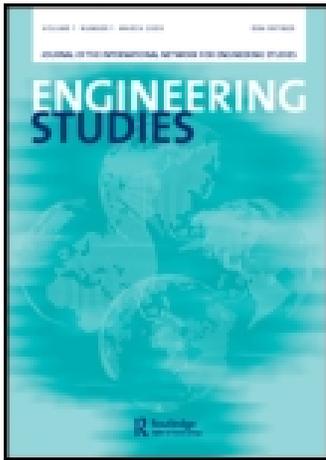


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‘Yes, I do belong’: the women who stay in engineering

Mary Ayre^a, Julie Mills^a & Judith Gill^b

^a Natural and Built Environment, University of South Australia, Mawson Lakes Campus, Mawson Lakes, Adelaide 5095, Australia

^b Education, University of South Australia, Adelaide 5095, Australia
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‘Yes, I do belong’: the women who stay in engineering

Mary Ayre^{a*}, Julie Mills^a and Judith Gill^b

^aNatural and Built Environment, University of South Australia, Mawson Lakes Campus, Mawson Lakes, Adelaide 5095, Australia; ^bEducation, University of South Australia, Adelaide 5095, Australia

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Despite considerable work to encourage girls and women to enter the profession, engineering continues to be heavily male dominated, a situation which has implications for quality and gender equity. The gender disparity is accentuated by women being more likely to leave the profession than men. A number of studies have investigated why women leave engineering. This study focuses on the converse question, ‘What makes some women stay when many others leave?’ A survey of a cohort of Australian female civil engineers found an unusually high retention rate. Interviews with volunteers from the group revealed that they had all entered the profession strongly believing in themselves as engineers, a belief that had endured despite the difficulties they encountered. As found in other studies, many of these women had experienced being isolated, overlooked and marginalised in the prevailing masculine culture of engineering workplaces. Their persistence in the profession appeared to be connected to steps they had taken to ensure that their work environment matched their expectations of interesting, challenging and enjoyable work in a supportive and inclusive culture. The implications of their experiences for other women engineers and for engineering managers are suggested.

Keywords: women in engineering; minority; workplace culture; commitment; persistence; family friendly

Introduction

In many economies, including major western ones such as the USA, UK and Australia, less than 13% of professional engineers are women.¹ For the last 40 years, there have been many initiatives to attract more women into engineering but, partly as a result of reductions in government funding in straitened economies, the number of schemes and their related success have plateaued since the mid-1990s. At about the same time research began to appear showing that women were more likely to leave the profession than men,² a trend which is still continuing.³

Women’s attrition from the profession reduces any gain from increased recruitment. Furthermore, the fact that they are more likely to leave than men strongly suggests that women are less satisfied in the engineering workplace than their male colleagues. Over the last 20 years, many studies have identified barriers to women’s progress and retention

*Corresponding author. Email: mary.ayre@mymail.unisa.edu.au

¹NSF, *Women, Minorities, and Persons with Disabilities*; WISE, *Statistics Summary*, 2; Kaspura, *Engineers Australia Survey*, 1.

²Preston, ‘Why Have All the Women Gone?’; CAWMSET, *Land of Plenty*.

³APESMA, *Women in the Professions*; Hunt, *Why do Women Leave Science and Engineering?*; Fouad and Singh, *Stemming the Tide*; Kaspura, *Engineers Australia Survey*, 8–9.

in professional engineering, for example, the gender pay gap, the heavily masculinised workplace culture and related difficulties in the management of childcare.⁴ In Australia, a series of studies of workplace culture in the engineering profession over the last 13 years has revealed features of its male-dominated context which lead to the discomfort and disillusionment of women engineers.⁵ In these conditions of unfulfilled expectations, women's decisions to leave appear hardly surprising. Yet many women do stay and thrive in the engineering profession. The focus of this study is on women who stay – why they do and what they do that explains their persistence.

Theoretical framework

Women's persistence in the engineering workforce

Much of the research on women in the engineering workforce has identified the ways in which the masculine culture of engineering tends to undervalue and marginalise women.⁶ Consciously or unconsciously, women engineers have to counter these damaging attitudes in addition to responding to the challenges everyone faces to succeed in a chosen career. Some recent studies have used conceptual or theoretical models to demonstrate direct links between the fulfilment of women engineers' expectations of career satisfaction and commitment, and their persistence in the profession.⁷

These models propose that persistence is related to an individual's personality characteristics as seen in attitudes, behaviours and aspirations, and also to workplace culture. In all the models, the individual and cultural contributing factors are mediated by the woman's experience in the engineering work environment, resulting in varying degrees of persistence in the workforce⁸ or 'career commitment'.⁹

Buse surveyed 630 degree-qualified men and women engineers, most but not all currently employed in an engineering role.¹⁰ She found that the women who had persisted in engineering displayed self-efficacy and confidence, and had been able to negotiate their way through difficult situations to their personal advantage.

In Buse's model, there are five contributors to persistence: four are characteristics or qualities of the individual engineer: self-efficacy, optimism, hope and identity. These 'individual' contributors are mediated by the 'ideal self', '...composed of an image of a desired future, hope and one's core identity',¹¹ which, 'predict[s] career commitment for women in engineering'.¹² The fifth contributor to persistence in this model is 'relational culture',

⁴Bagilhole et al., *Researching Cultures*; Hunt, *Why Do Women Leave Science and Engineering?*; Fouad and Singh, *Stemming the Tide*.

⁵Roberts and Ayre, *Counting the Losses*; Mills et al., "Engineering in Australia"; Mills et al., *CREW Revisited in 2007*; Kaspura, *Engineers Australia Survey*.

⁶Faulkner, "Doing Gender in Engineering Workplace Cultures. I"; Faulkner, "Doing Gender in Engineering Workplace Cultures. II"; Hewlett et al., *The Athena Factor*, 7–25; Buse, *Ideal Selves*, 20, 27; Watts, "Allowed into a Man's World," 49; Fouad and Singh, *Stemming the Tide*, 55.

⁷Buse, "Individual Factors Predicting Career Commitment"; Cech et al., "Professional Role Confidence"; Hughes, "Are the Predictors of Women's Persistence in STEM Painting the Full Picture?"; Plett et al., "Engineering Identity and the Workplace Persistence".

⁸Cech et al., "Professional Role Confidence," 643; Plett et al., "Engineering Identity and the Workplace Persistence," 14.

⁹Buse, "Individual Factors Predicting Career Commitment," 13.

¹⁰Buse, "Individual Factors Predicting Career Commitment".

¹¹Ibid., 4.

