2011

Pre-adulthood developmental psycho-social influences behind women becoming engineers in contemporary Australia

Andrew Ruscoe
Edith Cowan University

Edith Cowan University

Copyright Warning

Pre-Adulthood Developmental Psycho-Social Influences Behind Women Becoming Engineers in Contemporary Australia

Andrew Ruscoe

A Report Submitted in Partial Fulfilment of the Requirements for the Award of

Bachelor of Psychology with Honours

Faculty of Computing, Health and Science

Edith Cowan University

Submitted: Oct, 2011

I declare that this written assignment is my own work and does not include:
(i) material from published source without proper acknowledgement, or

(ii) material copied from the work of other students

Signature: [redacted]

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Pre-Adulthood Developmental Psycho-Social Influences Behind Women Becoming Engineers in Contemporary Australia

Abstract

This study explored the pre-adulthood development of female engineers with a focus on influences behind their career choice. Pre-adulthood encompasses the ages 0 to 23 and includes all development prior to settling on a career (Levinson, Darrow, Klein, Levinson, & McKee, 1979). This area of study derives its importance from the continuing low proportion of women in engineering (9.6%; Kaspura, 2009), the gender bias that this may indicate (Burke & Mattis, 2007), and the benefits of increasing the number of women in engineering (Engineers Australia, 2010). A phenomenological methodology was applied, utilising semi-structured interviews with 10 female graduate engineers aged 22 to 25 who had completed primary, secondary, and tertiary education in Australia. Content analysis revealed several potential influences behind career choice for these women, some of which do not appear in the literature. Potential influences included playing with Lego and blocks in childhood, gender bias from students at school and university, compatibility with perceived male culture, female "nerd" status at school, a male propensity to swear more than females interfering with facilitative male-female relationships, and anticipated lack of family-flexibility in engineering careers. These potential influences on career choice may highlight aspects of pre-adulthood and engineering in Australia that warrant further investigation and may be useful for increasing the proportion of women in engineering and reducing gender bias.

Author: Andrew Ruscoe
Supervisors: Dr Elizabeth Kaczmarek
Dr Deirdre Drake

COPYRIGHT AND ACCESS DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) Incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher degree or diploma in any institution of higher education;

(ii) Contain any material previously published or written by another person except where due reference is made in the text of this thesis; or

(iii) Contain any defamatory material.

(iv) Contain any data that has not been collected in a manner consistent with ethics approval.

The Ethics Committee may refer any incidents involving requests for ethics approval after data collection to the relevant Faculty for action.

Signed..... [redacted] .....

Date..... 29/11/11 .....

This thesis is dedicated to those who take the road less travelled.

The Road Not Taken

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

Robert Frost

Acknowledgements

I would like to thank the women who shared their stories with me for this project and Engineers Australia for helping me find these women. I would like to thank Dr Elizabeth Kaczmarek and Dr Deirdre Drake for working with me on this project. Many thanks to the wonderful friends who have helped me along the way to this point in my studies; Beth and Catherine deserve special mention. Finally, thankyou to my wonderful daughters who are my constant inspiration and to my lover who walks with me.

Table of Contents

Pre-Adulthood Developmental Psycho-Social Influences Behind Women Becoming Engineers in Contemporary Australia

Legislation aimed at preventing differing treatment of males and females based on their gender has been in place for decades in Australia and other western nations (e.g., *Sex Discrimination Act* of the Australian Government, 1984; UK Government, 1975; US Government, 1972). Many careers remain largely segregated by gender despite this legislation (Kermode, 2006; Sadker, Sadker, & Zittleman, 2009). For example, in Australia, women represent 9.6% of engineers and men represent 9.4% of nurses (Kaspura, 2009; Australian Institute of Health and Welfare [AIHW], 2010). There are no indications that the male-dominated nature of engineering is set to change in the near future given the proportion of female graduate engineers and female engineering enrolments is declining in Australia and elsewhere (Engineers Australia [EA], 2008; Kaspura, 2010).

The low proportion of women in engineering (WIE) is a concern because it may highlight gender bias in Australian society and may be limiting the engineering industry (Blakemore, Berenbaum, & Liben, 2009; EA, 2010). Researchers have found that while overt sexism has declined since anti-discrimination legislation was introduced, more subtle forms of discriminatory treatment remain and these contribute to perpetuating stereotypical gender roles (Eagly, Wood, & Diekman, 2000; Swim, Aikin, Hall, & Hunter, 1995; Tougas, Brown, Beaton, & Joly, 1995). Sadker and colleagues (2009) use the term *gender bias* to encompass these subtle forms of discriminatory treatment and this term will be used similarly in the current study. The segregation of gender in career choice may be in part the result of stereotypical gender roles and hence may indicate the presence of gender bias (Blakemore et al., 2009; Spelke & Grace, 2007). Gender bias is associated with harm that is direct (e.g., sexual violence, lower wages), indirect (e.g., impact on wellbeing), and secondary (e.g., consequences of poverty) (Swim & Hyers,

2009). Stereotypical gender roles may not be optimal for mental, physical, and relationship health (Barnett & Hyde, 2001). In addition to gender bias considerations, if the number of women in engineering could be increased this may help address skill shortages (Burke & Mattis, 2007; Watt, 2008a). Increasing the proportion of WIE could result in products and services that better suit public demand and could facilitate more creative solutions that better address society's needs and enhance industry competitiveness (EA, 2010; Powell, Bagilhole, & Dainty, 2007). Therefore, the value of research into the low proportion of WIE may be seen in the potential to reduce gender bias and the associated harm, and increase the number of WIE, gaining associated benefits.

Research examining the low proportion of WIE commonly groups scientific, technical, engineering, and maths careers together (i.e., STEM careers). Extensive recent research has examined attraction issues, that is the influences behind the low numbers of women entering STEM careers (e.g., Burke & Mattis, 2007; Hartman & Hartman, 2008; Lynch & Nowosenetz, 2009; Watt, 2008a). Some research highlights retention issues in engineering, that is characteristics of an engineering career that may result in women leaving engineering (e.g., Mattis, 2007; Mills, Bastalich, Franzway, Gill, & Sharp, 2006). Australian research on attraction and retention issues is scarce (Mills et al., 2006; Watt, 2008a). The current study takes a developmental approach, exploring pre-adulthood influences behind women choosing an engineering career. Pre-adulthood encompasses the ages 0 to 23 and includes all development prior to settling on a career (Levinson, Darrow, Klein, Levinson, & McKee, 1979). Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994) is widely used in recent career behaviour literature and considers developmental and gender related aspects to career choice and hence will be used as a framework for the present study.

Social Cognitive Career Theory (SCCT)

In SCCT, Lent and colleagues (1994) view *career choice* as a continuous process, perhaps better termed as *career development*, that encompasses career related interest development and academic development throughout the lifespan. From this viewpoint the distinction between attraction and retention issues becomes less relevant. The terms career choice and career development will be applied in the present study from a SCCT viewpoint. The developmental focus of SCCT makes it an appropriate framework for the current study exploring pre-adulthood development of WIE with regard to career choice. SCCT explains that *learning experiences* influence *self-efficacy* and *outcome expectations* that contribute directly and sequentially to *interest*, *intentional goals*, *chosen actions*, and *performance attainment*. Performance attainment then contributes to further learning experiences and the process repeats continuously throughout the life span but is most fluid during pre-adulthood (Lent et al., 1994). Hence the pre-adulthood scope of the present study allows for career development influences to be highlighted during this most fluid stage of development. Career development can be considered to remain fluid for university students who study engineering in Australia, noting the 45% dropout rate (40% for females) (Beanland, 2010).

SCCT describes how career choice may be influenced by gender biased learning experiences that affect self-efficacy and outcome expectations. Lent and colleagues (1994) also describe how gender may influence career choice by affecting opportunities. For example, contextual gender stereotyping may constrain intentional goals with or without this being perceived by the individual. Hence gender bias and gender stereotyping are key to understanding the influence of gender on career choice.

Background to Parental Role Stereotypes and Anticipated Family-Flexibility

Literature on developmental influences behind women becoming engineers will

be outlined in the current paper with influences presented chronologically as they may occur during development. Prior to this chronologically arranged discussion, background on the influence of parental role stereotypes and anticipated family-flexibility in engineering is presented in the current paper because of the complexity of the issue and because the influence on career choice may be the result of contributing factors from various stages during pre-adulthood. Further to this, while the influence of parental role stereotypes is not the only gender stereotype purported to influence women choosing engineering, it is the gender stereotype most commonly discussed in the literature.

Engineering commonly demands long hours in Australia considering the average working week for the majority of engineers is longer than 40 hours and for 32% of engineers is 49 hours or more (Kaspura, 2010). In contrast, the average working week for nurses is 33.4 hours (AIHW, 2010). In addition to long hours, STEM careers commonly demand mobility which is particularly not family friendly in two career families (Whitten et al., 2007). It can be seen that realities of long hours, lack of part-time opportunities, and mobility demands contribute to a lack of family-flexibility in engineering careers. Engineering students perceive career-family conflict to be a problem for engineers in general but more of a problem for WIE (Hartman & Hartman, 2008). Further to this, a prevalent reason given by women for leaving an engineering job is unachievable work-family balance, and female engineers in Australia are having fewer children than either the general or professional female population (Fouad, Fitzpatrick, & Liu, 2011; Mills, Mehrtens, Smith, & Adams, 2008). Hence it appears understandable that females may anticipate a lack of family-flexibility in engineering careers.

Much literature on the low proportion of WIE suggests that it is in part the result of internalised parental role stereotypes and the anticipation that an engineering career

will lack family-flexibility (Blakemore et al., 2009; Frome, Alfeld, Eccles, & Barber, 2008; Sadker et al., 2009). The stereotypical male parent role involves giving priority to full-time work and career while the stereotypical female parent role involves giving priority to the care of children (Blakemore et al., 2009). It is suggested that parental role stereotypes are socially learnt largely during childhood and at a later stage the individual begins to anticipate that an engineering career may not be family-flexible (Blakemore et al., 2009; Frome et al., 2008). Therefore, where there is a tendency for males and females to conform to parental role stereotypes, the proportion of females choosing an engineering career in pre-adulthood may be low due to females anticipating difficulty balancing an engineering career with primary carer responsibilities (Frome et al., 2008). Social cognitive theory and social role theory help explain the social learning of gender stereotypes (Bandura, 1992; Eagly, 1987).

Social cognitive theory involves the basics of social learning including extinction, reinforcement, and punishment in addition to emphasising the role of observation, imitation, and modelling in learning behaviour (Bandura, 1986). Bandura (1992) suggests that gender stereotypes are perpetuated in society largely through children observing and imitating adult gender stereotypical behaviour. In Australia, children under 15 years of age are much more often cared for by females than males, and males are much more often working than females (Australian Bureau of Statistics, 2006). Hence it follows that children may develop gender stereotyped parenting role behaviour by imitating what they see in Australian homes. That is, social cognitive theory helps explain the perpetuation of gender stereotypes through observational learning in childhood.

Social role theory explains how gender stereotypical expectations give rise to behaviour that conforms to gender stereotypes (Eagly, 1987). Gender stereotypes create expected behaviour that introduces gender bias into how children are treated. This

treatment leads to the individuals exhibiting the expected behaviour that affirms the stereotypes. Eagly and colleagues (2000) highlight that the tendency for people to conform to expectancies of others has been known for some time in psychology as *self-fulfilling prophecy* or *normative influence* (Deutsch & Gerard, 1955). The processes involved are often implicit and automatic, that is, the source and the target of the expectancies are unaware of the expectancy or the process occurring (Eagly et al., 2000). Hence, social role theory highlights the influence of gender stereotypical expectations on children and the potentially subtle nature of the process that leads to conformance with these expectations.

The presence of gender stereotypical expectations with regard to parenting roles in Australia is difficult to gauge primarily because, as Eagly and colleagues (2000) describe, the source and target may be unaware of such expectancies. The presence of these expectations may be inferred to some degree from a 2005 survey of Australian social attitudes. Some Australians believe that "a preschool child is likely to suffer if their mother works" (Western, Baxter, & Chesters, 2007). This belief appeared to be much more often held by males (40% agreeing) than females (26% agreeing) and much more often held by older Australians (43% of 65 years and older agreeing) than younger Australians (24% of 18-34 year-olds agreeing) (Western et al., 2007). These data may reflect a fading bias against mothers working. That is, there is some evidence to suggest that gender stereotypical expectations with regard to parenting may exist but may be fading in Australia.

In addition to social learning maintaining gender stereotypes, some research supports congenital biological differences between males and females contributing to the perpetuation of gender stereotypes (Blakemore et al., 2009). This is an extensive area of research falling largely outside the scope of the present study but should be mentioned to highlight that social learning may not completely explain the perpetuation

of gender stereotypes. Perhaps the most well supported example is the notion that prenatal androgens result in tendencies toward more stereotypical male behaviour and that this likely translates to career choice to some extent (e.g., Meyer-Bahlburg et al., 2004; Nordenström, Servin, Bohlin, Larsson, & Wednell, 2002; Pasterski et al., 2005). SCCT allows for biological predispositions to interact with learning experiences and hence influence career choice (Lent et al., 1994). Therefore, it is worth noting that the perpetuation of gender stereotypes and the observed low proportion of WIE may not be completely explained by social learning.

