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Making the Transition from Engineering Student to Practicing Professional: A Profile of Two Women*

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This paper presents follow-up interviews conducted with two women engineers who took part in a qualitative study by the author on gender and collaboration in an engineering classroom six years earlier. The women compare their student experiences with their emerging professional lives to highlight the barriers they have overcome as well as the obstacles remaining in this traditionally male-dominated profession. Pedagogical implications are drawn and the value of incorporating engineering work experience into the curriculum for women students in particular, is highlighted.

INTRODUCTION

FROM 1997 to 1999, I undertook an in-depth qualitative study of three student teams as they made their way through the collaborative writing process in a Canadian faculty of engineering technical communication course. In this study, I focused primarily on face-to-face interactions among student teams as they participated in the various writing and collaborative processes leading up to the submission of a final written report for the course. Three ethnographic techniques were used to obtain data: in-class observations of team meetings, semi-structured interviews with teams and individual students, and document analysis of students' course-related submissions. Through audio-taped recordings, the study was partially able to follow student teams outside of class as they conducted additional meetings necessary for the planning and coordination of the project. The goal of the study was to explore the collaborative process in detail and gain a greater sense of how student teams work to accomplish their goals. While verbal communication patterns formed the basis for analyzing most of the interactive behavior among students, non-verbal patterns were also documented.

The study revealed several key findings ranging in applicability from engineering student teams specifically to broader team-based situations in the classroom and industry. Firstly, my findings indicate that on mostly-male teams, which is a common occurrence in engineering schools, traditional gender-linked behaviors can be seen on the part of both men and women alike. In two of the teams studied, women were the lone members of their groups, working with three other male colleagues. In the collaborative situations that emerged, these women displayed what have been referred to as traditionally feminine interactional styles. That is, they were frequently tentative, accommodating, apologetic and, occasionally, even self-deprecatory in communicating with their male team mates [1]. In their interviews with me, they conveyed an awareness that these behaviors could prove problematic in the future, given the male-dominated structure of the engineering profession.

In what follows, I provide an update on the career paths of these two women six years after the study to gain an understanding of the barriers they have overcome in what is still a traditionally male-dominated profession and the obstacles that remain. I interviewed Melissa and Carol, who are now graduate engineers working towards their professional licensure with the hopes of gaining some additional insights into the engineering education curriculum and what improvements, if any, can be made to make this structure more inclusive to women.

CONTEXT TO THE INTERVIEWS

First, it may be helpful to provide some context on the educational institution in which these women graduated from. The University of Manitoba, located in Winnipeg, Canada is the only engineering degree-granting institution in the province. At the time of the study in 1997, the enrollment of women students peaked at 22%. A similar trend was detected among many Canadian universities in the late 1990s. Since that time however, enrollments have dropped and in the 2002–03 academic year, women were 16% of the total engineering student population at the

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University of Manitoba. Furthermore, their representation in the department of computer engineering, which holds promise for some of the most challenging and highly paid engineering work remains consistently low at approximately 8%. At the national level, while women are better represented in the profession than ever before, in 2002 they made up only 9% of overall membership, increasing a mere 2% since 1997. They are more strongly represented in such fields as environmental and chemical engineering than they are in the mining, electrical, mechanical and metallurgical fields [2]. While the engineering profession holds significant promise of offering career opportunities to Canadian women that did not exist until the last few decades, on the basis of these trends, it is legitimate to ask how well the engineering promise to women has been fulfilled.

One of the more significant findings from the 1997 study was the evidence it uncovered of interactional behavior that may be regarded as traditionally gender-linked, and the relationship between this behavior and the structure of the teams in which it was observed. For example, on both the male-dominated teams studied, Carol and Melissa (pseudonyms) were accommodating and tentative in many of their interactions with male colleagues. Carol, despite her role as team leader, went to great lengths to avoid conflict, even if it meant she had to assume additional responsibilities to do so. Similarly, Melissa's interactional displays with her team revealed a struggle with self-confidence and a tendency towards putting herself down in front of her male teammates.