¹²Ibid., 15.

in acknowledgement of findings that the culture of engineering is gendered,¹³ macho and hostile.¹⁴

The model shows two outcomes from all these contributors: ‘career commitment’ and ‘engagement’, the latter defined by Buse as ‘the simultaneous employment and expression of a person’s preferred self in task behaviors that promote connections to work and to others’.¹⁵ Both of these outcomes result in persistence. Hence, Buse finds that persistence depends on both individual personality and engineering culture.

In another quantitative study, Cech et al.¹⁶ explored gender differences in persistence in engineering of 288 undergraduates (125 women and 163 men) at four American universities. Although a study of students’ persistence, the work is of interest here because the students were asked whether they believed that they will be working as an engineer in five years’ time.

In Cech et al.’s model, family plans, self-assessment and ‘professional role confidence’ are all contributors to persistence. ‘Professional role confidence’, comprising ‘expertise confidence’, that is ‘. . . confidence in tasks and competencies required of this kind of professional’,¹⁷ and ‘career fit confidence’, including ‘professional socialization’, are linked to persistence as follows: ‘Students who develop *confidence in their fit* with the engineering profession will be more likely to persist in an engineering major and intend to persist in an engineering career.’¹⁸ Again, this study points to both individual and social or cultural characteristics as being important contributors to persistence.

Hughes¹⁹ qualitative study of science/engineering students’ persistence is based on a model which starts with ‘competence’, that is, the essential scientific knowledge and skills required to begin to develop a science identity. In this model, the female scientist uses her knowledge and skills to assess whether her interest, enjoyment and success in the field fits with her identity goals and values, and thus whether it is worth developing her competence and staying. A strong factor in this decision is whether she is achieving recognition by ‘credible experts’.²⁰ Recognition can be negatively affected by gender or ethnic origin if colleagues and clients judge women scientists on the basis of stereotypes. Thus, in Hughes’ model, a woman engineer’s expectation of success is affected by her competence, performance and recognition in the profession.

Another model of women’s persistence in the engineering workforce has been developed by Plett et al.²¹ from a (mainly) qualitative study of women holding degrees across all engineering disciplines. This model has five independent contributors leading positively or negatively to persistence in the engineering workforce. ‘Strong engineering identity’, ‘prosocial motivation’ and ‘relatedness’ can all enhance persistence. ‘Workplace barriers’ and ‘competing vocation’ can reduce persistence, as can negative aspects of prosocial motivation and relatedness. Relatedness is defined as the ‘desire to “work with” and relate to other people . . . known in the psychology literature as “relatedness” or “belonging”’.²²

¹³Gill et al., “Oh You Must Be Very Clever,” 228–32.

¹⁴Hewlett et al., *The Athena Factor*, 7–12.

¹⁵Buse, “Individual Factors Predicting Career Commitment,” 5.

¹⁶Cech et al., “Professional Role Confidence”.

¹⁷*Ibid.*, 647.

¹⁸*Ibid.*, 648 (italics added).

¹⁹Hughes, “Are the Predictors of Women’s Persistence in STEM Painting the Full Picture?”.

²⁰*Ibid.*, 552.

²¹Plett et al., “Engineering Identity and the Workplace Persistence”.

²²*Ibid.*, 13.

Plett et al. found that those women with a stronger engineering identity are the most likely to persist in the workforce. They also found that persistence was enhanced or reduced by positive or negative ‘workplace relatedness’²³ as well as other factors such as workplace cultural barriers, or a passionate desire to do something other than engineering, like staying at home with children.

Thus, all four studies find that, other things remaining equal, the stronger the individual’s feelings of personal fulfilment and belonging in the profession, the more likely she is to persist with engineering. Whilst earlier studies had focused mainly on what affects women’s job satisfaction and progress within the workforce, these recent studies link features of both personality and the social/cultural workplace environment directly with women’s retention in the engineering profession, albeit in slightly differing configurations.

Although the terms ‘identity’ and ‘engineering identity’ are used in these models to describe compilations of individual attitudes and characteristics identified as contributors to persistence, the term identity incorporates many different theoretical meanings that can be contested. For this reason, we use terms such as ‘attachment’ and ‘belonging’ in our study described below to convey the sense of liking and loyalty to engineering which contribute to the commitment and career persistence of our interviewees.

Gender and engineering workplace culture

Of particular interest to the present study is the role of the workplace culture in engendering a sense of recognition, fitting in or belonging, in the woman engineer who stays. As well as the models cited above, Faulkner too emphasises this point:

Workplace cultures are extremely consequential, in two crucial ways. First, they oil the wheels of the job and the organisation. Second, they shape who is included and who excluded at work. Getting on with one’s colleagues is, after all, a huge part of how much people feel they belong – *and are felt by others to belong*. This in turn can have a subtle but significant bearing on whether one stays and progresses within a company or occupation.²⁴

Informed by her observations and analyses of engineering workplaces and finding most of them to be gendered, Faulkner goes on to point out that it is more difficult for women to belong in engineering workplaces because the ‘... largest cultural group will tend to shape the workplace culture’.²⁵

Hunt also found that the higher the share of men in an engineering field, the more marked the impact on the female engineers, including a greater likelihood of leaving the profession.²⁶

The analysis of the gendered nature of engineering workplace cultures has been extended by Watts²⁷ to focus on the additional difficulties experienced by women with family responsibilities. Concentrating on the long hours culture in civil engineering in the UK, Watts found that women who cannot work long hours because of parenting responsibilities are made to feel conspicuous, a feature which impacts on their acceptance in the engineering workplace. Watts also noted that certain aspects of a woman’s personal life (particularly responsibilities for children) are far more likely to impact on her professional career in terms of the way she is seen by colleagues than for a man. Typically, Watts argues, fatherhood is seen as an obligation distant from a man’s professional career, whereas a woman engineer with

²³Ibid.

²⁴Faulkner, “Doing Gender in Engineering Workplace Cultures. I,” 5 (italics in original).

²⁵Faulkner, “Doing Gender in Engineering Workplace Cultures. I,” 16.

²⁶Hunt, *Why do Women Leave Science and Engineering?* 19.

²⁷Watts, “Allowed into a Man’s World”.

parental responsibilities needs to find a way of combining professional and caring roles. Not only does this subject the woman to considerable stress, but she also finds that she risks her colleagues' sense of her genuine commitment to the work.²⁸

The possible impact on persistence in the situation where a woman with a strong attachment to engineering is not accepted and respected as an engineer by male colleagues has been indicated by Tonso. In her ethnographic study of student engineers,²⁹ she reported that

Campus cultural and institutional practices exerted considerable influence over who was considered to be an engineer, in spite of how that person thought of her- or himself or how that person performed her- or himself as an engineer. In Marianne's case actually being an engineer took a backseat to being thought of as an engineer.³⁰

As a result, Marianne was inclining to a career other than engineering.

