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Experiencing Technical Work: A Comparison of Male and Female Engineers

by
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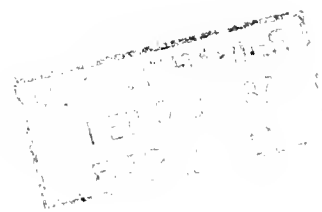

ABSTRACT

Analysis of questionnaire data from 51 matched male/female pairs of engineers shows that even though these pairs are in very similar positions and share similar orientations to the role of work in their lives, the women have a more ambivalent attitude toward technical expertise. The reasons seem not to lie in complications stemming from women's multiple roles, but relate, rather, to the singular, more "masculine" way that technical work is defined. In managerial roles, in contrast, where criteria of effective performance are more difficult to specify, women seem to be engaged in new models which are associated with less ambivalence. Such diversity, it is argued, is useful for all employees, male and female.

We live in an age of high technology, where, more and more, the most creative and important jobs require technical training and know-how. The proportion of women in these jobs is still small, but there has been a recent increase in the number receiving the requisite training and in the number entering the technical workforce (Jagacinski and LeBold, 1981; Kirkham and Thompson, 1984; Vetter, 1984; Estrin, 1985; Malcom, 1985). Organizations are actively recruiting technically trained women not only in response to changing values and policies related to equal opportunity, but also because they recognize that women represent an untapped potential for much needed technical work. It is important, therefore, to learn about the careers of these women and to investigate whether and how they differ from those of men.

We know a great deal about technical careers for men, and we have some well-defined notions about the best way for organizations to deal with a largely male technical workforce. But this knowledge cannot simply be generalized to the women now entering these jobs since it is based almost entirely on the study of male employees. It is necessary, also, to understand women's experiences as technical employees. And from the women's data, it should be possible to highlight assumptions underlying current organizational procedures that need revision in the light of shifting life patterns. For it is not only women who have been caught in the dramatic changes in values and outlook of the past few decades. To the extent that we can accommodate their needs, we will also be serving those of all employees.

This paper is based on a study designed to throw light on this general issue. It attempts to probe the experience of technical work for men and women and to explore the differences between them. It is based on data

collected from a population of technically trained women and a paired comparison group of men.

In the spring of 1985, 582 women members of the Society of Women Engineers and the Association of MIT Alumnae were sent two questionnaires about their careers, one for themselves and one to be given to a male colleague as close as possible to them in age, position, and experience. 279 women replied, and there were 155 male responses. 51 of these paired responses consisted of men and women both of whom had undergraduate engineering or computer science degrees. These 51 comprise the sample on which this paper is based.

By design, the study selected a group with proven technical skills who chose to capitalize on these competencies in their work lives, and it thus deliberately sought to equalize most factors related to occupational choice.[1] There is little difference in the external characteristics of these respondents. Their median age is 28, and ranges from 22 to 48 for the women and to 49 for the men. 80% of the pairs are within two years of age of each other, and only two are more than five years apart, including one pair who are both in their forties and one in which a 47-year old divorced woman with 4 grown children, who returned to school to get a degree in 1981, paired herself with a 24-year old male who is working, as is she, as a first level engineer.

The pairs also match closely in their present positions. Approximately two thirds of both the women and men are employed as engineers or computer specialists working as independent contributors in a variety of organizations. When categorized into three occupational levels: 1) first level engineers or computer analysts, 2) engineers or computer analysts with some coordinating responsibilities, and 3) supervisors, project managers, or managers, there is close correspondence between the pairs

(χ^2=17.2, P=.002). They were also closely matched on whether they were on the managerial or technical ladder, or on no career ladder (χ^2=18.1, P=.001). Further, the mean salary is just over $35,000 for both sexes, though the male supervisors are paid somewhat more than their female counterparts, and the women computer specialists are more highly compensated than are the equivalent males. Given the ages and positions of this sample, these figures are in line with other surveys of engineers.[2]

When one considers family structure, there are slight differences. Somewhat more of the women are single or, if married, childless: 21 of the women, as compared to 17 of the men, are not currently married; only 5 women, as opposed to 9 men, have children, and 2 of these are single parents. There are no male single parents in the sample. Further, the women, if married, are much more likely to have spouses in professional occupations, particularly in science and engineering, while the men are more likely to have wives with either no occupation or lesser professional and white collar jobs (P<.01).

