representing the middle category (medium emphasis). As the printed lines between the categories rendered them visually unequal, however, this may have contributed to the students' choice of this option. As will be discussed, the comments made by the students about those abilities they gave 'medium' emphasis indicated a treatment of this category as representing those abilities they neither emphasized nor de-emphasized. The abilities and the percentage of Canadian female and male and Norwegian students giving each ability 'very high emphasis' and/or 'high emphasis' are listed in

Table 8.1.⁶⁴ Significant differences ($p < 0.01$) between the responses of Canadian female and male students and between Norwegian female and male students are also recorded.

DEGREE OF EMPHASIS ASSIGNED TO ABILITIES

Overall, the degree of emphasis assigned the abilities tended to be high. The Canadian men gave all but one of the abilities at least a 'medium' degree of emphasis. On the first eight abilities listed in Table 8.1, more than 50% of the men assigned scores of 'very high' and/or 'high' emphasis. Seventeen of the nineteen abilities were given 'medium' emphasis or higher by the Canadian women. On the eight abilities which the men highly rated, and on an additional four abilities (ie. ability to understand other peoples' problems, ability to hold to deadlines, involved in social problems and intuition) more than fifty percent of the women gave answers of 'very high' and/or 'high' emphasis.

(i) High Emphasis

Although no ability rating was significant (t-tests and confidence intervals, $p < 0.01$) at the level of 'very high' emphasis, the 'high' emphasis given three abilities by the men was significant: (i) competence in working together with others; (ii) practical insight, and; (iii) creativity,

⁶⁴ 'High emphasis' is the label assigned the level of emphasis represented numerically as 6. In Table 8.1 the abilities are ranked from those given the most emphasis to those given the least.

TABLE 8.1
WHICH OF THE FOLLOWING ABILITIES OF THE PERSON WHO IS GOING TO DO TECHNOLOGICAL RESEARCH? IN THE PERCENT OF CANADIAN MALES, FEMALES AND NORWEGIANS ANSWERING 'VERY HIGH' EMPHASIS.

ABILITIES	MALES	FEMALES	M-F DIFF	NORWEGIANS	NM-NF DIFF
Competence in working together with others	79%	100%	n.s.	81%	p < 0.10
Practical insight	77	83	n.s.	63	n.s.
Creativity, inventiveness	77	91	n.s.	67	p < 0.01
Perseverance, patience	74	75	n.s.	67	p < 0.01
Objectiveness	67	83	n.s.	30	n.s.
Accuracy	66	67	n.s.	62	n.s.
Respect for the complexities of nature	62	75	n.s.	35	n.s.
Theoretical competence	58	75	n.s.	58	n.s.
Ability to understand other peoples' problems	30	58	p < 0.05	36	n.s.
Cool, realistic attitude	46	33	n.s.	7	n.s.
Ability to hold to deadlines	41	62	n.s.	20	p < 0.01
Ability to tolerate adversity	47	33	n.s.	53	n.s.
Ability to differentiate between the case and the person	33	33	n.s.	26	p < 0.01
Involved in social problems	32	58	p < 0.05	23	p < 0.01
Ability to work alone	29	34	n.s.	16	p < 0.01
Interested in one's own career	29	8	p < 0.05	5	p < 0.01
Dexterity	18	38	p < 0.05	2	n.s.
Intuition	16	75	p < 0.05	27	n.s.
Obstinate, headstrong	10	16	n.s.	6	n.s.

Source: Norlen Survey, Carleton University, 1988

inventiveness. The emphasis given by the women to these abilities, as well as the ability to understand other peoples' problems, was also significant ($p < 0.01$) at this level.

(ii) Moderately High Emphasis

The emphasis assigned to six abilities by both the women and men was significant ($p < 0.01$) at the level represented numerically as 5: (i) accuracy; (ii) respect for the complexities of nature; (iii) perseverance, patience; (iv) objectiveness; (v) ability to hold to deadlines, and; (vi) theoretical competence. The emphasis given by the men to an additional three abilities (ie. cool, realistic attitude, the ability to understand other peoples' problems, and the ability to tolerate adversity) was also significant at this level, as was the emphasis given by the women to intuition, dexterity, and involved in social problems.

(iii) Medium & Low Emphasis

The emphasis assigned to the ability to differentiate between the case and the person and the ability to work alone by both the women and men was significant at the level of 'medium' emphasis. An additional four abilities (ie. interested in one's own career, dexterity, intuition, and involved in social problems) were rated at this level by the men, as were the ratings by the women of the ability to tolerate adversity and a cool, realistic attitude. Significance testing ($p < 0.01$) revealed, then,

that only one ability (ie. obstinate, headstrong) was rated by the men below 'medium' emphasis. This ability and one other, interested in one's own career, were also rated below this level by the women.

INTERPRETATION OF THE TERM 'EMPHASIS'

The high degree of emphasis given most abilities suggested that questionnaire item no. 4 was not as successful as originally planned in discriminating between the values assigned abilities related to technological research. Commentary by the students also suggested this possibility. Seventeen men and one woman commented that an ability, for example, the ability to work alone, "was not particularly helpful but not harmful either," "couldn't hurt but wasn't necessary," or "would come in handy, but was not important." Those abilities about which they had commented were assigned a 'medium' degree of emphasis. In addition to the ability noted above, for the men these abilities included dexterity, intuition, involved in social problems and interested in one's own career. For the women, these abilities included those cited above with the addition of cool, realistic attitude and the exception of intuition, dexterity and involved in social problems.

'Medium' emphasis seemed, then, to reflect ambivalence on the part of the students. In other words, those abilities which needed neither to be emphasized nor de-emphasized were assigned a 'medium' degree of emphasis. In some respects,

this response category assumed the function of a neutral or, as one student wrote, a "no-opinion" category. In a similar sense, this level of emphasis was chosen when the students were uncertain about the meaning of a particular ability. Twelve men and two women assigned 'medium' emphasis to the ability to differentiate between the case and the person, but also indicated their uncertainty with either a question mark or a written statement. The remaining four women and nine men who also chose this degree of emphasis may have had similar doubts.

While questionnaire item no. 4 was intended to measure the value assigned by the engineering students to various abilities related to technological research, and specifically to determine the hierarchy of assigned values, the use of the term 'emphasis' may have prompted responses incompatible with this intention. By value we mean those qualities of the technological researcher thought of as more or less desirable, useful, estimable and important (Oxford English Dictionary, 1971: 4084). As the students' disparate use of the terms 'emphasis' and 'important' indicated, assigning 'medium' emphasis to an ability did not translate into a medium degree of importance or value. Abilities assigned this degree of emphasis tended, then, to be neither valued nor devalued.

CANADIAN-NORWEGIAN DIFFERENCES IN EMPHASIS

(i) Higher Emphasis Among Canadians

The Canadian students' treatment of the term 'emphasis' may explain why they assigned abilities a higher degree of emphasis than the Norwegians. Unlike the Canadians, only seven abilities were given 'very high' and/or 'high' emphasis by more than fifty percent of the Norwegians. On thirteen abilities a larger percentage of both the Canadian women and men gave 'very high' and/or 'high' emphasis. Two abilities, interested in one's own career and the ability to understand other peoples' problems, were given a higher degree of emphasis by the Canadian women than by the Norwegians, but a higher degree by the Norwegians than by the men. Theoretical competence was given an equal degree of emphasis by the Norwegians and Canadian men but a greater degree than both by the Canadian women. On only one ability (ie. accuracy), were there approximately equal percentages of Canadians and Norwegians responding with these degrees of emphasis. In addition, on only the ability to tolerate adversity did a greater percentage of the Norwegians assign 'very high' and/or 'high' emphasis.

(ii) Significant Differences in Emphasis

The degree of emphasis given this ability by Norwegians, however, was not significantly higher than that given by the Canadians. Although a larger percentage of the Canadians gave answers of 'very high' and/or 'high' emphasis

to thirteen abilities, there were only four significant differences ($p < 0.05$) between emphasis given by the Norwegians and that given by both the Canadian women and men (Table 8.2). The Canadians gave significantly higher degrees of emphasis to objectiveness, respect for the complexities of nature, a cool, realistic attitude and the ability to hold to deadlines. A significantly higher percentage of the Canadian women (but not the men) gave answers of 'very high' and/or 'high' emphasis than the Norwegians on an additional four abilities: (i) dexterity; (ii) intuition; (iii) the ability to understand other peoples' problems, and; (iv) involved in social problems.

(iii) Problems of Translation

On the Norwegian questionnaire, item no. 4 may have connoted the 'importance' attributed to various abilities rather than the 'emphasis' assigned. While the professional who translated the Norwegian questionnaire into English chose the word 'emphasis,' the English version of Sorenson and Berg's published article used the word 'importance.' The connotation of importance in the Norwegian questionnaire may have caused the Norwegians to be more discriminating in their responses than the Canadians. This possibility was suggested by the students' commentary to the effect that an ability given a 'medium' emphasis "may help" or "could not hurt," but was "not important." The ability 'dexterity,' for example, was noted as not important and was even ridiculed

TABLE 8.2
SIGNIFICANT DIFFERENCES BETWEEN PERCENTAGES OF CANADIANS AND NORWEGIANS
ANSWERING 'VERY HIGH' AND/OR 'HIGH' EMPHASIS.

ABILITIES	PERCENT MALE	PERCENT FEMALE	PERCENT NORWEGIAN	CDN-NOR DIFFERENCES
Objectiveness	67	83	30	$p < 0.05$
Respect for the complexities of nature	62	75	35	$p < 0.05$
Cool, realistic attitude	46	33	7	$p < 0.05$
Ability to hold to deadlines	41	62	20	$p < 0.05$
* Ability to understand other peoples' problems	30	58	36	$p < 0.05$
* Involved in social problems	32	58	23	$p < 0.05$
* Dexterity	18	38	2	$p < 0.05$
* Intuition	16	75	27	$p < 0.05$

* For these four abilities only the degree of emphasis given by the Canadian women was significantly greater than that given by the Norwegians.

Source: Norlen Survey, Carleton University, 1988

by four men, but was still assigned a 'medium' level of emphasis.

Only one ability which was noted as "harmful" to technological research by twelve men and two women, was rated below this level. The median response (significant at a probability < 0.01) to the ability 'obstinate, headstrong' was 'little' emphasis (represented numerically as 2). Had the word 'importance' been used instead of 'emphasis,' this thesis may have found results more closely approximating those found by Sorenson and Berg (ie. more discriminating responses).

THE TECHNOLOGICAL RESEARCHER

Although the Canadians tended to give greater emphasis than the Norwegians, there was a high degree of agreement among all students regarding those abilities most emphasized. Despite problems in the interpretation of the term 'emphasis,' the degree of emphasis given the abilities did provide an indication of what qualities were deemed by the students most valuable to the technological research process. While it is a crude measure of value, we can still compare the order of emphasis among the Canadians and Norwegians in so far as the terms 'emphasis' and 'importance' both connote the significance, value and worth of a quality.

(i) Abilities Considered Integral to Technological Research

The abilities most emphasized by the Canadian female and male engineering students are those they considered integral to the technological research process, as conveyed by their comments. As Sorenson and Berg (1987: 166) found, competence in working together with others was the most highly rated ability. While this may initially seem surprising, comments by forty-two men and eight women revealed that the students conceptualize "all" research as "done in groups" by "engineers work[ing] in teams," and hence, that competence in working together with others is "absolutely necessary" since "one can't succeed [as an engineer] without it."

Practical insight, creativity, perseverance, accuracy and theoretical competence were among the eight most highly emphasized abilities by both the Canadian and the Norwegians. More than 50% of the students in both samples gave these abilities ratings of 'very high' and/or 'high' emphasis. Objectiveness and respect for the complexities of nature were also among the eight most highly emphasized abilities by the Canadians. Significantly lower percentages of the Norwegians, however, gave these two abilities 'very high' and/or 'high' emphasis.

While the technological research process was characterized by the students as necessarily involving working competently with others, their comments also

indicated that it required: (i) "a theoretical background learned at university;" (ii) "responsible (no fudging) development and testing;" (iii) a "determination" and "dedication" to "continue even when its tough," and; (iv) "imaginative solutions keeping in mind time schedules, economic considerations, [and] user needs."

(ii) Objectiveness

The students did not as readily provide comments concerning the emphasis they gave the ability, objectiveness. The students' comments to the effect that "of course" its "obviously part of tech[nological] research," indicated a perception among the students that "objectivity" is an inherent aspect of the research process. A small number of students (ie. four men) made comments conveying a bond between objectiveness and a lack of emotion. One male student simply wrote "no emotion" in the margin beside this ability, while another expanded upon this noting that "I love engineering but emotions [are] bad for research."

The high emphasis, 'inherent' perception and separation of emotion from objectiveness are consistent with Keller's (1985) model of genderized science and Hacker's (1981) 'culture of engineering.' The mind/body dualism they found which exalts scientific abstraction and simultaneously derogates feminine qualities, clearly involves a high valuation of objectivity at the expense of emotionalism, as well as the treatment of objectivity as a prerequisite to

the (hard) scientific research process.

The lack of explanatory comments offered by the students may also indicate the degree to which objectiveness was perceived as an inherent ('obvious') aspect of the technological research process. Social psychology research on attitude change has found that cultural truisms, those attitudes and beliefs strongly and widely shared within a culture, are debated little or not at all, and hence people have few supporting arguments (cf. McGuire, 1964; McGuire and Papagerogis, 1961; Tannenbaum, 1967). Objectiveness, as an 'exalted' element of the scientific/engineering culture, may represent a (sub)cultural truism. This may help explain why few comments offered by the students pertaining to this ability were more than mere assertions. In fact, while nine men and one woman cited its "obvious" necessity, only three students gave fuller explanations saying that "to be scientific [one] must be objective." As the Norwegians did not share the Canadians' emphasis of objectiveness, it may not represent a (sub)cultural truism in the Norwegian culture of engineering.

(iii) Abilities Related to Technological Research

As with the ability, objectiveness, comments providing reasons given for the emphasis they gave 'respect for the complexities of nature' were sparse. While two men made humorous comments to the effect that "you can't fool with Mother Nature," the comments of seven men and one woman

indicated that "to put to use" naturally occurring phenomena such as "electricity" for "man's purposes" requires "devoted research." The valuation of the respect for the complexities of nature, then, was linked with both the process and purpose of technological research.

Like the above abilities, the ability to understand other peoples' problems and the ability to hold to deadlines were given a degree of emphasis significant ($p < 0.01$), at least, at the level represented numerically as 5. The relatively high emphasis assigned the ability to understand other peoples' problems and the ability to hold to deadlines is not unusual given their connection to two of the aforementioned abilities. Of the ten female and fifty-four male Canadian students who responded with a degree of emphasis above 'medium' for the ability to understand other peoples' problems, five men made comments to the effect that "working with others" required one to "understand others research problems." The only female student who made a similar comment wrote that "team work means you have to get along [with] and understand them." Those that emphasized this ability, then, tended to link it with the ability to work competently with others.

As comments about "time schedules" indicated, the ability to hold to deadlines was associated with practical insight. The emphasis given these two abilities, therefore, reinforced the picture of the technological researcher

described earlier. While the Norwegians shared the Canadians' evaluation of the ability to understand other peoples' problems, they gave much lower emphasis to the ability to hold to deadlines. Although these abilities were rated relatively highly, the emphasis they were given tended to be related to the emphasis given other abilities perceived as integral to technological research.