Other studies have yielded similar findings, also suggesting that career persistence is related to acceptance and recognition in the community of practice as an essential addition to one's own confidence in one's technical qualifications and expertise.³¹

Overall, this previous research makes the following points that are particularly relevant to the current study: a strong attachment to the profession combined with personal fulfilment as an engineer is crucial for women's persistence in the profession. However, the impact of the masculine engineering workplace culture can undermine this attachment to the point where the woman engineer might leave. Our interest, therefore, was to explore what influences the attachment and commitment to the profession of some women engineers who had stayed.

Our study: the women who stayed

In 2009, we commenced a two-phase study of all the women who had graduated in civil engineering from a single Australian university, called here Australian Technical University (ATU). The study used an online survey followed by semi-structured interviews with volunteers from the survey. Its original purpose was principally to explore retention issues in a group of women qualified as engineers which included some who had left the profession as well as those who had stayed. It is always difficult to access people who have left a profession, as the usual databases available such as organisation memberships are unlikely to include those who have left. For example, two previous national studies of women in the Australian engineering workforce³² had, due to the database used (current members of Engineers Australia³³), only included women who had stayed in the profession or intended to return shortly. Both of these surveys, across all engineering disciplines and all Australian States had found that women engineers were more dissatisfied at work than their male counterparts and more likely to leave the profession. By using a defined alumnae cohort for the ATU study, we were able to access the university's female civil engineering graduates who had left the profession as well as those who had stayed.

ATU was formed in 1991 from the amalgamation of an Institute of Technology and a College of Advanced Education, both of which had been degree-awarding bodies in

²⁸Ibid., 45–8.

²⁹Tonso, "Student Engineers and Engineer Identity".

³⁰Ibid., 298.

³¹Pierrakos et al., "On the Development of a Professional Identity," 5; Hughes, "Are the Predictors of Women's Persistence in STEM Painting the Full Picture?" 555.

³²Roberts and Ayre, *Counting the Losses*; Mills et al., *CREW Revisited in 2007*.

³³Engineers Australia, The Australian engineers' professional body.

their own right. ATU's Act of Establishment put particular emphasis on a commitment to equity and making higher education accessible to those traditionally under-represented in it. Prior to ATU's formation, there had been a civil engineering programme at the Institute of Technology, one of the two higher education institutions absorbed into the ATU, and the first woman graduated from that programme in 1974. By 2008, 76 women had graduated from ATU and the former Institute of Technology with bachelor degrees in civil engineering, and these graduates formed the database for the study.

Using alumni databases, social networking sites such as Facebook, and other members of the cohort, contact details were obtained for 65 female graduates (86% of the cohort). Fifty-six of these completed the online survey, an 86% response rate. Hence, overall 74% of the total cohort of graduates responded.

Fifty-three of the 56 survey respondents were still working in the engineering profession. The 20 'missing' graduates who were either uncontactable or did not complete the survey were possibly more likely to have left the profession than our respondents. Even if all of these had left, the resulting 70% retention rate in a cohort that ranged from 1 to 35 years since graduation would still be a higher retention statistic than found by several other western studies of women in engineering. However, anecdotal evidence suggested that the missing 20 had certainly not all left engineering. Friends in the cohort reported that some were temporarily working as engineers overseas, or taking a career break to travel but intending to return to engineering. Thus, the retention rate of the ATU cohort was certainly higher than 70%.

The ATU survey used the same framework of questions as the second national Australian survey, which is provided in full in Mills et al. (2008),³⁴ thus enabling comparisons that revealed interesting similarities and differences. The age group and years of graduation distributions were very similar. However, the ATU group had higher workplace satisfaction than the national group and yet were also nearly twice as likely to have responsibility for children. They enjoyed more favourable family-friendly provisions at their workplaces and were more likely to make use of them than the national group.³⁵ Interestingly, the ATU survey group were much more likely to be employed in the public sector (44%), than Australian engineers generally (16%),³⁶ despite public sector engineers' salaries being significantly lower than those in the private sector.³⁷ These differences between the national and ATU survey findings relating to workplace satisfaction, family responsibilities and public/private employment prompted us to investigate possible links between these features and the high persistence rate of the ATU group.

The interviews

Sixteen survey respondents, all of whom had stayed in the profession, volunteered to be interviewed. The interviews took place in 2010 at venues chosen by the volunteers. Most opted to be interviewed at their place of work, but three chose their homes and one chose her former campus at ATU. The interviews explored six general areas or themes, as follows:

- (1) *Work and home* (what influenced them to become an engineer, how they managed caring responsibilities).

³⁴Mills et al., *CREW Revisited in 2007*.

³⁵Ayre et al., "Not All Women Leave".

³⁶Marinelli and Calais, "Painting the Picture," 8.

³⁷Kaspura, *The Engineering Profession*, 80–1.

- (2) *A good engineer* (what makes a good engineer, whether in their own view they were good engineers, and whether their colleagues and managers shared this opinion; whether they felt they belonged in engineering, and what is needed to achieve this belonging).
- (3) *Educational background* (did their engineering education adequately prepare them for the engineering workplace).
- (4) *Women in the minority* (why are there so few women engineers, and what can be done about this).
- (5) *Activism* (whether they were active in promoting engineering for women).
- (6) *Intentions to stay or leave*.

The interviews were digitally recorded then fully transcribed. They were analysed using a thematic approach. In this paper, we focus on the questions related to being a good engineer, and intentions to stay.

The interviewees

All 16 had stayed in the profession for 3–22 years: 6 of them for 18 or more years and another 5 for 8–15 years. Their age range was 27–43, the same as that of the respondents to the online survey, but the interview group was more heavily weighted towards the upper ages. Nine (56.3%) interviewees had children, a higher proportion than of those who responded to the ATU survey (40%), and very much higher than the 22% of respondents to both national surveys. The interviewees' public/private employment split was the same as for the ATU survey group, which as mentioned previously was much more skewed towards public sector employment than the national average for engineers.

