Gender Dynamics in an Engineering Classroom: Engineering Students' Perspectives

Chapter 1 - Introduction

> *It is no exaggeration to say that we are in unchartered waters and that the changes which Australian universities are experiencing are as profound as those catalysed by the industrial and scientific revolution of the 19th Century. [Moran, 1995]*

Women are 51% of Australia's population. Using their talents to the full at all levels of scientific and technological education, training and employment is an economic necessity, and an investment in the nation's future [Apelian, 1994]. Women have contributed equally to the settlement and economic growth of Australia. They have taken on the toughest side of Australian life from digging wells to ploughing the land, so the exclusion of women from an industry seen as unfeminine has no historical logic or justification [Byrne, 1985]. The engineering profession remains today one of the few professions where women have not made substantial changes to the gender balance within its ranks [DETYA 1999]. This is of particular concern for Australia, which has traditionally failed to educate enough engineers to meet its needs and has therefore relied excessively on migration to fill the gap. [Australian Bureau of Labour Market Research, 1982 and Engineers Australia 2000].

The domination of the engineering profession by men and the consequent image of engineering as masculine, together with the emphasis on mathematics and science, has helped to keep many women out of engineering [Beder, 1998]. Western society continues to support boys in technical areas by providing them with more exposure to and experience with construction and mechanical/electrical devices from a very early age and into adolescence [Lewis, 1995; McIlwee & Robinson, 1992]. As such, assumptions and stereotypes that are embedded from these early stages of life are reinforced in both boys and girls. Yet engineering has attracted high achieving women, who have already been through an unconscious systematic 'toughening' and 'weeding out' system in both our school system and society in general. These high achieving women who are able to cope in this masculine culture have demonstrated that they can do extremely well within the existing engineering curriculum and can maintain high grades. Consequently, it has been difficult for engineering faculties to accept the suggestion that changes still need to occur to support the participation of women engineering students despite such low participation rates at the end of the twentieth century. The most recent figures available show that only 5 per cent of engineers in Australia are women [IEAust. Review, 1996] and 14 per cent of students in Australian engineering courses in 1998 are women [DETYA, 1999].

The engineering profession itself needs to change in response to the rapid changes being made in the world around us. These changes are often the result of the work of the profession itself, with the pursuit and implementation of technological development driving change in many sectors of the community. A major global concern is for conservation of natural resources and recognition of the need for sustainable development. As the creator and custodian of the technological changes that have led to these concerns, the engineering profession more than ever needs to respond. There is a vital link between the sciences, humanities and solving human needs, which if re-ignited would support the redirection of the profession towards managing technological advances with a more holistic approach. Women's interests have traditionally been perceived to be in areas closely related to human needs. Women have also demonstrated strengths in interpersonal relationships and communication skills. These are the skills and interests that the engineering profession needs to encompass [William, 1988; Review, 1996], and ones which a more balanced gender workforce can enhance [Byrne, 1985; WISET, 1995].

The last three decades have also seen vast changes in gender relations in our social and economic world. Connell [1995] has referred to the experiences that Western society has felt over the last 20 years as a 'crisis of the gender order'. However, in many ways it appears that engineering has been left behind. Engineering has been the focus of social reform policies and programs over the last two decades. More recently these policies have highlighted the need to move away from a liberal feminist approach which tries to change women so that they fit into the existing culture, also referred to as the 'deficit equity model' to reviewing the culture itself [WISET, 1995]. This work is being informed by contemporary theories of masculinity and poststructural feminist perspectives [Connell, 2000; Davies, 1989], which have criticized this liberal feminist framework that leaves unquestioned the masculine culture of engineering. According to Connell [1995], many male-dominated disciplines and professions have been challenged and destabilised by feminist theory and practices. These professions have in this process of challenging the status quo often encountered difficulties, resisting change bitterly on occasion, but eventually and undoubtedly leading to renewal and enrichment in a wide variety of ways. If this is the case then it is surprising that despite the effort to attract women into the engineering profession under similar feminist pressures their participation rate remains relatively low.

There are suggestions that engineering may be unique as a profession in that it will not easily embrace change due to its very nature [Carter and Kirkup, 1990]. One would expect that investigation into women engineers would be similar to women in other professions, and that it would be possible to study women professionals in general and simply look at engineering as another profession. Yet controversial feminist analysis of science and technology suggests that the specific masculine nature of the engineering culture and technology itself has acted as a major impediment to change [Lewis et al, 1997, Carter and Kirkup, 1990]. Scientific theory and method and the techniques of technology have been identified as masculine, and so for women to access and share control of the profession these basic theories and practices need to be recreated [Carter and Kirkup, 1990]. The teaching of scientific applications of engineering has been the preoccupation in educating engineers in its recent history and this has been to the exclusion of the social and environmental consequence of their work. This has been partly supported by the nature of the work that does not generally have direct dealings with the public but instead requires the efforts of large teams of engineers who are anonymous to the consumer. As with many other professions today, the only pathway to eligibility and recognition within the profession is via a post secondary qualification. Engineering currently requires a minimum 4 year degree course or a combination of past experiences and other qualifications and final years at University. Thus engineering education is the gateway to becoming an engineer and it needs to pass on to new recruits the broader implications of the results of their work. Transforming engineering will require a close examination of the engineering education system and how it can support cultural change while recognising that it is required to provide holistic solutions to the rapid technological developments in our society today.

Engineering education is thus critical in the progress towards cultural change within the engineering profession [Lloyd, 1979; Williams, 1988; IEAust. Review, 1996;

Burrowes, 2000] as well as critical in ensuring the ability of the engineering workforce of the future to adapt to its new circumstances [Lloyd, 1979]. The engineering classroom and more specifically the engineering curriculum has more recently been targeted [Tonso 1996; Holt and Solomon,1996; Stonyer, 1997; Mares et al, 1996] as a critical factor in supporting cultural change and in particular the inclusion of women. This study will expand on this recent research and will investigate the micro level of an engineering classroom by developing a picture of engineering student's perceptions of their learning environment.

The strengths and weakness of engineering education practices were highlighted in 1993 in a report from a conference initiated by the Departments of Industrial Relations and Industry and Technology and Regional Development and hosted by the Institution of Engineers, Australia [IEAust., 1993]. The report recognised that engineering education in Australia was operating at world best practice level in the engineering science and technology areas of the curriculum as well as responding to community concerns in increased allocation of time (up to 10%) for management. Lloyd [1979] had documented fourteen years earlier that across the thirteen engineering faculties in 1979 the percentage of hours of the course spent on mathematics, science and engineering science subjects averaged 96% (or 4% on non technical material). Thus there had been some advances from 1979 to 1993 towards recognising that engineers were being required to have broader management and business skills. Yet the areas related to social concerns for the environment and sustainable practice are still not being pushed despite being highlighted as a significant weakness, with the report stating:

> "Higher education institutions do not always have the key cultural skills needed for general and professional education, with the result that both staff and students tend to be insular and lacking in mobility, experience in business and knowledge of other languages and cultures."

Tonso sees engineering education as 'not simply training in a prescribed set of appropriate, academic courses, but as enculturation into a well established system of practices, meanings and beliefs' [1996 pg. 218]. Review of curriculum development and pedagogy [Lloyd, 1979, Jolly, 1996] has also highlighted the need for broadening to include not only inclusive methodology but material that would help locate the profession in its social context [Johnston 1999]. These changes are strongly supported by the Institution of Engineers Australia [1990, 1993, 1996] and are being implemented to various degrees at various engineering education institutions in Australia. In general however, these changes remain as 'add ons' to the traditional engineering content and seamless integration of these fundamental changes has not yet been achieved.