(iv) Abilities Not Integral to Technological Research

The remaining abilities were neither emphasized as highly nor as consistently as those already discussed. The emphasis, significant ($p < 0.01$) at level '5,' given by the men to a cool, realistic attitude and the ability to tolerate adversity might be interpreted as indicating an evaluation of these abilities as important to the technological research process. The low percentage of students, however, giving the two abilities a 'very high' and/or 'high' emphasis indicated that they were not stressed as integral to research. Comments by four male students did suggest that a cool, realistic attitude was associated with both practical insight and objectiveness (eg. "be sensible and scientific"). The ability to tolerate adversity was linked with perseverance by six male students who wrote, for example, that an engineer "must stick it out de[s]pite research problems (and in school)."

The emphasis given these two abilities by the female students was significant ($p < 0.01$) at the slightly lower

level of 'medium' emphasis. Recalling the previous discussion of the students' treatment of 'medium' emphasis as a neutral category where abilities are neither emphasized nor de-emphasized, it is apparent that the women perceived the two abilities as less integral to the research process than the men. Neither the women nor the men, however, disparaged a cool, realistic attitude or the ability to tolerate adversity as harmful to the research process. While each of these abilities was remarked upon by only one woman, their comments reflected the viewpoint expressed by the men.

(v) Abilities Neither Emphasized Nor De-Emphasized

There were six abilities the men assigned a 'medium' emphasis, and hence, that they neither emphasized nor de-emphasized. These included: involved in social problems, interested in one's own career, dexterity, intuition, the ability to differentiate between the case and the person, and the ability to work alone. While the latter two of these abilities were similarly rated by the women, they gave the other four abilities either a higher or lower degree of emphasis than the men. As previously noted, many of the students were uncertain about the meaning of the ability to differentiate between the case and the person. This likely contributed to its perception as "unnecessary but not bad" for the technological research process. Similarly, the ability to work alone was perceived in this manner because both female and male students stressed technological

research as a "team" endeavour. As a result they gave much greater emphasis to the ability to work competently with others. Although the Norwegian students gave lower degrees of emphasis to the ability to differentiate between the case and the person and the ability to work alone, the emphasis given by the Canadians and Norwegians demonstrated that none perceived it as essential to technological research.

DIFFERENCES IN EMPHASIS BETWEEN FEMALE & MALE STUDENTS

Unlike the Canadian men and the Norwegians, the Canadian women gave greater emphasis to the role of the following three abilities in the technological research process: (i) involved in social problems; (ii) dexterity, and; (iii) intuition. Although none of the women made comments in the margin beside questionnaire item no. 4 about being involved in social problems, six made related comments in response to item no. 17 (which asked for commentary). Both the Canadian female and male students frequently stated that an "engineer's responsibility is the betterment of society," or that "technology is for the good of the public at large." Only the women, however, tended to link this with specific involvement in social problems, including "unemployment," "corporate pollution," and "poverty." Three of the twelve women but only two of the eighty-five men made such comments.

Like the associations of dedication and responsibility to the abilities perseverance and accuracy, the linkage of

'involved in social problems' with an engineers' duties connotes the ethical conduct students' expect from engineers. As noted in Chapter V, one of the strongest reasons students gave for membership in a professional organization was the necessity of maintaining "ethical conduct," and "moral standards (high quality of engineering practice)." There was only one student -- a woman -- who explicitly made such a linkage, writing that "to be a good engineer you can't be caught up in only your own work. Too many engineers are interested only in their own work and not their communities, ethically you have to help your community."

While the emphasis given by the women to the ability to be involved in social problems was significant ($p < 0.01$) at level 5, intuition was significant at level 6: 'high' emphasis. Four other abilities were also given 'high' emphasis by the women: (i) competence in working together with others; (ii) practical insight; (iii) creativity, inventiveness, and; (iv) the ability to understand other peoples' problems. Only the first three of these abilities were also given this degree of emphasis by the Canadian men and Norwegians. Unlike the women, they did not emphasize either the ability to understand other peoples' problems or intuition. The women placed a much greater stress upon intuition. While 75% of the women gave it 'very high' and/or 'high' emphasis, only 16% of the Canadian men and 27% of the

Norwegians gave such scores. Two women associated intuition with creativity, making statements to the effect that intuition can be a "source of inspiration" or "insight." Of the twenty-six men who gave intuition an emphasis at least of level 5, only one man made a similar remark. Another women spoke of intuition as a "feeling [that] can help solve problems." Women, then, viewed intuition as playing an integral role in the technological research process. Neither the Canadian men nor the Norwegians seemed to share this orientation.

Although not nearly as great as the emphasis they placed upon intuition, the women also placed more emphasis upon dexterity than either of these two groups. Unfortunately, none of the students made any comments pertaining to this ability, except two men who questioned what dexterity was. They provided no hint, therefore, as to why they assigned dexterity a certain degree of emphasis. The low percentage of women and men (ie. 38% and 18%, respectively) giving dexterity 'very high' and/or 'high' emphasis, signifies the lack of primary importance the students attributed to this ability regarding its role within the technological research process.

STEREOTYPICAL GENDER ASSOCIATIONS AND EMPHASIS

(i) Emphasis-Gender Correspondence in Canadian Sample

When considering those abilities upon which the women placed greater emphasis than the Canadian men or

Norwegians, we found that they scored significantly higher on those four abilities typically associated with or attributed to females.⁶⁵ While they also scored lower than the Canadian men on an additional two abilities typically associated with males (ie. cool, realistic attitude and the ability to tolerate adversity), these differences were not significant. On only two abilities did a greater percentage of the men assign 'very high' and/or 'high' emphasis. While this was significant ($p < 0.05$) for interested in one's own career, it was not for a cool, realistic attitude. The men, then, also scored higher on abilities typically associated with or attributed to males.

(ii) Emphasis-Gender Correspondence in Norwegian Sample

In the Norwegian sample, the direction of the significant differences ($p < 0.01$) between the degree of emphasis given by the men and women also corresponded with abilities typically associated with males and females. In other words, the four abilities which a significantly greater percentage of the Norwegian women gave 'very high' and/or 'high' emphasis/importance were also abilities typically associated with females (refer to Table 8.1). These abilities included competence in working together with others, creativity, inventiveness, perseverance, patience

⁶⁵ See Appendix E for a detailed discussion of how it was determined whether the nineteen abilities were typically associated with or attributed to males or females.

and involved in social problems. Those three abilities which a greater percentage of the Norwegian men gave 'very high' and/or 'high' emphasis were also typically associated with males: (i) the ability to hold to deadlines; (ii) the ability to work alone, and; (iii) interest in one's own career.

(iii) Canadian-Norwegian Emphasis-Gender Correspondence

Only two of the significant differences between the Norwegian women's and men's ratings, however, coincided with significant differences between the emphasis given by the Canadian women and men. In both the Norwegian and Canadian sample, a significantly greater percentage of the women than the men gave 'involved in social problems' a 'very high' and/or 'high' emphasis. Similarly, a significantly greater percentage of Canadian and Norwegian men than women gave such scores to 'interested in one's own career.'

Based on this connection between abilities stereotypically associated with females and males and the greater emphasis given these abilities by the female and male samples, respectively, we might expect that the other fourteen abilities would display a similar correspondence. This, however, was not the case. Those abilities most highly emphasized in someone engaged in technological research did not receive significantly different degrees of emphasis by the Canadian women and men. This did not characterize the

Norwegians to the same extent as the Canadians. Three of the eight abilities given significantly different degrees of emphasis by the Norwegian men and women were among the four highest rated abilities. The remaining five abilities were among the eighth lowest emphasized abilities by the Norwegians. Four of the abilities which received significantly different degrees of emphasis by the Canadian men and women were concentrated among the six least emphasized abilities, while one received the tenth lowest degree of emphasis. Unlike the Norwegians, then, only those abilities not as highly emphasized by the Canadians in someone engaged in technological research tended to receive significantly different degrees of emphasis.

(iv) Degree of Similarity between Emphasis Given by Students

This indicated that there was a high degree of agreement among the students regarding those abilities most emphasized. The rank correlations between the Norwegian and Canadian responses reiterate this finding. As noted in Chapter IV, this correlation is a measure of association which indicates how strongly two sets of values are related. The rank correlation between the responses of the Canadian female and male students was very high -- 0.86. In other words, there was a strong degree of association between these two response sets. Specifically, this correlation means that knowing one set of responses (eg. the emphasis given by the men) allows one to predict accurately 86% of

the other response set (eg. the emphasis given by the women). The rank correlation between the Norwegian female and male students was slightly lower than this, though still high -- 0.72. Despite the four abilities which the Canadian students emphasized significantly more than the Norwegians, and an additional four abilities which the Canadian women emphasized significantly more (refer to Table 8.2), the correlations between the Canadians' and Norwegians' responses were high. The rank correlation between the emphasis given by the Canadian women and the Norwegians is 0.71. The rank correlation between the responses of the Canadian men and the Norwegians is slightly higher at 0.78. This meant that knowing the emphasis given by the Norwegians would allow one to predict 78% of the Canadian men's scores, and 71% of the Canadian women's scores. As a measure of the degree of similarity between two sets of values, the above correlations revealed that the emphasis given by the Canadian women and men shared the highest degree of similarity. The emphasis given by the Canadian men and the Norwegians shared the second highest degree of similarity, while the Norwegians' women and men had the third highest degree of similarity. The Canadian females and Norwegians shared the lowest degree of similarity.

(v) Ideal Image of the Technological Researcher

There tended, therefore, to be a uniform ideal image regarding those abilities which an individual involved in

technological research ought to possess. To reiterate briefly, those abilities perceived as integral to the technological research process included, (in order of declining emphasis): (i) competence in working together with others; (ii) practical insight; (iii) creativity, inventiveness; (iv) perseverance, patience; (iv) objectiveness; (v) accuracy; (vi) respect for the complexities, and; (vi) theoretical competence. This is well summarized by one student:

. . . as an engineer it is necessary to be able to work as a team to complete a project, to work alone on part of the project, to have personal responsibility and to produce top quality work on time.

The differences between the Canadian female and male students were rather small, focused primarily around those abilities not as highly emphasized. While the former placed more emphasis upon intuition, understanding other peoples' problems, social involvement, and dexterity; the latter placed more emphasis upon being interested in one's own career. Sorenson and Berg (1987: 166) found a similar small difference in emphasis between the Norwegian female and male students. The women placed more emphasis upon working competently with others, and social involvement; the men on interest in one's own career, creativity, and the ability to distinguish between the case and the person. In both the Norwegian and Canadian samples, then, the women tended to place greater emphasis upon those abilities typically

associated with females, and the men upon those abilities typically associated with males.

ABILITIES ASSOCIATED WITH WOMEN AND MEN IN ENGINEERING

(i) Students' Restraint in Linking Abilities with Gender

The students, however, strongly refrained from linking abilities as they relate to engineering with gender. Questionnaire item no. 14 asked the students whether they felt any of the nineteen abilities applied more to one sex than the other in engineering. They were to indicate their answers by placing an "x" on a seven-point scale. Again, an attempt was made to have the categories perceived as equal by the students. Hence, the categories were numerically represented as ranging from one ('females in engineering') up to four ('equally to both') and down to one ('males in engineering'). Like item no. 6, the printed lines between the categories rendered them visually unequal. Consequently, this may have contributed to the students' strong tendency to chose this option.

Given the great degree to which the students remarked that, for example, "sex has very little or no influence on one's ability to perform," the effect was weak. Not surprisingly, the majority of the students chose 'equally to both' option for each of the nineteen abilities. While 41% of the men consistently chose this response category, 58% of the women also did so. The women, then, displayed a greater restraint when associating abilities with gender. As

expected, in the female sample significance testing (t-tests and confidence intervals) revealed that no abilities emerged as significantly associated with either males or females in engineering. In the male sample, three abilities were significantly ($p < 0.01$) associated with gender.

(ii) Abilities Significantly Associated with Gender

The men's attribution of involved in social problems and the ability to understand other peoples' problems to 'females in engineering' was significant, as was their attribution of obstinate, headstrong to 'males in engineering.' These were also the three abilities on which the women and men gave significantly ($p < 0.05$) different responses. For all three, the women gave significantly more 'equally to both' responses.

The small number of differences between the women's and men's responses reflect the degree to which all the students refrained from gender-typing abilities. The rank correlation between the answers of the women and men was very high -- 0.84. As a measure of association, this correlation indicated a very high degree of similarity between the women's and men's responses.

(iii) Gender Differentiated Emphasis

It is interesting to note that one of the abilities associated with 'females in engineering' by the men received a moderately high degree of emphasis. The emphasis the men gave to the ability to understand other peoples' problems

was significant ($p < 0.01$) at level 5. Nevertheless, only 30% of the men gave this ability a 'very high' and/or 'high' emphasis. Fifty-eight percent of the women gave such scores, and the 'high' emphasis they gave this ability was significant ($p < 0.01$). As expected, those who might be the most sensitive to gender-typing (ie. women) and therefore refrain from so doing, would also be inclined to rate higher those abilities associated with their own gender. The other ability (ie. involved in social problems) which the male students associated with 'females in engineering,' was also given greater emphasis by the female students.

Like the ability to understand other peoples' problems, involvement in social problems was not perceived as integral by the men to technological research. The women, however, did not seem to share this perception. It seems that the two traits clearly associated with 'females in engineering' were given a moderate degree of emphasis by the men. They were considered possibly beneficial though not integral to the technological research process. We might expect, therefore, that the abilities associated with males would receive a higher degree of emphasis than those associated with females. The only ability the men significantly associated with 'males in engineering' also received the lowest degree of emphasis from all the students. It was, in fact, the only ability clearly considered antithetical to the research process by the students. As one student noted,

being obstinate or headstrong "would undermine research [be]cause eng[ineers] have to follow the logic when solving problems."

(iv) 'Masculinity,' 'Femininity' and Emphasis Given

Sorenson and Berg (1987: 166) found that certain abilities usually seen as 'masculine' (eg. obstinate, headstrong and interested in one's own career) were rated the lowest. 'Feminine' abilities (eg. intuition, the ability to understand other peoples' problems) were ranked of medium importance. These are similar to the findings generated by the current study into the genderization of styles of work and thought. A different pattern was exhibited by the eight abilities which t-tests ($p < 0.01$) revealed as significantly associated with gender by the male sample. Their confidence intervals, however, included the 'equally to both' category, and hence we can consider them as only indicating a direction of association.

The only two abilities with such significance in the direction of 'females in engineering' included intuition and dexterity: among those abilities most least emphasized by the Canadian male and Norwegian students. These two abilities are ranked fifth and fifteenth, respectively, by the Canadian women. Those abilities significant (t-test only) in the direction of 'males in engineering' included practical insight, creativity, objectiveness, theoretical competence, interested in one's own career and the ability

to work alone. The first four of these were among the highest rated eight abilities by all Canadian and Norwegian students (with the exception of objectiveness by the Norwegians). The other two were among those abilities least emphasized, although they did receive degrees of emphasis greater than that given to dexterity and intuition by the Canadian men (but not by the Canadian women or the Norwegians).

There is a clear pattern, therefore, in both the Canadian and Norwegian samples whereby those abilities usually viewed as 'masculine' are more highly emphasized than those usually viewed as 'feminine.' The Canadian women displayed a tendency to give greater emphasis to those abilities typically associated with their own gender. Since we did not have access to the emphasis given the nineteen abilities by the Norwegian women and men separately, we cannot know whether the Norwegians women may have displayed this same inclination. If they did it might explain, for example, why the Norwegians emphasized intuition more than the Canadian men but less than the Canadian women. The Norwegian women's scores may have combined with the men's in such a way as to increase the overall emphasis assigned this ability. A similar process might have occurred with dexterity and involved in social problems. This is, however, only speculation.