As described in the present study, social cognitive theory and social role theory have been used in the literature to explain how gender stereotypical parenting roles may be socially learnt during childhood as a result of children observing the status quo and being exposed to gender biased expectations (Bandura, 1992; Eagly et al., 2000). Literature supports the notion that internalised gender stereotypical parenting roles interact with an anticipated lack of family-flexibility in STEM careers to negatively affect STEM career development for women (Dean & Fleckenstein, 2007; Mills et al., 2008). Frome and colleagues (2008) showed that this issue appears to affect STEM career choice for females in pre-adulthood. That is, status quo and gender biased expectations during childhood may give rise to internalised parental role stereotypes that conflict with an anticipated lack of family-flexibility in engineering later in pre-adulthood to result in the low proportion of women becoming engineers. This influence can now be considered along with other influences on women becoming engineers that are described in the literature.

Chronological Presentation of Influences Behind Women Becoming Engineers

The present study considers that the process of choosing an engineering career is a continuous process over the lifespan as Lent and colleagues (1994) suggest. In line with the developmental approach of the present study, influences behind the career

development of females will be discussed chronologically and divided into four sections corresponding to four approximate time periods termed *pre-secondary school years*, *secondary school years*, *university years*, and *graduate years*. Some of these influences will be discussed in relation to SCCT to emphasise and explain their potential developmental impact. Influences that are purported to occur in more than one period will be discussed in the section corresponding to the period in which literature has most prominently identified them as first occurring.

Influences in the pre-secondary school years.

Blakemore and colleagues (2009) and Bandura (1992) suggest that playing with gender stereotypical toys (e.g., dolls for girls and construction toys for boys) in childhood may begin a developmental path that leads to the tendency to choose stereotypical careers as adults. There is some correlational evidence to support this (e.g., Metzler-Brennan, Lewis, & Gerrard, 1985) and anecdotal support from engineering students (Han, Sax, & Kim, 2007). Childhood play habits may be related to career choice by applying SCCT. For example, experimenting with blocks may result in elementary performance attainment in the domains of balance, structure, force, and spatial visualisation leading to further learning experiences and eventually to an interest and ability in physics that contributes to an engineering career in adulthood. Playing with dolls may result in performance attainment in the domain of nurturing that leads to further learning experiences and an interest in caring and family in adulthood that may be difficult to balance with an engineering career. Hence some literature suggests that gender stereotypical play in childhood may contribute to the low proportion of WIE but studies exploring this link appear scarce (Bandura, 1992; Blakemore et al., 2009).

Some literature suggests that gender stereotypical expectancies with regard to the performance of children in mathematics may contribute to the low number of WIE (Lindberg, Hyde, Petersen, & Linn, 2010). The belief that boys outperform girls in

mathematics is a stereotype commonly held by children, adolescents, parents, and teachers (Lindberg et al., 2010). Parents and teachers tend to underestimate maths ability of girls compared with boys even if their performance is the same (Zhang, Schmader, & Forbes, 2009). However, this stereotype is unsupported by research in Australia and elsewhere (Lindberg et al., 2010; Watt, 2008b). Lindberg and colleagues conducted a meta-analysis of 242 studies on this subject and concluded that girls' and boys' maths performance did not differ. Gender stereotypical expectancies with regard to maths performance may become self-fulfilling prophecies as previously described in the current paper with regard to parenting roles (Eagly et al., 2000). The self-fulfilling nature of teachers' expectations on performance in the classroom has been demonstrated by Rosenthal and Jacobson (1968, 1992). Self-fulfilment of gender stereotypical expectations may occur as a result of gender biased treatment (e.g., teachers being more attentive with boys than girls when teaching maths; Lester, 2010; Sadker et al., 2009). These expectancies, held by peers, parents, and teachers, may lead to girls having reduced self-efficacy in mathematics (Lindberg et al., 2010). In SCCT, reduced self-efficacy can be seen to lead to poorer outcome expectations as well as diminished interest, intentional goals, chosen actions, and performance attainment. Following SCCT, this effect then compounds by diminished performance attainment leading to poorer learning experiences which in turn further reduces self-efficacy and outcome expectations and the cycle repeats throughout career development. As postulated by Lindberg and colleagues, this process may result in decreased likelihood of pursuing a maths related career. Hence some literature suggests that gender stereotypical expectations with regard to mathematics ability may contribute to the low proportion of women becoming engineers but studies exploring this link appear rare.

Stereotype threat presents a further mechanism that may negatively influence females choosing maths related careers (Zhang et al., 2009). Steele (1997) describes the

concept of stereotype threat, where negative stereotypes can reduce measured performance in a particular domain by increasing anxiety and, in severe cases, the individual may no longer identify with the domain and no longer care about their performance in it. This is offered as an explanation as to why it is sometimes observed that females have better course grades than indicated by standardised testing in mathematics (Blakemore et al., 2009). Experimental research has shown stereotype threat negatively influencing maths performance in girls as young as 5 years old (Ambady, Shih, Kim, & Pittinski, 2001) and influencing career choice of female engineering students at university (Zhang et al., 2009). SCCT considers that anxiety may interfere temporarily with self-efficacy, leading directly to diminished performance attainment and that this may cycle back to have a more permanent effect on self-efficacy and outcome expectations, and therefore performance (Lent et al., 1994). That is, stereotype threat may further contribute to the low proportion of WIE and there is some experimental evidence to support this.

In summary, influences on females prior to secondary school that are commonly discussed in the literature include play behaviour and gender biased maths performance expectancies but studies that explore these influences appear rare. The influence of stereotype threat is supported by experimental evidence (Ambady et al., 2001). Influences that are mentioned in the literature as first occurring during secondary school will now be discussed.

Influences in the secondary school years.

Two exploratory studies highlight influences on career development during secondary school years reported by WIE. Mills and colleagues (2006) looked at what factors influence females to choose engineering as a career in Australia as part of a study using in-depth semi-structured interviews with 41 female and 10 male engineers. The sample used was approximately representative of the age range, geographical

location, and engineering fields of Australian engineers in general. Mills and colleagues (2006) acknowledge that their sample was not large enough or appropriately taken to represent engineering or WIE in Australia in general. Wentling and Camacho (2008) conducted a survey of 89 female engineering graduate students aged 21 to 30 years old and focus groups with 24 female engineering graduates. All graduates were from one university in the United States of America. The study focussed on factors that had hindered or assisted these women at secondary school in their decision to study engineering as well as factors that hindered or assisted these women at university while completing an engineering degree.

WIE report that they had a poor understanding in secondary school of what engineering was (Mills et al., 2006; Wentling & Camacho, 2008). Women interviewed by Mills and colleagues felt that better emphasis on non-technical and people oriented aspects to engineering would help influence females to choose an engineering career (Mills et al., 2006). That is, a lack of an accurate understanding of what engineering involves may discourage females from choosing engineering careers.

Females in secondary school appear to give higher priority than males to family-flexibility in careers and this may combine with an anticipated lack of family-flexibility in engineering to result in fewer females choosing to study engineering at university (Frome et al., 2008). This has also been noted as a negative influence on female engineering career development at university and in the workplace (Dean & Fleckenstein, 2007; Mills et al., 2008). The tendency of females, more than males, to prioritise family-flexibility in career may be the result of internalised gender stereotypical roles as previously described in the current paper. Following SCCT, the anticipated lack of family-flexibility in engineering may adversely influence career development of females through the negative outcome expectation of work-family conflict (Lent et al., 1994).

Female role models in secondary school are known to influence women positively when making decisions to study engineering or similar fields at university (Beyer, 2008; Demetre et al., 2009; Hoh, 2007). Unfortunately the low number of women in engineering and similar fields means female role models are scarce. WIE identify a lack of visible female role models in their secondary school years as a hindrance to their choice to study engineering (Mills et al., 2006, Wentling & Camacho, 2008). Further to this, role models and mentors appear to have a positive influence on the career development of women studying STEM fields at university (Fifolt & Abbott, 2008; Marszalek, Linnemeyer, & Haque, 2009; Whitten et al., 2007). Role models and mentors are accounted for in SCCT by contributing via vicarious learning to self-efficacy and outcome expectations. That is, the engineering field being predominantly male may negatively influence women choosing to study engineering through exhibiting a lack of female role models.

WIE identify that, in their secondary school years, their desire to make a positive contribution to society positively influenced their decision to study engineering because they expected an engineering career to provide such opportunity (Mills et al., 2006; Wentling & Camacho, 2008). This influence may be more pertinent for females than males. Females appear to give higher priority to helping behaviour and communal goals in employment than do males (Diekman, Brown, Johnston, & Clark, 2010; Eccles, 2007; Yanowitz, 2004). This may combine with a real or perceived lack of opportunity for helping behaviour and serving communal goals in engineering to result in fewer women than men in engineering (Diekman et al., 2010). There is some evidence to suggest this influence, and this perception of STEM careers, may exist prior to secondary school (Yanowitz, 2004) and in the university years (Diekman et al., 2010). Comments by one woman who had left engineering lends support to there being some truth behind this perception and its influence on engineering career development:

> I think I probably will say I regret leaving the industry because at the end of the day my heart truly believes in the engineering industry ... It's a lot of contribution engineering can make to the quality of life and people, and that's the main I suppose mission of it, but unfortunately the real world doesn't necessarily reflect the true engineering purpose. Yeah, unfortunately there's a lot more commercial stuff happening out there and that's just the business side of it, the wheeling and dealing and the realities of it. (Mills et al., 2006, p. 143)

The observed tendency for women to give higher priority than men to helping behaviour and communal goals, may form part of a gender stereotype and hence may be the result of social learning processes previously discussed in the current paper with regard to stereotypical parenting roles (Blakemore et al., 2009). Therefore a desire to contribute positively to society may influence girls choosing to study engineering negatively or positively depending on perceived opportunity to fulfil this goal in an engineering career.

Mills and colleagues (2006), and Wentling and Camacho (2008) found a dominating reason WIE gave for choosing to study engineering at university was an aptitude and liking for maths at school. Applying SCCT, it is likely that performance in this domain is commonly attained prior to secondary school and that this contributes to further performance attainment in secondary school and beyond. Mathematics at school is commonly considered a "critical filter" for females with regards to maths-related careers including engineering (Watts, 2008b). That is, child and adolescent interest and ability in maths may contribute positively to choosing a career in engineering.

Secondary school teachers often play a part in encouraging young women on an engineering career path. WIE report having excellent maths/science/technology teachers who encouraged them to follow their interest in maths/science/technology and

participate in related extracurricular activities (Wentling & Camacho, 2008). In addition, science and maths teachers may directly encourage students to choose an engineering career (Mills e al., 2006). That is, quality secondary school teachers in STEM fields are commonly reported to be a positive influence behind women choosing to study engineering.

In Wentling and Camacho (2008), WIE identify further expectations with regard to engineering careers that contributed to their decision to study engineering. As students they enjoyed problem solving and being challenged and expected that engineering would provide these opportunities. WIE also chose to study engineering because of the range and number of job opportunities as well as the high salaries generally available to engineers. Hence positively perceived attributes of engineering careers like challenge, abundant job opportunities, and high salaries may influence women to choose to study engineering (Wentling & Camacho).

Family factors play a major role in influencing women choosing to study engineering (Mills et al., 2006; Wentling & Camacho, 2008). It is likely that family influences on career development begin much earlier than secondary school but little research seems available on this. Family influences similar to those reported here for secondary school students remain influential at university (Powell et al., 2007). Family interest and involvement in science and engineering positively influence secondary school students into STEM career paths (Gilmartin, Li, & Aschbacher, 2006). During the secondary school years, parental moral support of career choice and anticipated financial support of university studies facilitates the choice to study engineering (Wentling & Camacho, 2008). WIE report that having an engineer in the family (commonly the father) contributed to their choice to study engineering by providing a role model and mentor as well as by providing assistance with maths/science/technology homework at school (Mills et al., 2006; Wentling &

Camacho, 2008). That is, WIE identify several family factors that influenced their career development at secondary school and university.

The media may influence the career development of girls (Davies, Spencer, Quinn, & Gerhardstein, 2002; Steinke et al., 2006; Steinke et al., 2009). It is likely that media influences on career development begin much earlier than secondary school but related research looks at influences on US middle school students with average age greater than 12. Women are commonly portrayed in the media as dependent, passive, and emotional with more interest in appearance and romance than in study or career (Steinke et al., 2006). This portrayal of women in the media appears to have a negative influence on girls aspiring to enter STEM careers (Steinke et al., 2006). It has been demonstrated that existing stereotypical television advertising can induce stereotype threat and result in reduced maths performance and avoidance of STEM related study and careers for women at university (Davies et al., 2002). In contrast, positive role models in the media (e.g., Kari in the science entertainment television program, Mythbusters) appear to have a positive influence on secondary school age girls (Steinke et al., 2009). In SCCT these influences can be considered as vicarious learning experiences that affect self-efficacy and outcome expectations. Hence, evidence suggests that role models in the media influence the career development of females.