The interview group was, therefore, representative of the larger survey group in some, but not all respects. Since the purpose of the interviews was to explore in more depth how women engineers persist in the Australian profession, the particular differences in the demographics proved to be advantageous to the interview study. The bias towards higher ages, and hence longer experience in the profession was useful since these women were manifestly stayers. Likewise, the higher proportion of engineers with caring responsibilities was an advantage in view of the many findings that the difficulties of raising a family constitute a major cause of women's attrition from the profession.³⁸

Findings

A good engineer

In order to explore the interviewees' attachment to engineering, they were asked 'What makes a good engineer?', and then whether they, and also their managers, evaluated themselves as such. In answer to the first of these questions, three characteristics were nominated almost equally frequently: problem-solving, people skills and technical skills. There was often a suggestion that technical skills were of secondary importance to people skills. Kathy (all names changed to preserve anonymity), a 42-year-old project manager in the public sector, replied:

A good engineer? I think a good engineer needs to have very good communication skills because they need to interpret what is required by a client, and they need to then turn that into

³⁸Directorate General for Research, *Creating Cultures of Success*, 67; Bagilhole et al., *Researching Cultures*, 40–2; Hewlett et al., *The Athena Factor*, 54–5.

something, and the difficulty can quite often be in that interpretation of the needs of the end user. Obviously technical skills is a good one too.

Anne, a director in the private sector with 14 years' experience replied in a similar vein from an employer's perspective:

Obviously an understanding, an ability to read plans, a technical mind is important, but generally I suspect that if I had applications from two engineers who had graduated from the same class at the same university, we would probably choose the more grounded, the better communicator, rather than analysing them down to their grades.

In this primary ranking of people skills, there was no suggestion that the technical work was too difficult or not interesting. All interviewees were confident in their capacity to use higher level technical skills and they presumed all engineers would have these skills. However, their current level of work required a certain level of interpersonal skills to underpin their technical skills; negotiation and mediation to 'make things happen' and 'deliver what's expected'. For the participants, these interpersonal skills comprised an important part of being a good engineer.

The suggestion that people skills may be a stronger indicator of a good engineer than technical skills (although these are essential) is interesting, because although also reported in another Australian study,³⁹ this view contravenes substantial evidence of the reverse ranking usually asserted (technical skills most important, followed by people skills),⁴⁰ often attributed to male dominance in the profession. Since technical matters are traditionally masculine, it is argued, and most engineers are male, technical expertise is the strongest indicator of a good engineer.⁴¹ Along with this greater respect in the profession for the technician, a stereotype has arisen that women's strengths lie more in communication and coordination, that is the people skills, than technical skills. A consequence is that women engineers are 'pushed' into project management and away from 'masculine' technical work, and subsequently find it much harder than men to proceed to senior management.⁴²

Replies to the subsequent question about what it means to be good at their current job made it clear that people skills were definitely foremost in our interviewees' day-to-day work, as noted in other research on what engineers actually do.⁴³ Brenda, a project officer with 20 years' experience in public sector organisations gave a reply typical of most:

... influencing people, negotiating with people, managing people is the key thing that I do, really. The technical aspect is the smaller part of what I do, but I need to be able to understand when they're talking about the different types of bridges, and bridge deficiencies and what the options are in terms of strengthening or replacing. ... but the communication aspect is more important.

³⁹Mills et al., "Engineering in Australia," 142.

⁴⁰Sheppard et al., "What is Engineering Practice?" 432–5; Faulkner, "Nuts and Bolts and People," 346; Anderson et al., "Understanding Engineering Work and Identity," 80; Hewlett et al., *The Athena Factor*, 13.

⁴¹Faulkner, "Nuts and Bolts and People," 350; Hewlett et al., *The Athena Factor*, 7–10; Sappleton and Takruri-Risk, "Gender Subtext," 293–5.

⁴²Bagilhole et al., *Researching Cultures*, 44; Faulkner, "Nuts and Bolts and People," 348–9; Hewlett et al., *The Athena Factor*, 28–30; Sappleton et al., "Organisational Culture," 10–12.

⁴³Faulkner, "Nuts and Bolts and People," 336; Trevelyan, "Technical Coordination," 198.

Overall, in the responses to these two questions together, to be a good engineer or good at their current job or both, people skills emerged as essential in our interviewees' current jobs, and being able to apply these with colleagues, managers, clients, suppliers, site workers and the public. Problem-solving and technical skills were seen as a given, but not sufficient on their own to make a good engineer. It is possible that this alternative perspective or notion of engineering from the traditional one may contribute to the persistence of these women, and we return to this point in the Discussion section later.

Interviewees were then asked whether they fitted their own definitions of a good engineer and whether their managers agreed, and all but two responded positively on both counts. Most noticeable amongst the 14 out of 16 who ranked themselves as good engineers and believed that their managers did as well was their obvious enthusiasm for engineering as well as for their present job, with many responding that they loved being an engineer and/or they enjoyed the challenge. Donna for example, a senior engineer in the private sector with eight years' experience replied, 'I guess it's the challenge. I like challenges . . . It becomes like an addiction. Like you want the next challenge.' These participants added that they had the necessary people, technical and problem-solving skills. Some claimed to have possessed these skills from the outset, others that they had developed them during their working life. Several had sought secondments or changed jobs in order to acquire or develop the skills they decided they needed. All informants reported receiving positive feedback from their managers about their performance, which was clearly a factor in their confidence and workplace satisfaction.

Two interviewees, both in the early career stage, were more hesitant about whether they fitted their own definitions of a good engineer and being good at their current job. Both felt they had not yet found the role that was right for them and were considering seeking a change in role or employer whilst remaining in engineering.

In summary, marked features of the participants' responses were enthusiasm for their current job, together with self-assessment as being a 'good engineer': views which offer some explanation for their persistence in the profession, as seen in the career persistence models cited earlier. However, the current study suggests that there are more factors involved in the context of persistence.

Workplace culture

Participants were asked if they felt they belonged in engineering, inviting them to interpret the term in any way they liked. Our use of the word 'belong' was not intended to imply any theoretical construct, but rather as a commonly used term for identifying with a community and feeling accepted by the other members. All replied that they did belong: many very emphatically.

When asked what caused them to feel that they belonged, three ways of interpreting the meaning of 'belonging' emerged. The first was almost identical to the definition of a good engineer described above: having the necessary skills and competence to do the job, and enjoying the work. Nancy, a manager in the public sector with 21 years' experience replied, 'I guess it's something that I've always enjoyed. I enjoy working with groups of people, in teams of people. I enjoy weighing things and making a decision based on that weighing of the evidence. I enjoy solving problems.' Donna's enthusiasm was similar:

It's what interests me – I think that's truly important at the outset. You have an interest in solving people's problems. Engineering's obviously a lot more technical than that, but the philosophy behind it is that we create solutions that meet people's needs, meet their expectations. And I enjoy doing that. I enjoy being involved in that creative exploration of solution finding.