Although neither of these women were shut out interactionally or made to feel uncomfortable by their colleagues, there is some indication that they were subjected to a 'culture of engineering,' as identified by McIlwee and Robinson [3]. This culture refers to a subtle force that permeates many engineering interactions and activities, and for men helps to reinforce their competence and sense of ownership in the profession. Carol's experience of listening to sexually explicit and demeaning jokes from her teammates as well as the displays of technical knowledge and self-confidence on the part of Melissa's colleagues may be illustrative of this culture [4]. Six years later, I was curious to learn how these women, now practicing professionals, had adapted to the culture of engineering.

THE INTERVIEWS

Melissa

At the time of the study, Melissa was eighteen and had just entered her first year of university, having graduated from a rural high school in the province. In a writing assignment administered at the beginning of the technical communication course, Melissa gave these reasons for choosing engineering as a field of study, providing an early indication of her level of sensitivity and compassion:

> Being raised on a farm, my parents stressed the value of a good education. My parents' attitude gave me the confidence to enter engineering. The world is fast-paced and ever-changing. Somehow, engineers keep up. In a world of pollution, racism, war and unemployment I want to keep up. I want to solve problems, help people and triumph over the odds. My reasons for entering engineering are more numerous than this, but these are the most important—my family and helping others [1:59].

These reasons are consistent with much of the literature which reveals a desire on the part of many young women who choose engineering to make a difference in the world and contribute to society, as opposed to their male counterparts who are attracted to engineering as a subject matter, in and of itself. Melissa's rationale was noticeably different from her male team mates, who at the time of the study, cited such factors as having achieved success in science-based courses, possessing problem-solving abilities and showing an inclination for tinkering with machinery. While her farm background had helped to familiarize Melissa with the tinkering process, she admitted that 'fixing things wasn't my strong point. I'd rather avoid it.'

She also differed from her male colleagues in terms of level of confidence in completing the engineering program. Interviewed towards the end of her first term, she expressed some concern as to whether she would be able to continue because, as she explained, her marks 'were not as high as they could be, because [engineering is] really difficult.' To pursue her developing interest in agricultural engineering, she was even considering transferring into agriculture 'depending on if I fail or not'. This low estimation of her own ability stood in marked contrast to her three teammates, who, when they were interviewed, expressed considerably more confidence in their academic performance, which they saw as consistently high. Melissa's concerns turned out to be unfounded, when in the 1997–98 academic year she maintained a solid B average and even received an A in her matrices course. While the most vocal of her male colleagues, David, despite his confidence in his own ability, achieved a lower grade-point average than his three teammates.

Melissa's behavior in the team meetings observed pointed to a shy, timid and soft-spoken individual, so soft-spoken in fact, that some of her contributions were not picked up on tape. Her quiet nature perhaps made the role of recording secretary on the team an obvious choice for her, as she herself admitted in the interview. Her quietness, though evident throughout the project from the early brainstorming phases to the final editing phase, was most noticeable in her lack of contributions to the team's technical discussions where the team tried to narrow the focus of their topic, which was the viability of a magnetic levitation system

for mass transit use in Canadian climates. She would occasionally ask a question, mostly for clarification purposes, but she was not an active participant in discussions having an engineering or technical focus. When asked in the interview about a possible explanation, she referred once again to her timid nature, which stood in contrast to the more assertive approach of her teammates:

> I'm a fairly timid person, so I don't really want to just shove into a conversation and say, 'shut up everybody else, this is what I want to say here'. A lot of the time it seemed like David and them 'were a lot louder and more forceful than I am. So I didn't feel right in speaking up. And I didn't want to interrupt when they were talking [1:6].

For all her quietness, Melissa's level of participation did increase over time as the term progressed. She was present for all meetings, even towards the end of term when she developed a serious throat infection. Her illness would have allowed the team to postpone their final oral report, but Melissa insisted on going Ahead, unwilling to 'let the team down' by extending their workload. Her doing so meant that she had to use a microphone for the presentation, just to be heard. Finally, she received a mark of A on her peer evaluations in which her teammates spoke highly of her and used such phrases as 'dedicated', 'motivated' and 'serious about her work' to describe her attitude.