In general, however, the design of the study seems to have worked: there are few gross differences between the men and women in this sample.

Background

There are differences, however, in the backgrounds of these two groups, as is evident from Table 1. More of the women grew up in families where they were either oldest or only children or, if they had older siblings, they were sisters, not brothers. Such sibling positions have often been assumed to be associated with high achievement for women. They were also less likely to come from families with lower socio-economic status (28% of the women as opposed to 42% of the men had fathers who worked in lower white collar, blue collar, or service occupations), though this difference did not quite reach statistical significance.

TABLE 1
Some Differences in Background

	women	men
no older brothers	74%	57%*
top credentials	64%	44%*
[MIT B.S.]	[38%]	[12%]**
no discontinuities	59%	78%*

* P<.05 (matched pairs test)
** P<.005

Further, the women had better educational credentials. Given the design, it is not surprising that more came from MIT. But even when one adds in other top schools or the possession of a doctorate, this difference, as is evident in the table, still persists.[3] All of this might lead one to expect that the women would actually be in higher, or better paid positions than the men - except for the fact that they have had more discontinuities in their careers. More of the women have had periods of no employment or part-time work. Thus, the effect of these differences in background on present position and compensation probably evens out, and confirms the occupational equivalence of the male and female groups.

Orientations

More interesting, and also more relevant to the main question of this paper, is the fact that there also is similarity between the men and women in their orientations to career and to the role of work in their lives. It should be noted, however, that this similarity is different from the equivalences discussed above, since in this case there is no pairwise similarity, but only similarity in overall distribution. What this means is that orientations are not systematically related to experience, age, or present position. Table 2 gives the distributional information.

TABLE 2
Orientations

	women	men
1. career orientation[a]		
managerial ladder	34%	32%
technical ladder	32%	30%
challenging projects	32%	38%
2. work in relation to private life		
accommodative	25%	27%
balanced	49%	39%
non-accommodative	25%	33%

[a]Excludes 1 woman who wants to move up both ladders.

Both groups, when presented with the supposition that there are "no differences in status or compensation," split approximately equally among the following three preferences:

1. a career that moves up a managerial ladder
2. a career that moves up a technical ladder
3. a career that moves from one challenging project to another, but does not move up any ladder.

And, on the basis of responses to two questions asking for the relative importance of and focus of interest on work, as opposed to life outside work, somewhat under half of each group is balanced, with the rest divided approximately equally between those who accommodate their work to their private lives and those who are more non-accommodative - more concentrated primarily on their work.

These orientations, which have been shown to be important in technical careers (Bailyn, 1977; McKinnon, 1980; Allen and Katz, 1985, Epstein, 1985), do not differentiate between the men and women engineers in this sample.

Self-Confidence

But despite these overall similarities, the experience of women in engineering jobs is not the same as that of men. One major difference

lies in the expressed self-confidence of these two groups. When asked, on a 7-point scale, to rate themselves on "overall self-confidence," the women's mean is 4.8 compared to a male mean of 5.5 (matched $t=2.7$, $P<.02$).[4] This difference persists in all orientations except the managerial, where the female mean of 5.5 is essentially the same as the male mean of 5.6, a point to which I will return in a later section.

Even more telling than these mean differences, however, are the correlations of self-confidence with other self-perceptions, which are shown in Table 3. These begin to give a picture of what engineering as a career is like for these talented women.

TABLE 3
Correlations with Self-Confidence

	women	men
perceived success at work	+.26	+.50***
perceived success outside of work	+.39**	+.27
importance of opportunity to develop technical expertise	-.30*	+.31*

* $P<.05$
** $P<.01$
*** $P<.001$

The picture for the men is about what one would expect: self-confidence is strongly positively correlated with perceived success at work, and also correlates significantly with the opportunity to develop technical expertise as an important job characteristic. Not so for the women. For them, self-confidence is most strongly correlated with perceived success in their lives outside of work, and is negatively correlated with the importance attached to the opportunity to develop technical expertise.[5]

We get a picture, therefore, of these technical women as quite conflicted. The relation between their work lives and their lives outside of work seems to be complicated by the character of the work they do in a way that is not true for the men. So, for example, while there is no relation ($r=.06$) between their perceived success at work and their perceived success in the non-work part of their lives, for the men this correlation is strongly positive ($r=.42$, $P<.01$). It all fits together for the men, but not for the women, who seem to be particularly conflicted by the role of technical expertise in their careers.