So why does engineering education need to become inclusive? The major reasons include social justice considerations as well as the advantages which the profession will gain. Equity and social justice in general are promoted by universities and included in their statuary policies. These policies argue that there is no reason why women and other minority groups should not be able to take up the advantages and privileges associated with a professional career in non-traditional areas such as engineering. The profession itself recognises [IEAust, 1996] that a diverse labour force is an advantage to industry as it will bring with it new talents and perspectives. This area incorporates 'cultural inclusivity' which is becoming more important as industries move towards globalisation. Labour shortages in some discipline areas of engineering have become critical and inclusivity can relieve some of the pressures here. Finally, from an educational perspective inclusivity is recognised as an effective method of teaching and learning as it acknowledges the different needs and interests of individual students.

1.1 Aims

This study investigates the learning environment and social world of an engineering classroom and the complex interactions between human behaviour, knowledge, and learning experiences within that classroom. The research question which is being asked in this study is to what extent is the gender of a student a determinant of different classroom experiences within engineering?

In particular, the classroom experience can be categorised into three main areas which emerge from the research into gender inclusive curriculum. These areas are: the gendered behaviour or gender relations that are formed and maintained within a classroom; the prior knowledge and experience of students and its effect on classroom experiences; and the different learning styles of students. Teacher behaviour potentially should be included on this list however as the study is concentrating on student perspectives and perceptions of their environment teacher behaviour itself was not studied. Students do raise issues associated with teacher behaviour in the classroom and these are included in Chapter 5.

To answer the above questions it is necessary to obtain an understanding of the behaviours and socio-cultural activities and patterns of a group of engineering students, from their perspective, in a 'typical' engineering classroom setting. This exploratory study has thus been based on an ethnographic research methodology, which has strengths in learning and interpreting human behaviour. This methodology was employed due to the nature of the data within this study which dictates a qualitative research methodology and as it provides a framework in which to create a holistic and rich picture of students and their interactions within the context of an engineering classroom. It needs to be recognised that this is a very different approach to the more conventional scientific methodology generally employed in engineering research. Ethnographic research is designed to present a dynamic picture of the student group and their interactions and provide an alternative, more humanistic research paradigm to the traditional empirical scientific approaches. To temper this difference and to improve the reliability and validity of the data a quantitative data collection method (surveys) were also employed. This allowed for the use of triangulation, which brought the interviews and observation data used in ethnographic research together with the survey data.

In the final analysis, a discussion of the implementation of inclusive educational practices will be revisited with the intention of supporting a move to a desired cultural change framework. Discussion of the alternative pedagogical directions for engineering education to ensure equal access and participation to all groups will provide direction for further work.

1.2 Overview of the Investigation

Chapter 2 sets the study in a historical context and reviews the current status of women in engineering. The Venn diagram, Figure 1.1, illustrates the organization of the literature review. The left-hand side of the Venn diagram (Figure 1.1) illustrates the major background topic areas covered in Chapter 2 and their interrelationships.

The first section of the chapter presents a background to the development of the engineering profession in Australia including a historical review of the educational pathways to professional status and of the image of the engineering profession in the community. The second section of Chapter 2 provides a review of Women in Engineering initiatives in Australia. A brief historical review of the social and political reforms which have occurred for women in Australia provides a context to the women in engineering movement. This chapter concludes with an overview of research into gender issues in engineering education and highlights current practices.

Chapter 3 then focuses on the right hand side of the Venn diagram, illustrated in Figure 1.1, and develops through a literature review a picture of the kind of environment that is experienced by students in engineering educational institutions and more specifically the experiences surrounding the engineering classroom. To begin with, the chapter presents a review of the significant amount of research into the culture of engineering that has occurred in Australia over the last decade. Much of this has come from the Women in Engineering advocates in various initiatives who were given short term projects to improve participation of women, through both recruitment and retention programs. With successes of the 1980s showing slowing improvements, attention was then turned to the culture of engineering which in fact has been instrumental in widening the search for solutions. More recently the research has turned to the classroom itself, and a review of the literature into the culture within the classroom is presented. As there have been very few studies of engineering classrooms a significant amount of literature from the secondary and tertiary science and mathematics fields has been used. The second section of chapter 3 steps back to review the literature of teaching and learning practices that support the inclusion of women in the classroom and where possible references are made to engineering or science and mathematics studies. Gender Inclusive Curriculum has gained some attention among engineering academics and some trials have occurred throughout the system. However, these practices remain as 'add-ons' in the system rather than a system wide strategy of change. The chapter concludes with a review of efforts and research into gender in education in other discipline areas in higher education.

Much of the current research investigating cultural change in the engineering profession and the engineering education sector, has not used methodologies which

have previously been accepted within an engineering research context. In general, conducting qualitative research within engineering has been seen as unscientific and results have been questioned or simply dismissed by some engineers [McLean et al, 1997]. The general acceptance within engineering of the need to broaden the scope of engineering to incorporate the human elements of technology and its implementation in society indicates the need for engineering to accept research methodology which can reflect the multiply realities and subjective experiences of individuals. The scientific approach is unable to do this with its emphasis on a social reality that is objective and external to the individual, with a goal to identify or isolate the 'truth' rather than to find and clarify 'meaning' within an environment. Burn [1997] asserts that whereas quantitative research aims to test theory, qualitative research's main concern is to generate and develop theory. It is thus important to note here that there is a fundamental difference in the outcome of a literature review for a qualitative researcher. As this research has a goal of understanding people and their behaviours it is vital to evaluate thoughts, feelings and perceptions of individuals within a context and extract the meaning and biases that are perceived by them. This suggests that the data that a qualitative researcher looks for will not necessarily support or disprove their hypotheses but present what is already known and what specific methodologies have been used to encourage other ways of looking at the data. To that end Chapters 2 and 3 have attempted to show the current status of thinking and practice within the areas of cultural change in an engineering faculty.

Educational research in particular has moved towards a more qualitative naturalistic approach and has gained credibility within the education sector as increasing evidence illustrates that it has been able to establish previously missed links and relationships within an educative process [Burns, 1997]. However, the slow acceptance of research findings in the engineering education sector appears partly due to this mismatch in the methodology which is not reflected in the fundamental basis of the ways engineers are taught to think. Therefore, it is recognised that justification of the methodology and a discussion of its reliability and validity are of particular importance in this study. As more projects of this nature are conducted systematically in the engineering environment, it is hoped that greater acceptance will grow so that the ideas and understandings which this research produces can more readily be introduced.

Chapter 4 presents the details of the methodology used for this study. It provides the description of the engineering classroom used and the demographics of the student population in the classroom and the variables of the demographics that are used to interpret the findings. With any research study involving human subjects there are ethical issues which should be addressed and these are presented in Chapter 4. Finally there is a discussion on the limitations of the study methodology.

The findings and results that were collected during the study are presented in Chapter 5. These findings are presented using the model developed to illustrate the categories representing the learning environment based on the literature review of Chapter 3. The final stage of the research is the analysis and interpretation of findings, which is described in Chapter 6. By correlating the findings with the theoretical field discussed in Chapter 3 the results are generalised with some limitations. A model to illustrate this is developed in Chapter 6 (Figure 6.1). This chapter essentially develops the picture of the students' behaviour and interactions within the environment of the local setting.