Melissa went on to pursue a major in biosystems engineering and completed her degree through a cooperative program, which gives students two eight-month paid work terms in industry towards the latter phase of their studies. This lengthened her program slightly, and she graduated in December 2002 with a 'degree of distinction' meaning she achieved a cumulative grade point average of 3.8 or higher. Now, at 24 years of age, she works for a process control company in Winnipeg, and is an engineer in training. The provincial licensing body requires engineers to complete four years of supervised work experience before becoming eligible to practice as professional engineers.

When I asked Melissa to re-read the profile I had generated on her six years earlier, she focussed primarily on the issue of confidence and how this has evolved, largely as a result of the cooperative program she enrolled in and her work experience since:

> I was extremely shy, very quiet and very nervous. But I knew that I could do anything I wanted to, if I put my mind to it . . . Through co-op, I originally worked for the company that my company is now doing work for. There was me and my boss in the engineering department. I got very broad experience from that. I was doing a lot of different stuff. I got to know the people doing the control systems through that. I did the design. You gain so much, doing, and knowing that you can do it. Then, the control systems company hired me a couple of years later and now we're providing the instrumentation and control strategy for that former company's new facility . . . I think its really terrible when people graduate and have no experience. My work just hired a guy, an electrical engineer, who graduated in May, and he's never had a real job, and its just frightening the things that he doesn't know . . . scary.

Melissa points to the role of the smaller biosystems department in the faculty, and its more broader-based discipline in encouraging her further and boosting her self-confidence in engineering:

> After first year, I went into biosystems, and biosystems classes are usually very, very small; you knew everybody. They help each other out. It's environmental stuff, and it's a softer side of engineering. It's not like electrical engineering, where its all numbers all the time. The other classes were so large, you didn't know anybody. That's kind of unfortunate in a class of 200. Interviewer: What is it that happens, when you have large classes? I think you just blend into the crowd, and whether or not you do well, matters to you and only you. That's kind of how it should be, but kind of—if you don't want to do well, you don't have to do well. If you have questions—I know a lot of people, myself included, you don't want to interrupt the class when there are 200 people there. And I know a lot of people who feel that way.

With her preference for smaller, more cooperative learning environments, it was not surprising that when I remarked on the sense of competition so well engrained in the culture of engineering, and engineering school, Melissa had this to say:

> I know. Going back to first year engineering orientation, they counted everyone in Room 229, and they said 'look to your left, look to your right, only one of you will be here next year.' That's the wrong image to present, the wrong approach. I was here to learn. I wasn't here to learn more than anyone else . . . to learn what I could learn. That's the bad thing about engineering. People think that way.

Her reference to the 'weeding out system' which has historically characterized the engineering and science curriculum and was designed to eliminate unwanted numbers of prospective students has been described by many theorists as a social practice that works against women's values and contributes to feelings of rejection, discouragement and lowered self-confidence [5–8].

Melissa believes this emphasis on competition is misplaced particularly in the work environment where teamwork and working towards a collective goal become critical. And it is here too, where she argues the non-technical, people skills come heavily into play:

> The one guy at work, he's so smart, it blows you away how smart he is, but he's not allowed to be in meetings any more, because he just cannot communicate. I think communication is huge. The math or science everyone focuses on, but anyone can learn that. It's the communication that's important.

In summary, while still soft-spoken in her demeanor, Melissa has clearly evolved from the quiet, insecure individual who came into engineering six years earlier. She now supervises three staff members in the process control company she

works for and currently spends much of her time writing detailed designs and specifications. When I asked if she faced any obstacles on the job relating to gender, she downplayed the role of discrimination against women engineers by male colleagues and supervisors, but did point to one employee group who still holds entrenched attitudes towards women:

> I know of some places where people have done co-op, they won't take a woman, because you have to deal with people out in field situations, the work crews. Where it's just all the guys are not well educated. A little bit crude. You're supposed to be a big, burly man. . . be able to boss people around. They don't feel we can handle it, they wouldn't feel right putting a woman in that situation. Even in my work, they freely admit, they'd rather not send me to certain clients, just because they don't think it would be fair to me. The one client that we have, one of the workers there, threw a computer at one of the guys from our office 'cause the computer wasn't working.' And they are like 'maybe we shouldn't send Melissa there'.