In summary, influences on females during secondary school years include knowledge of what an engineering career may involve, anticipated work-family conflict, desire to make a positive contribution to society, aptitude and liking for maths, quality secondary school teachers, anticipated employment prospects, and family influence. However, the majority of this information is drawn from one US study (Wentling & Camacho, 2008) and one Australian study (Mills et al., 2006) and hence support for these influences may be considered limited. The exception to this is the influence of female role models at school and in the media which seems well supported (e.g., Beyer,

2008; Demetre et al., 2009; Hoh, 2007). Influences that are mentioned in the literature as first occurring during university years will now be discussed.

Influences in the university years.

Powell and colleagues (2007) conducted a qualitative study of the university experiences of female engineering students by utilising semi-structured interviews with 52 female students (13 of these also participated in focus groups) at two UK universities. Powell and colleagues found women studying engineering reported gender bias while at university. For example, communication between male and female students was sometimes difficult (e.g., male students not listening to a female student and male students excluding a female student in group work). In addition, some university staff appeared to give obvious preference to helping female students, which was difficult to refuse for the female and gave rise to resentment in the male students. Hence, gender bias at university was typically reported as a negative influence on career development.

Several factors not already described in the present study are commonly reported by WIE to be positive influences on their career path at university (Powell et al., 2007; Wentling & Camacho, 2008). Good lecturers and enjoyable classes, in which the students performed well, influenced women to complete their engineering studies. Good lecturers are described as being approachable, possessing industry experience, effective teachers, supportive, and motivational. Industry placements while at university were seen as positive because of the practical experience gained and the building of confidence in the applicability of their university studies. Good relationships with other students and lecturers were considered as positively influencing women through university. Female engineering students enjoyed the like-mindedness, help, and support of colleagues at university. Further to this, female engineers found extracurricular activities with student organisations helpful and this has been reported elsewhere

(Hartman & Hartman, 2008). The financial benefit of scholarships was also appreciated. Hence, several factors including good lecturers, industry placements, good relationships, and scholarships may be positive influences at university behind females choosing an engineering career (Powell et al., 2007; Wentling & Camacho, 2008).

Engineering course content influenced women while completing their degrees. Women found the variety in course content offered by studying the various engineering streams was enjoyable but the variety also contributed to high workload and perceived irrelevance (Powell et al., 2007). High workload as well as irrelevant and overly theoretical course content are commonly cited by women to be negative aspects to studying engineering (Powell et al., 2007; Wentling & Camacho, 2008). That is, the variety experienced in engineering course content is in part a positive influence but high workload, irrelevant and overly theoretical course content may be negative influences on career development.

Some research has reported that women have used instances of discrimination as motivational. Lester (2010) found women enrolled in STEM related study at a US college reported experiencing discrimination that led to feelings of isolation, intimidation, and a loss of self-confidence. However, the women interviewed typically had translated these experiences to be motivational, giving them further inspiration to succeed. Typically the women had used this coping technique successfully in similar situations previously in their lives (e.g., at school) (Lester, 2010). Some participants in focus groups for Wentling and Camacho (2008) expressed being motivated by successfully contradicting stereotypes with regard to female ability in maths, science, and engineering. Hence, it may be that some WIE have used experiences and feelings of discrimination as motivators in their career development.

In summary, influences on females during university years included gender bias from students and staff, quality of lecturers, industry placements, relationships with

students and lecturers, involvement with student organisations, scholarships, workload variety, workload level, and perceived irrelevance of course material. However, the majority of this information is drawn from one US study (Wentling & Camacho, 2008) and one UK study (Powell et al., 2007) and hence support for these influences may be considered limited. Influences that are mentioned in the literature as first occurring during graduate years will now be discussed.

Influences in the graduate years.

The scope of the present study is limited to influences behind women choosing engineering as a career up until getting their first job out of university as a graduate. Commonly, research looks at career development influences on established female engineers but is not focussed on graduates alone (e.g., Association of Professional Engineers, Scientists and Managers, Australia [APESMA], 2010; Mills et al., 2008). This research will be briefly outlined in the present study as a guide to what factors may be influencing the career development of female graduate engineers.

Some WIE highlight experiencing boredom due the lack of intellectual and creative challenge (but not the workload) in engineering jobs (Mills et al., 2006; Mills et al., 2008). Female engineers in Australia face high levels of discrimination and sexual harassment, having to prove themselves while men are assumed to be capable, and feeling that engineering is a 'boys' club' (APESMA, 2010; Mills et al., 2008). A common reason given by women for leaving engineering is that women still predominantly assume the primary carer role within families and, although much progress has been made in this regard, engineering careers remain largely incompatible with such responsibilities (APESMA, 2010; Mills et al., 2006; Mills et al., 2008). Finally, it should be noted that men and women engineers predominantly report high levels of satisfaction with their careers (EA, 2008). The three most satisfying areas for WIE being physical work conditions, job security, and satisfaction with colleagues.

Hence, there are some aspects to working as an engineer that may negatively influence and some that may positively influence career development for WIE. While this may provide some indication of what may influence female engineers during the graduate years, no available research focuses on this period.

The Present Study

Studies that take a developmental approach to exploring the influences behind women becoming engineers appear absent from the literature. A developmental viewpoint (as presented in the previous section) must be pieced together from theoretical literature (e.g., Bandura, 1992) and a limited selection of studies (e.g., Mills et al., 2006; Powell et al., 2007; Wentling & Camacho, 2008). Studies seem to have given most attention to influences on established female engineers (e.g., APESMA, 2010; Mills et al., 2008), some attention to influences during secondary school and university years (e.g., Mills et al., 2006; Powell et al., 2007; Wentling & Camacho, 2008), and little attention to social influences prior to secondary school. It follows that the present study should have a developmental focus to help address what appears to be lacking in the literature.

Considering the pre-adulthood influences previously discussed in the present study it becomes evident that gender stereotypes may have an extensive role in producing the low proportion of WIE. That is, it is evident that gender stereotypes with regard to parenting, maths ability, and helping behaviour and communal goals may discourage women more than men from following an engineering career path (e.g., Diekman et al., 2010; Frome et al., 2008; Spelke & Grace, 2007). Further to this, literature suggests that gender bias plays a major part in maintaining gender stereotypes in society (e.g., Eagly et al., 2000) and gender bias has also been reported in the present paper as a direct negative influence on women following an engineering career path (e.g., Powell et al., 2007). Therefore, the low proportion of WIE may be extensively

linked with gender stereotypes and gender bias. Gender stereotypes are known to be dependent on culture and time (Blakemore et al., 2009, Lynch & Nowosenetz, 2009; Varma, 2010). It follows that research exploring the career development of WIE who grew up in contemporary Australia (i.e., the focus of the present study) may reveal themes not yet realised in available literature.

The present study uses a phenomenological framework and semi-structured interviews to explore the pre-adulthood career development of WIE in the least restrictive way. WIE may hold unique insight into gender bias because they may not have internalised gender stereotypes (Bem, 1981; Cameron, 2001; Swim & Hyers, 2009; Barreto, Ellemers, Cihangir, & Stroebe, 2009). Contrary to this, WIE may find it difficult to identify gender bias (Fouad et al., 2011). Women who attempt to violate gender stereotypes experience gender bias (Tougas, Brown, Beaton, & St-Pierre, 1999). The potential for WIE to have unique insight into gender stereotypes and gender bias adds to the benefit of the present study interviewing WIE. Therefore, the present study aims to add to the current body of knowledge by using the least restrictive approach and accessing potentially unique insight from WIE.

The current study aims to explore the factors that have influenced pre-adulthood career development of WIE. It may highlight aspects of Australian society that work against or assist females along the path to an engineering career. It follows that potential opportunities for increasing the number of women in engineering may be identified. The current study may also bring to light the impact of real or perceived inadequacies in engineering careers such as the lack of family-flexibility or the opportunity for helping behaviour and fulfilling communal goals. These aspects may indicate areas for potential improvement in the way the industry operates or promotes itself. Finally, the study may demonstrate the nature of gender bias in contemporary Australian society through its possible link with the low proportion of WIE. To achieve these aims, the current study

poses the question: What are the developmental psycho-social influences behind women becoming engineers?

Method

Research Design

Quantitative methods are inadequate for addressing multiple perspectives, complexity, and human centeredness (Webster & Mertova, 2007). Qualitative methods are effective for exploratory studies and provide unique insight into the experiences of participants and their interpretation of those experiences (Liamputtong & Ezzy, 2005). For these reasons the present study is qualitative in design. A phenomenological methodology was used because it suits the aim of better understanding the lived experience of females who follow the path to become an engineer. The present study was likely to involve issues of discrimination and these may be best understood through lived experience, as suggested in that interventions for discrimination commonly involve role-playing the experience (e.g., Stewart, LaDuke, Bracht, Sweet, & Gamarel, 2006). The focus of phenomenology is description rather than explanation of experience and this makes it ideal for an exploratory study (Moustakas, 1994). Semi-structured interviewing was employed to ensure the freedom to pursue unexpected but potentially relevant topics while providing adequate direction for participants.

Participants

The study involved interviews with 10 women currently employed as engineers in Perth, Western Australia, who had been working as graduate engineers for less than 3 years. This number of participants was thought to be sufficient to reveal elements of common lived experience (Starks & Trinidad, 2007). The participants were 22 to 25 years old ($M = 23.8$) and 6 worked in the resource sector and 4 in the construction sector. It should be noted that these sectors are not mutually exclusive (e.g., sometimes work in construction serves the resource sector). The engineers' qualifications included

civil, environmental, chemical process, and mechanical engineering. The young age of participants was intended to maximise the degree to which their pre-adulthood experiences reflected contemporary society. All participants completed primary, secondary, and tertiary education in Australia and this was intended to help ensure their pre-adulthood experiences reflected Australian society. The majority of the participants (8 of 10) had attended co-educational schools.

Materials

Two digital voice recorders were employed to record the interviews and notes were taken during the interview if required. A letter was sent to the Chair of the WA branch of Engineers Australia Women in Engineering group in order to facilitate contact with potential participants (Appendix A). A Study Information Letter and Informed Consent Form was supplied to each potential participant (Appendices B & C). A Demographic Sheet was supplied to the participants for them to enter details on the industry in which they were employed and their educational history (Appendix D). A Support Organisations List (Appendix F) was supplied to each participant. An interview guide (Appendix E) was used to conduct the interview. The questions asked included the broad opening question, "Can you tell me about any positive or negative experiences on the way to becoming an engineer?" and others such as, "Tell me about the time you made the decision to study engineering" (see Appendix E).

Procedure

Approval for the present study was sought from the ECU School of Psychology and Social Science Ethics Sub-Committee. Following the study's approval, the Chair of the WA branch of Engineers Australia WIE Group was sent the letter in Appendix A along with the Study Information Letter (Appendix B) and Support Organisations List (Appendix F). As a result of Engineers Australia's interest and the Chair's personal interest in WIE, the distribution of the Study Information Letter and Support

Organisations List was facilitated by Engineers Australia in WA. Interested individuals then contacted the primary researcher. On contact with the primary researcher, the potential participant was thanked for their interest and compliance with the study criteria was checked because of its unusually restrictive demographic requirement. An interview was then scheduled at a time and place of mutual convenience (during June, July, and August of 2011) and potential participants were sent an Informed Consent Form (Appendix C) and Demographic Sheet (Appendix D) to be completed before they attended the interview.

The primary researcher has followed his own path to becoming an engineer, has worked with many engineers, some female, has worked part-time as an engineer in order to balance career with family, and has observed closely the development of his teenage daughters. As a result, the primary researcher had formed many opinions with regard to pre-adulthood development, gender issues, and the engineering career path. This presented some challenge because the phenomenological researcher must set aside their own biases and prejudgements prior to the interview (described as *Epoche* by Moustakas, 1994). The primary researcher made a conscious effort during the interviews to set aside his own opinions and allow the participants to direct the interview by using open ended questions and by only examining specific issues after they were raised by the participant. The primary researcher also observed his role carefully in the interview process when transcribing to help improve Epoch in the next interview in which he was involved. Acknowledging and setting aside priori knowledge and opinions in this manner improves rigour in qualitative research (Creswell, 2009; Starks & Trinidad, 2007).

At the interview, the researcher began by introducing himself, describing the aim of the research, and advising that the participant may refuse to answer questions and withdraw from the study at any time. The participant was supplied a paper copy of

the Study Information Letter and Support Organisations List that they should already have had an opportunity to read when they initially found out about the study from Engineers Australia. The participant was asked to supply the signed Informed Consent Form (Appendix C) and completed Demographic Sheet (Appendix D), and the researcher signed the Informed Consent Form before beginning the interview. The participant was told that the interview would be digitally recorded and transcribed verbatim with the exception of personal identifying information which would be coded with pseudonyms. They were advised that the researcher may occasionally take notes during the interview and would later email a descriptive summary to the participant for verification and clarification of meaning and content (see member checking below). Each participant was advised that the digital recording, transcript, and description of key content would be stored securely for 5 years and then erased.