EVIDENCE OF A HEGEMONOUS 'MASCULINE' STYLE OF WORK & THOUGHT

(i) 'Masculine' Styles as Intellectual Reason

In Chapters I-III, we discussed how the organization of human attributes around sex has had a significant impact of the world beyond sex. We spoke of the cultural transformation of females and males into women and men; the cultural process which simultaneously divides the practices and bodies of knowledge we call science from those we call 'not-science.' When Keller (1985) mapped the dualism of 'masculinity' and 'femininity' onto this categorization, 'masculinity' was revealed as synonymous with reason and objectivity and hence with the pursuit of scientific knowledge. 'Femininity' was revealed as synonymous with feeling and subjectivity and hence as antithetical to the pursuit of scientific knowledge. Hacker (1981: 342) extended this mapping into the 'culture of engineering,' finding that

Activities, styles of interaction, jobs, machines, devices, even bodies of knowledge were often characterized as having masculine or feminine properties . . . These gender based perceptions were also stratified . . . What was womanly has low status; what was manly had high status.

As previously noted, those abilities most emphasized in someone doing technological research did not receive significantly different degrees of emphasis by the Canadian women and men. The abilities most emphasized, then, tended to be those abilities widely thought to be predominantly displayed by males.

This valuation is congruent with Keller's (1985) model of genderized science, as well as Hacker's (1981) 'culture of engineering.' Those abilities given greatest emphasis and the students' commentary provide evidence of a hegemonous 'masculine' style of work and thought in technological research. As itemized by Sorenson and Berg (1987: 155) it is a style which emphasizes mastery, control and the domination of nature; objectivity, lack of affection and the separation of investigator and object of investigation; instrumentality and rationalism.

When discussing the evidence produced by the emphasis given by the students, we are referring to the Canadian women and men, as well as the Norwegians, because of the high degree of agreement in the ranking of the nineteen abilities. When discussing evidence provided by commentary, we are referring primarily to the Canadian male students due to the small number of women, and hence, the small number of comments they made. We did not have access to any comments made by the Norwegian sample.

(ii) The Control and Use of Nature

Comments by the men regarding six of those abilities most highly emphasized supplied the greatest confirmation that engineering students might exhibit a genderized style of work and thought. The seventh most highly emphasized ability was respect for the complexities of nature. The comments of seven men and one woman made reference to

using natural resources for "man's purposes," such as "capturing energy," and "controlling natural forces like electricity." These comments reflected an emphasis on mastery, control and domination of nature. It is interesting to note that Thomas Tredgold, Honourary Member of the Institution of Civil Engineering, set forth the following definition of engineering for the purposes of obtaining their Charter (1818):

Engineering is the art of directing the Great Sources of Power in Nature for the use and convenience of Man (McFarlane, 1961: 81)

We are not, however, in the position to speculate on any connection other than to note the consistency with which the control of nature has remained part of the goal of engineering.

The jokes made about this ability by three male students also reflected this emphasis since ridiculing the body elevates the mind. Their remarks consisted of "you can't fool with Mother Nature," and "I have great **respect** for women's bodies" [his emphasis]. The sexualization of nature and its association to women is noteworthy. As only one male student volunteered such a comment, however, we cannot know how widely shared this association may be among the engineering students. Ridiculing nature, then, may represent the other side of exalting the scientific (Hacker, 1981: 348).

(iii) Objectivity & Emotion

The treatment of nature as something distinct from oneself as an engineer and from the research process, as something to be controlled, provides evidence of a cognitive separation of the investigator from the object of investigation. Their relation to the technological research process, then, may be characterized by a quest for separatism and control from a perspective of 'otherness.' This may also be related to their high evaluation of objectiveness, accuracy and theoretical competence. Comments linked with these abilities include, respectively: Comments by ten male students and one female noting objectivity as "obviously necessary;" by three male students to the effect that "to be scientific [one] must be objective;" by four male students that one should not be "emotional;" and by two women and eighteen men indicating that an engineer has to be "rational" and "logical." This model of engineering, then, requires the renunciation of emotion and subjectivity, while simultaneously requiring the objectification of that which is investigated; the identification of relevant variables and the disposal of 'irrelevant' (subjective) ones. These comments bear a resemblance to a statement by Bertrand Russell (1913: 47-48):

the scientific attitude of mind involves a sweeping away of all other desires in the interests of the desire to know -- it involves the suppression of hopes and fears, loves and hates, and the whole subjective, emotional life.

The relatively high emphasis the students gave a cool, realistic attitude with its connotations of an unemotional, self-controlled, indifferent stance may also be a manifestation of this model of engineering. Similarly, the comments the students made regarding the ability to tolerate adversity suggested a higher evaluation of abilities typically attributed to men. These included, for example, the need to be "tough," "rigorous," and "persistent."

(iv) 'Feminine' Attributes & Emphasis Given

As well as 'masculine' aesthetical attributes, the students associated 'feminine' aesthetical attributes with engineering. Specifically they associated it with the goal of producing technology [techniques]. While eleven men and two women spoke of this goal as, for example, "making new technology as simple and serviceable as possible," three of these men noted that technology should be "beautifully simple" or "work beautifully well." It must be noted, however, that it is the rational, complex, objective "scientific" methods which allow the 'femininely' simple technology to be produced.

Evidence for a hegemonous 'masculine' style of work and thought advocated in engineering education can also be found in those abilities not emphasized as integral to the technological research process. While they are not denigrated as harmful to it, neither are they considered a

valuable contribution. Intuition, involvement in social problems, and the ability to understand other peoples' problems are not perceived as important. Intuition was joked about as "women's ESP" or "instinct" by five men. As noted previously, this represents the flip side of exalting the objective and rational. Involvement in social problems was noted as possibly interfering with technological research by two men. The ability to understand other peoples' problems tended to be highly emphasized by the men only when it was associated with working competently with other people on a research project, and hence, when it involved understanding their research problems.

Although it is difficult to draw conclusions because of their small sample size, the women placed a higher emphasis upon the abilities typically associated with 'femininity' than the men. Specifically, they gave a greater emphasis to four abilities: (i) dexterity; (ii) the ability to understand other peoples' problems; (iii) involved in other peoples' problems, and; (iv) intuition. The last three of these abilities suggested that the women share a slightly higher evaluation of 'feminine' qualities regarding their role in the technological research process in engineering. It seems, then, that the women themselves have accepted the 'female' stereotype. This should not be construed as a criticism of these women, however, because of the powerful cultural system by which all practices and activities are

divided into two mutually exclusive categories -- 'masculine' and 'feminine.' The women's higher valuation of 'feminine' qualities may represent an attempt on their part to turn what the men may think of as a liability (eg. intuition), into an asset. This may be part of a larger process aimed at counteracting any identity conflicts generated by the women's immersion into the male-created, male-dominated and male-oriented 'culture of engineering.'

This does not mean, however, that they do not share the men's high evaluation of objectivity and rationalism. On the contrary, as the high degree of agreement between the students indicates, the model of engineering suggested by all engineering students is one which exalts the scientifically abstract. The remarkable similarity between the female and male students concerning the abilities most emphasized, as well as their valuation of technology as progressive and the manner in which they link gender with technology, may provide an indication of the success of the professional engineering school in the socialization process (cf. Reid, 1974). Nevertheless, the model exhibited by the female students may not rely, as the men's seemed to, as heavily upon a simultaneous denigration of the socially subjective and 'feminine.'

(v) An Alternative Style of Work & Thought

It is particularly the women's valuation of intuition which suggests this. As recorded above, two women associated

intuition with creativity citing it as a source of inspiration or insight, while one women spoke of it as a feeling to help guide the solution of research problems. This may indicate the incorporation of a more relational, interactive style of work and thought to technological research. It bears some resemblance to the relational style of programming used by girls and women which Turkle (1984) documented within computer cultures (see Chapter II). It is also reminiscent of Barbara McClintok's method of scientific enquiry -- 'a feeling for the organism' -- as described by Keller (1983).

Evidence of an incorporation of the subjective is also provided by the women's significantly higher evaluation of being involved in social problems and the ability to understand other peoples' problems, as well as their commentary. While the men linked the latter ability with the goal of technological research (ie. technological development), one women commented on the interpersonal activity required to do such research (ie. that "team work means you have to get along [with] and understand them [your fellow workers]"). The women were also the ones who linked "the primary goal of the engineer of making life a little better for everyone" with being involved in specific social problems. One woman even labelled such involvement an engineer's ethical duty.

In both the abilities the women emphasized and their

comments evidence exists of an alternative style of work and thought; an alternative model of engineering, one which incorporates so-called 'feminine' qualities. It should be noted it is not incumbent upon women to induce this change. As Sorenson and Berg (1987) note, Keller's (1985) argument does not rely on women to act automatically according to 'feminine' values. There is some evidence, in fact, of an incorporation of such values by the men.

There are four abilities which the men highly emphasized and which also might be viewed as 'feminine' qualities. These include creativity, accuracy, the ability to understand other peoples' problems, and competence in working together with others. Related to the latter two abilities were the findings in Chapter VI that 2% of the male students associated 'feminine' technological artefacts with a social or human orientation. An additional 9% associated these artefacts with accurate, dexterous work. There is some evidence, then, that 'feminine' abilities ought to be emphasized in someone engaged in technological research. In a similar sense, some of the abilities viewed as 'masculine' were deemed unimportant to the research process (eg. interested in one's own career). In the case of obstinate, headstrong, it was even judged "harmful" to technological research.

IN CONCLUSION

Nevertheless, those abilities most emphasized by both

the Canadian women and men and the Norwegians tended to be those typically associated with 'masculinity,' while those not emphasized were associated with 'femininity.' The students comments reiterated this. There were, however, important exceptions. These revolved around the higher evaluation by the Canadian women of such abilities as intuition, involved in social problems, ability to understand other peoples' problems and dexterity. Although we may consider this as evidence of the existence of an alternative style of work and thought within the engineering culture, it is equally plausible that students, male or female, may not as yet be fully socialized -- that the engineering culture may not be fully reproduced. If the engineering culture is a matrix of shared attitudes, assumptions and beliefs taught, not explicitly but by shared problem-solving as Rosenbrock (1981: 165) suggests, students who are not part of the engineering work force may not, as yet, be fully socialized.

As Sorenson and Berg (1987: 167) note, however, the overall differences between the female and male students are too small to allow interpretations such as assuming that the influx of female students in the engineering field automatically will create a crisis in the hegemonous value system. In addition, in the Canadian study the extremely small sample size of the women does not provide a sound basis for either decisive conclusions or extrapolations.

In the next and final chapter of this thesis we will review the material presented in the previous chapters, in order to determine to what degree we can make such claims or inferences. This will be conducted within a context that discusses whether the genderization of technology is an occupational phenomena or the manifestation of a broader cultural phenomena. In so doing, we will also discuss the implications of this research for future studies of technology.

CHAPTER IX
CONCLUSION

In this thesis we specifically sought to document manifestations of the genderization of technology among engineering students at a Canadian university. In this chapter we will review the evidence of such genderization at the three levels outlined by Sorenson and Berg (1987), as well as any evidence concerning their degree of interdependence. We will also re-examine those aspects of the students' belief-system about technology not explicitly linked with genderization. As we are not in a position to establish causality, particular attention will be paid to the degree to which we can make valid conclusions and generalizations. Based on these, and the work of many feminist scholars, implications for future studies of technology will be drawn.

THE MODEL OF GENDERIZED TECHNOLOGY

As discussed in Chapters I and II, the assumption that technology is value-free or that values effect only the use of technology has been refuted by many non-feminist scholars (eg. Marx, 1906; Braverman, 1974; Ellul, 1964). Building upon these works and those of feminist scholars, a model of genderization was developed wherein genderization referred to the development of technology over a long historical period in conjunction with the growth of the white male, capitalist hierarchical system of power, such that technology enters into our gender identity:

femininity is incompatible with technological competence; to feel technological competent is to feel manly . . . (Cockburn, 1985: 12).

Simply stated, the genderization of technology refers to the monopoly men as a social group share over technology because, collectively, men know all there is to know about the creation and implementation of technology and its associated techniques. Technology, then, comprises a resource which can be used by 'technocrats' (ie. men) to dominate 'technopeasants' (ie. women).

A definition of technology was developed, therefore, which required that the social context of technology not be ignored. Technology was defined as the totality of social relations involved in the production, transmission and acquisition of the knowledge associated with the techniques that are used to accomplish certain tasks in society; this totality most often governed by men's attempts to organize, control and understand the world. ⁶⁶

This investigation of technology as genderized, as more than merely tools, was prompted specifically by the research of Sorenson and Berg (1987). Although they neither provided a definition of technology nor conceptualized genderization as signifying men's monopoly over technology, they implied that technology may be termed genderized on many of the same

⁶⁶ Refer to Chapter 1 for an indepth discussion of the definition of technology and its genderization.

bases as this researcher. These included, for example: ⁶⁷

- Men act to exclude women from the technical sphere (Cockburn, 1983)
- Men use technology to dominate and control women (Faulkner and Arnold, 1985)
- Women and men use techniques differently (Turkle, 1984)
- Women and men use different kinds of techniques (Form and McMillan, 1983)

These findings, in addition to others reviewed in this thesis, suggested that the genderization of technology may be visible (and possibly brought about and maintained through mechanisms) at three levels: (i) the institutional; (ii) the symbolic, and; (iii) the behavioural. As noted by Sorenson and Berg (1987: 168), although the data do not allow a proper test of the model of genderized technology, findings consistent with it were found at all three suggested levels of genderization.

EVIDENCE OF GENDERIZATION AT THE INSTITUTIONAL LEVEL

At the institutional level we found indications of a gender division of labour in engineering at Carleton University, across Canada and internationally. Although female enrolment in engineering has increased, women remain vastly under-represented with approximately one in ten engineering students being female since 1984, both at Carleton University and in Canada.

⁶⁷ These and other relevant findings are presented in Chapters II and III.

(i) Departmental Distribution at Carleton University

Despite departmental fluctuations of enrolment in the four engineering departments at Carleton University (ie. electrical, civil, mechanical and aeronautical, and systems and computer), a consistent pattern of department distribution by gender was apparent. An initial analysis was conducted of the distribution of fourth-year students at Carleton University for the years 1978-79, 1983-84, and 1988-89. It was found that while the department of mechanical and aeronautical engineering had the lowest participation rates for women, this department had the second highest participation rates for men. The civil engineering department had the second highest participation rates for women and the lowest for men. This pattern reflected the decreasing enrolment of men in civil, and the increasing enrolment of women in all departments except mechanical and aeronautical. Electrical engineering had the highest participation rates at Carleton University for both women and men.

The validity of this picture of the differential enrolment of women and men was questionable due primarily to the small numbers of fourth-year women enrolled in each department. This analysis was supplemented, therefore, by a review of the distribution of women and men across all four years of engineering studies at Carleton University for 1983-84, 1986-87 and 1988-89. The patterns of overall

concentration of women and men corresponded strongly with those that had been noted in connection with the distribution of fourth-year students.

This, then, supported the validity of the image developed of the gender division of labour among fourth-year engineering students. The men were most concentrated in electrical, followed by mechanical and aeronautical, civil and lastly by systems and computer engineering. Although sharing a similar concentration in electrical, women were least concentrated in the department of mechanical and aeronautical. This is the department with the second highest degree of male concentration.