1.3 Closing

The study that is reported on in this thesis is an attempt to systematically present students perceptions of their learning environment in an engineering classroom and their experiences within it to determine the extent to which gender affects different classroom experiences. The resulting understanding will provide a framework in which strategies can be developed to more effectively engage females students in the engineering profession.

Chapter 2 - Historical Context of the Research Study

Engineering as a profession is about change. Over its early history, significant changes occurred in the way engineering was practiced and how engineers were educated. Our social and professional environments have in fact seen an acceleration of change and engineering has been at the heart of most of these changes. Lloyd discusses in his book Engineering Manpower in Australia [1979] the tremendous change in the environment in which engineering was being practiced since the Second World War. In looking back over the last two decades (since Lloyd's comment) there has again been a period of substantial technological change which has seen our society move from an industrial age to an information age [Caines, 1999]. During this time, concerns for the natural environment and for sustainable practices have increased and remain today as unresolved and ongoing issues facing engineering practice.

Despite this changing environment, engineering education has largely been left unchanged during the last half century [Simmons, 1995]. Perhaps the last significant change, which occurred following the Second World War, was the enhancement of science and engineering science content in the course. The so-called 'sexual revolution' was also gearing up at this time with substantial social debate and upheaval beginning to occur. Yet, it was not until the 1980s, some decades later, that the gender imbalance in engineering began to ring alarm bells and policies and programs to correct that imbalance began to emerge. This chapter briefly overviews this history highlighting important events from the engineering profession and educational perspective as well as examining the contributions and impact of the Women in Engineering movement.

2.1 Development of the Engineering Profession in Australia

Engineering is a profession that provides solutions to society's needs. Engineers design, create and maintain products and services for society. Engineering is defined in the Oxford Dictionary [1984] as the "application of science for the control of power". Yet the process is one that requires significantly more than just knowledge of science. The profession of engineering needs to straddle the gulf between science, the humanities and solving human needs. Despite this, engineering has tended to focus on the scientific application of its function. So why has this gulf developed? And how has this impacted on women in engineering?

The engineering profession has grown out of the technical entrepreneurs of the past, such as Graham Bell, Ada Lovelace, Henry Ford and Florence Nightingale. It managed in this time to remain in touch with broader social issues and needs through its place in a 'hands on' industrial environment. Yet as engineering fought for status and a place in a university setting, it moved from its base in an industrial environment to a base in a science academic sphere. The emphasis on a scientific foundation for engineering has been a constraint in projecting the true image of engineering and has been a barrier for women entering the profession. Because of its position in the "shadow of science", engineering triumphs have not been popularly recognised in fields such as space exploration. Great engineers of the twentieth century such as Harwick Johnson and Grace Hopper remain virtually anonymous.

2.1.1 The Evolution of Engineering in Western Culture

Until the Renaissance, mathematics had been studied in the cloister in a theological framework. During this period, it began to be influenced by the requirement for practical devices such as the need for an accurate calendar and the desire for better cannons. Allowing the mathematical sciences to be shaped by practical considerations at this time put Western culture in a unique position. Margaret Wertheim [1997] commented that historians have noted that while the Greeks developed marvellous theories about the world, they never took the step of marrying theory to practical goals. Similarly the Chinese, although superb mathematicians, did not become sufficiently involved in solving practical problems.

This growing respect for practical knowledge in crafts and trades saw the flourishing of engineering and architecture through the arts. Both artists and philosophers were looking at the world around them in a new way. Engineering continued to develop combining aspects of art and science until the Industrial Revolution in Britain during the late 19th century, which saw the emergence of a formal profession of engineering in Western society, and a new professional who began to incorporate capitalist values. Noble [1977] traces the beginning of the modern American engineer to the early canal companies and machine shops where the engineer often branched off on an entrepreneurial route to ownership. This route, says Noble, was soon cut off by the growth of canal and railroad projects and the expansion of industrial enterprises which provided large corporate and bureaucratic settings for a new generation of engineers who remained subordinates within those large organisations.

Shepard [1957: p536] referred to engineers as "marginal men [sic], part scientist and part businessman, sharing values and ideologies with both camps". Due, however, to their position in the organisation, engineers have generally worked for and taken the side of big business, with the philosophy of regulation and reform coming from within the business community "through the agency of the engineer" [Layton, 1971: p67], thus suggesting that engineers have felt their first loyalty to the business that they work for, rather than to humanity.

In the business world, engineers have commonly been seen [Beder,1998] as being preoccupied with technical issues to the exclusion of all else, unwilling or unable to appreciate contextual imperatives or to contribute effectively to business and political decisions. This has probably been the main factor leading to the 'de-engineering' of the public sector in Australia, and to the view of engineering as a commodity to be purchased when needed, rather than a critical strategic capability requiring long term investment and development, or an integral part of decision-making [IEAust. Review, 1996]. Unfortunately, these negative images are continuing to keep women, as well as laterally creative men, disconnected from this profession [Byrne, 1994].

However, Sharon Beder suggests that "[e]ngineering appears to be at a turning point. It is evolving from an occupation that provides employers and clients with competent technical advice, into a profession that serves the community in a socially and environmentally responsible manner" [Beder,1998,p 34]

2.1.2 The Development of Engineering Education

Early recognition of the need to train engineers scientifically came to Britain from France in the first part of the nineteenth century. Initial attempts to introduce engineering at British universities were opposed by the university system. Vocationally orientated education was looked down upon: "common people were trained for a specific vocation and gentlemen were educated" [Ahlstrom, 1982;p88]. Thus, one way of improving the status of engineering was to increase the scientific content of its courses and thereby "capitalize on the growing respectability of science" [Noble 1977;p26].

From the early part of the nineteenth century in most States of the Commonwealth of Australia there has been a tradition of training engineers in both universities and technical colleges. This training followed the British system in which a professional body controlled the professional standards and conferred professional status on the academic qualifications. The Australian system differed from the British system at its instigation due to the limited industrial opportunities that were available in Australia at the time. Consequently, Australian universities and colleges decided to teach methods of design, which added a year to the 3-year British model. This further isolated engineering training from an industrial base and hands-on experience. This was a significant step for the profession, as the pathway for most professional engineers until then had been in apprenticeships in company offices.

This transition to an academic pursuit continued to be emphasised and illustrated by demarcation problems during World War II. It was noted that it was physicists, not engineers, who did most of the electronic engineering to develop the radar and associated devices and systems. It was therefore concluded that the electrical engineering syllabus was inadequate, and science became more and more central and basic to the curriculum [Barus, 1987; Simmons, 1995]. Subsequently, the need to teach science in engineering schools has been grossly inflated by the needs of the engineering profession for esoteric knowledge and of engineering educators for academic respectability [Noble, 1977]. In fact, a recent survey of engineering students at an American university found that all students surveyed perceived that competency in mathematics and science was a 'filter' that preceded the choice of engineering [Durchholz, 1979 p720]. Eugene Ferguson substantiates this argument by observing that verbal and mathematical thoughts have come to be considered superior because perceptive processes are not supposed to involve 'hard thinking', and because non-verbal thought is seen as being more primitive. Therefore, engineering courses have favoured and taught these analytical skills [Ferguson, 1977]. Thus, there has been an implicit acceptance of the notion that high status analytical courses are superior to those that encourage the student to develop an intuitive 'feel' for the incalculable complexity of engineering practice in the real world [ibid p168].