To the respondents who replied in this vein, ‘belonging in engineering’ is about the scope of the work they do, and their competence and satisfaction in doing it, which are recognised contributors to persistence in the models cited earlier.

The second most prominent interpretation of belonging was the interviewees’ reaction to their ever-present awareness of being outnumbered by males. Those who mentioned this aspect typically started with the negative effects of their minority status, unconsciously echoing research findings,⁴⁴ as described below.

One aspect of being in a numerical minority mentioned was being highly visible, which can be uncomfortable. As remarked by Rosie, a manager in the private sector with 18 years’ experience, ‘You stand out being female . . . You can’t do anything about your gender. If you walk into a work site or in a laboratory you stand out. So you’re up against that every time.’ Anne’s reactions to too much visibility was typical of others’:

I’ve had to go out of my way to not be looked at. . . . The female thing in the construction industry is . . . something you have to be aware of and you have to be conscious of, and you have to work hard to overcome: whether that’s appearance, whether that’s attitude, whether that’s having very broad shoulders and very thick skin and not listening to a lot of things that are said.

As well as the discomfort of being conspicuous, for some, as for Nancy, always being outnumbered was isolating, ‘It can be a bit isolating if there’s not another woman working with you. And you’re seen as this special breed, you know.’ As Faulkner has suggested, being both highly visible as a woman and yet invisible in an engineering team is a factor in the poor retention of women engineers.⁴⁵

Other respondents noted how women’s numerical minority can result in their needs and sensitivities being overlooked, as in Brenda’s case:

I was the construction engineer for several road projects and I was the only woman on site. There were basic issues, like having to use the men’s toilets on site and the lunch rooms being plastered wall to wall with posters of naked women.

Brenda solved these problems by discussion, achieving compromises that were acceptable to all parties. As she remarked, the consequent improved awareness of these oversights and discourtesies amongst her male co-workers also benefitted subsequent female engineers working with that team.

Such immediate solutions were not available in the other cases cited above. Their strategies, ranging from ‘being more tough’ to changing employer took time before the women felt they belonged. Their strategies were also employed by other participants to address different aspects of their work environment which did not fulfil their expectations of personal fulfilment, notably the impact of family responsibilities as discussed below. Since their solutions offer useful suggestions for persistence and retention to both individual women engineers and engineering employers, they are collated in the ‘Discussion’ section.

Like some of the others, Brenda had sometimes found her minority gender status to be an advantage, ‘I’ve certainly found that being a minority has been an advantage for me. I kind of fit. I’m not a difficult person. I’m intelligent enough and so I stand out I suppose.’ Faulkner also noted that women engineers can employ this phenomenon to their advantage.⁴⁶

⁴⁴Murphy et al., “Signaling Threat,” 883–4; Bagilhole et al., *Researching Cultures*, 13–14; Hewlett et al., *The Athena Factor*, 14–20; Faulkner, “Doing Gender in Engineering Workplace Cultures. II”.

⁴⁵Faulkner, “Doing Gender in Engineering Workplace Cultures. II,” 172.

⁴⁶*Ibid.*, 179.

The third interpretation of belonging amongst our interviewees was the degree of professional acceptance, respect and inclusion that they were accorded from male colleagues. Answering the question about whether she belonged in engineering with reference to her recognition by colleagues, Brenda added, 'It feels comfortable. I go to meetings and we talk about things . . . the discussion that I have I feel that I'm participating – more than participating really, in decisions that are being made.' Pauline, an engineer with four years' experience working for a large private sector company talked about 'fitting in', 'You need to fit in with your team. I definitely think you do. I think pretty much anyone can fit in. They just have to find their place. I feel like I've found mine already.'

Margaret, however, a private sector engineer with three years' experience, qualified her 'Yes, I belong' response with a proviso which draws the distinction suggested earlier between confidence in her professional competence and a feeling of not being accepted by her colleagues:

Yes, I do [belong] – I suppose in the technical respect, like being able to solve problems. I suppose in some other ways I feel like I don't belong which is probably more to do with just differences between people, having different perceptions . . . and wanting to do things differently sometimes.

Margaret was the only one in the group thinking of leaving the profession.

Studies of persistence have suggested that women engineers are more likely to stay in workplaces where their professional and personal expectations of respect and acceptance are met. These responses of the ATU interviewees show that despite their numerical minority nearly all felt included and respected by male workmates and clients. In this respect, the culture of their workplaces provided an environment that supported their persistence in engineering.

Impact of family responsibilities

Many of the interviewees with children, however, indicated that making use of their employers' family-friendly provisions had had a negative impact on their expectations of inclusion and respect. Rosie, with two children, explained why she recently changed her job to work in a small organisation with few members of staff:

The fact is you get treated differently. You get criticised and marginalised because you have that flexibility compared to men who don't have that flexibility because they either don't have a family or their partner is the primary care-giver, and so it continues to be a struggle. One of the reasons I moved here is because I was sick and tired of being criticised, you know just smart comments about leaving early to pick up children and being a part-timer.

Brenda had three children and worked part-time. She described the reactions from her male colleagues when she leaves 'early':

If you do those things like work part-time, you get the remarks. I still get the remarks here when I leave, because I leave at 2.30 every day, so I'll get the remark 'Gosh, you're leaving already?' Well, yea, that's what you do. So you always get people that make comments. . . . And I think for some women they find oh no, it's not friendly towards women. It's more focused towards men.

These comments made by women in senior positions were also echoed by younger women, including those who had not yet had children. Frances, for example, remarked, 'I might one day have children. I'll have to think about what happens there. Otherwise there's nothing

that they [men] can do that I can't do.' The masculine culture of the typical engineering workplace generates a perspective that women working shorter hours lack commitment⁴⁷ making these women with children feel different from other (male) engineers, despite most of the men too being parents.

These examples illustrate the problems that women face when their employers' formal family-friendly policies are not strongly supported and endorsed by their line managers. They go some way towards explaining why such a large proportion of the interviewees worked in the public sector where it is possible to change role or hours without loss of status or benefits, and where it is generally more acceptable to make use of family-friendly employment provisions.

Half the interviewees had chosen to work for their current employer principally because of their family-friendly policies. Gillian, for example, said she would be staying with her current employer (a large government department) because of the flexibility:

Yes, because I would like children, so I think staying with [my government department] and the maternity leave and the flexibility that they show in terms of coming back to work like two or three days a week. I think that's really good. You can work from home, and have flexible working hours. We work in a flexi-system where you can start anywhere between seven and ten and finish anywhere between four and seven. It means that if you wanted to drop your children off at school, or pick them up after work you could change your hours to suit.