Prior to the interview commencing, the participant was given the opportunity to ask any questions they may have had. The participants were generally advised of the broadness of the interview questions and the unstructured nature of the interview. This was because many participants appeared to be expecting a list of quite specific questions. The digital voice recorders were then activated and the interview commenced with the first question of the interview guide in Appendix E. The unstructured nature of the interview meant that the rest of the interview followed the intention of the schedule as outlined in Appendix E rather than specific questions. During and prior to the interview, listening techniques as described by Bolton (1987) and Egan (2007) where utilised to build rapport with the participant. The interview was terminated after 45 minutes to 1 hour with the participant being asked if there was anything else they would like to add. Once the participant indicated they were happy to stop, the recorders were stopped. On completion of the interview the participant was thanked.

Analysis

Transcription and analysis were initiated as soon as possible to help identify blindspots in the study and provide an opportunity to rectify them for further interviews as outlined by Miles and Huberman (1994). Analysis followed the steps described for phenomenological research in Moustakas (1994) incorporating aspects from Creswell (2007, 2009). This process began with Epoche as suggested by Moustakas to help maintain rigour as was described in the above procedure implemented prior to the interview. During phenomenological reduction the researcher must keep focus on the research topic (*bracketing*). Initially every statement in the interview was given equal value (*horizonalisation*). Following this, a process of reduction was conducted where statements found to be irrelevant to the study or statements that repeat the meaning of other statements were removed. Only the statements that carried the invariable meanings associated with the phenomena (known as *horizons*) remained (Moustakas, 1994).

A chronologically arranged descriptive summary of the phenomenon was formed for each participant following phenomenological reduction as described by Moustakas (1994). This description was emailed to each participant asking for clarification and verification of content and meaning. This was employed as a form of member checking consistent with that generally applied in qualitative research (Creswell, 2009; Doyle, 2007). Member checking is one of the most significant methods for achieving rigour in qualitative research (Doyle, 2007). Feedback received from participants on this description was positive, (e.g., *"it's actually quite interesting reading over a summary about yourself"*) and some minor corrections and additions were suggested by some participants.

Continuing the process described by Moustakas (1994), horizons were grouped into *clusters of meaning* around common themes and sub-themes in a hierarchical

manner. This process was conducted using the transcripts from all the interviews. Themes and sub-themes were then portrayed in the present study using significant statements from participants with various perspectives. Utilising significant statements from various perspectives is a known method for helping to establish rigour in qualitative research (Creswell, 2009). The participants' common experience (*textual description*) and the context in which it was experienced (*structural description*) were then combined in a vignette (*essence*) representing the common experiences of the participants and portraying what it may be like to experience the phenomenon.

Findings and Interpretations

The aim of the present study was to explore the pre-adulthood experiences of women who had become engineers, focussing on possible influences behind their career choice. Content analysis was conducted on the interview transcripts and influences appeared to be related to four main themes with contributing sub-themes as shown in Table 1. The following section will outline material from the present study around each theme and sub-theme in the order presented in Table 1 and comparisons will be made with available literature. This will be followed by a vignette presenting the essence of the phenomenon experienced by the participants as described by Creswell (2007).

Table 1

Themes and Sub-themes

Theme	Sub-themes
Home	Early interests
	Parents
Social Group	Being a female
	Being a *"nerd"*
Education	Ability and interest
	Teachers and lecturers
	Course content
Engineering Career Expectations	Job prospects
	Job content
	Family-flexibility

Home

Two sub-themes emerged centred on the home-life of the participants in the present study and they were early interests and parental influence. This added support to the limited research available on the influence of early interests (e.g., Metzler-Brennan et al., 1985) and parents (e.g., Wentling & Camacho, 2008).

Early interests.

Childhood interests recalled by participants as possibly being related to their career included playing with Lego and blocks, drawing and looking at building designs, and seeing engineering projects close up. Many participants recalled frequently playing with Lego and blocks in their childhood and related this play as possibly contributing positively to their career development. Chloe described this process:

...building things, little cars going down ramps, everything that you could sort of, I could plonk myself in a room and be surrounded by blocks. That was

> *because Mum was a single Mum, she had to work so that was a really good baby sitter. And from there I learnt to entertain myself and it went from just mucking around with Lego to doing a bit of, I actually really liked designing houses and stuff, she loved going through them on weekends, like the display homes and stuff because we used to live where all the houses were getting built so I used to get dragged through those on the weekends. So again, loved design, picked things I didn't like the design of, or how things were actually built.*

The involvement of males rather than other females was sometimes mentioned as a possible influencing factor behind this play. For example, Heather described:

> *I had two brothers and no sisters so like we played games, we played with Lego I guess and blocks and like building houses out of blocks and things like that are some of the games I would have played when I was quite young.*

Ashley recalled from age 5 or 6, "*I have memories of my dad as a kid building... with blocks and I remember him specifically saying 'You gotta make a big firm foundation otherwise it won't stand' so I think that's when my engineering education began*". Ashley was careful to clarify that her early interests also included those more stereotypically female by saying "*I was also interested in pink dresses and Barbies*". The relationship between playing with blocks in childhood and STEM career choices may add support to literature that postulates the low proportion of WIE is partly due to girls generally being encouraged to play with stereotypical female toys like dolls rather than stereotypical male toys like blocks (Bandura, 1992; Blakemore et al., 2009).

Participants in addition to Chloe (quoted above) referred to developing an interest in building design and house plans at a young age and related this to their career in engineering. Such early interest in design and ability in spatial processing may be causally related to later interest and ability in engineering by applying SCCT (Lent et al., 1994). Heather recalled that from around 13 years old:

I love looking at buildings, like I look at newspapers and look at floor plans and things like that, you know that's the sort of things I like, so when I sort of found out what a structural engineer was, I thought well what else am I gonna do?

Participants in the present study had grown up amongst major engineering industry such as mining or civil works. Sophie described being inspired and amazed by these surroundings and relates it to her career interest:

Thinking back I've always been drawn to engineering because my dad [caretaker of a large drinking water reservoir] *used to take us out on the boat and, this massive dam and I was just always like inspired by it.... and then obviously growing up* [in a mining and power generation region] *...you can see the big clouds just driving around the area, just by living there... some of the roads go really close to the cooling towers and stuff and the mine and you can see in the mine and you can see the cooling towers and stuff and... I remember being a little kid and just being like amazed by it, so always interested in that stuff.*

Parents.

Parents were remembered by most participants as being supportive and encouraging of the participant's decision to study engineering at university however it was also generally asserted that their parents would have been equally supportive of a wide range of career paths. The finding that parental moral support had a major role in the career development of WIE is reflected in the literature (Wentling & Camacho, 2008). In the present study, Sophie recalled:

She [Mum] *knew that I would do it and I would be good at it, or I would try my hardest to be good at it so she was just happy for me to do whatever I wanted to do, and I think that she was happy that I was doing something that I could get a good job in and not just loaf around at uni for 10 years.*

Lauren recalled that her father may not have been as supportive of career choices other than engineering when she explained, "*My sister had a bit of trouble from my father in particular, she does psychology, she's doing honours right now, and he was worried about her doing something that wouldn't pay much*". Emily explained that she had observed other parents who did not support their daughters in considering an engineering career and such observations generally highlight how influential parents may be on career choice:

> *I have not personally experienced this but I've since spoken to other girls who were at high school, you know like careers fairs and that sort of thing, and they'll be there with their parents and their parents are sort of very anti-girls-doing-engineering which is strange in this day and age I would have thought but yeah it sort of like really affected me because...if your parents have that attitude, like how limited are you?*

Some participants in the current study had fathers who were engineers. The influence of engineering fathers on women choosing engineering careers is noted in the literature with regard to providing a role model and mentor as well as through assistance with maths/science/technology homework at school (Mills et al., 2006; Wentling & Camacho, 2008). In the present study, Ashley described how her father, an engineer, may have influenced her maths performance in primary school and that this may have had an impact on her career development:

> *He* [father] *was rather concerned that I wasn't doing well at maths, my mum wasn't nearly as concerned.... I remember my dad actually used to give me tutor books and stuff like that.... And so I think when I suddenly was becoming good at maths, I wanted him to be proud of me and he was more proud of me I suppose...and so I have always leaned towards those subjects I suppose because I was good at them and I knew that that was what he did as well.*

Ashley clarified this further saying, *"My dad would be proud of me no matter what I did, so it was never 'I've got to do this in order to make daddy proud' "*. Amelia suspected that the influence of her engineering father may have been profound and unconscious, and may have resulted in her following a career that she sometimes felt no personal motivation to follow:

> *A lot of the girls that I know, and a lot of the guys as well, a lot of the girls, their fathers are all engineers, and that's a real interesting topic... I think it's a subconscious influence and maybe like halfway through my degree I'm like 'why the heck am I doing this?' so it's not really a ... self-motivation.*

Some participants in the present study had non-engineering fathers who worked in engineering industries like mining, oil and gas, or civil works. This may suggest that fathers who are not necessarily engineers, but who are employed in engineering industries, may positively influence their daughters toward becoming an engineer. Facilitative role modelling by non-engineering fathers is not mentioned in the literature. Participants noted a disadvantage to having parents who had not attended university. These participants expressed missing the guidance, understanding, and knowledge that they believed a university educated parent may have been able to provide in high school and university, a notion supported in Wentling and Camacho (2008). Amy found this *"a pretty big challenge to overcome. I didn't have anybody else to ask what was uni about and what do you do there and how hard is it and what was it like*." Lauren described frustration that she related to being the first family member to attend university, saying her family "*don't understand the study commitments and when I went home I had to study, turn the TV off and let me study*". It seems it is possible that having a father in industry facilitated an engineering career choice by providing a role model for the participants in the present study. However for some participants, the lack of parental

role model who had attended university presented a challenge in their engineering career development.

Social Groups

A social theme commonly explored in research on the career development of WIE is one involving social groups as defined by gender. Such research generally asserts that a part of the reason for the low proportion of WIE is that the "masculine culture" of engineering is incompatible with females in some respects (e.g., Mills et al., 2006). This assertion was supported in the present study and will be discussed below. In contrast to this, the present study also highlighted that there are some females who felt greater compatibility with aspects of what they perceive as male culture compared with female culture and this is not examined in the literature on WIE. Further to this, a social theme that appeared more obvious in the present study than that involving the participant being a female was that involving the participant being an "*uber-nerd*" and this does not appear to be examined in the literature. These influences contributed to a social group theme and will now be discussed beginning with incompatibility and compatibility with perceived male culture followed by the sub-theme of being a nerd.

Being a female.

Research has highlighted that WIE have expressed discomfort with the male dominated environment they experience at university and in the workplace (e.g., APESMA, 2010; Mills et al., 2006; Mills et al., 2008; Powell et al., 2007). This assertion was supported in the present study and started in upper school for Chloe:

> *One of the biggest obstacles is probably the amount of males in the class situation. I was in classes, I was one of two girls in our class. Even here* [Chloe's workplace] *like you walk around the floor and it's the same at uni and that can be a positive and a negative. Negative because it's really sort of you feel out of your comfort zone a lot.*

Chloe continued her description and highlighted discomfort that may be interpreted as stereotype threat (Steele, 1997) in her workplace: *"If you walk into a room you will get noticed so if you do good things then you will be remembered but if you screw up you will really be remembered"*. Chloe had felt the stereotype that *"girls shouldn't be good at maths"* since primary school and, to an extent, it had motivated her to outperform boys at maths. Females using this stereotype as a motivation is a notion reflected in some research (Lester, 2010; Wentling & Camacho, 2008). Literature reports this stereotype being held by peers, parents, and teachers (Lindberg et al., 2010). Parents and teachers were not highlighted in the present study as gender stereotyping maths ability. Chloe attributed her perception largely to the comments of peers.

Some of the participants who highlighted feeling discomfort in male dominated classes and in the workplace attributed their discomfort to what was most probably sexism and sexual harassment but these terms were seldom used to describe such behaviour. Instead participants tended to use words like "*uncultured*" and relied on implication to communicate the behaviour. Gender biased treatment from teachers and lecturers was generally presented as very rare while that originating from male students was more common. Ashley outlined the way that she felt most female engineering students made adjustments to avoid this gender biased treatment:

> *I think most women* [engineering students] *do it actually, you tend to look at the engineering common room and go "I don't want to be in there, and the type of boys who, mainly mechanical, I don't really want to associate with those people". So engineering male boys are not the nicest and most cultured people as I am sure you're aware.*

A surprising finding in the present study, generally not mentioned in the literature, is that significant problems occur with the male dominated culture because of the higher level of swearing that males appear to use amongst themselves compared

with females. The swearing itself had been a source of discomfort for women at university, on vacation work, and in the workplace as a graduate but most participants who highlighted swearing as an issue suggested that they would rather males did not change their language to suit females. These women had commonly experienced men obviously avoiding swearing in the presence of women and this had caused the women to feel uncomfortable with attention being drawn to their gender. For example, Heather vividly remembers attending a meeting that was opened with the line, "*okay gentlemen let's keep the language down there's a lady in the room*". Further to this, men avoiding swearing in the presence of women led to women being socially excluded. Jessica described how she believed this affected her career development during vacation employment and as a graduate:

> *It's very male orientated and you can be, I guess, left out of some things because the guys are being a bit cautious about saying the wrong thing or doing the wrong thing.... how you talk, it's a lot of swearing and using words I guess they choose not to talk around females which is a courtesy thing I guess but then you feel that they are not saying, not telling jokes and stuff and being themselves in front of you because they're just being a bit careful, and it's hard to get to know them and then build a working relationship where you can actually go to them for help and stuff like that.*

That is, Jessica highlighted the potentially far-reaching consequences of a seemingly simple "*courtesy*" on career development for WIE.