Technical Expertise

When asked to indicate on a 7-point scale the importance of each of a list of 17 job characteristics, the men are somewhat more inclined than the women to consider important the "opportunity to develop technical expertise" (men: 6.0; women: 5.6; matched $t=2.0$, $P<.05$). This difference is greatest for those with a managerial orientation, where the men have a mean of 5.8, and the women only 4.8. And it is not only orientation that makes a difference, actual position does too. Women in supervisory positions or on the managerial ladder have means under 5.0 on the importance of developing technical expertise as compared to 6.0 for the men in these positions. For the women, therefore, the importance of technical expertise is significantly less if their orientation is managerial ($P<.01$) and if they are in supervisory positions ($P<.01$) or on the managerial as opposed to the technical ladder ($P<.05$).

None of these - not career orientation, not present position, not career ladder - makes the same difference for the men. What does relate to the importance of technical expertise among the men is their involvement with their work. It is the non-accommodative men - those who are

primarily focused on their work - who are most inclined to attach importance to developing technical expertise (mean=6.3); and there is a significant positive correlation between the importance of the opportunity to develop technical expertise and the importance of a heavy workload (r=.31). Neither is true for the women.

Table 4 presents the correlations between the importance attached to technical expertise and the other self-perceptions discussed above. It shows that in the minds of the men in this sample, developing technical expertise is very much a part of the successful pursuit of their careers, indeed of their lives. That it creates ambivalence for the women might not be surprising except for the fact that this is a group of women who are technically highly competent and have chosen to pursue technical careers.

TABLE 4
Correlations with Technical Expertise

	women	men
perceived success at work	-.11	+.36**
perceived success outside of work	-.07	+.25
self-confidence	-.30*	+.31*

* P<.05
** P<.01

The Ambivalence of Technical Expertise

Why should these technicaly competent women feel this ambivalence toward technical expertise? Why should their self-confidence go down as they ascribe greater importance to the opportunity to develop their technical competence?[6]

Perhaps the answer lies in the pattern of women's lives. In science, for example, investigators have identified a pervasive myth that marriage, children, and scientific work of high quality are incompatible (Bruer, 1984). And, as has already been shown, the self-confidence of these women engineers is strongly tied to their success outside of work. By placing emphasis on technical skills, therefore, these women may be undermining a deeply-held cultural premise, which could easily have negative consequences for their sense of self.[7] But if this were so, then one would expect the ambivalence about technical work to be greatest among those women who are trying to combine their work with family, and in fact we find the exact opposite. Even though those women who are married, have children, and put great store on the non-work parts of their lives report more conflict between work and other life arenas, it is not these groups, as is evident in Table 5, that seem to be the most ambivalent about technical expertise. On the contrary, it is the single women, without children, who are non-accommodative (that is, place more emphasis on work

TABLE 5
Women's Correlations between Self-Confidence and Technical Expertise Under Various Family Conditions

		correlation	amount of perceived conflict[a]
Total Group (N=51)		-.30	4.0
1.	single (N=21)	-.51	3.7
	married ((N=30)	-.14	4.2
2.	no children (N=46)	-.30	4.0
	children (N=5)	+.20	4.4
3.	non-accommodative (N=13)	-.60	3.2
	balanced (N=25)	-.08	4.3
	accommodative (N=13)	-.36	4.2

[a]Based on a question asking how often a person experiences conflict between the demands of work and life outside of work: mean on a 7-point scale with 7="always" and 1="never."

than on other aspects of their lives) who show the greatest ambivalence. It is among these groups that the correlation between self-confidence and the importance of technical expertise is most strongly negative.[8]

It seems, therefore, that one cannot look to the personal lives of these women for an understanding of their ambivalence about technical competence. Indeed, the multi-dimensional character of their lives may be protecting them against this conflict. It is of interest, for example, that the few women in this sample with children show quite a different pattern. Their self-confidence is higher (5.4 as opposed to the group mean of 4.8) and the importance they attribute to technical expertise is lower (4.6 as against a group mean of 5.6).[9] This group is also the only one in which self-confidence and the importance of technical expertise are at all positively correlated, though not to a statistically significant extent.