(ii) Departmental Distribution in Canada

This division of labour was also compared against that exhibited by the total enrolment figures for engineering in Canada. As noted in Chapter VII, we could not compare enrolment in chemical or systems and computer engineering because of the different categorization schemes used by Carleton University and Statistics Canada. In Canada, women were found to be concentrated in the department with the lowest rate of male participation: chemical engineering. Prior to 1983-84, they were also concentrated in the civil engineering department, the department characterized by the second lowest rate of male participation. Women were consistently least concentrated in the department with the second greatest rate of male participation: mechanical and

aeronautical.

As at Carleton University, electrical engineering across Canada had the highest participation rate for men. While the women at Carleton University were also most concentrated in this department, it had the second highest rate of female participation for students across Canada. Excluding chemical and systems and computer engineering, then, we found that the patterns of distribution of women and men at both Carleton University and across Canada corresponded, as follows:

Male	Female
1. Electrical	1. Electrical
2. Mechanical & Aeronautical	2. Civil
3. Civil	3. Mechanical & Aeronautical

(iii) An International Division of Labour

Although the Norwegians had a higher representation of women in engineering than Canada, Norway also displayed a similar gender division of labour within engineering education. The male participation rate was such that most men were concentrated in electrical, followed by mechanical, civil and lastly by chemical engineering. Conversely, women were most concentrated in chemical, with lower participation rates in electrical and mechanical engineering.

As noted in Chapter VI, the above patterns of departmental enrolment are part of a larger international gender division of labour within engineering education.

Seven European countries (ie. Austria, Belgium, Finland, Greece, Italy, the Netherlands, and Switzerland), as well as the United Kingdom and the United States, shared a pattern of enrolment such that the greatest concentration of engineering students were in electrical, followed by mechanical, civil, and lastly, chemical engineering. While the order of concentration in the first three of these departments varied in an additional five countries (ie. France, the Federal Republic of Germany, Norway, Spain and Japan), chemical engineering always had the lowest male concentration. In the thirteen countries for which female participation rates were available, women's enrolment was the highest in chemical engineering and the lowest in mechanical. These countries were Austria, Belgium, Canada, Denmark, Finland, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and the United States. We have found strong evidence, therefore, of a consistent gender division of labour in engineering education not only in Canada, but in many westernized countries.

(iv) Interdependence Between Institutional and Symbolic Genderization

It was suggested in Chapter VII that genderization at the institutional level may be linked with genderization at the symbolic level. If technological artefacts act as signs, signifying certain behaviours and values to be 'masculine'

or 'feminine,' then such processes may contribute to the production and maintenance of the documented gender division of labour among engineering students. To make this inference we had to ascertain whether the artefacts associated with the departments in which women were concentrated were more often gender-typed in a 'feminine' direction.

To ascertain this, ten professional engineers were asked to name technologies they thought of as characteristic or representative of the primary engineering fields, and to associate seventeen technological artefacts, if possible, with these fields. We did not find, however, that the artefacts rated in a 'feminine' direction were associated by the engineers with those departments with the highest rates of female participation. The strongest evidence for the proposed relationship centred around the engineers' association of 'masculine' artefacts with the department in which women are least concentrated: mechanical and aeronautical engineering. This suggested that the gender-typing of artefacts may contribute to the multiple causation of the gender division of labour in engineering education. While we found evidence in the direction consistent with the proposed linkage between institutional and symbolic genderization, our data did not provide a proper test of this linkage. Hence, we had reason to suspect they were interdependent, but could not assume a causal relationship existed such that the disappearance of genderization of one

of these levels is sufficient to end it at another.

Sorenson and Berg (1987: 155) also made note of this interdependence when they found that their gender-typing results were partially in accordance with the relationship between gender-typing and the gender division of labour among Norwegian engineering students. While the women were highly concentrated in chemistry unlike the men, the women were much less concentrated in those fields, like mechanical engineering, in which the men were concentrated. Artefacts relating to chemical engineering were seen as neutral or 'feminine,' and artefacts of fields such as construction and metallurgy were labelled 'masculine' (Sorenson and Berg, 1987: 160).

While we could speculate about the relationship between the levels of symbolic and institutional genderization, we could not draw reliable conclusions even about the students at Carleton University. As a result of the small number of artefacts gender-typed and hence the lack of variety, we could not ascertain whether the artefacts associated with the departments in which women were concentrated were more often gender-typed in a 'feminine' direction than were artefacts of other departments. Despite the need for a broader artefact base for gender-typing and a greater identification of artefacts with particular engineering fields, we did find exploratory evidence consistent with the proposed relationship.

EVIDENCE OF GENDERIZATION AT THE SYMBOLIC LEVEL

The proposed relationship, however, was only feasible in as far as engineering students gender-typed artefacts and/or made gender associations to technology. Although the students were opposed to linking gender with either engineering or technology, many of them did make gender associations. Many made statements such as "one's sex does not make you an engineer," but only seventeen percent of the women and eighteen percent of the men consistently made no gender associations.

Students were asked to indicate what degree of 'masculinity' or 'femininity' (if any) each of seventeen technological artefacts possessed. While the most frequently chosen response by both the Canadian female and male students was 'neither masculine nor feminine' (ie. neutral), the men were characterized by a greater tendency to gender-type artefacts than the women. The Norwegians, in turn, displayed a greater tendency to gender-type artefacts than either the Canadian women or men.

(i) Neutral Artefact Ratings

While there were no statistically significant differences between the Canadian women's and men's neutral ratings, analyses of variance ($p < 0.05$) revealed that the Norwegians' neutral ratings were significantly different from the Canadian men's ratings of four artefacts and the Canadian women's of an additional three artefacts. In other

words, the men gave significantly higher neutral ratings than the Norwegians to the cement mixer, the centrifuge, the packing machine for fish fillets, and the telephone exchange. The women gave significantly higher neutral ratings to these artefacts, in addition to the melting oven for ore, the soldering iron and artificial fibre. We found, then, a greater similarity between the neutral ratings of the Norwegians and Canadian men than between the Canadian women and men, and between the Canadian women and men than between the Norwegians and the Canadian women.

(ii) 'Masculine' Artefact Ratings

Although the women did not give significantly more neutral ratings than the men, they did give significantly less 'masculine' ratings. Only one artefact, ie. the excavator, was rated by the majority of women as 'masculine.' This, however, was not statistically significant. The Canadian men and Norwegians gave significant 'masculine' ratings to four artefacts: the excavator; the melting oven for ore; the cement mixer, and; the electrical drill.⁶⁸ Consistent with their tendency to give lower neutral ratings, the Norwegians rated two

⁶⁸ Although Sorenson and Berg did not report which artefacts emerged as significantly 'masculine' or 'feminine,' they (1987: 159) did note that many ratings were significantly different from the neutral category. Hence, it is reasonable to expect that those artefacts which a majority of the Norwegian students rated as 'masculine' or 'feminine' would have emerged as significant. This majority, however, should be at least as large as the majority of Canadian men's ratings that were measured to be significant (ie. 57%).

artefacts significantly more 'masculine' than the Canadian men, and an additional three artefact significantly more 'masculine' than the women. These included the excavator and the cement mixer for the men. For the women it also included the melting oven for ore, the electrical drill and the soldering iron. This reflected the greater similarity between the 'masculine' ratings of the Canadian women and men than that between the Canadian men and Norwegians, which, in turn, was greater than that between the Norwegians and the Canadian women. Thus, although the Norwegian and Canadian men were most similar regarding the neutral ratings, the Canadian women and men exhibited the greatest similarity regarding the 'masculine' ratings.

(iii) 'Feminine' Artefact Ratings

The 'feminine' ratings, however, were most similar between the Canadian women and the Norwegians, followed by that between the Norwegians and the Canadian men, and lastly between the Canadian women and men. This reflected the Norwegians' greater tendency than the Canadians to gender-type artefacts and the Canadian women's slightly greater tendency than the Canadian men to gender-type artefacts in a 'feminine' direction. The Norwegians gave significantly greater 'feminine' ratings to the telephone exchange, the centrifuge, the packing machine for fish fillets and artificial fibre. While approximately the same percentages

of Canadian women and men rated the packing machine for fish fillets, the telephone exchange and the typewriter as 'feminine,' greater percentages of women rated the thermometer, fibre-optics, the reflex camera and the microscope as 'feminine.' It is not surprising, therefore, that the Norwegians' and Canadian women's 'feminine' ratings would be most similar, although they were least similar in regards to neutral and 'masculine' ratings.

Despite this similarity, only one artefact (ie. the typewriter) was gender-typed in a 'feminine' direction by the majority of Canadian women and men. This rating, however, did not deviate significantly from the neutral category. The packing machine for fish fillets, the telephone exchange and the typewriter were gender-typed in a 'feminine' direction by a majority of the Norwegian students.

Overall, the Norwegians were characterized by a greater tendency to gender-type artefacts than either the Canadian women or men. Similarly, the men tended to gender-type artefact to a greater degree than the women, although the women did gender-type artefacts in a slightly (but not statistically significant) stronger 'feminine' direction. Like the men, however, greater percentages of the women rated artefacts in a 'masculine' direction than a 'feminine' one. Nevertheless, only the women's and men's ratings of the melting oven for ore were significantly different. Although

Sorenson and Berg (1987: 165) noted that the female engineering students tended to be more restrained when gender-typing, the difference was small. While they did mention that some differences were statistically significant, they did not specify which artefacts these pertained to.

(iv) Artefact Qualities Contributing to Gender-Typing

Although we measured which artefacts were gender-typed, it was also productive to investigate what qualities contributed to the identification of artefacts as 'masculine,' 'feminine' or 'neither masculine nor feminine.' On this basis we could begin to provide a framework by which to judge whether other artefacts were likely to be gender-typed and in what direction. Building a complex understanding of one of the ways in which technological products and processes may be linked with a specific gender may contribute to our understanding of the gender division of labour in Canadian society, in addition to our understanding of technological development and use.

To determine which qualities contributed to an artefact's gender-typing, questionnaire items no. 7, 8 and 9 asked students to list words which described a type of technology they thought of as 'masculine,' 'feminine' or 'advanced.' As in the gender-typing of artefacts, the Norwegians were the least restrained when making gender associations. Although the men did make more gender

associations than the women, we could not state conclusively that they were less reserved. The small number of women participating in the survey meant that the number of their associations was not substantial enough for comparison purposes. Given that it required no controversial gender associations, it was not surprising that 'advanced' technology received the greatest number and variety of associations. Like the Norwegian responses, the number and variety of associations made by the Canadians to 'feminine' technology was larger than those made to 'masculine' technology.

As in the Norwegian study, gender associations to technological artefacts reflected two main properties: how they looked and who they were used by. The associations often referred to the physical characteristics of the artefacts and reflected the type of user attributes these artefacts were presumed to require. Analysis of the associations revealed that 'masculine' technology was characterized as large, dirty, noisy and rugged, in contrast to 'feminine' technology which was small, neat, accurate and physically light. The qualities associated with 'feminine' technology, then, were in direct opposition to those associated with 'masculine' technology. A review of those artefacts gender-typed in a 'masculine' direction by the Norwegian and Canadian students indicated that all five artefacts were strongly linked with male-dominated,

traditional blue-collar industrial jobs. These artefacts included the excavator, the cement mixer, the electrical drill, the melting oven for ore, and the soldering iron. The artefacts labelled 'feminine' by the Norwegians and Canadians were artefacts used mainly by women. These artefacts included the thermometer, the telephone exchange and the typewriter. They were also those artefacts which could be associated with the traditionally female-dominated occupations of nurse, telephone operator and secretary, respectively.

(v) Engineering Duties Associated with Gender

The engineering duties that some of the students linked with gender could also be associated with either female- or male-dominated activities. The duties judged unsuited for women, ie. 'construction,' 'installation, erection' and 'maintenance,' could all be associated with industrial male-dominated occupations. The students' comments indicated that these duties were believed to require physical abilities women did not possess. Similarly, those duties judged unsuited for men were believed to require abilities the men did not possess to the same degree as women. Thus, women who possess greater interpersonal skills and patience were better suited than men for duties such as 'writing, information services,' 'library work, patents' and 'personnel.' These are also duties which could be associated with female-dominated occupations in the service

sector. As when gender-typing technological artefacts, the students based their decisions, at least partially, on the gender of the perceived dominant user.

Despite what the responses of some of the students indicated, we found that only one duty was significantly associated with gender by the male students -- 'construction' (chi-square, $p < 0.05$). In addition, significance testing revealed that the responses of the male and female students were not significantly different. This indicated that when the students did judge duties as unsuited for women or men, they tended to chose the same ones -- construction for women and library work for men. But as when asked to gender-type artefacts or make gender associations to technology, many of the students refrained from making gender linkages.

(vi) Qualities Associated with 'Advanced' Technology

As associations to 'advanced' technology did not require explicit gender linkages, students were least reluctant when answering this question. The associations to 'advanced' technology tended to refer to specific types of technological artefacts, such as computers, microprocessors and lasers. The students also linked adjectives like "new, improved, creative, innovative, progressive and pioneering" with 'advanced' technology. While these have positive connotations, a small number of the Canadian men (ie. 14%) made negative associations. Such associations consisted of,

for example, "overpriced," "unreliable," "dangerous," and "for military purposes." Eight percent of the men also linked 'masculine' technology with destruction, warfare and military combat.

As the similar negative associations to 'masculine' and 'advanced' technology suggested, we found a greater similarity between the 'masculine' and 'advanced' associations than between the 'feminine' and 'advanced' or 'masculine' and 'feminine' associations. The 'masculine' and 'advanced' technology shared associations concerning complexity and specific new technological products. This applied only to the associations of the Norwegians and Canadian men because the number of women providing associations was too small for comparison purposes. Both the Norwegians and Canadian men made associations such as "complex, difficult" and "complicated" to 'advanced' and 'masculine' technology. They also associated specific artefacts, such as "computers" and "electronics," with both 'advanced' and 'masculine' technology.

The few similarities between the qualities associated with both 'feminine' and 'advanced' technology focused around their smallness, fragility and humane purposes. These similarities indicated that a third set of properties may exist by which technological artefacts were gender-typed. These properties resembled the mind/body dualism outlined in Keller's (1985) model of genderized science and Hacker's

(1981) 'culture of engineering.' They found an exaltation of 'masculine' qualities and hard scientific abstraction, objectivity and advancement, occurring simultaneously with a degradation of 'feminine' qualities, the soft social sciences and the unscientific. It seemed probable, therefore, that "new," "innovative" technological developments would be more likely to be gender-typed in a 'masculine' direction than a 'feminine' one. It is possible, however, that this could be transformed depending upon the gender of the dominant user given the other property by which artefacts are gender-typed (ie. who they are used by).

(vii) Symbolic Genderization

In conclusion, the most distinct finding which emerged from both the gender-typing of artefacts and the gender associations was the allocation of technology to differentiated realms of male and female activity. 'Masculine,' large technological artefacts were linked with mechanical and industrial, male-dominated work, while 'feminine,' light and small technological artefacts were linked with female dominated occupations involving caring, social work.

Our finding of a clear tendency to gender-type at least certain artefacts supported the proposed relationship between institutional and symbolic genderization. In as far as different artefact qualities and the gender of their

perceived 'typical' user contribute to artefact gender-typing, technological artefacts may contribute to the signification of specific behaviours and values as either 'masculine' or 'feminine.' This process of signification may also effect decision-making pertaining to educational and occupational choice and hence, the gender division of labour in engineering. This process, however, was not one which could be tested within the parameters of the current study.