Lloyd suggested in the late 1970s that if "the engineering profession is to be accepted by society in the future, its members will need to be both technically competent and in tune with the attitudes and needs of society" [1979, pg 47]. Lloyd identified, at that time, five external influences that were placed on the engineering education system [Lloyd, 1979 pg 48]:

1. The changing needs and attitudes of society, industry and the Profession,
2. Government policy and the influence of government appointed controlling bodies,
3. Developments in technology,
4. Pressures in the secondary and tertiary education system which are likely to cause change,
5. Developments in educational practice and knowledge of the learning process.

Each of the influences are as relevant today as they were in the 1970s and have found continued support from a number of reviews of Engineering Education in Australia. One of the most comprehensive reviews was the Williams Report [1988] that was conducted in the pre-Dawkins era, before the expansion of the university sector in Australia.

The 1988 Williams Report on engineering education in Australia sought employers' opinions on graduate skills. It was reported that, on the whole, employers felt that engineering schools catered well for basic science skills and knowledge, but less adequately in areas concerned with "engineering as part of the broader business context" [Jones, 1988 p20-21]. The Report recommended that engineering education needed to incorporate knowledge areas such as industrial relations, management of people and management of costs and resources and communication skills. The Report also identified qualities that are important to engineering but not engendered by a wholly technical curriculum. These include judgement, previous experience, understanding of social complexities, and creativity and visual skills. In fact, one of the conclusions stated that "engineering schools have been more responsive to changes in engineering science and equipment than to changes or needed changes in engineering practice, and too little interest in the human element of technology".

It must be noted that the scientific approach has yielded solutions to engineering problems that the old trial-and-error methods never could. However, students are commonly taught in scientific courses that there is only one right answer to problems that they are set. Yet there is seldom only one solution to real-life problems, nor one method of reaching the solution. A Massachusetts Institution of Technology (MIT) report of engineering education found that scientific courses did not encourage the development of engineering judgment: "Neither the data, the applicability of the method, nor the results are open to question" [Ferguson, 1977 p163].

The most recent review of Engineering Education was commissioned in 1995 by the Institution of Engineers Australia, [IEAust. Review, 1996] and reinforced the suggestion that engineering graduates should take on a more effective societal role and become better communicators. "This means that, in addition to having the ability to explain technical problems, they must be politically and socially aware so that technical decisions can be made, understood and communicated, with sensitivity, especially across cultural boundaries" [IEAust. Review, 1996, p 54].

The sentiments of the Review have been reinforced throughout the profession to various extents. Ian Mair, 1995 president of the Institution of Engineers Australia pushed for a broader definition of engineering and his successor Connors more confidently indicated that engineers no longer saw themselves as technocrats. Beder cites Bryan Thurstan writing in the *Engineering Times:*

> A greater recognition of non-engineering inputs would certainly heighten the profession's standing in the community. With the depth of skills the engineering profession has to offer, it would probably go a long way to raising the public's awareness of the role of engineers in society, and as a bonus would certainly enhance the profession's status. [Thurstan, cited Beder, 1998, p xv]

2.1.3 The Image of Engineering

The image and status of the engineering profession has been in decline as the public identifies engineers with controversial and environmentally damaging technologies and projects [Beder, 1998]. Beder uses the case study of sewage treatment and disposal in the Sydney region and the subsequent controversy over Sydney beaches and fisheries. Other infamous projects in Australia include the Snowy Mountain Scheme and the recently identified problem of salinity in farming land to the west, the Tasmanian Franklin River Dam Project and uranium mining. The image of engineering is of a profession that is not socially responsible, not people orientated, inflexible and arbitrary and unrelated to context or to "the web of humanity" [Byrne, 1994]. This has resulted from a combination of the acceptance of engineers in the structure, power, and basic ideological principles of business, and the past emphasis on technical skills which has consequently placed the social and environmental dimensions of their work at a lower priority.

Engineers have generally not become household names despite their feats during the later part of the twentieth century. While in other fields people become celebrities, great engineers remain anonymous. Few people know, for example, the name of the engineer who invented the integrated circuit, the microchip that launched the electronic revolution and heralded the coming of a new age. Compare this with past eras when people such as Thomas Edison, Graham Bell and Henry Ford were 'culture heroes' in their lifetimes and beyond [Florman, 1996 p130]. The achievements of the Apollo and Space Shuttle programs are attributed to scientists when they are in reality engineering achievements [Braham, 1992, p76].

So, what kind of perceptions do students have of engineering and why do students choose (or reject) engineering? Engineering courses have not had a good image or reputation in the high school systems of Australia, USA or UK [Beder, 1998]. It is generally recognized that students do not choose engineering until later in high school and those that do come from the pool of students who have enjoyed mathematics and science classes or who have 'tinkered' with technical equipment. Mares's study [1996] identified that there was a strong link between women choosing engineering and their ability in mathematics and science at school. Male students have a perceived unobstructed path into engineering often being influenced by their childhood hobbies and 'tinkering'. In addition, the study at Brown University [1996] found a perception that studies in science and engineering would lead primarily to careers in fields associated with the military. This has a more significant negative effect on women than men. A study by Smeaton [cited: Jolly, 1996] showed that Year 12 girls who have the maths and science qualifications to enter engineering expect to find that entering the profession would require a loss of femininity and a willingness to think and act like their male compatriots. Most of them would find this unappealing. Smeaton also demonstrated that girls in Year 12 did not see their interests being served and their contribution rewarded when entering the engineering profession. These feelings have been documented through other studies by Beder [1998] and Johnston [1999] which found that the human and social possibilities of scientific endeavour was a reason for women more so than men to choose to pursue a science based career.

The image of engineering as a purely technical activity has until recently been reinforced by the engineering community and the education system. Engineers have generally sought to increase their influence through emphasizing those aspects of technological decisions that they are best educated to deal with. Many engineers felt that too much exposure of the social and political nature of technological decisions would threaten their role as experts and open such decisions up for public scrutiny. This portrayal of engineering and technological decision making as a purely technical activity not only served to disenfranchise the public with respect to technological developments but has also served to discourage many students from choosing engineering as a career. Often it is students with broader interests and a different range of talents who have been put off, those who want to work with people rather than machines and numbers, those who care about social issues. Too often it is female students who have been discouraged. [Beder, p8]

Engineering today is at a critical stage of development. The Institution of Engineers Australia Review [1996], *Changing the Culture: Engineering Education into the Future*, recommended nothing less than cultural change in engineering education and the profession. It stated that the engineering education system needed to be much more outward looking, with the capability of producing graduates able to lead the engineering profession in its involvement with the great social, economic, environmental and cultural challenges of our time. The Review highlighted that the non-scientific component of technology has been neglected in the engineering education system and that this aspect of the curriculum needs urgent review.

2.2 Women in Engineering in Australia

In the twentieth century, women in Western cultures emerged from being second class citizens [Beauvoir, 1953] with clearly defined and limited roles, to achieving the right in society to be considered equal partners. However, due to the residue of history, there still remain unspoken attitudes regarding the appropriateness of some new roles. This can be illustrated in the unequal representation of women and men across a spectrum of occupations including engineering and senior managerial positions.

2.2.1 Social and Political Reforms

The Whitlam Labour Government in Australia made attempts in the early 1970s to introduce debate on social reform policies as was then occurring in Europe and North America. Multiculturalism and affirmative action for women were high on the political agenda. The USA and most Continental European countries had passed legislation on women's issues during the 1970s but it was not until the early 1980s, a decade later, that Australia established a National Policy in this area. The Federal Sex Discrimination Act 1984 and the Affirmative Action (Equal Employment Opportunity for Women) Act 1986 (now known as the Equal Opportunity for Women in the Workplace Act 1999) provided the first phase for major social change in Australia.