Let us look, rather, at the nature of the work these women do.[10] Table 6 presents the relevant data. From this table it is clear that it is primarily among those in strictly technical jobs, who are on technical ladders, and technically oriented that we find this ambivalence about technical expertise.[11] In contrast, among the women in managerial positions, with managerial orientations, on managerial ladders, though few in this sample, there is little evidence of this conflict about technical work. In fact, when we aggregate these work conditions and compare the women who are either first level engineers or computer scientists, or are on the technical ladder, or have a technical orientation with those who share none of these attributes, we get a striking difference in the correlations between self-confidence and the importance of technical expertise:

no technical attributes (N=18)	r=+.20
at least 1 technical attribute (N=33)	r=-.54.

TABLE 6
Women's Correlations between Self-Confidence and Technical Expertise Under Various Work Conditions

		correlation
Total Group (N=51)		-.30
1.[a]	first level engineer/computer analyst (N=26)	-.50
	engineer/computer analyst with some coordinating responsibilities (N=9)	-.09
	supervisor/project manager/ manager (N=8)	+.09
2.[b]	technical ladder (N=18)	-.55
	managerial ladder (N=7)	-.04
3.	technical orientation (N=16)	-.36
	managerial orientation (N=17)	-.07
	project orientation (N=17)	-.11

[a]Excludes those who are in none of these positions.
[b]Excludes those in organizations without dual ladders.

It seems, therefore, that there is something in the way that technical work is experienced by these women that accounts for their diminished self-esteem and ambivalence.[12]

Discussion

One explanation for these findings is based on a view of technical work as "gender alien" for women, and thus as "role distancing" rather than "role embracing."[13] The reason behind this might lie in basic differences between men and women (cf. Spiro, 1980; Gilligan, 1982; Rossi, 1985). Rossi, for example, summarizes these differences as follows:

> ...there is some predisposition in the female to be responsive to people and sounds, an edge in receiving, interpreting, and giving back communication. Males have an edge on finer differentiation of the physical world through better spatial visualization and physical object manipulation. The female combination of sensitivity to sound and face and rapid processing of peripheral information implies a quicker judgment of emotional nuance...

> It also suggests an easier connection between feelings and their expression in words. Spatial perception, good gross motor control, visual acuity, and a more rigid division between emotional and cognitive responsivity combine in a counterpart profile of the male (1985, p. 182).

And we see some evidence for these distinctions in our sample as well. The women engineers, for example, place more importance on being able to work with people than do the men (matched $t=2.1$, $P<.05$). These differences, therefore, which are seen by Rossi to make parenting of infants more congenial to women than to men, might make technical work more readily congruent with the predispositions of men than with those of women.[14]

A related explanation points to the fact that technical work has evolved in response to its definition and construction by men. Keller (1985) makes the argument for science, and describes a different, more "feminine" mode of doing science in her analysis of the life and work of Barbara McClintock (Keller, 1983). Her conclusion goes well beyond the possibility of making science more "comfortable" for women, and emphasizes, rather, the contribution to knowledge of a diversity of approaches:

> My vision of a gender-free science is not a juxtaposition or complementarity of male and female perspectives, nor is it the substitution of one form of parochiality for another...A healthy science is one that allows for the productive survival of diverse conceptions of mind and nature, and of correspondingly diverse strategies (1985, p. 178).

Similarly, it is the diversity of patterns in pursuing technical work that is at issue here.

And it is in the possibility for defining alternative modes of practice that there may lie an instructive difference between technical and managerial roles. It is easier to evaluate technical output than it is to gauge managerial effectiveness. Such unambiguous criteria may be particularly important for women who find themselves in an "alien" area. One female scientist in an R&D lab, for example, when asked to compare the

technical ladder with the managerial one, replied that "technical would be best for a female doing the kind of research that I am - because there is less opportunity for discrimination..." Less opportunity, one presumes, for judging output by other than accepted criteria. But also less opportunity for engaging the work in unexpected ways.