Brenda, who has always worked in the public sector but moved to another section and changed role when she knew she was pregnant in order to be able to work part-time, stated:

I knew when I was pregnant that I could not go back to doing construction work because I wasn't prepared to do the hours and I was going to work part-time, so I specifically started looking for work still within [my organisation] but in a different role where I knew that working part-time would be more of an option. I did get a job doing that.

Several of these public sector engineers who were in their 40s remarked that changes in management attitudes towards employees with caring responsibilities had been slow to come, but now looking back, the changes were noticeable. These women were hopeful that these improvements would continue.

The interview data revealed that a lack of family-friendly employment policies, or disapproval for using the policies which were available, resulted in some cases in participants changing their working environment to one where the conditions and/or attitudes were more supportive of work/life balance. This strategy is described by Buse as 'intentional change' used by persistent women engineers, '...actively manipulating circumstances in an effort to mitigate personal discomfort caused by gender bias – bettering their own situations and, sometimes, affecting the attitudes and behaviors of others'.⁴⁸

Will you stay?

At the conclusion of the interview, volunteers were asked if they intend to stay in their current job and in the profession. All but one said they will definitely stay in engineering, with answers like Anne's, 'Can't imagine doing anything else' and Brenda's, 'Yea, yea, I'm not leaving'. Twelve intended to stay in their current jobs. Several of these commented that a key factor in their satisfaction was the positive attitudes of a manager towards women in engineering. Nancy, for example, spoke warmly of the importance of male mentors:

⁴⁷Mills et al., "Engineering in Australia," 19; Bagilhole et al., *Researching Cultures*, 40–2.

⁴⁸Buse, "Individual Factors Predicting Career Commitment," 4.

... right through my career I've met men that have been interested in doing that [increasing the number of women]. [X], a very early mentor of mine, was very supportive of women in engineering. ... And I've stayed in contact with him even after his retirement and my moving on. And later [Y] was the same. And I think they both set out to deliberately increase the percentage [of women engineers] they had in their sections, recognising that that was a good thing. Our CEO here has always been very pro getting females into engineering roles ... and trying to break down that bloke culture.

Three interviewees were considering changing employer but staying in engineering. Two of these women were hoping to find employment where it was easier to combine professional and parental responsibilities than it was in their present position, and the third woman said she would move if she was not happy with the outcome of an imminent restructuring at her current workplace. These three considering leaving their current employer will, therefore, also be demonstrating 'intentional change'⁴⁹ as described above. Only Margaret was currently considering leaving the profession as explained earlier.

As half the group had already done one or more times, the few who were considering changing their employer will make the change in order to fulfil their own visions of being an engineer.⁵⁰

Discussion

These women have stayed whilst many others have left the profession, despite sharing with those in previous studies experiences of being isolated, overlooked and unheard within a strongly masculine culture. The most striking features of the interviews were the confidence with which all the women asserted that they were good engineers, and that they belonged in engineering, although for some women it had taken time to feel they belonged. Where their workplace experience had not supported their expectations of personal fulfilment and belonging, these women appear to have employed one or more of three main strategies.

The first strategy is suggested by the interviewees' emphasis on the importance of people skills as well as technical skills in a good engineer. As indicated earlier, in this male-dominated profession it is usual to describe the work as principally technical, although research has shown that this is generally not the case, especially in the senior positions that many of our participants held or aspired to. However, our persisters held the more realistic view that good engineers supplement their technical expertise with skills in 'working with people', 'solving problems' and 'making things happen'. This shift in perspective could be considered as a redefinition of engineering to reflect more accurately these women's experience and accomplishments in the profession. Their confidence in their recognised proficiency in all these skills, including the technical ones, has perhaps helped to strengthen their feelings of personal fulfilment.

The second strategy addressed the expectation of having their professional competence recognised and acknowledged by male colleagues and clients in order to feel they belonged in the engineering workplace. Several interviewees claimed that they had had to work at this aspect to achieve this standing, either by 'proving' themselves, becoming more visible, assertive or 'tough', or working harder than a man. Eve, for example, noted:

⁴⁹Buse, *Ideal Selves*, 30; Buse, "Individual Factors Predicting Career Commitment," 7.

⁵⁰Buse, "Individual Factors Predicting Career Commitment," 15; Cech et al., "Professional Role Confidence," 658–9; Fouad and Singh, *Stemming the Tide*, 37–8; Plett et al., "Engineering Identity and the Workplace Persistence," 13.

You've gotta work a bit harder as a female engineer I believe to prove yourself. . . . when I go out on site and talk about what solution I can provide, they're usually very hesitant to listen to me . . . new clients that is. They're sort of not sure of whether to believe what I'm saying, and then once I prove myself I gain their respect, whereas perhaps if it was a male engineer they'd see it differently. . . . You just have to be very tough and not let it get to you. When I first started, it was hard, but yea, toughened up now!

Thus, some found that their competence was more appropriately acknowledged when they re-positioned themselves to achieve recognition and respect by making changes in their personal style or visibility.

The third strategy was to deliberately change their workplace if they did not feel they belonged where they were. As reported by Rosie and Brenda, a group of attitudes which militate against feeling accepted and respected in the profession are those directed towards women with parental responsibilities. Not only do women engineers often report being tediously teased by colleagues for working part-time or using flexi-time, but also, and more seriously, they can be subtly or overtly penalised by managers who do not support their organisation's family-friendly policies. Rosie solved this problem by moving to a different workplace and Brenda to a different section within her large organisation, although the teasing remained. This strategy inevitably involved the women in aspects of negotiation of workplace conditions that their male colleagues were less likely to have to undertake.

Several participants noted that having more women engineers in a workplace helped them to persist. Some had deliberately changed role in order to move into a workplace where there was a more favourable female-to-male ratio. For Jennie, this was achieved by temporarily taking a sideways step in the same organisation. With 22 years' experience, Jennie was a senior project manager in a privatised formerly public sector organisation. At the time of the interview, she had recently returned to her original workgroup after a secondment to a non-engineering section. She described how she found it much more comfortable there than formerly because in her absence the female-male ratio in that workplace had improved:

I feel I belong more because just looking around me now I can see more women turning up, around the floor. Once upon a time I felt I didn't belong because [her organisation] was very male dominated. . . . That's probably a reason why I broke away from engineering group earlier – got to get out, you know – I think that was my subconscious telling me to find somewhere else. But I feel I belong now because I'm seeing more . . . engineering graduates who are female. They're all late 20s early 30s, and . . . they're swanning around here working as consultants amongst the older engineers who've all gotta get used to it. I find that really nice. It's company. . . . It's nice to have that diversity around, instead of feeling like you're the only one.