The political climate during the 1990s has been moving towards the view that women have achieved equal status. Susan Ryan, the then Minister for Education and Minister Assisting the Prime Minister on the Status of Women, stated optimistically at the National Women's Conference, Canberra, in 1990:

> "1972 was the year the feminist movement in Australia started articulating a political agenda, a feminist agenda which would be implemented through the mainstream political process. By 1990, virtually all of that agenda has been achieved and a great deal more."

Ann Morrow, Convenor, Women's Employment and Training Advisory Group (WEETAG) commented in her paper at the *Beyond Beginnings Conference* in 1992 that a male colleague said to her

> "Ann, you're not still going on about women's employment, education and training are you? I thought that by now, all your problems had been solved and it was the men's turn to campaign for a better deal!"

Unfortunately, the sentiments in these statements set the tone through the 1990s. If these statements are to be believed then all barriers to women's achievements have been overcome. However, the under-representation of women in the science, engineering, technology and management fields is clearly an area where one could question the optimism of the statements.

In the second half of the 1990s the incumbent Federal Government continued to erode the opportunities for women to move forward as the dismantling of the women's policy machinery took place across the public sector. By 1996 the Office for the Status of Women's (OSW) budget had been cut by 40% and the OSW grants were cut from $1 million to $500,000 a year. Government policy was also seen to be detrimental to women, including cuts to childcare, the removal of minimum hours for part-time and casual work, and the watering-down of affirmative action legislation. Finally at the United Nations (UN) Millennium summit in September 2000 Australia decided not to sign the optional protocol to the UN Convention on the Elimination of Discrimination against Women. The decision not to sign this convention is of considerable concern to Australians, particularly when the Government had been playing an active role in the three years of drafting the protocol and had not voiced any concerns during that period.

2.2.2 Progress of Women in Engineering

The early research into women's rights and women in non-traditional fields of work and study took a prefeminist analysis approach and concentrated on trying to change women to fit into the prevailing environment [Byrne, 1985; WISET, 1995]. This research struggled as it tried to work within an environment that did not use or accept concepts of patriarchy and women's oppression. Without this structure the analysis of women's exclusions from areas of work based upon their gender resulted in research concentrating on examining sets of values such as parental occupation and personality attributes [Dabke, 1995; Duane, 1995].

The Australian Bureau of Labour Market Research [1982] produced a report in the early 1980s on the engineering profession in Australia, which showed that there were very few women engineers. The report highlighted the fact that the profession was one of the most sex-segregated occupations in Australia at that time and was markedly inferior in this respect to the engineering profession in most other industrialised countries. The report also highlighted the great concern for Australia of failing to educate enough engineers for its needs and that Australia was relying on migration to fill the gap.

This report triggered research on women and engineering [Byrne, 1985]. Byrne's subsequent report, *Women and Engineering: A Comparative Overview of New Initiatives*, provided a very important baseline of current practices in women in engineering issues and programs in Australia and provided comparisons with other Western nations at the time. It clearly restated Lloyds' [1979] and later Williams' [1988] claims that the engineering profession needed to recognize that an engineering graduate would require a greater awareness of economics, psychology and the environment. The implication was that if the profession was to carry responsibility for the social influences of technological change, then it needed more women and more exposure to the 'female perspective'.

Byrne's report [1985] also showed that there was a need for a comprehensive and systematic approach to increasing the number of women in engineering. Little had been done in Australia up to the time of the report. At the federal level, the Department of Employment and Industrial Relations had produced a video on *Women in Professional Engineering* but there was still no national effort to persuade institutions to initiate coherent and integrated long-term programs, nor any attempt to look for funding for initiatives, which were starting to appear. The report documented work being done in eleven tertiary institutions (particularly the Institutes of Technology) which had made attempts to encourage women into engineering. A range of initiatives had been trialled from targeted brochures to information seminars for women.

Numerous Women in Engineering programs have continued to appear and disappear at various institutions in varying forms. The direction and achievements of these programs have been characterised as having undergone a number of distinct phases [Roberts and Lewis, 1996]:

- The initial phase focused on recruitment. Programs had explicit aims to increase the participation of female students in the areas of women in engineering and science, and performed most of the (now) recognised advocacy tasks. The focus of such programs was on women in schools and in the community.
- The second (overlapping) phase addressed the issue of retention of women students. This phase focused on support programs for women enrolled in engineering and science, including mentoring and women only activities to encourage and strengthen networking.
- The third phase was influenced by the poststructuralist feminist movement and therefore moved towards changes at organisational and cultural levels.

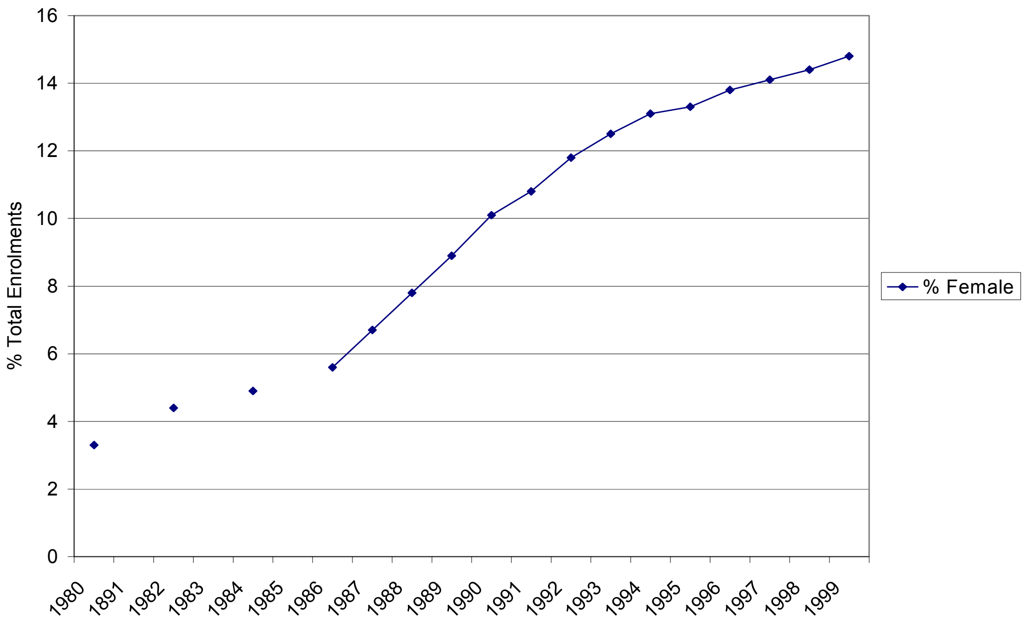

Figure 2.1: National Trends in Female Participation in Tertiary Engineering Programs 1980 – 1999

I Even without the support of a national agenda, these separate programs were making a difference to the numbers of women deciding to study engineering. By the late 1980s the numbers were increasing at over 1% per year (see Figure 2.1) [Data

Matters, 1995; Lewis, 1998, DETYA, 1999]. However, it was not until the mid 1990s, when the percentage increases were slowing to 0.5% and then 0.3% in 1998, that the political focus in Australia returned to women in non-traditional areas.

n May 1993, the Federal Minister for Science and Small Business established the Women in Science, Engineering and Technology Advisory Group (WISET) to advise on strategies to improve women's participation in Science, Engineering and Technology (SET) careers and education. The Advisory Group published a discussion paper in May 1995, which presented 14 recommendations [WISET, 1995].