EVIDENCE OF GENDERIZATION AT THE BEHAVIOURIAL LEVEL

Based on our model of genderization, we expected that technology as an instance of applied science might be characterized by the cultural association between the scientific endeavour and 'masculinity.' The implication of this claim was that genderized technology at the behavioural level might be measured as the hegemony of 'masculine' styles of work and thought in technological research. We concentrated, therefore, on measuring the abilities most emphasized in someone doing technical research and whether the female and male students placed differential degrees of emphasis on these abilities. We also measured whether the students linked these same abilities with either men or women in engineering.⁶⁹ Thus, we attempted to measure the hegemony of 'masculine' styles

⁶⁹ While we had data concerning which abilities were most emphasized by the Norwegians and Canadians, only the Canadian students were asked to link abilities to males and females in engineering.

of work and thought by determining whether those abilities most emphasized by the respondents were those associated with 'masculinity.'

(i) Abilities Most Emphasized

Despite problems with the interpretation of the term 'emphasis' by Canadian students, the degree of emphasis given abilities did provide an indication of what qualities were deemed by the students most valuable to the technological research process. Although the Canadian students tended to give higher degrees of emphasis than the Norwegians, we could still compare the order of emphasis assigned the abilities. The most highly emphasized abilities were those which the Canadian female and male engineering students considered integral to the technological research process, as indicated by their comments. Competence in working together with others was the most highly rated ability by both the Canadian and Norwegian students. Practical insight, creativity, perseverance, accuracy and theoretical competence were among the eight abilities given ratings of 'very high' and/or 'high' emphasis by more than fifty percent of the students in both samples. Objectiveness and respect for the complexities of nature were also among the eight most highly emphasized abilities by the Canadians. The Norwegians, however, did not share this evaluation.

The technological research process, then, was characterized by the Canadian students as necessarily

involving "work[ing] in teams," "a theoretical background," "objectivity," "responsible (no fudging) development and testing," "determination," "dedication," and "imaginative solutions." This is a process also conceptualized by the students as geared towards the utilization of natural phenomena for "man's" purposes, yet governed by practical considerations (eg. "economics," "user needs," and "time schedules"). The moderately high emphasis (significant, at least, at level '5') given both the ability to understand other peoples' problems and the ability to hold to deadlines was not surprising considering their respective connections to the two abilities, working competently with others and practical insight. While the Norwegians shared the Canadians' evaluation of the ability to understand other peoples' problems, they gave much lower emphasis to the ability to hold to deadlines.

(ii) Differences in Emphasis Between Canadian Women & Men

The remaining abilities tended to be emphasized neither as highly nor as consistently as those already noted. Except for the ability, obstinate and headstrong, which was viewed as "harmful" to technological research, these abilities tended to be neither emphasized nor de-emphasized. There were, however, some conspicuous differences in how the Canadian female and male students emphasized these abilities.

While the emphasis given by the men to a cool,

realistic attitude and the ability to tolerate adversity was significant at level '5,' the emphasis given by the women was significant at the slightly lower level of 'medium' emphasis. There were six abilities which the men gave the latter level of emphasis, and hence, which they neither emphasized nor de-emphasized. These included: involved in social problems, interested in one's own career, dexterity, intuition, the ability to differentiate between the case and the person, and the ability to work alone. While the women shared the men's evaluation of the last two of these abilities, they rated significantly higher all but one of the remaining four abilities. Although the Norwegian students gave lower degrees of emphasis to these last two abilities, the emphasis given by both themselves and the Canadians suggested that none perceived it as integral to the technological research process.

Unlike the Canadian men and the Norwegians, the Canadian women gave significantly higher emphasis to the following four abilities: involved in social problems, dexterity, intuition, and the ability to understand other people's problems. While they associated being involved in social problems with an engineer's ethical responsibility to work for "the betterment of society," they linked intuition and the ability to understand other peoples' problems with the requirements of the technological research process. While intuition was viewed as a source of insight and

creativity, the ability to understand other peoples' problem is linked with the necessity of working co-operatively with other engineers on a "team project." The women, unfortunately, provided no comments about dexterity which might indicate why they assigned it such a high degree of emphasis. Their higher valuation of those abilities typically associated with 'femininity,' however, suggested that they may be attempting to rename as assets those abilities often viewed as liabilities. If the 'culture of engineering' degrades 'feminine' qualities as Hacker (1981) noted, this may be part of a cognitive psychological process which acts to compensate for what could become a degradation of self for the women engineering students.

(iii) Differences in Emphasis Between Norwegian Women & Men

The Norwegian women also tended to give higher degrees of emphasis than the Norwegian men to those abilities typically associated with females (Sorenson and Berg, 1987: 166). There were four abilities which a significantly higher percentage of these women gave 'very high' and/or 'high' emphasis: competence in working together with others, creativity, perseverance, and involved in social problems. Those three abilities to which a greater percentage of the Norwegian men gave such degrees of emphasis were also abilities typically associated with males: the ability to hold to deadlines, the ability to work alone, and interest in one's own career. Like the Norwegian men, the Canadian

men scored higher on abilities typically associated with males. While the Canadian men gave greater emphasis to both being interested in one's own career and a cool, realistic attitude, only the emphasis given the former ability was significantly different from that given by the Canadian women.

Only two of the significant differences between the Norwegians women's and men's ratings, coincided with significant differences between the emphasis given by the Canadian women and men. In both the Canadian and Norwegian samples, a significantly greater percentage of the women than the men gave 'involved in social problems' a 'very high' and/or 'high' emphasis. Similarly, a significantly greater percentage of Canadian and Norwegian men gave such scores to 'interested in one's own career.' Those abilities most highly emphasized in someone engaged in technological research, however, did not receive significantly different degrees of emphasis. This indicated that there was a high degree of agreement among the Canadian and Norwegian students regarding those abilities most emphasized, and hence, a uniform ideal image regarding those abilities considered integral to the technological research process in engineering.

(iv) Abilities Associated with Females and Males in Engineering

Although both the Canadian women and men strongly refrained from linking abilities as they relate to engineering with gender, only for the women did no abilities emerge as significantly associated with either males or females in engineering. In the male sample three abilities were significantly associated with gender. The men's attribution of involved in social problems and the ability to understand other peoples' problems to 'females in engineering' was significant, as was their attribution of obstinate, headstrong to 'males in engineering.'

While the two traits associated with females in engineering had received moderate degrees of emphasis by the Canadian men, the ability associated with males in engineering was given by the lowest degree of emphasis by both the Canadian women and men. This was contrary to the expected higher appraisal of those abilities linked with males in engineering.

Conversely, the direction of gender-association (by the men, at least) of six other abilities, was consistent with this expectation. Both dexterity and intuition were rated in the direction of 'females in engineering' by the Canadian men and women. While they were given the fifth and fifteenth lowest degrees of emphasis by the women, they were given the seventeenth and eighteenth lowest degrees of emphasis by the

men. Four of the six abilities rated in the direction of 'males in engineering,' were among the eight most highly emphasized abilities by all Canadian and Norwegian students. These abilities included practical insight, creativity, objectiveness, and theoretical competence. There was a pattern, therefore, in both the Canadian and Norwegian samples whereby those abilities typically associated with 'masculinity' were more highly emphasized than those associated with 'femininity.'

(v) Evidence of a Hegemonous 'Masculine' Style of Work & Thought

This valuation of abilities typically viewed as 'masculine,' as well as the students' comments, suggested that engineering education is characterized by a hegemonous 'masculine' style of work and thought. This is a style which emphasizes mastery, control and the domination of nature; objectivity, instrumentality and rationalism; lack of affection and the separation of investigator and the object of investigation.

Nature was commented upon as something to be used for "man's" benefit, and ridiculed by being sexualized. This treatment of nature as something distinct from oneself as an engineer and from the research process provides evidence of a cognitive separation of the investigator from the object of investigation. This may also be related to their high evaluation of objectiveness, accuracy and theoretical

competence. Comments noting "objectivity," "rational[ity]" and "logic" as "necessary" to the "scientific" engineering process depict engineering as based upon the renunciation of emotion and subjectivity, and the simultaneous objectification of that which is investigated.

Evidence of a hegemonous 'masculine' style of work and thought was also found in those abilities not emphasized as integral to the technological research process. These abilities included intuition, involvement in social problems and the ability to understand other peoples' problems. While intuition was ridiculed, involvement in social problems was viewed as possibly interfering with the technological research process. The ability to understand other peoples' problems tended to be emphasized by the Canadian men only when it was associated with working competently with other people on a research project.

Although the women tended to place higher emphasis upon those abilities typically associated with 'femininity,' this did not mean that they did not share the men's high valuation of objectivity and rationalism. On the contrary, the high degree of agreement between all the students concerning those abilities most emphasized reflected a model of engineering which exalts the scientifically abstract. Nevertheless, the women's higher valuation of certain abilities suggested that they might incorporate more of the subjective into their view of the technological research

(iv) Correspondence Between Distribution of All Enrolled Women & Fourth-Year Women

The pattern of concentration discussed above corresponds strongly with those noted in connection with the distribution of fourth-year women. Their concentration in 1983-84 corresponded with the pattern of their overall departmental distribution in this year. The distribution of fourth-year women in 1988-89 matched the overall pattern of concentration in 1986-87, although not precisely with that of 1988-89. While electrical engineering retained the highest concentration of women, the decreasing degree of female enrolment in first, second and third year in civil engineering and the increasing degree in computer and systems resulted in a different overall pattern of concentration in 1988-89 than that exhibited by fourth-year women.

(v) Correspondence Between Distribution of All Enrolled Men & Fourth-Year Men

The pattern of distribution of fourth-year men also corresponds strongly with their overall distribution. Their distribution in 1983-84 and 1986-87 coincides with that of fourth-year men for 1978-79 and 1983-84. The fourth year mens' distribution in 1988-89 also corresponded to their overall concentration in 1988-89. Male enrolment, then, is characterized by a consistent pattern of concentration in electrical, followed by mechanical and aeronautical, with the lowest concentration shifting from computer and systems

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process. In other words, the women's valuation of the objective and rational may not rely as heavily as the men's seemed to upon a simultaneous degradation of the socially subjective.

While we did note some evidence of an incorporation of such values by the men, those abilities most emphasized by both the Canadians and the Norwegians tended to be those typically associated with 'masculinity,' while those not emphasized as highly were associated with 'femininity.' The exceptions to this revolved around the higher valuation by the women in both the Canadian and Norwegian samples of such abilities as intuition, involved in social problems, and the ability to understand other peoples' problems. Hence, although we found some indication of an alternative style of work and thought within the engineering culture, we found stronger evidence of a hegemonous 'masculine' style of work and thought.

(vi) Interdependence Between Institutional and Behaviourial Genderization

If genderization at both the levels of the symbolic and the institutional is related, it is also conceivable that they are related to the third specified level suggested by our model of genderization. For instance, while women may be concentrated in those fields that are less threatening in terms of their identification of artefacts as 'masculine,' they may also be concentrated in those fields whose research

style is less oriented towards mastery, control, and the domination of nature; instrumentality, rationalism, and objectivity; lack of affection, and the separation of the investigator and the object of investigation. To make such an inference we had to determine whether certain styles of work and thought in technological research emphasized these qualities. We also had to determine whether alternative styles of work and thought existed based, perhaps, on a more interactive approach to problem-solving. Lastly, we had to determine if the engineering fields in which women were concentrated were more often characterized by these alternative styles of work and thought.

As discussed above, we find evidence of a hegemonous 'masculine' style of work and thought emphasized by the Canadian and Norwegian students. Similarly, we found some indication of an alternative style of work and thought in the women's comments and their valuation of certain technical researcher qualities. While we did find systematic differences between the women's and men's valuation of researcher qualities and in their attributions of specific abilities to males and females in engineering, we did not find any such differences between students enrolled in

different engineering departments.⁵ Although departmental comparisons within the female sample showed no differences, the small number of women in each department made such comparisons unreliable. As the men showed no such differences, it was unlikely that the women would display departmental differences in either the valuation of technical researcher qualities or the attribution of specific abilities to females and males in engineering.

As we could not determine that women were concentrated in those fields more often characterized by an alternative style of work and thought, we could not infer that institutional and behavioural genderization were related. Specifically, we could not infer that women were less concentrated in those engineering fields whose research styles are less oriented towards mastery and control of nature; scientific objectivity and rationalism; and emotional reticence. It is still possible, however, that if the women are less likely to be concentrated in an educational field which transmits such values, this may have contributed to their under-representation in engineering.

⁵ It should be noted that because of the omission error discussed in Chapter IV, we cannot properly make this claim about male students in systems and computer engineering. Given that the other students did not exhibit any differences in response by department, we should not expect these students to either.

THE STUDENTS' BELIEF-SYSTEM CONCERNING TECHNOLOGY

The purpose of this analysis was to answer questions regarding to whom the students did or did not ascribe responsibility for technology, and whether they evaluated technology and those that may share responsibility for it in positive or negative terms. The questionnaire items not intended to explicitly measure the genderization of technology were categorized under two themes: (i) technological determinism versus technological causality, and; (ii) technology as progressive versus technology as hazardous.

(i) Technological Determinism Versus Technological Causality

Responses to the questionnaire strongly indicated that the students perceived engineers to be responsible for the technology they help to develop, and evaluated such responsibility positively. They did not, however, attribute sole responsibility to themselves, and this responsibility was not always as highly evaluated as their own.

Political authorities, for example, tended to be viewed as negatively influencing technological development. The agreement by the students with the statement that there is "too little emphasis on engineers and their technical knowledge in political decisions in Canada today" further testified to this negative evaluation. It also indicated the value they place upon the engineer's role in technological development. The students also assessed the role the

military plays in technological development negatively. Since the military may have been viewed as an extension of political authorities, this may have reflected the negative evaluation of such authorities.

This negative evaluation, however, seems to have been contradicted by the students agreement that the federal and provincial governments both have and ought to have an important influence on the development of technology. Since the government may have been equated with providing funds for research and development, and 'political' with the curtailment of such funds, no contradiction may have existed.

Unlike the provincial and federal governments, government employees were neither viewed as having much influence upon technological development nor as influencing such development positively. What little causal influence the students attributed to government employees was not regarded as beneficial.

Similar negative sentiments were expressed towards unions by the students who agreed that unions both have and ought to have little influence on technological research. This was reinforced by the majority of students who responded with a 'no' to the question: 'Do you think it is important that engineers are members of labour organizations?' Both these responses and the students' comments (eg. "unions were bad for ethical companies")

indicated that the engineering students perceived union membership as inconsistent with the role of the professional engineer. In accordance with this, the students believed that it was important for engineers to be members of professional engineering associations.

The only group which did not receive a uniform response from the students was the Canadian Consumer Council (CCC). Large percentages of the students reported that the CCC both has important and little influence, while equally large percentages reported that it ought to have both important and little influence. The lack of agreement may have reflected the uncertainty the students felt concerning what this council's functions are, who its members are and what role it plays in the Canadian economy.

As in the case of engineers, researchers, and the federal and provincial governments, both the banks and business leaders were perceived as having an important influence on technological development. While the influence of business leaders was positively evaluated in the sense that the students responded that it 'ought' to occur, the students felt that the banks ought to have little influence. Government employees, unions, and the banks, then, were viewed as ideally having little influence on technological development.