Carol

At the beginning of the 1997 study, Carol had just completed two years towards a chemistry degree prior to entering the faculty of engineering. Although she had always wanted a science-based career, she had been advised that the job prospects for engineering graduates were far better than for chemistry majors. Also, her boyfriend at the time was studying civil engineering and she was intrigued by his work. Thus, her choice to study engineering stemmed more from outside influences than from a persistent attraction to it as a discipline. This supports much of the literature on gender and engineering which makes a distinction between the extrinsic sources that motivate many women to study it as opposed to men's seemingly more natural gravitation towards it.

Originally from a small town in Manitoba, Carol returned home for weekends during the academic year and worked at her parents' grocery store. In Winnipeg, she lived alone and worked approximately eight hours a week at the copy center located on campus. Thus, in addition to maintaining a full course load, Carol had the responsibility of two part-time jobs.

The first meeting in which I met participants in 1997 to discuss procedures for the study provided an early indication of her sense of responsibility and time management. When attendance at the meeting was low, consisting only of herself and Mike, another member of the research team, Carol commented out loud. She said that she had entered the meeting in her daybook and didn't understand why the other three team members were unable to attend. She expressed some concern, hoping this wasn't an indication of the team's level of commitment to the technical communication course. As soon became apparent, her early sentiments about the team's level of commitment proved to be largely accurate.

Carol's grades for her first year in engineering further reflected her work ethic and organizational skills. For the 1997–98 year, she maintained a consistent B average, which stood in marked contrast to her three teammates, two of whom were not taking full course loads and did not have part-time jobs. Randy and Steven both had grades so low that they were required to withdraw from engineering, with the option of repeating their first year on probation. The third student, Mike, was able to maintain a C average and was eligible to continue, but he was placed on probation, his continuance dependent on his bringing up his grade-point average.

Carol took on the key position of team leader for her group in the technical communication course, and was responsible for certain tasks such as drafting agendas, arranging and chairing meetings, as well as ensuring that final report specifications, including format and layout, were correct. Soon, however, Carol's assertiveness and ability to provide leadership and direction to many team meetings became overshadowed by her willingness to take on tasks that should have been the responsibility of her less than motivated colleagues. She was often apologetic to her team, especially for any action she deemed necessary to take and she frequently used humor as a way to dispel emerging conflict. In this excerpt from a team meeting in which she chairs, Carol is in the midst of dealing with the fact that other team members have not completed their parts of the team proposal or addressed some of the major issues related to a course assignment:

> I wouldn't have started it but it was really like, I don't mean to seem bitchy or bossy. I was just getting really freaked out last night 'cause I was looking, and I've got to study for Calculus, and I have to do this and have to do that. Then I started playing with markers. I went to use this marker to highlight things, and I realized they had smiley faces and footprints and stars. It was like my god, I'm twenty and my mom gave it to me for my birthday! Yeah, my mom got me markers for my birthday! And I'm like, thanks Mom [laughter] [1:38].

Carol pursued her degree in civil engineering and graduated in 2001. She is now an engineer in training with one of the largest engineering employers in the province, a major utility which offers highly competitive salaries and employee benefits. When I asked her to review the 1997 research data from her team, similar to Melissa, Carol focussed on the evolution of her self-confidence since that time, and attributes much of that growth to experience in the engineering workplace:

> I look at myself when I first started engineering, compared to the person that I am now, and I joke with my workmates that they wouldn't even recognize me. They wouldn't know who I was when I started engineering. And I can't imagine how, if I was still the same person that I was when I started engineering I would even function in a working situation. I didn't want to rock the boat. I didn't want to say anything

> bad. I didn't want anyone to call me a bitch. Now, I could care less. If that's the way it is, that's fine. What I've learned is that I'm confident in what I'm doing, and I don't need to back down. I don't need to worry about hurting someone else's feelings. I think it's being able to separate the two. If I tell somebody the way that a job at work has to go, they're not going to attack you personally, and if they do then that's their problem, it's not mine.