Some participants in the present study felt greater compatibility with what they perceived as male culture than what they perceived as female culture. This is a notion that does not seem to be mentioned in research on WIE and contrasts with the focus on incompatibility females find with the male dominated environment. Referring to the male dominance in her upper school STEM subjects and engineering at university,

Emily stated, "*actually, me personally, I tend to get along better with guys anyway or the types of girls that do engineering. They're.... more down to earth*". Preferring a male domain was similarly expressed by Sophie:

> *I have always been more comfortable around boys than girls, I find your exchanges sort of much more task orientated, to the point, that's me, if you have a problem with someone you punch them and then you're over it where as girls will bitch and manipulate and make people cry, and give people eating disorders. So I just like that it's up front, you see what you get, I mean that's a generalisation I know but in general that is my experience and even to this day I am much more intimidated in a room full of women than a room full of men, much more intimidated, just because there's like that fear of judgment, "What is she doing?" and "Can you look at her shoes!".*

Such comments reflect that perception of male and female culture may influence some females toward following an engineering career path, a notion not considered in the literature.

Being a *"nerd"*.

A sub-theme involving "*nerd*" versus non-"*nerd*" groups emerged in the present study in contrast to female versus male group theme commonly discussed in available literature. The term *nerd* reflects the language used by the participants in the present study and, for the purposes of the following discussion, refers to an individual with high academic ability and focus through primary and lower school, a focus on tertiary entrance in upper school, and a focus on successful completion of their chosen degree at university. Developmentally, this theme emerged as social isolation and difficulty in much of the participant's younger years at school where like-minded peers (nerds) seemed very hard to find. This was followed eventually by significant social relief, often when the participants reached upper school where they found themselves amongst

a group of like-minded peers studying subjects for tertiary entrance. Further social pleasure followed when the participants found themselves at university and at work, with people who they could consider like-minded. It will be shown below that this social theme may present negative and positive effects on the career development of WIE.

Participants commonly described varying degrees of bullying in primary school. When the reason for the bullying was examined it was mostly put down to differences that may be considered as differences between "nerdy" and "non-nerdy" groups. Chloe described "*I really didn't enjoy primary school all that much ... as I was quite shy and got bullied a lot*". Sophie highlighted that *"you can get picked on for being good at maths*". Amy described how this continued into secondary school:

> *I always found it quite challenging at school because I was quite applied at my school work... and you know tall poppy syndrome and people not really appreciating people applying themselves at school when you're in like year 8 and 9... so wasn't really like the most supportive group of individuals, so yeah I found that like hard, people not really appreciative of people who wanted to apply themselves at school.*

Lauren highlighted the extent of bullying she experienced as a nerd at school "*I was already ahead of the class from year 4 and I guess I got bullied extremely hard for that from year 4 through to year 12*".

Sarah described the supportive peer environment that many participants found in upper school:

> *We were all pretty supportive and interested in similar you know science and maths and that sort of stuff, that helped... I was in a different friendship group in lower high school but I changed friendship groups mainly because I got to know these students from the classes that I was in and you know got along with them a*

lot better... they were just much nicer people, more down to earth, interested in similar things, studied similar subjects.

The influence of the nerd/non-nerd social grouping may be negative and positive. For example, commonly, previous to year 11, participants were socially punished (by being bullied) for being a nerd, potentially having a negative influence on their career development. However as they managed to remain a nerd they were eventually rewarded with finding like-minded friends within a nerd group. Lauren aptly described a point where this social punishment had become too much for her and interfered with her career development:

I was extremely good at it [maths] *at the start of year 10 and I am talking like I had 100% averages.... but then peer pressure, you know "too smart" kind of thing, so I started not doing very well deliberately.... just to conform kind of thing.*

Lauren then went on to describe how this "*rebellious period*" had further negative academic ramifications through upper school and her first years of university.

The extent of the nerd/non-nerd social grouping theme may be further appreciated by noting its continued impact into adult life. Lauren explains:

It's difficult going back there with my friends who didn't do TEE [Tertiary Entrance Examinations]... *because they're all married with kids at my age so that's kind of very difficult to relate on a similar field kind of thing... even now when I go up and visit they're like "you went to uni, you did this, you did that and I'm at home with the kids" and.... they're always like "well you're smarter than me" and.... that's a bit difficult with your friendships as well when your friends say that kind of thing.*

Lauren's story illustrates that social punishment for being a nerd may be experienced over a long period of time. Considering her *"rebellious period"* described above, social

punishment for being a nerd had the potential to negatively influence engineering oriented career development through interfering with her maths performance at school. However, finding like-minded nerds along the engineering career development path may be a rewarding positive influence. It may be that being female interacts with being a nerd as a social influence and this will now be briefly discussed.

It is possible that bullying experienced as a female nerd is more accentuated in the pre-adulthood career development of engineering females than males. While participants appeared to derive some pleasure from finding a group of nerds of either gender, typically they conveyed greater pleasure in finding a group of female nerds. For example, Heather described:

> *University in general I found as a very positive experience, making friends and especially finding girls who are interested in the same thing as me, we managed to find a group of say five of us girls doing engineering and it's probably the first time I had... found people that I could really... relate to.*

That is, female nerds may have greater difficulty finding other female nerds on an engineering career path and this may exacerbate the negative influence of being a nerd on engineering career development for females.

Education

Three sub-themes related to the formal educational history of the participants emerged in the present study. These were ability and interest (mainly at primary and secondary school), teachers and lecturers (predominantly at secondary school and university), and course content (mainly at university). It will be seen that these three education sub-themes were linked for the women in the present study as practically applicable course content contributed to ability and interest depending on attributes of the teacher or lecturer.

Ability and interest.

A predominant positive influence on pursuing an engineering career that was reported in the present study was the participants' high level of ability and interest in maths and science in primary and secondary school. The majority of participants remembered always liking and performing well in maths and science and this supports the notion described by SCCT that attainment of a performance domain in secondary school would be dependent on earlier attainment of a similar performance domain (Lent et al., 1994). Heather explained, *"all through school I was always sort of, it always sounds silly saying this but it was my favourite subject, like I liked doing maths, if that makes sense"*. Liking and performing well in maths at secondary school is supported in the literature as a predominant reason that WIE give for choosing to study engineering at university (Mills et al., 2006; Wentling & Camacho, 2008). In the present study, the choice to pursue an engineering degree at university was often a case of the participant simply assuming that their liking for maths and science in school would be best satisfied by an engineering career without having much knowledge of what engineering actually involved. Emily explained that she didn't know what engineering was *"but at the time it didn't really bother me. I'm like, oh well if it's got maths and science it doesn't really bother me. I really like that"*.

Many participants highlighted that when choosing to study engineering at university there was a combination of being drawn toward a career that would use maths and science as well as avoiding careers that may depend on ability that they did not have in other subjects. Avoiding other careers as a positive influence on choosing engineering does not appear to be discussed in the literature on WIE. Chloe described this influence:

> *I think the other big thing was I knew I wasn't good at English, hands-down. I knew I couldn't spell, had very bad grammar, can't learn a language to save my*

life, um I think it was all those things that basically rules out a lot of job options.

Other participants seemed to have ability and interest in a diverse range of subjects in addition to maths and science. For example, two participants chose to study double degrees in engineering and a second language. In fact, pursuing a diverse range of interests at university was unusually common for participants in the present study with 70% studying a double degree. In comparison, 30% of engineering degrees completed in Australia by females in 2009 were double degrees (Kaspura, 2011). Pursuing a double degree allowed the career development of participants to remain more fluid through university compared with that of their single degree counterparts. Sarah described this phenomenon:

> *I knew that I wanted to do something engineering or science and so when it came to choosing a course at uni, my brother was quite useful at helping me, I wasn't sure which way I wanted to go so he was like "well why not put down to do a double degree? ... if you can get into it then you can get a bit of a taste of both". I never dropped either degree so I did a Bachelor of Science and a Bachelor of Engineering.*

Participants appeared to lose their secondary school enthusiasm for maths at university and a predominant reason given for this was the way in which the course was delivered at university compared to in secondary school. Sarah describes *"at high school I really enjoyed maths but at uni... you lost the enthusiasm just because of the way they taught it"*. The influence of teachers and lecturers will now be discussed.

Teachers and lecturers.

Many participants cited secondary maths/science/technology teachers as being a positive influence on their career development. Emily expressed:

> *I had a really, really good year 8 science teacher and I had him again in year 10 as well and he was really, really good like definitely pulled you into sort of the*

science sort of aspect of it and really got you understanding what was going on....Probably the same with maths teachers as well.

Thinking back to secondary school, Chloe recalled, "*some of the maths teachers there were pretty awesome*". Participants described characteristics of these teachers as *"getting students involved"*, *"didn't teach necessarily from the textbook"*, *"made it 'real world' "*, *"enthusiastic"*, had good interpersonal skills, and built a relationship with the students over a number of years. The encouraging role of secondary maths/science/technology teachers for WIE is supported in the literature (Mills et al., 2006; Wentling & Camacho, 2008). Some participants in the present study recalled teachers from primary school as being motivational in mathematics and enthusiastically described a competitive maths game organised by the teacher that they *"loved playing"*.

The most common comment with regard to the influence of teachers and lecturers on their career development was that participants had experienced many poor lecturers at university. Emily described that "*some of the lecturers were there because they were academics first and foremost and then they couldn't lecture to save their lives*". Amelia asserted that the engineering school at her university *"is pretty pathetic in terms of some lecturers don't put any effort in"*. Participants also talked about many good lecturers who had been a positive influence on their career development. Emily asserted:

We had some fantastic lecturers who were just amazing and particularly the ones who had previous industry experience when they came back in they just knew how we think as engineers, they knew how to communicate and what we actually needed to hear to be able to understand the concept that they were trying to get through to us. Whereas I found uni lecturers, academics, they weren't necessarily always good at that.

Heather described:

> *There's one lecturer we had for a few of the... units and he was just really unapproachable like you would go and ask him a question and he'd just sort of almost brush you off sort of thing like, "oh it's in the notes" or he'd say something quite vague and you're like "I still don't understand" and he didn't really sort of give very much. Where as there would be others and you would go and talk to them and they would try and do what they can to help you understand.*

Participants described good lecturers as being set apart from poor lecturers by having practical experience and knowledge which was applied in lectures, responding well to questions (not necessarily immediately), having good communication skills, and putting effort into lectures. The influence of lecturers and the attributes of good lecturers that were highlighted in the present study are reflected in the literature (Powell et al., 2007; Wentling & Camacho, 2008).

Course content.

Participants commonly reported challenging aspects to their university course including long contact hours and some *"dull"* or irrelevant course content. Chloe described the workload was *"high.... I don't think I would go back to uni in a hurry"*. Ashley related that, in her final year, *"trying to manage both that* [workload] *while also trying to manage 'am I actually gonna get a job at the end of this?' ... that was rather stressful"*. What made the workload very frustrating to these women was the perceived irrelevance of some of it. Sarah described without hesitation that she *"definitely"* found a significant part of the course irrelevant and that *"really frustrated us, you had to do it if you wanted to go on and do your third year units"*.

The perceived dullness and lack of relevance was in part related to the lecturer's approach as previously discussed in the present study. Chloe described, *"I had a couple of lecturers at uni that just talked at you and there was nothing relevant about it"*. At

the end of second year, Lauren had made the decision to quit engineering because of disinterest in the material and disappointing performance, she *"felt like I wasn't getting anywhere and I didn't wanna work in that stuff, I hated it"*. It was only through a chance meeting with some established engineers that she stayed the course and happily found that much of the course content in early years is not indicative of what an engineering job entails, *"they said it gets better. Like first and second year suck and they all almost gave it up because it was that bad but now they really enjoy it"*. Lauren's experience highlights the negative influence irrelevant course material can have on career development. High workload and perceived irrelevance of university course content are commonly reported by women as negative aspects to studying engineering (Powell et al., 2007; Wentling & Camacho, 2008).

Secondary school and university course material that participants in the present study highlighted as motivational on their career path was characterised by perceived relevance and *"real world"* applicability. Unfortunately *"that's one of the downfalls at* [Emily's university] *is that it's a very theoretical kind of course"*. Ashley described, *"I like learning, stuff that I enjoy, stuff that has practical application so I can see where this is going as opposed to differential calculus out of a book"*. Amy expressed how applicability facilitates her learning, *"I kind of need to like read all the examples and the methodologies and understand the context and the point of the kind of problem and then I will be able to do it"*. Hence practical application in secondary school and university course content was noted to motivate and facilitate learning in career development in the present study and this is reflected in the literature (Powell et al., 2007; Wentling & Camacho, 2008).