The two principles that the Group adopted were:

- The need for a paradigm shift away from asking what is wrong with women, to questioning what it is about the environment of Science, Engineering and Technology (and society's perception of it) that fails to attract and retain the interest of girls and women.
- The need to adopt a holistic policy approach (as advocated by Byrne [1985]) to the various clusters of issues associated with girl's and women's participation in SET.

Following the WISET report, a group called the Australasian Coalition of Advocates for Women in Engineering (ACAWiE) was formed during the second National Women in Engineering Forum in December 1995 to liaise with the Office for the Status of Women. The members were individuals from the separate Women in Engineering Programs that were active at the time within various institutions throughout Australia and New Zealand.

2.2.3 Research into Women in Engineering

It was not until December 1994 that an inaugural national event for women in non-traditional areas in Australia was held. This event was a one-day forum held in Sydney with the theme *Transforming Cultures – Nurturing Diversity in Organizations* [Forum, 1994]. The Forum had a balance between educational issues and workplace themes and had a strong representation from indigenous women and overseas Women in Engineering programs. There have been five forums since the 1994 event and, in general, the forums have been designed to be highly interactive and to promote small group discussion and networking. It was clearly recognized by the second forum in 1995 that women studying and working as engineers or advocates (professionals working in or with Women in Engineering Programs) in this area were generally working in isolation from other women and required affirmation and renewal. These forums have been recognized as being the opportunity for such interaction.

A major theme covered during these forums has been women's experiences in a non-traditional area of work and study. However, from the first Forum in 1994, sessions have been devoted to defining the culture of engineering and the need to transform that culture into a gender-neutral one. This was clearly happening in a broader context of defining equity in the Higher Education sector in Australia following a Commonwealth Government Report, *A Fair Chance for All* [DEET, 1990]. This report advocated the move away from a deficit model to one of cultural change. The deficit model was one that was encouraging the development of strategies directed at changing individuals' skills, preparedness and attitudes and defining male as the norm. In 1990 the Australian Government was advocating a move from focusing on the individual to changing the system. However, in the late 1990s there was a return to the deficit model with the notion of disadvantaged individuals, as outlined in the Federal Government report, *Equity, Diversity and Excellence* [1996]. At the same time, Women in Engineering advocates and research continued to view the need for a paradigm shift towards a cultural change framework [WISET, 1995; Copeland, 1998]. This was stated in the WISET Report [1995] and later although with not as much conviction in the Review of Engineering Education, Changing the Culture [IEAust. Review, 1996]. Frustration was at a peak amongst the advocates of Women in Engineering in the late 1990s due to the stagnation of interest in the political arena and the clarity with which the research was identifying the 'masculine' culture and its impact on women. In particular, the role of Women in Engineering Programs was being questioned due to the misunderstanding and misinterpretation of the Affirmative Action for Women legislation [Messer, 1998]. There were many other areas in which hard won feminist gains were being challenged by masculine and political backlash. The plateauing of the number of women choosing courses in engineering combined with the shortage of engineers, particularly in the Information Technology area, was also adding to this frustration. However, programs remain focused on women, with men deemed the norm using the deficit model. As such, the culture, still the domain of men, has largely been left unchallenged and largely unaffected by the Women in Engineering movement of the last two decades.

Workplace issues had been encouraged at the forums [Smith and Forfolias 1995; Cullity and Krautil, 1995], however, attempts to get industry involved have been short lived. It appeared difficult for female engineers to maintain commitment to these forums due to the nature of their work responsibilities. In addition, although explicit issues that affect women engineers working in industry were identified, many of the concerns that were raised pertained to women working as professionals in business in general. Programs for women engineers have been initiated in some large engineering industries and organisations such as Victoria Electricity Commission, Esso and Ford. However, the majority of women working in Women in Engineering Programs have been in the university system. Two workshops at the 1995 forum; *The Hidden Rules* [Armstrong et al, 1995] and *Advocating Women in Engineering* [Godfrey, 1995] singled out academic institutions for discussion as both a working and training environment. These discussions have led to a more academic approach in presenting Women in Engineering research. The increase in academic content also reflected a growth in Australian research in this area as well as a move towards integrating other academic research areas including feminist perspectives and educational theories.

The Women in Engineering Forum continues today in association with the annual conference for the Australasian Association of Engineering Education (AaeE) and provides a meeting forum for the Women in Engineering Program directors and advocates. This collaboration has taken many years to foster and was a strategic development by the Women in Engineering Advocates. It is significant to recognise the importance of this merger, which illustrates the move towards research related to gender in education. In fact, most of the current research into Women in Engineering issues in Australia has been published and presented at this Forum or at the AaeE Conference. Although efforts to encourage women into engineering in Australia have focused on educational institutions, there has been surprisingly little research into gender issues in the engineering curriculum until the late 1990s.

2.3 Gender in Education

2.3.1 Developments in Australia

Research into sex differences in the educational system in Australia was carried out in the late 1960s and early 1970s in the context of the so-called sexual revolution. From the early 1930s until the mid 1970s, boys were more likely than girls to participate in post-compulsory education [McInnis, 1996]. This was especially noticeable in the tertiary sector where in 1971 less than a third of students were female [AEC, 1991]. In addition, in 1977 an OECD report had described the Australian workforce in the 1970s as the most highly occupationally sex segregated of any industrialized nation that it had studied. This research prompted concern regarding girls' participation in the education sector and led to social and political debate into the need to improve the quality of girls' education. This debate continues today and has been expanded to include issues related to boys' education. In particular, however, the research identified and questioned certain characteristics of the Australian education sector including the fact that girls have lower retention rates, narrower choice of school subjects and considerably lower qualifications than men.

An important discussion that has been taking place in parallel with this main debate has asked, to what extent do schools have the ability to influence outcomes for girls? A 1973 Report of the Interim Committee for the Commonwealth Schools Commission thus recommended an investigation into schools' influence on girls' outcomes. The result was the landmark report published in Australia, *Girls, School and Society* [CSC, 1975] to address these issues. It argued, among other things, that schools reinforced gender stereotypes by using biased curriculum materials and undervalued skills that supported interpersonal relationships - skills which were categorized as female traits. In this report the Federal Government called upon teachers and schools to redress educational disadvantages experienced by girls.

A parliamentary paper in 1980 made note of the States' and Territory's actions in issuing statements to schools following the 1975 report, aimed at eliminating existing practices. This paper observed that there appeared to be a general agreement on principles and recognised that improvements had been made in girls' participation rates, but declared that there was little sign of willingness to implement the hard options suggested in Girls, School and Society. This led to a further Commonwealth report in 1984, *Girls and Tomorrow: The Challenge for Schools* [CSC, 1984]. This report reiterated that the existing education system produced and reproduced undesirable gender based division in society. It argued for a comprehensive and coordinated approach to provide equity for girls and boys at school, particularly in terms of developing confidence, self-esteem and marketable skills. It emphasised women's lack of participation in mathematics, science and technology subjects and the implication of this for further education and employment. The report recommended the development of a national policy dedicated to improving schooling and its outcomes for girls.