(ii) Technology as Progressive Versus Technology as Hazardous

Given that the students perceived themselves as, at least, partially responsible for technological development, it was not surprising that they tended to view technology as progressive in the sense that it "leads mainly to improvements in society." It was in regard to some of the potential consequences of technology for society that the students were less positive, as indicated by their responses about the military and increased automatisisation. Although a majority of the students agreed that "increased automatisisation ought to be an important aim for the development of technology," a consensus did not exist. While large percentages of the students disagreed with the statement, similarly large percentages also responded by stating that they 'neither agreed nor disagreed.' Concern over the effects of automatisisation on workers' employment and job satisfaction was indicated by the comments of ten students.

A concern with the effects of technological development was also indicated by the students' lack of agreement with the statement that "technology is being used too infrequently to solve ordinary peoples' problems." The students' responses, therefore, to the statements about automatisisation, military aims and peoples' problems reflected a concern with the consequences of how technology

was being used. Although slightly more women than men disagreed with the statement about automatisisation, there was no substantial evidence of a gender difference in perceptions of technology as progressive or hazardous. It seemed, then, that despite certain reservations about technological development and use, the students tended to view technology as progressive. They did not, however, evaluate it in unequivocally positive terms.

(iii) Criteria Emphasized in Selection of Technology to be Developed

Although we attempted to measure what specific criteria the students felt ought to be used in the selection of technology to be developed, the combination of the format of the seven-point scale and the listed criteria prevented any satisfactory measurement. Both exploratory and confirmatory analyses revealed that relatively high emphasis was given to most criteria. All of the criteria, except 'idiot proof' and 'originality,' had ratings that were significant at the level above 'medium' emphasis. These criteria included 'serviceable and user friendly,' 'economical in procurement,' 'robust against stress and strain,' 'predictable contribution and functionability,' and 'simplicity and elegance.'

The two exceptions noted above were significant at the level of 'medium' emphasis. Comments by some of the students indicated confusion with what the criteria 'idiot proof'

and the phrase 'level of exploitation of theoretical inventions' referred to. If the lesser emphasis given these two criteria was a consequence of this uncertainty, it further reflected the inadequacy of this measure to discriminate among the criteria used or the weight given these criteria during the technological selection process.

Although we could not determine what criteria the students felt ought to be emphasized when selecting technology to be developed, a consensus did emerge among the students that technological development was progressive. In fact, when making comments on the questionnaires, six male students used the phrase "technological progress" synonymously with the phrase "technological development." There was also a general consensus among the students that they shared responsibility for technological development with a variety of entities who have differing economic, political and/or military agendas.

VALIDITY RECONSIDERED

As noted in Chapter IV, this thesis did not propose to test specific hypotheses. Rather, through the use of various exploratory and confirmatory procedures, we sought to determine whether our data were consistent with specific inferences drawn from our model of genderized technology. When re-considering validity, then, we are considering whether the nature of our sample, our data and our statistical manipulations have allowed us to measure that

which we purported to measure. Hence, now that we have reviewed comprehensively the findings generated by the current research into the genderization of technology, we will carefully re-examine how valid our basis is for such conclusions.

(i) Statistical Considerations

In this thesis we relied heavily upon exploratory data analysis to indicate both the direction and dispersion of the students's beliefs about technology, including technological artefacts, technical researcher qualities, and technological responsibility. This analysis was supplemented by complementary confirmatory procedures when appropriate. These procedures were intended to determine the significance of the direction and dispersion indicated by the exploratory analysis. They indicated, in other words, whether such findings were likely to have occurred by chance.

Such significance tests, however, were primarily intended for use on numeric data. The data generated by our survey was either ordinal or categorical. Despite the lack of correspondence between the data properties and the requirements of confirmatory procedures, certain procedures could still generate valid results. To accomplish this, care was taken to ensure that the assumptions upon which those procedures were based were satisfied, and that the procedures used were robust with respect to assumption satisfaction. Thus, through cautious data analysis we tried

to confirm that we were measuring that which we had purported to measure.

(ii) Sample Considerations

There is one aspect of our data which may have undermined, at least partially, the validity of our findings. This concerns the nature of the sample utilized in this thesis. As reported in Chapter IV, certain confirmatory procedures can be used on ordinal data, although intended for use on numeric data, when the data have a fairly normal distribution, the sample size is large, and the procedure robust. In addition, procedures such as chi-square tests, t-tests and anovas are based upon the prerequisite of random sampling. Our data, however, did not always fulfil these requirements.

Our sample was not random because it had been our intention to survey the entire third-year population of engineering students at Carleton University. The eighty-five useable questionnaires received from the male students represented fifty-three percent of the total number of third year men and a fairly large male sample size. The twelve useable questionnaires obtained from the female students represented a response rate of eighty-six percent of the total number of third-year female engineering students (ie. fourteen). Unfortunately, it could not provide a large sample size. We were faced, then, with the problem of compensating for the lack of a nonrandom sample and of

comparing two discrepant sample sizes.

To compensate, specific measures were taken to enhance the validity of our findings, and hence, any conclusions we might have drawn. For example, when t-tests and confidence intervals were used, transformations (eg. logten) were used to ensure that the data generated by the small female sample had a fairly normal distribution. When conducting analyses of variance, we had to equalize the variances of our two discrepant samples by again using transformations. When using the chi-square test our small female sample size meant that we had to correct for small expected values by correcting for continuity. Thus, through statistical manipulations and the use of robust confirmatory procedures, we compensated for the discrepant sizes of our female and male samples.

(iii) Descriptive and Theoretical Generalizations

We could not, unfortunately, compensate for the lack of a random sample of the engineering population. This meant that we had to treat our sample as the 'universe' of third-year engineering students. It also meant that we had to restrict ourselves to making generalizations about that specific population whose members shared an equal probability of being included in the survey. Logically, then, we could generalize only to those third year students not already surveyed. Due to an unintentional omission, however, we could not generalize to students enrolled in

systems and computer engineering. But as no departmental differences were found between the students' responses, it is unlikely that these students would exhibit any.

While we were able to make reliable statements about third-year engineering students at Carleton University, we could not make such claims about first, second or fourth-year students. Nevertheless, there was a logical basis to make tentative generalizations about these groups because of the combined effectiveness of recruitment and socialization within the engineering institution. Unlike these groups, generalizations about engineering students at other universities would be far too speculative because we lacked any solid basis for such inferences. Generalizations would be even more speculative in regards to professional engineers. Thus, while we had a basis for making descriptive generalizations about the universe of students surveyed, we lacked one for establishing theoretical generalizations.

(iv) What Do We Know About Institutional Genderization?

Having recalled the model of genderization specified in this thesis, it became clear that we could not provide an adequate test of this model because it constituted a theoretical statement. Our data allowed only a test of certain descriptive statements based on our model: The concrete manifestations of the genderization of technology were visible, and thus, potentially measurable at the institutional, symbolic, and behavioural levels of

reinforce those dichotomies we seek to destroy. This is danger is political because in valuing what science and technology has devalued we might inadvertently bolster the attempts of the powerful to assert an opposition between (male) objectivity and (female) subjectivity and deny the possibility of any mediation between the two (Keller, 1982: 593). This should not be interpreted as an argument for abandonment. Rather, it is a call for caution and awareness.

It is also a call for the reconstruction of objectivity. Having revealed the androcentric, exploitive construction of this concept, and hence science and technology, there is a temptation to reject them entirely. But we cannot abandon our attempts to understand the world, and as a result we must construct an alternative process of knowledge production and use. Although we have no way of imagining, in advance, a fully articulated replacement, we can draw from our criticisms criteria a feminist (or rather, a humanist) science and technology should fulfil (Fee, 1981: 389). Clearly, it could not support the separation of knowledge production and use, between thought and feeling, between subject and object, or science and society. We have set ourselves, therefore, an extensive task.

(iii) Empirical Implications

From a feminist perspective, we can begin to resurrect women's place in the history of the development and evolution technology and techniques. We can uncover their

highest rates of female participation. As discussed above, our data did not allow a proper test of this relationship even though we found evidence in the direction expected. Hence, we cannot validly claim that such a relationship exists.

(vi) What Do We Know About Symbolic Genderization?

As we could make valid descriptive generalizations about genderized technology at the institutional level, we could also make such generalizations about symbolic genderization. While we made the simple generalization that engineering students gender-typed technological artefacts and made gender associations to technology, generalizations concerning gender were more questionable. Although the men rated as neutral three artefacts less than the women, and as 'masculine' four artefacts (the women rated no artefacts 'masculine'), analyses of variance indicated that the women's and men's ratings were significantly different for only one artefact: the melting oven for ore. Because of the nature of our sample, this small difference could have been the result of sampling or measurement error. Hence, we could not validly make the descriptive generalization that women are less likely to gender-type technological artefacts than the men in engineering. Sorenson and Berg (1987: 164) also came to this conclusion. Nevertheless, our data were strongly consistent with such a possibility, and Sorenson and Berg (164) did note that their data provided some

support for this contention.

Similarly, because of the small female sample size, we could not state that female engineering students were less likely to make gender associations to technology. In fact, a higher percentage of the women provided useable gender associations than the men. We could only validly state, however, that both female and male engineering students used at least two properties when gender-typing and making gender associations to technology: how the technology [technique] looked and who it was used by.

We could also make this claim about the Norwegians, just as we could make the descriptive generalization that the Norwegians are more likely than the Canadians to gender-type artefacts and make gender-associations to technology. This was based on our finding that the Norwegians made significantly more gender associations than the Canadians, in addition to gender-typing significantly fewer artefacts as neutral, and significantly more as 'feminine' and 'masculine.'

(vii) What Do We Know About Behaviourial Genderization?

Although Sorenson and Berg did not conclude that there were significant differences in the Norwegian women's and men's gender-typing of artefacts, they did note systematic differences in their valuation of technical researcher qualities. We also found systematic and significant differences in the Canadian women's and men's valuation of

researcher qualities. In both cases, although less in the Norwegian sample, this tended to apply to those abilities which were not as highly emphasized.

Based on our findings, therefore, we could make the valid descriptive generalization that although there was a high degree of agreement regarding those qualities most emphasized, the women tended to give higher emphasis to abilities typically associated with 'femininity.' In addition, those qualities most emphasized tended to be abilities typically associated with 'masculinity.' This finding provided part of the basis for our claim of a hegemonous 'masculine' style of work and thought in engineering.

Our evidence of an alternative style of work and thought came primarily from the higher valuation by the women about four abilities typically associated with 'femininity,' and from the small number of comments they made about these abilities. Despite indications of an alternative style, then, we could not validly claim that such an alternative exists. We could, however, make the generalization that women are less likely to associate engineering abilities with gender because we found that only the men associated abilities with either males or females in engineering.

(viii) What Do We Know About Behaviourial-Institutional Interdependence?

As stated above, offering an explanatory theory constitutes a theoretical generalization. Thus, we were making a theoretical generalization when we proposed that institutional and symbolic genderization were related such that women may be more concentrated in those fields whose research styles are less oriented towards mastery, control and domination of nature; scientific objectivity and rationalism; and emotional reticence. We did not find any departmental differences in valuation of technical researcher qualities or in the attribution of abilities to males and females in engineering. Similarly, we could not claim that there were alternative styles of work and thought in the engineering educational institution. Hence, our data did not allow a proper test of this relationship, and we could not validly claim that such a relationship exists.

(ix) What Do We Know About The Students' Beliefs About Technology?

Although we found evidence of genderization at each of the proposed levels, we also investigated aspects of the students' belief system which were not explicitly related to the genderization of technology. While the engineering students tended to evaluate technology positively, there was evidence of a cognitive separation in their assessment of technological responsibility. This depended upon whether it was the development or utilization of technology that was

being considered. This cognitive separation was also linked with their evaluation of technology as progressive or hazardous. There seemed to be a series of linkages between self-responsibility, technological development and the progressive/positive consequences of technology, and another series between others' responsibility, the utilization of technology and the potentially hazardous/negative consequences of technology for society. Thus, we could make the descriptive generalization that while technological developments tended to be evaluated positively by the engineering students, the manner in which they were utilized or implemented may be evaluated negatively.

(x) Students' Reactions to Questionnaire

Now that we have reviewed what we know about both the students' beliefs about technology and its genderization, there is an additional factor which affects the validity of these findings. This concerns the students' reaction to the questionnaire, and specifically, whether they answered sincerely and honestly. In other words, were their responses reliable? As one student wrote,

you may find that when people realize that the questionnaire is directed towards male/female relations and presence in engineering, this may influence their answer. They may answer to what society wants or answer just to be against what you want.

The students' responses may have reflected what they perceive to be valued or normative in society (eg. men and

women are equal). Alternatively, believing that I intended to create a portrait of the "sexist engineer," the students might have also responded in a manner intended to negate such a possibility. One student, for example, who made a small number of gender associations wrote that "you're trying to make engineers look sexist." Hence, although he did gender-type some technological artefacts and link some engineering abilities with gender, this may have represented only a portion of his tendency to gender-type. This might have typified, ther, the responses of the large percentages of students who made inconsistent gender associations. It might also have extended, albeit partially, to the smaller percentages who refrained from making any gender associations. This was suggested by the large number of students who made comments to the effect that "engineering and technology are not related to sex."

This attitude was also communicated during the questionnaire completions when we found that the two classes surveyed were widely interspersed with a variety of smirks, giggles, grins, laughter, quizzical looks at fellow students, bemused glances at the researcher, and quiet self-directed muttering. As noted in Chapter IV, despite indications of disdain and scepticism, only one student refused to complete the questionnaire, and few non-serious responses were detected. Thus, the willingness of the students to complete the questionnaire and the

thoughtfulness of their answers and comments led the researcher to conclude that the students' responses could be treated as reliable.

After completing analyses of the students' responses, this conclusion was further reinforced for the researcher. As may be apparent from the comments discussed in Chapters IV-VIII, the students' supplied a phenomenal number of comments. The number provided was much more extensive than had been expected. This explained why questionnaire completion took ten minutes longer than the twenty minutes indicated by the pilot study.

It seemed reasonable to speculate that the motivation for this outpouring of commentary, and also their willingness to complete the questionnaire despite the stress placed on voluntary participation, was partly the result of their desire to demonstrate that engineering and technology were unrelated to gender. In so doing, however, many of their comments provided indications of what was interpreted to the genderization of technology. On this basis, then, the responses were believed to be reliable.

IMPLICATIONS FOR FUTURE STUDIES OF TECHNOLOGY

Feminist perspectives on technology whether social, marxist, radical or some combination thereof, all argue that gender must be taken into account in any analysis of technology: its conceptualization, development or use. Such a perspective begins from an awareness that in a society

characterized by a gender division of labour and a differential valuation of gender attributes, technology has drastically different ramifications for women and men. To propose that technology is genderized, is to propose that it has been socially constructed in such a way that it reflects those gender attributes which are valued in society as superior and reinforces the gender division of labour. The socially constructed attributes valued in society -- strength, objectivity, rationality, unemotionality -- are those considered 'masculine.' This association reflects a particular system of relations wherein that which is "male" is valued and dominant over that which is "female," and thus, which justifies the oppression of women and their relegation to the private/home sphere.

Implicit in the above discussion of the genderization of technology is a conceptualization of it as a general cultural phenomenon. Despite our investigation of the culture of engineering we are not treating the genderization of technology as a phenomenon specific to this culture. In so far as, however, this thesis is an occupational/educational study, we are observing the concrete manifestations within the engineering culture of a broader cultural phenomenon. As noted in connection with our discussion of theoretical and descriptive generalizations, while we have a strong basis for making statements about these concrete manifestations, we lack a similar basis for

making claims about the genderization of technology as a cultural phenomena. Nevertheless, we can draw from our study, in combination with others, theoretical, ideological and empirical implications, all of which may provide direction for further research.