Engineering Career Expectations

Three sub-themes emerged in the present study with regard to career expectations that influenced the career development of participants. Anticipated job

prospects played a major positive role in contributing to engineering related course selection decisions in secondary school years for most participants. Anticipated job content had a positive influence on career development while anticipated lack of family-flexibility had a negative influence for many participants. The three sub-themes of anticipated job prospects, anticipated job content, and family-flexibility in engineering careers will now be discussed.

Job prospects.

Participants commonly commented that, in secondary school, the job opportunities predicted to be available for engineers contributed to their decision to follow an engineering career path. High salary was commonly tied with this influence but rarely mentioned directly. For example, Sophie explained *"my brother said 'why do you want to be a scientist they don't earn any money, they are always poor', and I am like, 'fair enough'"*. The influence of anticipated job prospects was intertwined with the influence of parents (previously discussed in the current paper) who were often supportive of the career for the same reasons. When Ashley was in year 12, *"I was seriously toying with music but I was thinking, no, it's not really going to get me a job. Engineering, I will get a job. But again that was probably from my dad going 'well, engineers get jobs'"*. While Lauren's father was supportive of her engineering career choice he was unsupportive of her sister's psychology career choice because *"he was worried about her doing something that wouldn't pay much"*. Sophie highlighted that anticipated salary levels were a positive influence for her:

> *Those people that spend that long at uni and then they finish and they get a job and it pays 50 grand a year like what's the point? To me, like what's the point? But some people are more driven by other things other than money which isn't the motivator for me but definitely a motivator.*

Job opportunities and high salaries available to engineers are supported by Wentling and Camacho (2008) as being motivators for females in secondary school choosing engineering as a career.

Amelia perceived that financial gain was a prime motivator for many students at university and for engineers in general and this has had a strong negative impact on her drive to be an engineer. Since university she has felt that much of engineering does not sufficiently prioritise helping behaviour and communal goals. Amelia described *"I am very bitter about my university...they don't promote the seeking of wisdom they promote commerce students getting degrees"* and *"I feel like... I am compromising my own values by working as an engineer"*. Amelia's comments are supported by research that suggests some WIE are disappointed by commercial influences interfering with their desire to make a positive contribution to society (Mills et al., 2006). Hence for most participants, the anticipated job prospects for engineers were a positive influence on career development but for some, the perceived dominance of financial gain as a motivator may be associated with negative feelings toward the career.

Job content.

Aspects of anticipated job content that may have influenced career development of participants in the present study included avoiding job content of other careers (predominantly medicine) and being drawn to engineering because it was expected to involve maths, science, and problem solving. In addition, participants appeared drawn to workplace communal behaviour (e.g., team building). These contributors to the anticipated job content sub-theme will be discussed below.

Participants in the current study commented that, while considering careers in secondary school, part of what was behind choosing an engineering career was that they had considered and eliminated other careers, predominantly medicine, as an option. Reasons given for not choosing medicine included *"I didn't wanna have to deal with so*

much sickness, illness and suffering and pain", *"I don't like touching people, being too emotional and all that sort of stuff, I'm not very good at that kind of thing"*, and *"I didn't think I could handle people dying and being responsible for that"*. Hence a part of the reason why these women chose engineering was to avoid the anticipated job content of other careers. The literature on WIE does not appear to reflect this influence.

As previously described in the current paper, participants commonly cited an interest and ability in maths and science at school as a reason behind their choice to pursue an engineering career. This was because they commonly expected to use maths and science in an engineering career. Further to this, in secondary school years many participants found they enjoyed applied technical problem solving and anticipated that an engineering career would feed this interest. Literature supports enjoying problem solving as being a motivator behind females choosing to study engineering (Wentling & Camacho, 2008). In the present study, Sophie described her thoughts in secondary school when considering engineering, *"I just thought you know, no-brainer, do it, and I love maths and science and I love solving problems and I love technical critical thinking and I love analysis"*.

Participants felt that WIE appeared generally better able than men to contribute toward communal goals within their workplace such as communication, the spread and retention of knowledge, morale, viewpoint diversity, teamwork, and friendliness. Chloe outlined her experience with WIE was that *"they ask different questions as well so... I think it brings a lot to a team.... more communicative like it actually invoked a lot more lessons learnt... sharing of knowledge"* and Amy described her experience that WIE *"build the team and get it more of a community and a family... people go to work everyday but it shouldn't be like a sad and lonely place it's got to be somewhere that's a bit of fun, people know each other not just on a work basis"*. It can be seen that

contributing toward communal goals within their workplace was motivating for these participants following an engineering career path.

WIE being motivated by opportunity to contribute to workplace communal goals in engineering jobs adds weight to the assertion made in Mills and colleagues (2006) that better knowledge in secondary school of such opportunities may encourage females to choose an engineering career. Further to this, the desire and anticipated opportunity to contribute to communal goals at a societal level (e.g., the quality of life) is commonly raised in the literature as an influence behind females in secondary school choosing engineering as a career (Mills et al., 2006; Wentling & Camacho, 2008). Themes revealed in the present study did not reflect this. However, the desire and opportunity to contribute to communal goals within the workplace commonly had a positive influence on engineering graduates in the present study.

Family-flexibility.

The dominant concern that participants in the current study had looking to the future was that engineering careers were not family-flexible and participants were anticipating problems with balancing their career with the demands of family, especially if they should have children in the future. Two issues that contributed to this influence were the participant's perception of the profession's family-flexibility and their anticipated parenting role. These two issues will now be discussed in the present study.

Lauren's perception of family-flexibility in engineering was that, even without children, the travel demands of an engineering career would interfere with her relationship. She was concerned about *"juggling mine and my partner's career* [engineer also]... *because he works for* [competing company]... *and the nature of his work means that he will probably go to* [another country] *in a couple of years' time, and what that means for me".*

Participants appeared to gain the impression that engineering jobs were

incompatible with being a mother because of the anticipated travel demands and long hours involved in engineering. In addition, they gained this impression from what they observed in their workplace with other WIE and by the impression that management portrayed. Emily described:

> *Even then I still notice that there are so many female engineers that I have got to know since starting work that they... become part-time once they've had kids, and then they stop work because, they don't get promoted... they stay on the same salary.... There is still that general acceptance within the industry that if the female has kids then she's eventually going to stop work so even if she decides that she is going to keep working and the husband takes time off and looks after the kids while they're really young or whatever then there's still, I think, in general, there's an understanding at the top levels that she might take time off and therefore it's not a good idea to promote her.*

For Ashley, "*the managers' beliefs*" led her to believe her workplace was not family-flexible. She also referred to what she had observed with engineers who had become mothers, *"I don't know what the policies are as to how you come back but nobody comes back"*. Ashley was getting a clear message that *"my career's gone once I pop out a few babies"*.

The lack of family-flexibility in engineering careers had generally not been thought about deeply by the participants until they had a partner and had started their job as a graduate. Ashley described:

> *I can pinpoint it exactly, I'd never considered it at all... I was sitting in some induction thing at work and they were talking about the higher management levels and there were no women in upper management at all and that really, really bothered me... I don't know why it suddenly became an issue that there were absolutely no women there, and why aren't there women there? And that*

was when I did a bit more digging and I realised that yeah we really don't have any women in upper management, then I discovered when I tried to talk to my boss... about it, that was when I got comments back with those kind of attitudes.

Several statements implied that participants expected females would be most affected by family responsibilities. It was commonly expressed that stereotypical parenting roles were the norm for their workplace, their partner's workplace, and their social network. Lauren stated that, with regards to having children, WIE have *"got a few more things to juggle in the medium to long term career... I guess that maybe male engineers don't really have to think about"*. Chloe described:

The biggest thing is still the family, the kids business.... So I think that's probably the biggest thing and to do that you have to take time off work... so your male counterparts keep going and you don't. Like assuming you take maternity leave like you can't just have a baby and go back to work... and here we work from 7 'til 5 so doing that with young children is pretty impossible.

Some participants anticipated sharing parental responsibilities. Emily highlighted that *"obviously it takes two to tango, you need the male partner to be more involved in the family"*. Ashley explained that her partner had a less demanding career than she did and she was expecting that he would contribute significantly to parenting responsibilities. However, even with the parenting role shared her biggest concern for the future was:

Having a family, and not actually getting a job afterwards, trying to come back, I don't think it's a very, well in big scale engineering companies, I don't think it's a very secure area for young people who are trying to work out if they're going to have a family or not.

Summarising family-flexibility in the current study, participants commonly reported that the lack of family-flexibility in engineering was of prime concern in their

future career development but it typically had not become a concern until starting out as a graduate. The demands of engineering were anticipated to pose difficulty in parenthood even where the caring role was anticipated to be shared in their partnership. Lack of family-flexibility in engineering is widely recognised in the literature as having a negative influence on career development for WIE (APESMA, 2010; Mills et al., 2006; Mills et al., 2008).

Vignette

As suggested by Creswell (2007, 2009) and Moustakas (1994), the *essence* of the phenomenon explored in the current study will be portrayed in a vignette told in first person to complete the findings and interpretations section of the present paper. This vignette is intended to focus on the shared experiences of participants, rather than individual experiences. The author would like to advise the reader to guard against forming generalisations about the participants in the present study from this vignette, it is intended only to help the reader understand what it may be like to experience the phenomenon (Creswell, 2007).

I am 24 years old and I am currently employed as graduate engineer. Looking back on my life I remember many experiences that may have contributed to me becoming an engineer as well as some challenges along the way. As a child I remember *"I used to play Lego a lot, and build stuff"* with blocks. My dad worked in the resource industry when I was a child and our community was very much involved with engineering projects. I remember *"just being like amazed by it"*. At school, *"I was one of those people who could ace maths and science"*. I was bullied quite a lot for it, *"you know, the tall poppy syndrome"* but *"I didn't really care what other people thought"*, *"I love maths and science"*, *"I liked getting things right"* and in maths you know if you get it right, *"all of this subjective stuff, that really just does my head in"*. When thinking about what career to choose in high school it was a bit restrictive *"not actually knowing*

what engineering was" but I thought I'd enjoy it if *"it's got maths and science"*. I anticipated *"there would be a lot more work in engineering compared with"* other options and engineers *"earn good money"*. My parents were *"very supportive"* of an engineering career although *"it's difficult coming from a family where no one has been to university before"*, I missed their guidance and they *"don't understand the study commitments"*. I formed a different friendship group going from year 10 to year 11 and they were *"much nicer people, more down to earth, interested in similar things"*, *"all pretty supportive"*. *"My teachers were quite positive and encouraging"*, *"when someone is passionate about things it makes it so much easier to learn"*. There were many more males than females in classes like maths and physics but that didn't bother me much.

High marks in year 12 allowed me to pursue engineering as a part of a double degree at uni. At uni the *"long hours... just wears on you a bit"* and some of the maths, like *"when were we ever gonna need it again!"*, *"that... really frustrated us"*. Lecturers lacking teaching ability and practical knowledge were *"really common"*. There were times in my degree when I only kept going because, *"when I make a decision I will probably just follow that through"*. Now I love my work and the people I work with but it can be quite a demanding job. Looking to the future the biggest concern for me and many other women in engineering is *"to be able to have kids and go back to the job you love"*. Looking around at engineers, I see fathers who are only able to work like they do because they have a partner with a job *"that doesn't have the same kind of demands that someone in... industry has"* or they have a partner with *"no job"* at all.

Conclusion

The current study explored the developmental experience of women who have become engineers with a focus on the pre-adulthood psycho-social influences behind their career choice. A developmental approach appears to be rare in related research and

the phenomenological methodology was effective in portraying the developmental journey a female engineer may have experienced. The developmental nature of career choice evident in the present study supports the developmental approach taken by social cognitive career theory (Lent et al., 1994). Psycho-social influences behind career choice emerged around the main themes of home, social group, education, and engineering career expectations.

Influences that emerged in the current study which appear well supported in research included role models in secondary school and university years, high ability and interest in maths and science in secondary school, and the expectation to use these skills in an engineering career (e.g., Mills et al., 2006; Wentling & Camacho, 2008). Participants reported gender bias from students at school and university although parents and teachers are also often indicated as sources of bias in current literature (Lindberg et al., 2010; Powell et al., 2007). Concern over the family-flexibility of an engineering career was also common, which supports extensive literature suggesting lack of family-flexibility in engineering careers and a predominance of stereotypical gender roles with regard to parenting contributes to the low proportion of women in engineering (e.g., APESMA, 2010; Mills et al., 2008). Adding to this, participants in the current study anticipated difficulty balancing the demands of an engineering career with being a parent even if they were expecting to share caring roles equally with their partner.

Several findings in the current study added support to, and elaborated on, influences evident in a limited amount of research (Metzler-Brennan et al., 1985; Wentling & Camacho, 2008). Such findings included the potential influence of playing with Lego and blocks in childhood, anticipation of good job prospects within the field of engineering, moral support for career choice from parents, and the challenge of not having a parent who had attended university. Further influences identified in the current

study that appear in a limited amount of research included the positive influence of quality teachers and applied course content contrasted with the challenge of poor lecturers, high workload, and perceived irrelevance of coursework at university (Powell et al., 2007; Wentling & Camacho, 2008).