In managerial roles, in contrast, the criteria of effective performance are much more amorphous. And though such ambiguity may well make it more difficult for non-traditional employees, it may also permit them more easily to redefine the way they perform their work. And, when we turn to the more managerially oriented women, we do see some evidence of new patterns. Their self-confidence is high, hardly different from their male pairs. But they differ significantly from these male peers in that they put very little emphasis on technical expertise, whereas the men in these managerial roles still value it highly.[15] It seems, therefore, as if the women were following a different model of managing technical work than the one we have come to expect. Is it a useful model? An example may help throw light on this question.

Elsbeth Monroe is a divisional manager in the central R&D lab of a large successful electronics company. As part of a study of a number of such labs (see Bailyn, 1985), I interviewed her and other managers and professionals in great detail. Mrs. Monroe (the mother of 2 small children) is thought of very highly by the top management of the lab. She started her career, after a PhD in Physics, as an "engineer on the bench," became a group leader after about 3 years, then a department head, and now a manager of a division. The time between PhD and division manager was about 10 years. She says of herself that she "runs the group and nurtures the people." And those who report to her respond with great enthusiasm: it was in her division that I found one of the most successful and

satisfied groups in my sample, including senior scientists and supervisors who were working well with each other and dividing tasks and responsibilities in innovative ways. The research lab, I was told, "needs people like her who can turn research ideas into practicalities, even if they are not high-powered scientists." Quite a contrast with her boss, who was highly respected as brilliant, but was seen as an interfering and non-supportive manager. As his frustrated chief engineer remarked: "you don't keep a dog and bark yourself."

It now seems that Dr. Monroe is not an idiosyncratic example. Like the women managers in this sample, she represents a model of technical management less tightly linked to the imperative that technical management require top technical expertise. We have come to assume the necessity of this link on the basis of research on current practice. But the employees we have studied have been predominantly male, and we may have mistakenly generalized our findings universally from this part of the population.

Take, for example, a recent Special Issue on Managing Technical Professionals in the IEEE Transactions on Engineering Management[16] whose purpose is "to provide a research-based framework...on the variables critical to the effective management of engineers, scientists, and other technical professionals in organizations...and...to effectively communicate relevant scholarly research findings...to the practitioners of engineering and R&D management" (p.1). Six of the articles in this interesting issue report empirical research. They are based on a variety of methods: participant observation, cross-cultural field studies, detailed interviews, structured questionnaires, and a simulated decision-making exercise. Presumably, most of the respondents in these studies were male, but this fact is mentioned only once ("nearly all of the participants were males" [Stahl, et al., 1984, p.26]), in passing, with no

further comment. And this despite the use of "his/her" in the text and the almost routine presentation of demographic information such as age and education.

That there are few, or no women in these samples is, of course, not surprising, though even those few, when looked at separately, may provide suggestive contrasts to male patterns.[17] But it is just because the usual number of women in any population of technical professionals is so small, that the distinctively matched sample in this study is so interesting. The women are similar to the men in so many respects, and yet there are these vital differences in self-image, differences that not only reflect dilemmas in women's lives, but may also detract from the best utilization of their talents. If, however, we look at these findings from the perspective of the organization rather than the individual, we may see them as pointing toward new models, perhaps more adaptive to current needs. From this point of view, the results in this paper would suggest that organizations might benefit by rethinking the assumptions on which their current procedures are based. For if they do not, they run the risk of making current practice dysfunctional not only for women but also for men in new life patterns. It is suggestive, for example, that the only group of men who show the same ambivalence about technical expertise as the women do, are those few (N=9) whose wives are also engineers or scientists.[18]

The issues, thus, are broader than the problems of women's careers in technology. The findings in this study should alert us generally to dangers and possibilities of organizational practice, and suggest ways to diversify these procedures. And, as I have tried to indicate elsewhere (Bailyn, 1984), such modifications would benefit everyone: men as well as women.

NOTES

1. Deaux (1984) in a summary article on research on gender comments that, in general, there are few external differences between men and women in the same occupational groups. The point is corroborated for management by Etzion (1984) and Wallace (1985).