(i) Theoretical Implications

Most obviously, we must continue to ask and try to answer those questions raised in this thesis and the work of Sorenson and Berg (1987: 151): What does genderization mean? In what ways is technology genderized? What are the consequences? How is genderization brought about? How can we do away with it?

Although we speak of genderization as an "it," we are referring to a cultural phenomenon as broad in proportion as the gender system which characterizes and divides Canadian society. To broach such issues we must realize there is a relationship between patriarchy and the social construction of technology since technology reflects the values of those in the position in Canadian society to construct, that is, men. Technology, then, must be treated as an "equity issue."

Technology has everything to do with who benefits and who suffers, whose opportunities increase and whose decrease, who creates and who accommodates. If women are to transform . . . technology, we must develop ways to assess the equity implications of technological development and develop strategies for changing social relationships as well as mechanical techniques. To do this we must have a definition of technology that will allow us to focus on such questions of equity (Bush, 1983: 163).

As a result, any feminist or non-feminist analysis of technology is inseparable from a feminist analysis of power. The recognition that any analysis of technology is inseparable from considerations of power is premised upon the belief that technology is embedded within the social hierarchy that characterizes Canadian society. This, however, is a hierarchy characterized by divisions of class and ethnicity, as well as gender. Hence, we arrive at a conceptualization of technology inseparable from considerations of gender, ethnicity and class. Such an approach will facilitate analyses not only of gender inequities, but also ethnic and class inequities.

Commitment to an equity analysis of technology allows one to stop treating technology as a "black box" (Sorenson and Berg, 1987: 169). Technology is not an absolute, neutral in respect to gender, class and ethnicity. As a set of social relations, technology is revealed as a historical process whose development is inseparable from that of our patriarchal, capitalist, racist society. Analyses of technology, then, will reveal how technology has contributed to our current socio-political structures. This, in turn, will augment our understanding of their more general interrelationship.

(ii) Ideological Implications

As Sorenson and Berg (1987: 169) note, the development of technology, as well as science, is also intertwined

historically with the establishment of the hegemony of rational and instrumental reason. From the traditional liberal philosophy characterized by this hegemony, any attempt at linking gender with science and technology is nonsensical. As Keller (1982: 592-3) notes,

as long as the course of scientific thought is judged to be exclusively determined by its own logical and empirical necessities, there could be no place for any signature, male or otherwise, in that system of knowledge.

Liberal ideology of rational "man," however, has carried with it a subset of themes and theories on the nature of sex differences, and a dichotomizing of experience into two distinct and opposite categories: female and male (Fee, 1981: 381). From this realization, we observe that nearly all technologists and scientists are men. We also find that there exists a bias in the choice and definition of problems and solutions. Lastly, the objectivity which is presented as the hallmark of scientific neutrality and technological production is revealed as an attribute believed to be sex-linked.

But what is it we mean when we speak of objectivity as an attribute of both cold, hard, impersonal science and "man"? Fee (1981: 384-387), when noting the multitude of meanings this vague idea carries, outlines four interpretations of objectivity. Firstly, this concept as rational neutrality can be used to create a distance between 'the pursuit of knowledge' as an abstract and value-free

ideal, and the military, economic and political uses to which this knowledge is put. It passively absolves, therefore, any individuals involved in knowledge production from their social responsibility. Secondly, objectivity may be interpreted as requiring a separation between rationality and emotionality. Once this hierarchy between thinking and feeling is established, those identified with "thought" (ie. men) can justify their domination over those identified with "feeling" (ie. women). Thirdly, related to this hierarchy is the object/subject split which legitimizes the domination of nature; its manipulation and transformation for human ends. Fourthly, the assertion of objectivity can be used to mask the actual conditions of scientific and technical work whereby the individual is a salaried employee, part of an institutional hierarchy, working on a task formulated by others which is itself dependent upon economic and political decisions. The production of scientific and technical knowledge, therefore, is not objective in the sense that it is value-free, autonomous of social organization.

Having challenged the objectivity of scientific and technical practices, we are now in the situation of necessarily constructing an alternative. Much of this challenge has issued from those of us who justifiably denounce the lack of 'feminist principles,' 'feminine qualities' and 'women's values' in science and technology. In our criticisms, however, there is a danger that we might

reinforce those dichotomies we seek to destroy. This danger is political because in valuing what science and technology has devalued we might inadvertently bolster the attempts of the powerful to assert an opposition between (male) objectivity and (female) subjectivity and deny the possibility of any mediation between the two (Keller, 1982: 593). This should not be interpreted as an argument for abandonment. Rather, it is a call for caution and awareness.

It is also a call for the reconstruction of objectivity. Having revealed the androcentric, exploitive construction of this concept, and hence science and technology, there is a temptation to reject them entirely. But we cannot abandon our attempts to understand the world, and as a result we must construct an alternative process of knowledge production and use. Although we have no way of imagining, in advance, a fully articulated replacement, we can draw from our criticisms criteria a feminist (or rather, a humanist) science and technology should fulfil (Fee, 1981: 389). Clearly, it could not support the separation of knowledge production and use, between thought and feeling, between subject and object, or science and society. We have set ourselves, therefore, an extensive task.

(iii) Empirical Implications

From a feminist perspective, we can begin to resurrect women's place in the history of the development and evolution technology and techniques. We can uncover their

role not only as inventors, but also the role of technology in shaping their lived experiences, as in Stanley's (1984) article, "Women Hold up Two-Thirds of the Sky: Notes for a Revised History of Technology." During such enterprises we will be revaluing women's activities, and thus, exposing them as legitimate areas of research.

Investigations of technological history will necessarily involve examinations of women and household techniques. Studies, such as Cowan's (1983) More Work For Mother: The Ironies of Household Technology from the Open Hearth to the Microwave, ask how the characteristics of women's work changed, where and when, and how women's and men's status was effected. Considerations of technology and women in the home must not ignore women's contraceptive methods and reproductive techniques. Defining technology within a social context, we realize that the effects of new household or reproductive techniques will depend upon the context in which they are developed and used.

Their health effects, then, also depend upon context, as does the health effects of techniques within the workplace. The headaches, eyestrain and stomach ulcers experienced by many women working on microprocessors, then, is not a function of working with this particular technique. Rather, it is a result of the structural organization of the work process, that is, the rising pace of work, job routinization and deskilling premised upon the availability

of a cheap (ie. female) labour force. (cf. Arnold, Birke & Faulkner, 1981; Norlen, 1987; Menzies, 1981 & 1982). Similarly, the "exhaustion" phenomenon among women workers in third world Export Processing Zones is the result of the intense rate of production, not simply the result, for example, of staring down a microscope while assembling circuit boards for computers (cf. Elson and Pearson, 1981; Mitter, 1986; Mies, 1982).

The perspective proposed above reveals that the notion of 'technological transfer' from the first to the third world is an elitist misconception, based as it is upon an implementation scheme intended to fragmentize and deskill production processes (cf. Lee, 1984). It is not the transferred techniques, then, that make production in these third world countries dependent upon countries in the first. It is the patriarchal, capitalist context in which they have been used and developed which is responsible.

We can see, then, that an equity analysis of technology makes it possible to link first and third worlds. As most research on women, technology and paid labour, housework, or reproduction (and their respective histories) focuses on women in the first world countries, future analyses can provide bases to further link first and third world women. While this will allow us to gain insights into the relations of production and the gender division of labour, it will also help us gain insight into the way in which the

oppression of one set of women is both the condition and consequence for the oppression of another set.

Although we have named only a few potential areas of future research, each area contains innumerable avenues for analysis. Within each avenue, as our definition of technology requires, the research must be historically grounded, examining specific periods and places. Building upon this basis, we can conduct comparative analyses and studies that range across time and space. Such an expansive undertaking might be broached by setting parameters for our investigations. Following the suggestions of Bush (1984: 157, *her italics*), we might examine the four contexts in which technology operates:

1. **The design or developmental context** which includes all the decisions, materials, personnel, processes and systems necessary to create techniques from raw materials.
2. **The user context** which includes all the motivations, intentions, advantages and adjustments called into play by the use of particular techniques.
3. **The environmental context** that describes nonspecific physical surroundings in which techniques are developed and used.
4. **The cultural context** which includes all the norms, values, myths, aspirations, laws and interactions of the society of which the technology and techniques are a part.

We can use Bush's (1984: 165-167) example of refrigeration to illustrate how such contexts might be used in an equity analysis of technology. The developmental context would include an analysis of how refrigeration uses the properties of gases and the principles of thermodynamics and

compression to perform the tasks of making ice, preserving and freezing food and cooling air. It would also include an analysis of the entire web of relationships involved in the design, manufacturing and distribution of the refrigeration units themselves. The user context would include the commercial, medical and domestic uses of refrigeration, as well as the advantages and disadvantages these uses involve. The environmental context would examine the effects of the developmental and user contexts on the environment by asking questions such as: Since refrigeration effects agriculture, what are the effects of cash crop monoculture on soil erosion and the use of pesticides? The cultural context would examine the interaction between the development and adoption of refrigeration and our sex-role beliefs, racist values and capitalist norms. Such a perspective demands an investigation of all the advantages and disadvantages the use of a particular technique may involve. By investigating who designs, who manufactures, who uses, who benefits, who suffers (and equally, who does not), we have a mode of investigation which is historical, dialectical, materialist and subjective.

IN CONCLUSION

With a feminist perspective -- "a perspective from the periphery" -- we can gain insight into the values and assumptions which underlie technology. The use of such a perspective in this thesis, prompted by the work of Sorenson

and Berg (1987), has facilitated an initial analysis of the link between gender and the way we think about, develop and use technological products and processes. Although we could not conduct a complete test of our model of genderized technology, evidence consistent with the model was found at all three proposed levels of genderization: (i) the institutional -- a gender division of labour within engineering education; (ii) the symbolic -- genderized technological artefacts, and; (iii) the behavioural -- a hegemonous 'masculine' style of work and thought valued in technological research. Ultimately the use of such a perspective and corresponding attempts at empirical analysis is directed towards the establishment of new categories and frameworks for technology's organization, development and evolution. These attempts, in other words, are aimed at reconstructing technology in such a way as to make values such as harmony with nature, subjectivity and non-exploitation integral to technological practices. We are, then, talking about cultural transformation.

APPENDIX A
PROBLEMATIC IMPLICATIONS OF THE TERM 'GENDER'

In social psychology gender identity is defined as one's self awareness of being male or female. The term 'gender' has long been used to distinguish what is socially assigned from what is biologically determined. Feminist analyses, however, which theorize gender have broadened our understanding of this concept. Pat Armstrong and Hugh Armstrong (1985), for example, resist the use of the term 'gender' because it makes the misleading suggestion that the distinction between the socially assigned and the biologically determined is clearly established. Physical capacities do not exist outside of, that is, autonomous from, power structures and productive processes. It is for this reason that Cockburn (1986) argues that physical effectivity is appropriated by males during childhood, youth and maturity. She argues that certain bodily differences between males and females are largely a social product. Height and weight are correlated with class, produced by different standards of living, as well as with biological sex. Boys are conditioned from childhood in numberless ways to be more physically effective than girls (Cockburn, 1986: 97). It is recognized in this thesis that to use the term 'gender' may imply, inaccurately, that biology itself is outside of history and society. Nevertheless, the term 'gender' will be retained to denote those 'feminine' and 'masculine' qualities widely supposed to be possessed or displayed predominately by females and males, respectively.

This is further discussed in the main body of this chapter.

APPENDIX B:
QUESTIONNAIRE PROVIDED BY SORENSON AND BERG

To the one who is going to fill out the questionnaire:

Technology and technological development, and therefore also civil engineers and architects, play an important part in society. This questionnaire contains some questions concerning this. We are interested in the NTH (The Norwegian Institute of Technology) students' views on different aspects of technology and technology's functions within society. This is not a test of knowledge. We are interested in your opinions about the different themes.

Thank you for helping!

1. Take a stand on the following technological theories and indicate by an "x" whether you agree or disagree with them. Make an "x" beside each statement.

	Agree wholly	Agree a bit	Neither nor disagree	Disagree a bit	Disagree wholly
New technology leads mainly to improvements in society					
Technology ought to be developed independently of political and economic interests					
Technology is used too infrequently to solve ordinary peoples' problems					
Civil engineers have a moral responsibility for the technology they help to develop					
Too little money is used today in Norway to develop new technology					
Military aims have too large an influence on technical research					

1. (continued)

	Agree wholly	Agree a bit	Neither nor	agree disagree	Disagree a bit	Disagree wholly
Technological development ought to be directed by political authorities						
Increased automatisation ought to be an important aim for the develop- ment of technology						
There is too little emphasis on civil engineers and their technical knowledge in political decisions in Norway today						

2. Do you think it is important that civil engineers and architects are members of a labour or professional organisation, such as the Norwegian Society of Chartered Engineers, the Norwegian Architects League, The Federation of Researchers or The Norwegian Union of Government Employees?

() yes () no

3. If yes to question 2, then why? (put maximum two "x's"!)

() It is necessary to have an organisation that takes care of the employee interests of civil engineers and architects

() Will have advantages of membership

() It is important to be organised in a union, in solidarity with others

() It is usual to be organised

() Wish to influence the organisation

If no to question 2, why? (put maximum two "x's"!)

() Unnecessary in the type of position I think I will get

() Do not think civil engineers and architects ought to be in unions

() Do not think membership gives any result

() Disagree in the policies the organisations put forward

4. Which of the following do you think ought to be emphasised in the abilities of the person who is going to do technical research? Make an "x" beside each ability.

Ability	Very little emphasis		Medium emphasis			Very high emphasis	
	1	2	3	4	5	6	7
Theoretical competence							
Practical insight							
Ability to tolerate adversity							
Accuracy							
Ability to hold to deadlines							
Dexterity							
Respect for the complexities of nature							
Ability to work alone							
Intuition							
Perseverance, patience							
Involved in social problems							
The ability to understand other peoples' problems							
Creativity, inventiveness							
Objectiveness							
Ability to differentiate between the case and the person							
Cool, realistic attitude							
Obstinate, headstrong							
Interested in one's own career							
Competence in working together with others							

5. The development of new technology very often implies a choice between different solutions. Below is a list of different possible criteria for such choices. Indicate what weight in your personal opinion ought to be ascribed for each criterion. Make an "x" for each criterion.

Criterion	Very little emphasis		Medium emphasis			Very high emphasis	
	1	2	3	4	5	6	7
Simplicity and elegance							
Originality, level of exploitation of new theoretical inventions							
Economical in procurement							
Economical in use							
Serviceable and user friendly							
"Idiot proof"							
Robust against stress and strain							
Predictable contribution and functionability							

6. Below are mentioned some different forms of technology. For each of them we would like to know if you comprehend that this form of technology has a masculine or feminine character.

Type of technology	Clearly feminine		Neither feminine nor masculine		Clearly masculine	
	1	2	3	4	5	6 7
Melting over for ore						
Excavator						
Dentist's drill						
Thermometer						
Electrical drill						
Soldering iron						
Microscope						
Reflex camera with mirror						
Packing machine for fish fillets						
Typewriter						
Centrifuge						
Artificial fibre						
Gas absorption						
Chromatograph						
Telephone exchange						
Weight scale						
Cement mixer						
Fibre-optics						

7. Can you with the help of 3 to 6 cuewords describe what for you is characteristic for a type of technology which you associate with something manly or masculine?

8. Can you with the help of 3 to 6 cuewords describe what for you is characteristic for a type of technology which you associate with something womanly or feminine?