The present study revealed many potential influences behind females choosing an engineering career that do not seem to appear in current research. A male propensity to swear more than females may have interfered with facilitative male-female relationships at university and at work. Compatibility with perceived male culture may have been facilitative for some women. Being a female nerd may have been challenging in primary and early secondary school and facilitative in upper school and beyond. Deliberate avoidance of subject matter (e.g., humanities) and careers (e.g., medicine) with which some participants felt incompatible had contributed to them becoming an engineer. The desire and opportunity to contribute to communal goals within the workplace had a positive influence on some participants. These findings present several pathways for future original research.

In line with the aims of the present study, a range of avenues for future work may be derived. For example, the issue of gender bias from fellow students within Australian schools and universities requires verification and, if prevalent, intervention may be justified. Bullying of female nerds in early school years warrants further investigation, perhaps through questionnaires in schools. Female compatibility with perceived male culture requires further investigation possibly with a larger sample and more anonymity for participants (much research highlights female-male incompatibility where the current study has also highlighted perceived compatibility). The issue of a male propensity for swearing could be further studied to establish if the findings of the current study are reflected in the general community. The perceived contribution of engineering women to communal goals in the workplace calls for further investigation

to establish if this is supported elsewhere, if others in the workplace share this perception, and if it is a strength more prevalent with female than male engineers (as suggested by participants). Hence, the current study has successfully revealed many areas for potential future work that could shed further light on influences behind women choosing an engineering career.

Some limitations must be considered to the current study. As outlined by Moustakas (1994), Epoche is rarely achieved perfectly and hence study findings may be influenced by researcher bias. Further to this, the interviewer, being male and an engineer, may have been both an advantage and limitation in the current study. This may have resulted in participants tending to report less incompatibility and greater compatibility with male engineering culture than would have otherwise been reported. In addition to this, the interviewer being an engineer appeared to facilitate the establishment of rapport in the interview process. That is, the gender and career of the interviewer may have resulted in a study that was less likely to find females reporting incompatibility with male culture however this must be weighed against enhanced rapport and greater likelihood of compatibilities being reported.

Exploring the issue of the low proportion of women in engineering by interviewing females who have successfully become engineers may have been both an advantage and a limitation. It is logical that exploring the pre-adulthood of females who do not become engineers may yield insight into this issue and this may be an approach that future work could utilise. For example, participants in the current study typically did not consider family-flexibility issues until their graduate years and it is possible that their non-engineer counterparts were influenced by this sooner. There may be influences on career choice that did not emerge as a theme in the current study (e.g., desire to contribute to society; Mills et al., 2006) that could be more commonly reported by non-engineer females. However, as previously discussed in the present study, women in

engineering may hold unique insight into gender bias because they may be more likely to have experienced it (Tougas et al., 1999). Participants did seem to provide unique insight into gender-related issues in the present study.

The low proportion of women in engineering in Australia is a continuing phenomenon (Kaspura, 2009). This denies Australia the benefits associated with having more women in engineering and may indicate gender bias in Australian society. The current study, with its phenomenological methodology and developmental focus, presents a unique approach to exploring the issue of women in engineering. This approach seems to have been successful in yielding support for existing research (e.g., anticipated lack of family-flexibility in engineering careers), adding to currently limited research (e.g., playing with Lego and blocks in childhood), and contributing new material to this area of study (e.g., compatibility with aspects of perceived male culture). The study's exploratory nature has successfully revealed areas of potential future work that may contribute to increasing the number of women in engineering and reducing gender bias.

References

Ambady, N., Shih, M., Kim, A., & Pittinsky, T. L. (2001). Stereotype susceptibility in children: Effects of identity activation on quantitative performance. *Psychological Science, 12*, 385-391.

Association of Professional Engineers Scientists and Managers Australia. (2010). *Women in the professions: The state of play 2009-10*. Retrieved from http://www.wigb.gov.au/images/stories/pdf/

Australian Bureau of Statistics. (2006). *How Australians use their time, 2006* (ABS cat. no. 4153.0). Retrieved from http://www.abs.gov.au/

Australian Government. (1984). *Sex Discrimination Act 1984*. Retrieved from http://www.comlaw.gov.au/Details/C2010C00056

Australian Institute of Health and Welfare. (2010). *Nursing and midwifery labour force 2008*. Bulletin no. 81. (Cat. no. AUS 130). Canberra: AIHW.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Upper Saddle River, NJ: Prentice-Hall.

Bandura, A. (1992). Social cognitive theory. In R. Vastsa (Ed.), *Six theories of child development: Revised formulations and current issues* (pp. 1-60). London, UK: Jessica Kingsley Publishers Ltd.

Barnett, R. C., & Hyde, J. S. (2001). Women, men, work, and family: An expansionist theory. *American Psychologist, 56*, 781-796.

Barreto, M., Ellemers, N., Cihangir, S., & Stroebe, K. (2009). The self-fulfilling effects of contemporary sexism: How it affects women's well-being and behavior. In M. Barreto, M. K. Ryan, & M. T. Schmitt (Eds.), *The glass ceiling in the 21st century: Understanding barriers to gender equality* (pp. 99-123). Washington, DC: American Psychology Association.

Beanland, D. G. (2010). *Challenges and opportunities facing the education of engineers*. Retrieved from http://www.engineersaustralia.org.au/

Bem, S. L. (1981). Gender schema theory: A cognitive account of sex typing. *Psychological Review, 88*, 354-364.

Beyer, S. (2008). Predictors of female and male computer science students' grades. *Journal of Women and Minorities in Science and Engineering, 14*, 377-409.

Blakemore, J. E. O., Berenbaum, S. A., & Liben, L. S. (2009). *Gender development.* New York, NY: Psychology Press, Taylor & Francis Group.

Bolton, R. (1987). *People skills: How to assert yourself, listen to others, and resolve conflicts*. Pymble, NSW: Simon & Schuster Australia.

Burke, R. J., & Mattis, M. C. (2007). Preface. In R. J. Burke & M. C. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. x-xvi). Cheltenham, Gloucestershire, UK: Edward Elgar Publishing.

Cameron, J. E. (2001). Social identity, modern sexism, and perceptions of personal and group discrimination by women and men. *Sex Roles, 45*, 743-766.

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches* (2nd Ed.). Thousand Oaks, CA: Sage.

Creswell, J. W. (2009). *Research design: Qualitative, and mixed methods approaches* (3rd Ed.). Thousand Oaks, CA: Sage.

Davies, P. G., Spencer, S. J., Quinn, D. M., & Gerhardstein, R. (2002). Consuming images: How television commercials that elicit stereotype threat can restrain women academically and professionally. *Personality and Social Psychology Bulletin, 28*, 1615-1628.

Dean, D. J., & Fleckenstein, A. (2007). Keys to success for women in science. In R. J. Burke & M. C. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. 28-44). Cheltenham, Gloucestershire, UK: Edward Elgar Publishing.

Demetry, C., Hubelbank, J., Blaisdell, S., Sontgerath, S., Nicholson, M. E., Rosenthal, E., & Quinn, P. (2009). Supporting young women to enter engineering: Long-term effects of a middle school engineering outreach program. *Journal of Women and Minorities in Science and Engineering, 15*, 119-142.

Deutsch, M., & Gerard, H. B. (1955). A study of normative and informational social influences upon individual judgment. *Journal of Abnormal Psychology, 51*, 629-636.

Diekman, A. B., Brown, E. R., Johnston, A. M., & Clark, K. E. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. *Psychological Science, 21*, 1051-1057.

Doyle, S. (2007). Member checking with older women: A framework for negotiating meaning. *Health Care for Women International, 28*, 888-908.

Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Eagly, A. H., Wood, W., & Diekman, A. B. (2000). Social role theory of sex differences and similarities: A current appraisal. In T. Eckes, & H. M. Trautner (Eds.), *The developmental social psychology of gender* (pp 123-174). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Eccles, J. S. (2007). Where are all the women? Gender differences in participation in physical science and engineering. In W. M. Williams, & S. J. Ceci (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp 199-210). Washington, DC: American Psychology Association.

Egan, G. (2007). *The skilled helper: A problem-management and opportunity-development approach to helping* (8th Ed.). Belmont, CA: Thomson Brooks/Cole.

Engineers Australia. (2008). *Valuing the difference: An update on the progress of women in engineering.* Retrieved from http://www.engineersaustralia.org.au

Engineers Australia. (2010). *Engineer your career.* Retrieved from http://www.engineeryourcareer.org.au

Fifolt, M. M., & Abbott, G. (2008). Differential experiences of women and minority engineering students in a cooperative education program. *Journal of Women and Minorities in Science and Engineering, 14*, 253-267.

Fouad, N., Fitzpatrick, M., & Liu, J. P. (2011). Persistence of women in engineering careers: A qualitative study of current and former female engineers. *Journal of Women and Minorities in Science and Engineering, 17*, 69-96.

Frome, P. M., Alfeld, C. J., Eccles, J. S., & Barber, B. L. (2008). Is the desire for a family-flexible job keeping young women out of male-dominated occupations? In H. M. G. Watt, & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 195-214). Washington, DC: American Psychology Association.

Gilmartin, S. K., Li, E., & Aschbacher, P. (2006). The relationship between interest in physical science/engineering, science class experiences, and family contexts: Variations by gender and race/ethnicity among secondary students. *Journal of Women and Minorities in Science and Engineering, 12*, 179-207.

Han, J. C., Sax, L. J., & Kim, K. A. (2007). Having the talk: Engaging engineering students in discussions on gender and inequity. *Journal of Women and Minorities in Science and Engineering, 13*, 145-163.

Hartman, H., & Hartman, M. (2008). How undergraduate engineering students perceive women's (and men's) problems in science, math and engineering. *Sex Roles, 58*, 251-265.

Hoh, Y. K. (2007). Introduction to prominent women in chemical engineering: An outreach activity. *Journal of Women and Minorities in Science and Engineering, 13*, 377-390.

Kaspura, A. (2009). *The engineering profession: A statistical overview, 6th edition, 2009*. Retrieved from Engineers Australia website: http://www.engineersaustralia.org.au

Kaspura, A. (2010). *The engineering profession in Australia: A profile from the 2006 population census*. Retrieved from Engineers Australia website: http://www.engineersaustralia.org.au

Kaspura, A. (2011). *The engineering profession: A statistical overview, 8th edition, 2011*. Retrieved from Engineers Australia website: http://www.engineersaustralia.org.au

Kermode, S. (2006). Is nurse education sexist? An exploratory study. *Contemporary Nurse, 22*, 66-74.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*, 79-122.

Lester, J. (2010). Women in male-dominated career and technical education programs at community colleges: Barriers to participation and success. *Journal of Women and Minorities in Science and Engineering, 16*, 51-66.

Levinson, D. J., Darrow, C. N., Klein, E. B., Levinson M. H., & McKee, B. (1979). *The seasons of a man's life*. NY, New York: Alfred A. Knopf, inc.

Liamputtong, P., & Ezzy, D. (2005). *Qualitative research methods*. Melbourne, Victoria: Oxford University Press.

Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and mathematics performance: A meta-analysis. *Psychological Bulletin, 136*, 1123-1135.

Lynch, I., & Nowosenetz, T. (2009). An exploratory study of students' constructions of gender in science, engineering and technology. *Gender and Education, 21*, 567-581.

Marszalek, J., Linnemeyer, S. A., & Haque, T. (2009). A cox regression analysis of a women's mentoring program in engineering. *Journal of Women and Minorities in Science and Engineering, 15*, 143-165.

Mattis, M. C. (2007). Upstream and downstream in the engineering pipeline: what's blocking US women from pursuing engineering careers. In R. J. Burke & M. C. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. 334-362). Cheltenham, Gloucestershire, UK: Edward Elgar Publishing.

Metzler-Brennan, E., Lewis, R. J., & Gerrard, M. (1985). Childhood antecedents of adult women's masculinity, femininity, and career role choices. *Psychology of Women Quarterly, 9*, 371-381.

Meyer-Bahlburg, H. F. L., Dolezal, C., Baker, S. W., Carlson, A. D., Obeid, J. S., & New, M. I. (2004). Prenatal androgenization affects gender-related behavior but not gender identity in 5-12-year-old girls with congenital adrenal hyperplasia. *Archives of Sexual Behavior, 33*, 97-104.

Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd Ed.). Thousand Oaks, CA: Sage.

Mills, J., Bastalich, W., Franzway, S., Gill, J., & Sharp, R. (2006). Engineering in Australia: An uncomfortable experience for women. *Journal of Women and Minorities in Science and Engineering, 12*, 135-154.

Mills, J., Mehrtens, V., Smith, E., & Adams, V. (2008). *CREW revisited in 2007 the year of women in engineering: An update on women's progress in the Australian engineering workforce.* Retrieved from http://www.engineeringaustralia.org.au/groups/women-in-engineering/resources

Moustakas, C. (1994). *Phenomenological research methods.* Thousand Oaks, CA: Sage.