Similar to Melissa, Carol had little patience for the competitive spirit that permeated much of her undergraduate engineering experiences:

> I remember my thermodynamics prof. saying, 'You're the best of the best, you're the brightest of the brightest, there's no one smarter than you people. Engineers are the best.' And I just remember thinking, what's wrong with you? . . . I did find that some parts of engineering really tried to pump you up, as in 'engineers rule the world' kind of thing. And I just would shy away from it because I think that's such a load of crap . . . I don't know if I avoided telling people I was an engineer. It wasn't because I was embarrassed to say I was in engineering, from the nerdy standpoint. It was the attitude and the ego and the cockiness that went with it that I really just wasn't up for.

Unlike Melissa, Carol did not complete a cooperative program with industry, but she did gain early experience with her current employer through three consecutive summer work terms beginning in 1998. The job involved physical labor and like Melissa, Carol also encountered some entrenched attitudes about the suitability of women for such work. Both of these accounts echo Bagilhole, Dainty and Neales' study on the experience of women engineers on British construction sites [9]. Carol recounts:

> It was physical labor. Throwing 80 pound coils of wire around, and pounding things into the ground with sledge hammers, and riding around covered in dirt with a bunch of guys. When I sat down for the interview he says, 'Well, this really isn't a job for a girl.' That was the first thing out of his mouth. I said 'Okay, why isn't it a job for a girl?' 'Well, there's lots of heavy lifting and carrying' and I said, 'You know I can do that.' He said, 'Well I know you're determined, but it isn't a job for a girl.' I remember carrying a coil of wire across the yard, walking with my boss who had hired me, who didn't think I could do the work, and somebody came up and looked at him, and said, 'I cannot believe you are making her carry that.' And he said, 'I asked her, she won't let me carry it.' And by the end of the summer he had said to my dad that he was so happy he had hired me. And he was *so* shocked.

Carol did this job for two summers and by the third summer she had moved on to do shoreline inspections along the riverbanks for the utility. She describes it as a progression of increasingly more decision-making and responsibility. Then, by her graduating year, the utility considered her automatically eligible to be interviewed for permanent work because of her prior summer work experience. The company also places engineers-in-training on a two-year program of rotations, so they can gain experience in different areas of the utility. The rotations last for 6 months and if at any point during the rotation, a permanent job is posted that an employee is interested in, they can apply for it. Her first six months was as construction inspector, where once again she had to prove herself to men in the field:

> Basically, I'd chase contractors around and make sure they were doing a good job, following the drawings that I had, which was interesting. I was faced with situations where I had to kick a few people off job sites. It was a position where I had to learn some confidence because that was something I'd never seen before. Sure, I'd looked at examples in textbooks, but I'd never actually seen it. I remember the first day I told him [the contractor] 'to dig till they hit clay,' and I had no idea what clay looked like . . . I had to pretend that I had confidence even if I wasn't sure. One contractor would just not listen to me. It was very frustrating. They built the road completely wrong and I kept telling them the whole time 'You're not doing it right, stop, stop!' and they wouldn't. When they were done, and I said 'You didn't do it right, you have to do it again', they couldn't believe that, and they phoned my boss, and said 'This girl doesn't know what she's talking about.'

Carol's reference to 'pretending you have confidence even when you're not sure' is consistent with the notion of impression management, something that male engineers cultivate as part of their professional socialization. Impression management is embedded in McIlwee and Robinson's concept of the culture of engineering [3]:

> Organizations, at least in part, are constituted by relationships between people. Individuals who can manage these relationships well—who are able to impress others with their abilities and talents—are in possession of a resource every bit as valuable as an academic degree or technical expertise [16].