Another interviewee, Helen, had been so unhappy in her early years as an engineer that she left the profession and worked for seven years in an unrelated occupation. She had recently returned to engineering with her original public sector employer but in a different role than formerly and like Jennie is now more comfortable in her workplace since in 'the area that I'm in at the moment, there are quite a few females'. Jennie's and Helen's employers were both large and flexible enough to be able to offer easy transition between different sections for employees seeking a change, and all such changes were made without loss of security or benefits such as pension rights.

Thus, where their workplace experience is not supporting their expectations, it appears that persistent women engineers find ways to re-position themselves in relation to the prevailing culture, thereby achieving a better sense of belonging. The interviewees in this study did this either by redefining the characteristics of a good engineer, making slight adjustments in personal style or behaviour, or by moving to a different workplace chosen because it is more inclusive of women.

Conclusion and recommendations

The analysis presented here suggests features and strategies that can increase women engineers' sense of belonging or attachment to the workplace, and add to the likelihood of staying in the engineering profession. Taken together their responses suggest that a close match between an individual's expectation of personal fulfilment as an engineer and the reality of their workplace experience is strongly linked to remaining in the profession.

Where some of these features are lacking, the solution adopted by many women engineers is to make a change. Notably in this study, the change was often to find another employer who actively encourages a more inclusive culture. This sort of solution has been criticised on the grounds that it only helps that individual: there are no long-term gains for women engineers in general.⁵¹ The focus, it is argued, must be on change in the culture to ensure that female engineers as well as males are accepted and respected in their engineering workplace.⁵² Whilst we strongly endorse this view as the most desirable way forward for the profession, we also strongly support individual agency, as demonstrated by the women in our study, since it allows them to stay in the profession and may also influence organisational culture. Employers may be forced into cultural change when they eventually realise that their women engineers are leaving to join more culturally inclusive workplaces.

The implications from this research for engineering management seeking to attract and retain good women engineers are that as well as affirming their competence in their engineering skills, it is important to ensure that women feel they are valued by visible acceptance and respect shown by their male managers (as in Nancy's case) and colleagues. Our study supports recommendations from other studies⁵³ of ways to address the masculine culture in order to help women engineers as well as men to achieve personal fulfilment in their professional capacity and thus improve retention. Whilst there is a need for agreed and published equality and diversity policies, these on their own cannot effect the necessary culture change to ensure that all feel respected and valued. In addition, there must be visible leadership in implementing these policies. Incentives and rewards for line managers who meet diversity/flexibility goals are recommended. However, care must be taken to ensure that there are no unintended consequences for those who utilise these policies, such as unfavourable performance reviews, demotion on return after maternity leave or team members resenting a perceived increase in workload when a female colleague reduces her hours to accommodate her caring responsibilities.

This study of a group of Australian female engineers who have stayed in the profession confirms recent international research evidence of personal and organisational factors which promote persistence. Our study offers further support to the notion that women who feel a sense of belonging are the ones who will persist in the profession. However, a clear commitment to engineering is not enough to ensure a sense of belonging to the profession. That sense must be supported by the workplace culture at the site and hence necessarily involves colleagues, managers, clients and technicians. The employing organisation's culture must recognise and affirm women's as well as men's competence and commitment, so that all, not just the numerically dominant group, find the work enjoyable and personally

⁵¹Powell et al., "How Women Engineers Do and Undo Gender," 421; Hughes, "Are the Predictors of Women's Persistence in STEM Painting the Full Picture?" 566.

⁵²Mills et al., "Engineering in Australia," 28; Faulkner, "Doing Gender in Engineering Workplace Cultures. I," 16–17; "Doing Gender in Engineering Workplace Cultures. II," 184–6; Hughes, "Are the Predictors of Women's Persistence in STEM Painting the Full Picture?" 566–7.

⁵³Faulkner, "Doing Gender in Engineering Workplace Cultures. II," 185; Frehill, "SWE Retention Study," 39; Buse, "Individual Factors Predicting Career Commitment," 15; Fouad and Singh, *Stemming the Tide*, 58–61.

fulfilling in an inclusive and supportive workplace. Where the prevailing workplace culture does not support these principles, the employer is likely to lose women engineers to a competitor. Where these principles are demonstrably present the evidence suggests that women engineers are highly likely to stay.