Nordenström, A., Servin, A., Bohlin, G., Larsson, A., & Wednell, A. (2002). Sex-typed toy play behaviour correlates with the degree of prenatal androgen exposure assessed by CYP21 genotype in girls with congenital adrenal hyperplasia. *Journal of Clinical Endocrinology and Metabolism, 87,* 5119-5124.

Pasterski, V. L., Geffner, M. E., Brain, C., Hindmarsh, P., Brook, C., & Hines, M. (2005). Prenatal hormones and postnatal socialization by parents as determinants of male-typical toy play in girls with congenital adrenal hyperplasia. *Child Development, 76*, 264-278.

Powell, A., Bagilhole, B., & Dainty, A. (2007). The good, the bad and the ugly: Women engineering students' experiences of UK higher education. In R. J. Burke & M. C. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. 47-70). Cheltenham, Gloucestershire, UK: Edward Elgar Publishing.

Rosenthal, R., & Jacobson, L. (1968). *Pygmalion in the classroom: Teacher expectation and pupils' intellectual development.* . New York, NY: Holt, Rinehart & Winston.

Rosenthal, R., & Jacobson, L. (1992). *Pygmalion in the classroom: Teacher expectation and pupils' intellectual development (Newly expanded ed.)*. New York, NY: Irvington Publishers.

Sadker, A., Sadker, M., & Zittleman, K. R. (2009). *Still failing at fairness: How gender bias cheats girls and boys in school and what we can do about it*. New York, NY: Scribner.

Spelke, E. S., & Grace, A. D. (2007). Sex, math, and science. In W. M. Williams, & S. J. Ceci (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp 57-67). Washington, DC: American Psychology Association.

Starks, H., & Trinidad, S. B. (2007). Choose your method: A comparison of phenomenology, discourse analysis, and grounded theory. *Qualitative Health Research, 17*, 1372-1380.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*, 613-629.

Steinke, J., Lapinski, M. K., Long, M., VanDerMaas, C., Ryan, L., & Applegate, B. (2009). Seeing oneself as a scientist: Media influences and adolescent girls' science career-possible selves. *Journal of Women and Minorities in Science and Engineering, 15*, 279-301.

Steinke, J., Lapinski, M. K., Zietsman-Thomas, A., Nwulu, P., Crocker, N., Williams, Y,...Kuchibhotla, S. (2006). Middle school-aged children's attitudes toward women in science, engineering, and technology and the effects of media literacy training. *Journal of Women and Minorities in Science and Engineering, 12*, 295-323.

Stewart, T. L., LaDuke, J. R., Bracht, C., Sweet, B. A. M., & Gamarel, K., E. (2006). Do the "eyes" have it? A program evaluation of Jane Elliott's "Blue-Eyes/Brown-Eyes" diversity training exercise. *Journal of Applied Social Psychology, 33*, 1898-1921.

Swim, J. K., Aikin, K. J., Hall, W. S., & Hunter, B. A. (1995). Sexism and racism: Old-fashioned and modern prejudices. *Journal of Personality and Social Psychology, 68*, 199-214.

Swim, J. K., & Hyers, L. L. (2009). Sexism. In T. D. Nelson (Ed.), *Handbook of prejudice, stereotyping, and discrimination* (pp 407-430). New York, NY: Taylor & Francis Group.

Tougas, F., Brown, R., Beaton, A. M., & Joly, S. (1995). Neosexism: Plus ça change, plus c'est pareil. *Personality and Social Psychology Bulletin, 21*, 842-849.

Tougas, F., Brown, R., Beaton, A. M., & St-Pierre, L. (1999). Neosexism among women: The role of personally experienced social mobility attempts. *Personality and Social Psychology Bulletin, 25*, 1487-1497.

UK Government. (1975). *Sex Discrimination Act 1975*. Retrieved from http://www.legislation.gov.uk/ukpga/1975/65/pdfs/ukpga_19750065_en.pdf

US Government. (1972). *Title IX*. Retrieved from http://www.dol.gov/oasam/regs/statutes/titleix.htm

Varma, R. (1010). Computing self-efficacy among women in India. *Journal of Women and Minorities in Science and Engineering, 16*, 257-274.

Watt, H. M. G. (2008a). Gender and occupational outcomes: An introduction. In H. M. G. Watt, & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 3-24). Washington, DC: American Psychology Association.

Watt, H. M. G. (2008b). What motivates females and males to pursue sex-stereotyped careers? In H. M. G. Watt, & J. S. Eccles (Eds.), *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences* (pp. 87-113). Washington, DC: American Psychology Association.

Webster, L., & Mertova, P. (2007). *Using narrative inquiry as a research method.* New York, NY: Routledge.

Wentling, R. M., & Camacho, C. (2008). Women engineers: Factors and obstacles related to the pursuit of a degree in engineering. *Journal of Women and Minorities in Science and Engineering, 14*, 83-118.

Western, M., Baxter, J., & Chesters, J. (2007). How are families managing? In D. Denemark, G. Meagher, S. Wilson, M. Western, & T. Philips (Eds.), *Australian social attitudes 2: citizenship, work and aspirations* (pp. 241-261). Sydney, NSW: UNSW Press.

Whitten, B. L., Dorato, S. R., Duncombe, M. L., Allen, P. E., Blahha, C. A., Butler, H. Z.,...Williams, B. A. (2007). What works for women in undergraduate physics and what we can learn from women's colleges. *Journal of Women and Minorities in Science and Engineering, 13*, 37-75.

Yanowitz, K. L. (2004). Do scientists help people? Beliefs about scientists and the influence of prosocial context on girls' attitudes toward physics. *Journal of Women and Minorities in Science and Engineering, 10*, 393-399.

Zhang, S., Schmader, T., & Forbes, C. (2009). The effects of gender stereotypes on women's career choice: Opening the glass door. In M. Barreto, M. K. Ryan, & M. T. Schmitt (Eds.), *The glass ceiling in the 21st century: Understanding barriers to gender equality* (pp. 125-150). Washington, DC: American Psychology Association.

Appendix A

Letter to Engineers Australia

Dear Melissa Marinelli,

I am writing to you in your capacity as the Chair of Women in Engineering – Western Australia. My name is Andrew Ruscoe and I am an engineer with 18 years' experience in the renewable energy industry in Western Australia. Over the last 8 years I have been studying psychology on a part-time basis and this year I will be conducting my 4th year research project. The low proportion of women in engineering has been a developing area of interest for me and hence I have proposed a project entitled *Pre-adulthood Influences Behind Women Choosing Engineering as a Career in Contemporary Australia.*

For this project I wish to interview 10-12 female engineers about their experiences during school and university years that may have shaped their decision to pursue an engineering career. Attached is a Study Information Letter and Support Organisations List intended to be sent to potential participants. The study has been approved by the ECU Human Research Ethics Committee.

It is my hope that Women in Engineering see value in this research and hence may support it by passing the Study Information Letter and Support Organisations List on to the Western Australian graduate membership of Engineers Australia. Please let me know if you are able to do this. If you have any questions or suggestions with regard to the study then please feel free to contact myself or the other people nominated on the Study Information Letter.

Thank you,

Andrew Ruscoe.

MIE Aust 3892278
aruscoe@our.ecu.edu.au
Home: 9447 9165
Work: 9360 6621

Appendix B

Study Information Letter

Dear Potential Participant,

Thank you for your interest in this study. My name is Andrew Ruscoe and I am studying 4th year psychology at ECU. This study, entitled *Pre-adulthood Influences Behind Women Choosing Engineering as a Career in Contemporary Australia,* aims to explore your experiences from childhood to adulthood that may have shaped your decision to pursue an engineering career in Australia. To be a participant in the study you must be a female born during the years 1986 to 1989, currently employed as an engineer in Western Australia, and all of your education (primary to tertiary) completed in Australian schools. This letter is intended to briefly explain this research and what may be required of you if you choose to participate in the study.

If you choose to participate, I would be conducting an interview with you during July/August 2011 with regard to the above topic at a place and time convenient to you. The interview will take approximately 45 minutes and I may contact you at a later date for some clarification. Participation in this study is voluntary. You may refuse to answer any question. You may withdraw from this study at any time without explanation and any information that you have provided to me will be destroyed.

Interviews will be recorded digitally and transcribed. Pertinent themes will be extracted from these interviews and presented with some direct quotation in a final report. Any personally identifying information in these quotes will be substituted with false names. The final report may be provided for you on request. During the formulation of the report only my supervisors and myself will have access to the recordings. On the completion of the final report, at the end of the year, the recordings will be placed in storage for 5 years and then deleted.

This research is part of the course requirement for my psychology degree with honours and has been approved by the ECU Human Research Ethics Committee. If you require further information on this project or would like to participate then please contact me, Andrew Ruscoe (aruscoe@our.ecu.edu.au or 9447 9165) or my supervisors Dr Elizabeth Kaczmarek (6304 5193) and Dr Deirdre Drake (6304 5020). If you would like to contact an independent person with regard to the project then please contact Fourth Year Co-ordinator Dr Andrew Guilfoyle (6304 5192) or the Research Ethics Officer, Edith Cowan University, 100 Joondalup Drive, JOONDALUP WA 6027, (6304 2170). If at any stage you feel distressed in this study then please contact the appropriate support organisation (see list attached).

Thank you,
Andrew Ruscoe.

Appendix C

Informed Consent Form

I _____ (the participant) have read and understood the information letter provided with this consent form and any questions I have asked have been answered to my satisfaction. I realise that I can have further questions answered at any time using the contact numbers for the research team on the information letter provided.

I agree to participate in this study entitled *Pre-adulthood Influences Behind Women Choosing Engineering as a Career in Contemporary Australia* with Andrew Ruscoe as the primary researcher. I realise that participation is voluntary, I can refuse to answer questions, and I may withdraw from the study at any time without penalty or explanation.

I understand that I will be interviewed for this study and that this interview will be recorded and the recordings placed in storage for 5 years on completion of the study. I understand that the interviews may be discussed amongst the research team indicated on the information letter.

I understand that a report containing information about the interview and direct quotes from the interview may be published on the proviso that I am not identifiable in this report.

Participant's signature _____ Date_____

Interviewer's signature _____ Date_____

Appendix D

Demographic Sheet

Date of Birth _____

Company Name _____

Industry (e.g., mining, power) _____

Education

Name of Tertiary Institution _____

Location Suburb_____ State_____

Years of Attendance _____ to _____

1st Secondary School

Name _____

Location Suburb_____ State_____

Years of Attendance _____to_____

2nd Secondary School (if you attended more than one)

Name of School _____

Location Suburb_____ State_____

Years of Attendance _____to_____

1st Primary School

Name of School _____

Location Suburb_____ State_____

Years of Attendance _____to_____

2nd Primary School (if you attended more than one)

Name of School _____

Location Suburb_____ State_____

Years of Attendance _____to_____

3rd Primary School (if you attended more than two)

Name of School _____

Location Suburb_____ State_____

Years of Attendance _____to_____

Appendix E

Interview Guide

The interview typically began with the first question listed below. Given the interview's semi-structured nature, the participant was allowed significant freedom to drive the conversation. Following the participant's response to the first question, the questions below were used as a guide only to cover the following aspects to their career development path. Over the course of the interview, it was intended that the researcher asked about what may have been positive influences on the participant following an engineering career path and what may have been negative influences that hindered them on their path. In the first question the intention was to have the participant tell their story as they see it. The second question was intended to ask them more about the time they made the decision to study engineering at university and the third question was intended to ask them more about their life leading to that point.

Q1. Can you tell me about any positive or negative experiences on the way to becoming an engineer?

- At University? On starting the job?
- Have you experienced any obstacles along the way to becoming an engineer? Motivating experiences?

Q2. Tell me about the time you made the decision to study engineering.

- What contributed to the decision? At the time, did you have any concerns about the decision? Any particular motivators?
- Can you tell me about your family and what they thought of your decision?
- What were the views of your friends and peers?
- Have you developed any concerns since that time about pursuing an engineering career?

Q3. Tell me about your life up to the point you made the decision to study engineering? .

- What do you think led to you having such interest and/or ability by this point?
- During this period can you remember any experiences where you felt resistance toward you following your interests? Any experiences that motivated you to follow your interests?

Appendix F

Support Organisations List

ACTU Workers' Helpline
1300 362 223
www.actu.org.au

Fair Work Australia Help Line
1300 799 675
www.fwa.gov.au

Lifeline WA
13 11 14
www.lifelinewa.org.au
lifeline@lifelinewa.org.au

Ngala Helpline
9368 9368
www.ngala.com.au
ngala@ngala.com.au

Relationships Australia
1300 364 277
www.wa.relationships.com.au

Women's Council for Domestic and Family Violence Services WA
9420 7264
www.womenscouncil.com.au
info@womenscouncil.com.au

Women's Domestic Violence Helpline
9223 1188
www.dcp.wa.gov.au

Women's Law Centre (WA)
9272 8800
www.wlcwa.org.au
wlcentreofwa@iinet.net.au