The first National Policy for the Education of Girls in Australian Schools [CSC, 1987] was endorsed by the Australian Education Council and major non-government education bodies in 1987. The National Policy proposed a framework for action and seven recommendations including policy review guidelines and reporting systems. The actions to improve girls' schooling were developed out of values and principles, which were made explicit in the Report. These translated into four broad objectives, each with specific priority areas:

1. to raise awareness of the educational needs of girls recognising that girls had equal capacity for learning and equal right in schooling and awareness of the changing role and status of women;
2. to give girls equal access to and participation in appropriate curriculum, which meant a fundamental review and reform of the curriculum to eliminate bias by including girls lives within material and diversify teaching and learning practices. In addition, specific areas of the curriculum were identified for reform including science, mathematics and technology areas;
3. to provide a supportive school environment, to challenge the patriarchal power reflected in the school organisation and practices;
4. to ensure equitable resource allocation through review of resources policies and legislation of ongoing general resources to address the educational needs of girls.

The following four years saw annual reports from the Department of Employment Education and Training (DEET), *Girls in Schools* summarizing initiatives in relation to each of the four National Policy objectives. These reports provide a valuable insight into the achievements and difficulties that were being experienced in implementing these policies. In particular, eliminating sexual harassment was focused on as a means of promoting a supportive school environment as set out in Objective 3. Although initiatives included development of abuse protection programs and single sex classes for girls, there was also a call for the need to focus on the behavioural development of boys. The broader question 'What about Boys?' gained momentum in the early 1990s with the increasing improvement in girls' performance in schools and the intensified public interest in boys' declining performances. Both the 1991

National Policy Review and the 1994 National Advisory Committee on the Education of Girls acknowledged and incorporated issues for boys in education. The key message which emerged was, if mutual understanding and tolerance between the sexes is to be achieved, the education of boys needs to change [McInnis, 1996]. In New South Wales (NSW) a Government Advisory Committee was set up to investigate boys' education. The subsequent O'Doherty Report [1994] outlined the nature of the problem and recommended the development of an inclusive equity strategy.

DEET's first report *Girls in Schools* observed that schools were implementing isolated curriculum projects in line with Objective 2 of the National Policy. However, this was not enough to ensure female students would pursue non-stereotypical subjects or career choices. This was in contrast with the substantial amount of work being done on career education initiatives to promote non-traditional occupations for girls by the end of the 1980s, including the Women in Engineering Programs highlighted in Section 2.2.2. However, by the second report, the concept of 'inclusive curriculum' was gaining currency and during the final two years substantial funding ($5m) was directed into curriculum projects [DEET, 1990 & 1991].

2.3.2 Developments in Science and Engineering

The end of the nineteenth century marked the time when women finally gained access to higher education in science. However, very few were able to work in industry. As Margaret Wertheim declares in Pythagoras' Trousers [1997:p165], "just as the male clergy had kept control of the path to religious salvation, male scientists now maintained a firm grip on the path to technological salvation". The barriers in science had transferred from the academic environment to industry as the professionalization of science progressed. However, with this transfer the battles that women faced to study engineering remained. "If science based technology was going to *save* humankind, women were going to be savees, not savers " [ibid: p169].

Much of the understanding of gender in engineering education has come from studies in the science fields and/or at the secondary school level. There are surprisingly few studies into gender in the engineering classrooms, although it is likely that similar issues apply to engineering. There are also unique features in engineering that need to be understood. For example, a common perception of a budding engineer is of a person who has 'tinkered' with cars or electronic kits prior to enrolling in these courses [Robert & Lewis, 1996; IEAust. Review, 1996]. Although the subject material dealt with in engineering courses and the work performed in an engineering career do not usually fit this stereotype, they do bring with them assumptions of 'prior knowledge' and terminology to which a proportion of engineering students and particularly women, have not had exposure. In addition, even though there is no proven or obvious relationship between ability to do mathematics and science subjects at secondary school and ability to be a good engineer [Beder,1998], engineering courses are strongly tailored to suit this mathematics and science background. This has been an obvious problem for women in the past, due to the number of women taking mathematics and science at high school level. This problem is changing in nature as the number of women taking mathematics and science classes at secondary level in Australia is steadily increasing. In NSW in 1999 female students were 50.63% of the 16,002 students undertaking 2 Unit Mathematics and 42.91% of the 7,633 students undertaking 3 Unit Mathematics [Department of Women, 2000]. They were also 34.23% of the 7,236 students undertaking 2 Unit Computer Studies and 14.8% of the 1,782 students undertaking 3 Unit Computer Studies [Department of Women, 2000]. However, despite reasonable gender balance in these subjects (except 3U Computer Studies), a recent government study [DEYTA, 2000] into women in Information Technology (IT) found that compared to male students only a very small percentage of these female students went on to courses leading to careers in IT. Although no similar studies were undertaken regarding mathematics and science students, the percentage of women entering engineering suggests that these findings may also relate to courses which lead to engineering careers.

Students' ability to do mathematics and science is, unfortunately, commonly believed to be the 'filter' that preceded a choice to enter engineering. Students felt that "an interest in doing these subjects with a desire to combine them in a career was essential" [Durchholz,1979, p720]. This filter turns into what is perceived as a 'weedout' system at the introductory science classes level which has been seen to eliminate those students who are not deemed 'fit' to be in science [Brown University, 1996; Pfatteicher, 1999]. The apprehension that accompanies this 'weedout' atmosphere discourages some students from following their interests in these fields. Female students in particular find the 'weeding out' teaching styles much less appealing because women in our society suffer from lower self-esteem and have a tendency to attribute failure to themselves. Yet academics have accepted that the drop out of female students is due to a kind of 'natural selection' process [Seymore, 1992; Seymore and Hewitt, 1997]. In fact, studies have repeatedly shown that students leaving science are intelligent and strongly motivated, but are discouraged by the competitive atmosphere [Austin, 1987; Seymore 1992]. Seymore found over a third of students moving out of Science, Mathematics and Engineering fields indicated that their primary reason for leaving was their 'morale was undermined by this Darwinian competitive culture' [Seymore, 1992]. Research by Horner and Shaver [cited Rosser, 1995, p11] indicates that women learn more easily when cooperative rather than competitive pedagogical methods are used. Thus, according to Tonso [1996], the far greater contribution to attrition in the Science, Mathematics and Engineering fields stems from the structures of the educational experience and the culture of the disciplines.

> "Many men can argue genuinely – from their position as men – that there is no prejudice, that there is no discrimination, that women have equal access to their system but choose not to take the right subjects, to obtain the necessary qualifications, to gain the right experience. If men perceive their standards, based on their experience, as the only standards (and the only human experience) then it is reasonable for them to argue that women simple do not 'measure up' in their terms. [Spender, 1982]

The sensitivity and complexity of the debate-surrounding women's participation in education are well described in Dale Spender's comments above. This, overlaid with the similar sensitivities and complexities of issues associated with women in engineering, would suggest it is time to 'think outside the square'.