References

- Anderson, Kevin J., Sandra S. Courter, Tom McGlamery, Traci M. Nathans-Kelly, and Christine G. Nicometo. "Understanding Engineering Work and Identity: A Cross-case Analysis of Engineers Within Six Firms." *Engineering Studies* 2, no. 3 (2010): 153–74.
- Association of Professional Engineers, Scientists and Managers, Australia (APESMA). *Women in the Professions: Survey Report*. Melbourne: Association of Professional Engineers, Scientists and Managers, 2007.
- Ayre, Mary, Julie E. Mills, and Judith Gill. "Not All Women Leave: Reflections on a Cohort of 'Stayers' in Civil Engineering." Proceedings of the 2011 ASEE annual conference, Vancouver, Canada, on CD Rom, June 26–29, 2011.
- Bagilhole, Barbara, Abigail Powell, Sarah Barnard, and Andrew Dainty. *Researching Cultures in Science, Engineering and Technology: An Analysis of Current and Past Literature*. Bradford: UK Resource Centre for Women in Science, Engineering and Technology, 2007.
- Buse, Kathleen. *Why They Stay: The Ideal Selves of Persistent Women Engineers*. Doctor of Management Qualitative Research Paper. Cleveland, OH: Case Western Reserve Univ., 2009.
- Buse, Kathleen. "Why They Stay: Individual Factors Predicting Career Commitment for Women Engineers." Paper presented at the first international conference on engaged management scholarship, Cleveland, OH, June 2–5 2011.
- Cech, Erin, Brian Rubineau, Susan Silbey, and Caroll Seron. "Professional Role Confidence and Gendered Persistence in Engineering." *American Sociological Review* 76, no. 5 (2011): 641–66.
- Congressional Commission on the Advancement of Women and Minorities in Science Engineering and Technology Development (CAWMSET). *Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology*. Arlington: Virginia National Science Foundation, 2000.
- Directorate General for Research. *Creating Cultures of Success for Women Engineers*. Final Report of the WomEng Project. Brussels: European Commission, 2006.
- Faulkner, Wendy. "'Nuts and Bolts and People': Gender-Troubled Engineering Identities." *Social Studies of Science* 37, no. 3 (2007): 331–56.
- Faulkner, Wendy. "Doing Gender in Engineering Workplace Cultures. I. Observations from the Field." *Engineering Studies* 1, no. 1 (2009a): 3–18.
- Faulkner, Wendy. "Doing Gender in Engineering Workplace Cultures. II. Gender In/Authenticity and the In/Visibility Paradox." *Engineering Studies* 1, no. 3 (2009b): 169–89.
- Fouad, Nadya A., and Romila Singh. *Stemming the Tide: Why Women Leave Engineering*. Center for the Study of the Workplace Report. Milwaukee: Univ. of Wisconsin, 2011.
- Frehill, Lisa M. "SWE Retention Study and Work/Life Balance." *SWE: Magazine of the Society of Women Engineers* (Fall 2009): 34–40.
- Gill, Judith, Julie E. Mills, Suzanne Franzway, and Rhonda Sharp. "Oh You Must be Very Clever! High-achieving Women, Professional Power and the Ongoing Negotiation of Workplace Identity." *Gender and Education* 20, no. 3 (2008): 223–36.
- Hewlett, Sylvia A., Carolyn B. Luce, Lisa J. Servon, Laura Sherbin, Peggy Shiller, Eytan Sosnovich, and Karen Sumberg. *The Athena Factor: Reversing the Brain Drain in Science, Engineering and Technology*. Harvard Business Review (HBR) Report, Harvard. Cambridge, MA: Center for Work-Life Policy, 2008.
- Hughes, Roxanne. "Are the Predictors of Women's Persistence in STEM Painting the Full Picture? A Series of Comparative Case Studies." *International Journal of Gender, Science and Technology* 3, no. 3 (2011): 547–70.
- Hunt, Jennifer. *Why do Women Leave Science and Engineering?* Montreal: National Bureau of Economic Research, 2010.
- Kaspura, Andre. *The Engineering Profession: A Statistical Overview*. Canberra: Engineers Australia, 2012.

- Kaspura, Andre. *The Engineers Australia Survey of Working Environment and Engineering Careers, 2012*. Canberra: Engineers Australia, 2013.
- Marinelli, Melissa, and Martina Calais. "Painting the Picture – a Statistical Update on Women in Engineering in Australia." Paper presented at the 15th conference of women engineers and scientists (ICWES), Adelaide, Australia, 19–22 July 2011.
- Mills, Julie E., Wency Bastalich, Suzanne Franzway, Judith Gill, and Rhonda Sharp. "Engineering in Australia: An Uncomfortable Experience for Women." *Journal of Women and Minorities in Science and Engineering* 12, nos. 2–3 (2006): 135–54.
- Mills, Julie E., Virginia Mehrtens, Elizabeth Smith, and Valerie Adams. *CREW Revisited in 2007 the Year of Women in Engineering: An Update on Women's Progress in the Australian Engineering Workforce*. Canberra: Engineers Australia, 2008.
- Murphy, Mary C., Claude M. Steele, and James J. Gross. "Signaling Threat: How Situational Cues Affect Women in Math, Science, and Engineering Settings." *Psychological Science* 18, no. 10 (2007): 879–85.
- National Science Foundation (NSF). "Women, Minorities, and Persons with Disabilities in Science and Engineering: Data Tables, Table 9– 5." National Science Foundation, 2013. <http://www.nsf.gov/statistics/wmpd/2013/pdf/tab9-5.pdf> (accessed August 1, 2013).
- Pierrakos, Olga, Thi K. Beam, Jamie Constantz, Aditya Johri, and Robin Anderson. "On the Development of a Professional Identity: Engineering Persists vs Engineering Switchers." Paper presented at the 39th American Society for Engineering Education/Institute of Electrical and Electronics Engineers frontiers in education conference, San Antonio, TX, 18–21 October 2009.
- Plett, Melani, Caitlin Hawkinson, Jennifer J. Van Antwerp, Denise Wilson, and Crystal Bruxvoort. "Engineering Identity and the Workplace Persistence of Women with Engineering Degrees." Paper presented at the 2011 American Society for Engineering Education annual conference, Vancouver, Canada, 26–29 June 2011.
- Powell, Abigail, Barbara Bagilhole, and Andrew Dainty. "How Women Engineers Do and Undo Gender: Consequences for Gender Equality." *Gender, Work & Organization* 16, no. 4 (2009): 411–28.
- Preston, Anne E. "Why Have All the Women Gone? A Study of Exit of Women from the Science and Engineering Professions." *The American Economic Review* 84, no. 5 (1994): 1446–62.
- Roberts, Pam, and Mary Ayre. *Counting the Losses...The Careers Review of Engineering Women: An Investigation of Women's Retention in the Australian Engineering Workforce*. Canberra: National Women in Engineering Committee, Engineers Australia, 2002.
- Sapleton, Natalie, and Haifa Takruri-Rizk. "The Gender Subtext of Science, Engineering, and Technology (SET) Organizations: A Review and Critique." *Women's Studies* 37, no. 3 (2008): 284–316.
- Sapleton, Natalie, Haifa Takruri-Rizk, Sunrita Dhar-Bhattacharjee, and Rae Bezer. "The Organizational Culture of NW Engineering Workplaces: The Influence on Women Engineers." Paper presented at the 6th annual Institute for Advanced Science-Science Technology and Society conference: critical issues in science and technology, Graz, Austria, 24–27 May 2009.
- Sheppard, Sheri, Anne Colby, Kelly Macatangay, and William Sullivan. "What is Engineering Practice?" *International Journal of Engineering Education* 22, no. 3 (2006): 429–38.
- Tonso, Karen. "Student Engineers and Engineer Identity: Campus Engineer Identities as Figured World." *Cultural Studies of Science Education* 1, no. 2 (2006): 273–307.
- Trevelyan, James. "Technical Coordination in Engineering Practice." *Journal of Engineering Education* 96, no. 3 (2007): 191–204.
- Watts, Jacqueline H. "'Allowed into a Man's World' Meanings of Work–Life Balance: Perspectives of Women Civil Engineers as 'Minority' Workers in Construction." *Gender, Work & Organization* 16, no. 1 (2009): 37–57.
- WISE. *Statistics Summary*. WISE Campaign, 2012. http://www.wisecampaign.org.uk/files/useruploads/files/wise_2012_stats_summary.pdf (accessed August 1, 2013).