In this sense, men's more aggressive style of self-presentation and self-confidence may be seen as part of a set of interactional resources they bring to the engineering field, largely through a gender-role socialization that emphasizes hands-on competence. While she may have had to work harder than her male engineering colleagues to establish her authority on the job, Carol's self-confidence has clearly evolved to a point to where she now makes some men feel uncomfortable:

> When I broke up with my boyfriend of three years, the one who got me into engineering, he said 'I don't know you anymore, you've changed so much.' And I'm like 'have I?' He said to me 'You're scary. You are a confident, smart woman who knows exactly what she wants, I'm scared of you.' A lot of guys are. A good male friend, who is also an engineer, has said 'I want to date dumb girls, they're not intimidating.' There's never any question who's smarter there.

After her first six month rotation with the utility, Carol moved into a job in the gas distribution, planning and design area. A permanent position opened up in the department, which she applied for and got. Her work now focuses on system improvements, capital upgrade projects and relocation. She does design and planning work which her supervisor

still seals until her formal training period finishes in two years. Nonetheless, she is assuming increasing responsibility, such as supervising a summer student. Prior to the follow-up interview, she had just returned from Chicago where she was on an intensive two-week course on gas distribution engineering. While there, she learned aspects of pipe design, how to pick locations for pipe installations and network modeling software which her department office had purchased, but didn't know how to use.

The utility has a built-in mentorship program in which engineers-in-training are matched with experienced engineers who are available for questions and consultation. Carol appears to have gained more however, in terms of mentorship from her own supervisor, who is only five years older than her:

> It's a great relationship. It's a very open relationship. I can go into his office, and if I don't like something I can close the door and I can vent. He just asks 'Well, what's the matter, what are you mad at me about?' Usually it is not that. I'm not mad at him; I'm upset about things. I don't think we've ever had a disagreement. My boss tells me he's trying to groom me into a mini-me. Its an on-going joke and it makes me laugh, because I see myself becoming more and more like my boss in my writing skills and the way that I approach people. He's very good. He's probably been the best mentor I could have had.

From McIlwee and Robinson's perspective, Carol is well situated in terms of her future engineering career. They argue that women's mobility in engineering is greater in larger workplaces that typically have in place programs and policies to protect under-represented groups in society than is the case in smaller, consulting firms more influenced by the culture of engineering. McIlwee and Robinson maintain that due to the increasing levels of bureaucracy in larger engineering workplaces such as state utilities, and federally funded aerospace companies, the work culture is less dominated by engineers and more management-driven, with an emphasis on clear rules for advancement [3].

SUMMARY

In their 1993 study, Robinson and Reilly surveyed women engineers in the US and found that self-confidence was ranked as the most important element for professional success and advancement [10]. However, as much of the literature on gender and engineering suggests, self-confidence is a more fragile construct for many women compared to men, even when their academic performance is demonstrably higher. Data from my earlier study support the assertions made by Tonso, namely that a lone woman working on a team does face certain disadvantages [11]. For the male-dominated teams in my study, gender-linked behaviors were displayed on the part of both men and women alike. The ramifications for women however are much greater in the engineering field, and potentially more harmful. Thus, the practice of assigning lone women to student teams especially in the early part of their programs should be discouraged. Without a doubt, a continued need exists to encourage women to assert themselves in productive ways and for men to work cooperatively.

The follow-up interviews conducted with Melissa and Carol six years after my initial contact with them reveals an evolution in self-confidence that appears to be directly related to work experience gained during their undergraduate engineering program. Thus, this article recommends that engineering schools continue to make a concerted effort towards promoting cooperative, intern and/or summer work experience for engineering students in general, with a specific emphasis on women students. These interviews also touched on the competitive ethos that permeates engineering schools and the culture of engineering in general, and that this spirit is not one which necessarily meshes with women's experiences. In an effort to be more inclusive, engineering schools where possible, should consider downplaying some of the more explicit, and potentially offensive competitive language and practices. Finally, these interviews point to discriminatory behavior in the workplace, not from engineers or other professionals but from senior employees in the skilled trades who work with engineers. Introducing a course in the undergraduate curriculum or in early professional practice on how to deal with the trade occupations, with a specific component devoted to entrenched attitudes towards the role of women in society may go a long way towards improving future work relations and opening up career opportunities for women engineers.

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