9. Can you with the help of 3 to 6 cuewords describe what for you is characteristic for a type of technology which you comprehend as advanced?

10. How much influence do you think the following groups in society have on the development of technology? (Make an "x" for each group)

Group	Has a very important influence	Has an important influence	Has little influence	Has no influence
The Parliament				
The government				
Government employees				
Business Leaders				
Labour unions				
The banks				
The consumer council				
Researchers				
Civil engineers in industry				

11. How big an influence do you think the following group in society ought to have on the development of technology? (Make an "x" for each group)

Group	Ought to have a very important influence	Ought to have an important influence	Ought to have little influence	Ought to have no influence
The Parliament				
The government				
Government employees				
Business leaders				
Labour unions				
The Consumer Council				
Researchers				
Civil engineers in industry				

12. Which section of engineering are you taking and in what year are you?

13. Sex () man () woman

APPENDIX C
REVISED QUESTIONNAIRE

Dear Engineering Student,

I am a graduate student doing research towards my Master's degree in sociology. My goal is to investigate Carleton University students' views on different aspects of technology and technology's functions within society. Your perceptions as an engineering student are of particular interest because you have a quite close relationship with and knowledge about technology. In addition, your viewpoints are likely to effect important future developments in the technological fields.

On the following pages you will find a series of questions aimed at recording your views. Read each question carefully and please answer every question even if you are not sure of your answer. PLEASE DO NOT CONSULT ANYONE ON YOUR ANSWERS. This is not a test of your knowledge. I am interested only in your opinions.

If you have any comments about the questionnaire or wish to expand upon any of your answers, please write them in the space provided on page ten. Any comments or questions would be welcomed and appreciated.

Please note that all of your answers will be kept in the strictest confidence, and will be used only for research purposes. No one else will see your answers.

Thank you for helping!

1. Take a stand on the following technological theories and indicate by an "x" the degree to which you agree or disagree with them. Make an "x" beside each statement.

Agree wholly	Agree a bit	Neither agree nor disagree	Disagree a bit	Disagree wholly
New technology leads mainly to improvements in society				
Technology ought to be developed independently of political and economic interests				
Technology is used too infrequently to solve ordinary peoples' problems				
Engineers have a moral responsibility for the technology they help to develop				

1. (continued)

	Agree wholly	Agree a bit	Neither agree nor disagree	Disagree a bit	Disagree wholly
Military aims have too large an influence on technical research					
Too little money is used today in Canada to develop new technology					
Technological development ought to be directed by political authorities					
Increased automation ought to be an important aim for the development of technology					
There is too little emphasis on engineers and their technical knowledge in political decisions in Canada today					

2. (a) Do you think it is important that engineers are members of professional organizations, such as the Canadian Council of Professional Engineers, the Association of Consulting Engineers, the Association of Professional Engineers of Ontario, or Women in Science and Engineering?

() yes

() no

(b) If yes to question 2, then why?
(put maximum two "x's"!)

(c) If no to question 2, then why?
(put maximum two "x's"!)

- () It is necessary to have an organization that takes care of the employee interests of engineers
- () Will have advantages of membership
- () It is important to be organized, to be in solidarity with others
- () It is usual to be organized
- () Wish to influence the organization

- () Unnecessary in the type of position I think I will get
- () Do not think engineers ought to be organized
- () Do not think membership gives any results
- () Disagree in the policies the organizations put forward

3. (a) Do you think it is important that engineers are members of labour organizations, such as the Canadian Union of Professional and Technical Employees?

() yes

() no

(b) If yes to question 3, then why?
(put maximum two "x's")

(c) If no to question 3, why?
(put maximum two "x's")

- () It is necessary to have an organization that takes care of the employee interests of engineers
- () Will have advantages of membership
- () It is important to be organized, to be in solidarity with others
- () It is usual to be organized
- () Wish to influence the organization

- () Unnecessary in the type of position I think I will get
- () Do not think engineers ought to be organized
- () Do not think membership gives any results
- () Disagree with the policies the organizations put forward

4. Which of the following do you think ought to be emphasized in the abilities of the person who is going to do technological research? Indicate with an "x" what weight, IN YOUR OPINION, ought to be ascribed for each ability.

Ability	Very little emphasis		Medium emphasis			Very high emphasis	
	1	2	3	4	5	6	7
Theoretical competence							
Practical insight							
Ability to tolerate adversity							
Accuracy							
Ability to hold to deadlines							
Dexterity							
Respect for the complexities of nature							

Ability	Very little emphasis			Medium emphasis			Very high emphasis	
	1	2	3	4	5	6	7	
Ability to work alone								
Intuition								
Perserverance, patience								
Involved in social problems								
The ability to understand other peoples' problems								
Creativity, inventiveness								
Objectiveness								
Ability to differentiate between the case and the person								
Cool, realistic attitude								
Obstinate, headstrong								
Interested in one's own career								
Competence in working together with others								

5. The development of new technology very often implies a choice between different solutions. Below is a list of different possible criteria for such choices. Indicate what weight, IN YOUR PERSONAL OPINION, ought to be ascribed for each criterion. Make an "x" for each criterion.

Criterion	Very little emphasis			Medium emphasis			Very high emphasis	
	1	2	3	4	5	6	7	
Simplicity and elegance								
Serviceable and user friendly								

Criterion	Very little emphasis		Medium emphasis			Very high emphasis	
	1	2	3	4	5	6	7
Originality, level of exploitation of new theoretical inventions							
Economical in procurement							
"Idiot proof"							
Robust against stress and strain							
Predictable contribution and functionability							

6. Below are mentioned some different forms of technology. For each of them I would like to know if you feel that this form of technology has a MASCULINE OR FEMININE character. Use an "x" to indicate in YOUR PERSONAL OPINION what degree of femininity or masculinity each form of technology possesses.

Types of technology	Clearly feminine		Neither feminine nor masculine			Clearly masculine	
	1	2	3	4	3	2	1
Melting oven for ore							
Excavator							
Dentist's drill							
Thermometer							
Electrical drill							
Soldering iron							
Microscope							
Reflex camera with mirror							
Packing machine for fish fillets							

6. (continued)

Types of technology	Clearly feminine	Neither feminine nor masculine				Clearly masculine	
	1	2	3	4	3	2	1
Typewriter							
Centrifuge							
Artificial fiber							
Gas absorption-chromatograph							
Telephone exchange							
Weight							
Cement Mixer							
Fiber-optics							

7. Please list from three to six words (adjectives or nouns) which describe a type of technology that you think is manly or masculine.

8. Please list from three to six words (adjectives or nouns) which describe a type of technology that you think is womanly or feminine.

9. Please list from three to six words (adjectives or nouns) which you feel are descriptive of advanced technology.

10. How much influence do you think the following groups in society have on the development of technology? Make an "x" for each group indicating the degree of influence you feel is appropriate.

Group	Has a very important influence	Has an important influence	Has little influence	Has no influence
The Federal Government				
The Provincial Government				
Government employees				
Business leaders				
Labour unions				
The banks				
The Canadian Consumer Council				
Researchers				
Engineers in industry				

11. How big an influence do you think the following group in society OUGHT TO HAVE on the development of technology? Make an "x" for each group indicating the degree of influence you feel is appropriate.

Group	Ought to have a very important influence	Ought to have an important influence	Ought to have little influence	Ought to have no influence
The Federal Government				
The Provincial Government				
Government employees				
Business leaders				
Labour unions				
The banks				
The Canadian Consumer Council				
Researchers				
Engineers in industry				

12. Which of the following engineering duties do you think are particularly UNSUITED for MEN? (indicate your choices with a maximum of three "x's")

☐ Research	☐ Construction
☐ Development	☐ Supervision of department, district, floor, or section
☐ Designing, drafting	☐ Administrative, Management, and Executive positions
☐ Testing, inspection, laboratory services	☐ Writing, Information services
☐ Installation, erection	☐ Library work, Patents
☐ Production, operation	☐ Teaching, Instructing
☐ Maintenance	☐ Purchasing, Marketing, Sales and Service
☐ Layout, location	☐ Consulting and Private Practice
☐ Field exploration	☐ Finance, Accounting, and Budgetary Control
☐ Personnel	
☐ Other, please specify	

If you think there are such duties, why do you think they are unsuitable for men engineers? _____

If you do not think there are any such duties, why do you think there are no engineering duties unsuitable for men? _____

13. Which of the following engineering duties do you think are particularly UNSUITED for WOMEN?

☐ Research	☐ Construction
☐ Development	☐ Supervision of department, district, floor, or section
☐ Designing, drafting	☐ Administrative, Management, and Executive positions
☐ Testing, inspection, laboratory services	☐ Writing, Information services
☐ Installation, erection	☐ Library work, Patents
☐ Production, operation	☐ Teaching, Instructing
☐ Maintenance	☐ Purchasing, Marketing, Sales and Service
☐ Layout, location	☐ Consulting and Private Practice
☐ Field exploration	☐ Finance, Accounting, and Budgetary Control
☐ Personnel	
☐ Other, please specify	

If you think there are such duties, why do you think they are unsuitable for women engineers? _____

If you do not think there are any such duties, why do you think there are no engineering duties unsuitable for women? _____

14. Do you feel that any of the following abilities apply more to males than females, or more to females than to males in engineering? Use an "x" to indicate to what degree each ability applies more to one sex than the other.

Abilities	Females in Engineering			Equally to both			Males in Engineering
	1	2	3	4	3	2	1
Theoretical competence							
Practical insight							
Ability to tolerate adversity							
Accuracy							
Ability to hold to deadlines							
Dexterity							
Respect for the complexities of nature							
Ability to work alone							
Intuition							
Perserverance, patience							
Involved in social problems							
The ability to understand other peoples' problems							
Creativity, inventiveness							
Objectiveness							
Ability to differentiate between the case and the person							
Cool, realistic attitude							
Obstinate, headstrong							
Interested in one's own career							
Competence in working together with others							

15. (a) In what department of engineering are you currently enrolled?

() Electrical () Mechanical and Aerospace
() Civil () Systems and Computer

(b) In what year of engineering are you enrolled (eg. 1st, 2nd, etc.)? _____

- 16 Sex

() female () male PLEASE DO NOT OMIT THIS QUESTION !

17. Comments: Yours comments or questions would be helpful and welcome.

[illegible]

18. If you would be willing to be interviewed briefly at some later date, please write your name and the phone number at which you can be reached in the space below. TO ENSURE THE PRIVACY OF YOUR RESPONSES, PLEASE DETACH THIS PAGE. IT WILL BE COLLECTED SEPARATELY FROM THE QUESTIONNAIRE.

Again, thank you for your time and cooperation.

APPENDIX D
EXTREME RESPONSES MEASURED AS OUTLIERS &
FAR OUTLIERS

To determine what values (ie. responses) are outliers and far outliers, we must first find the upper and lower quartiles. Quartiles are those values that quarter a batch. The middle quartile (ie. the median) divides the two top quarters from the bottom two. To determine the upper and lower quartiles we must break the top and bottom halves of the batch in half again. To do this we find what $N/4$ is (when N is the number of values), and then count in that amount from the top to get the upper quartile, and that amount from the bottom to get the lower quartile. For example, consider the following data batch:

48 29 28 28 26 22 22 22 20 16 10 9 8 7 4

$N=15$, so $N/4 = 15/4 = 3 \text{ \& } 3/4$, and we round up to 4; therefore, we want the fourth largest and fourth smallest values. Counting in we find these numbers, the upper and lower quartiles, to be 28 and 9, respectively. We then use these two values to determine the midspread:

$$\begin{aligned}\text{midspread} &= \text{upper quartile} - \text{lower quartile} \\ &= 28 - 9 \\ &= 19\end{aligned}$$

The outliers, then, are those values that are one-and-a-half midspreads (19×1.5) above the upper quartile (28) or below the lower quartile (9). So the upper outlier must be at least the upper quartile plus 1 & $1/2$ midspreads:

$$28 + (19 \times 1.5) = 56.5$$

Therefore, in our example there are no upper outliers. Similarly, there are no lower outliers since no batch values

are lower than $-19.5 [9 - (19 \times 1.5)]$. Neither are there any far outliers as the values are not distributed enough even to contain outliers. For this thesis the computing system, Minitab, Version 5.1, was used to determine whether there were any unusual batch values (ie. atypical student responses).

APPENDIX E
NINETEEN ABILITIES ASSOCIATED WITH GENDER

In order to determine whether specific abilities were typically associated with or attributed to males or females, twenty-five people were asked to indicate, if possible, what gender the nineteen abilities were stereotypically linked with. This sample consisted of twelve females and thirteen males whose ages ranked from 19 to 63 (the median being 26), and whose occupations included: a registered nurse, 8 professional engineers, 2 electrical technicians, 5 university students, 2 'homemakers' (one female, one male), a certified public accountant, a lawyer, a laboratory technician, a daycare worker, a dairy farmer, a bank teller, and a retired registered nurse.⁷¹ The percentage of students making associations are summarized below:

Abilities Associated with Females		Abilities Associated with Males	
Competence in working together N=15 with others	76% N=19	Practical insight	60%
Patience, perseverance N=19	64% N=16	Objective- ness	76%
Ability to understand N=16 other peoples' problems	88% N=22	Theoretical competence	64%
Involved in social problems	88% N=22	Cool, realistic attitude	84% N=21

⁷¹ The term 'homemaker' was chosen by these two individuals.

(continued)
Abilities Associated
with Females

Dexterity 92%
N=23

Intuition 100%
N=25

Abilities Associated
with Males

Ability to 72%
hold to N=18
deadlines

Ability to 88%
tolerate N=22
adversity

Abilities Associated
with Males

Ability to 84%
work alone N=21

Interested in 100%
one's own N=25
career

Obstinate, 100%
headstrong N=25

Abilities Associated
with both Genders

Creativity,
inventive-
ness

% Females=52
N=13

% Males=48
N=12

Abilities
Associated
with neither
Gender

Ability to 92%
differentiate N=23
between the
case and the
person

Accuracy 80%
N=20

On sixteen of the abilities people exhibited no difficulty in gender-typing. Fifteen of these abilities were clearly associated with either females or males by well over half of the respondents. The following six abilities were associated with females: (i) competence in working together with others; (ii) patience, perseverance; (iii) the ability to understand other peoples' problems; (iv) involved in social problems; (v) intuition, and; (vi) dexterity. Nine abilities were associated with males: (i) practical insight; (ii) objectiveness; (iii) theoretical competence; (iv) cool, realistic attitude; (v) ability to hold to deadlines; (vi)

ability to tolerate adversity; (vii) ability to work alone; (viii) interested in one's own career, and; (ix) obstinate, headstrong. These associations were supplemented by the respondent's commentary which created a picture of men as "stronger, tougher," "more impatient, less tolerant," "more practical, less fanciful," "more career-oriented," "more intellectual," and "less emotional, communicative, sensitive and giving" than women. This commentary indicates why approximately half of respondents associated 'creativity, inventiveness' with males, while the other half associated it with females. Although men may stereotypically be "more intellectual" than women, only half of the respondents associated creativity with men. Two abilities were not associated with either males or females. Ninety-two percent (N=23) of the respondents did not make an association to gender because they were unsure of the meaning of the ability to differentiate between the case and the person. Eighty percent (N=20) did not associate accuracy with either males or females. While most people provided no reason for this choice, three respondents stated simply that it was not a gender linked ability. Of the five students who did make such an association to accuracy, four linked it with females while one linked it to males noting it as an aspect of men's intelligence. Overall, then, the twenty-five respondents were highly consistent in both their associations to gender and the reasons they gave for their choices.

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