2. See, e.g., the 1985 Electronic Engineering Times annual salary survey, Part 2. Electronic Engineering Times, June 24, 1985, 102-104; the Profile of IEEE women members: Their salaries, demographics, attitudes toward the workplace, and professional status. IEEE Catalog No. UH0160-2, 1984; and Jagacinski and LeBold (1981).

3. Even though women had more graduate degrees than men (49% vs. 39%), only 4 of the women, as opposed to 8 of the men had PhDs.

4. This difference corroborates findings of two recent studies of M.I.T. students: a 1981 study of undergraduates (see Slaughter, 1982) and a survey of graduate students undertaken in 1985 (see Dresselhaus, 1985).

5. Further, while salary is not significantly related to any of these self-perceptions for males, it is significantly correlated with self-confidence ($r=.38$, $P<.01$) and with perceived success at work ($r=.43$, $P<.01$) for the women, which may signify their reliance on external signs of success.

6. Cf. Slaughter (1982), who reports that women seniors at M.I.T. have less self-confidence than do entering women, whereas among men, the self-confidence of the seniors is higher than that of the freshmen. Further, she finds that self-confidence is negatively correlated with high grades for women, but not for men.

7. What evidence there is, in science, does not support the notion that family involvement reduces or interferes with women's scientific productivity, despite the prevalence of the belief that it does (Bruer, 1984). There is some evidence, however, from research on women in management, that success in a managerial career extracts a personal cost (cf. Etzion, 1984; Wallace, 1985).

8. When one puts these factors together, one finds that those women who are single, without children, and NOT accommodative in orientation (N=13) have a correlation between self-confidence and the importance of technical expertise of -.49.

9. These means are similar to those of the managerial women given in a previous section. But only 3 of the 5 women with children have a managerial orientation (2 have a technical orientation), none is in a supervisory position, and only 1 is on a managerial ladder.

10. This is the same conclusion that was reported by Bruer (1984) who suggests that one must seek the solution for women in science by looking at factors internal to science, not external.

11. As in the case of children, the other personal categories are also independent of the work categories. The only exception is among the single women who, when functioning as independent contributors, are more likely to be in first level positions than is true for their married counterparts. In the case of accommodation, in fact, there is a contradictory trend: non-accommodative women are more likely to be managerial, and accommodative ones are more likely to be technical.

12. It should be added, further, as the following figures show, that the effect of these technical attributes overshadows that of the personal ones:

correlation between self-confidence and the importance of technical expertise

	not in first level position, not on technical ladder, not technically oriented	at least one technical attribute
single, no children, not accommodative	r=+.21 (N=4)	r=-.49 (N=9)
at least one family/ non-work attribute	r=+.29 (N=14)	r=-.60 (N=24)

13. The terms "role distance" and "role embracement" stem from LaRossa and LaRossa (1981), as quoted and used by Rossi (1985, p. 183).

14. It is possible, also, that there is a developmental effect here. Keller (1981), for example, found that "the [undergraduate] women who are happiest at M.I.T. are those who are least identified with traditionally female values - especially those who define the center of their emotional life in the realm of thought rather than feeling" (p. 18). In contrast, the findings on the older sample in this study show that women with a dominant thinking mode had greater ambivalence (r=-.38) than did those whose dominant mode was feeling (r=-.07). This distinction is based on a modified version of the Myers-Briggs Type Indicator of Jungian Personality Types which was included in the questionnaire. The thinking-feeling dimension has been shown in previous work to be relevant to occupational distinctions (cf. Garden, 1985).

15.

	females		males	
	self-confidence	importance of technical expertise	self-confidence	importance of technical expertise
1. first level engineer	4.8	5.8	5.1	6.2
supervisor/ manager	5.0	4.9	5.5	6.0
2. technical ladder	4.8	5.8	5.6	6.1
managerial ladder	5.6	4.6	5.7	6.0
3. technical orientation	4.6	6.4	5.1	6.3
managerial orientation	5.5	4.8	5.6	5.8

16. M.K. Badawy, guest editor. Special Issue on Managing Technical Professionals. IEEE Transactions on Engineering Management, vol. EM-31, no. 1, February 1984.

17. See, for example, The Women Graduates, chapter 6 in Bailyn (1980).

18. The correlation between self-confidence and the importance attached to technical expertise for these men is -.41.

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