Chapter 3 - The Culture of Engineering Educational Institutions

> *Education is about the transmission and transformation of culture on the one hand and about the development of understandings relating to the human condition and of ourselves on the other. Schooling of itself cannot change society or the relationship between the sexes. But it can help young people critically examine both and to sort through their priorities, taking into account the realities of the situation as it presents itself to them and appreciating their own potential as agents in transforming it.* [Jean Blackburn, Australian Women's Education Coalition Conference, 1981]

"Education is the tool of the dominant class in society" [Crotty, 1992, 78]. Dale Spender [1982], in her research into the history of feminist writing, has been able to describe how the education system has operated over centuries to ensure that this exclusion and privilege has continued. The term 'cultural reproduction', which is defined as the way in which knowledge and the curriculum are structured and defined so that they seem to reproduce the cultural conditions of the prevailing social order, has been used to refer to this circumstance. This concept reinforces Jean Blackburn's comments above of the importance of education to the way our society builds and works within its cultural boundaries. Yet, for women of previous centuries this exclusion remained elusive as Spender [ibid] and Wertheim [1997] document how women's ideas have been made invisible over centuries so that each new generation of women has had to start anew.

However, during the last 50 years there has been substantial change for women within the education sector. Women have not only gained increasing access to education but have proved their ability to achieve to the highest level in this sector. Their achievements have not only been seen in the 'traditional' areas of english and social studies but are also challenging boys in the traditionally 'male' dominated areas of mathematics and science. The evidence seems irrefutable. For example, in the 1999 NSW Higher School Certificate honours list, girls topped more that two-thirds of subjects [Department of Education Statistics, 2000]. This fact was confirmed in a recent Federal Government Report [DETYA, 2000a], *Factors Influencing the Educational Performance of Males and Females in School and their Initial Destinations after Leaving School*, which states that the average girl is out-performing the average boy in more subjects. Yet, the report goes on to say that despite the fact that more females than males are entering the higher education sector, girls' post-compulsory pathways are less likely to lead to successful labour market outcomes and that this is an obvious disadvantage now that women frequently have to be economically independent. Thus, it would appear that girls are doing well but not at the expense of boys. That is, the educational experience of girls has in fact not led them to the same level of achievement as the educational experience of boys.

Gender difference and sex stereotyping within the classrooms of mathematics and science (and to a much lesser extent engineering) have been studied and will be outlined in this chapter. This research has shown that men and women often experience the classroom differently and that teachers have been shown to inadvertently treat genders differently. In the arguments presented, there has been no attempt to venture into the debate of 'nature versus nurture', that is whether male and female attributes are determined by one's genes or by the environment in which one is brought up. Nor does the discussion assume that specific attributes are characterised solely by one of the sexes and acknowledges that in reality women and girls, as with men and boys, are not one homogenous group and that there is overlap between attributes and gender. Johnston [1999] has suggested that changes made to the engineering course at the University of Technology Sydney to make it more inclusive and attractive to women have actually improved it for everyone involved. In a broader context it could be seen that the presentation of a set of values which include the feminine as well as the masculine will lead to a more humane and balanced engineering profession and society.

Tonso [1996] and others believe that it is the engineering education sector that must change first before inclusion of women can be realised. Engineering remains largely (if unconsciously) defined by men, and can be an uncomfortable environment for women [Johnson, 1999]. However, it is not only the way technology and engineering are defined but also how the profession is practised and taught that clearly discourages most women – and some men [Johnston, 1999]. The Women in Engineering movement of the last two decades has indeed been significant in highlighting these inequities within the profession but the profession itself has also recognised the need for change [Lloyd, 1979, IEAust. Review, 1996; Beder, 1998]. There is a growing acceptance of the idea that it is the culture within engineering in particular which needs to change. An essential component of this change is increasing participation of women and other minority groups to reflect the diversity of the community which engineering serves. Yet despite this call for change spanning three decades, engineering still appears to have some way to go to achieve a more healthy balance.

In this chapter, research conducted into gender issues in engineering education will be explored by firstly examining the image of engineering courses from a prospective student perspective and then investigating the culture and practices operating in engineering faculties in order to understand the experiences of students, particularly women, during their training years. This research has been tackled by researchers from many perspectives: educational, epistemological, anthropological, ethnological, feminist and contemporary theories of masculinity which together form a picture of the ways a masculine discipline is created, maintained and projected. Then the engineering classroom is examined firstly from a gender dynamics or behavioural viewpoint before the teaching and learning environment is examined more closely. The final section compares the educational environment in other disciplinary areas for similarities and differences found in their culture and approach to gendered behaviours and teaching practices.

3.1 The Culture of Engineering

The culture of engineering faculties and of the profession itself has been defined as masculine. So what does culture encompass in this context and how does it manifest itself and affect the people that work within the environment? Culture has been defined by the Macquarie Dictionary [1998] as "the sum total of ways of living built up by a group of human beings, which is transmitted from one generation to another". In the engineering profession, men have had access and dominated this profession and have therefore determined its culture. In an attempt to expand our understanding of the details of this culture, a number of researchers have used contemporary theories of masculinity and feminist scholarship to set the context of their work. Researchers such as Tonso [1996], McLlwee and Roberinson [1992] and closer to home McLean, Lewis, Copland Lintern, O'Neill [1996, 1997] ; Lewis and Copland [1998], Lee and Taylor [1996] Jolly [1996], Stonyer [1997; and Smith, 1999] and Godfrey [1995; and Parker,1998] have generally reinforced each other's research on the culture of engineering institutions, despite the different approaches and the different locations in which their studies were undertaken. Their findings will provide us with a descriptive picture of the kind of environment experienced by students in engineering faculties and will focus on differences experienced by each gender.

A major theme which emerged from the research into the masculine culture of engineering education was referred too as engineering 'hardness' [Godfrey, 1996; Jolly, 1996; Stonyer and Smith, 1999; Smeaton, 1996], which has been related to theories of masculinity [Stonyer, 1997]. Many facets of this hardness have been identified, the most notable being the "work hard/play hard" concept. Stonyer and Godfrey both noted that time pressures are enormous during semester for students, with courses having high contact hours, long days and short breaks. Stonyer and Smith [1999] concluded that to keep up with workloads, engineering students needed and valued routines and the disciplined nature of the course. It is interesting to note that a number of researchers [Godfrey and Parker, 1998; Lee and Taylor, 1996; Wilson, 1992] have noticed overtones of military values and attitudes and in particular an environment which does not promote choice. The research concluded that this work hard environment led many students to quickly interpret that the more stressful and challenging the process or 'ordeal' the more valuable and worthy it is [Stonyer and Smith 1999]. In fact Godfrey [1996] established that the difficulty of the course and high academic standards were thought by students to contribute to their feeling of self worth, status and reflected glory in statements such as "I am an engineer". This work hard/play hard ethic is, however, not a completely negative response and is in fact seen as courageous by both males and females within the culture. The 2000 winner of Outstanding Women of the Year in a Non-Traditional Area (Higher Education), for example, was outspoken in this regard claiming "I work hard and play hard – I try to do everything" [Loh, 2000]. It is hard to believe that engineering alone has the academic rigour and dominance over difficult tasks that is

being suggested here. Thus comparisons with other disciplinary areas seems necessary to understand the significant of these findings. Comparison to other disciplines and professions will be investigated in the final section of this chapter.
An unfortunate response to the time pressures within engineering courses, says Godfrey [1996], is to adopt 'survival techniques' such as, 'just-in-time' learning which provides little chance of real and deep understanding. For female students a typical additional response to the engineering 'hardness' identified was the ability to 'take it' or 'handle anything' [Stonyer and Parker, 1999]. Jolly [1996] finds that women clearly set great store by their ability to put up with difficult conditions and prided themselves with giving back as good as they got. However, both Jolly [1996] and Stonyer and Parker [1999] identified that in fact the ability to cope is seen as heroic in such a way that they are unlikely to acknowledge the existence of the problem. Also they identified that women taking engineering courses demonstrate a world view and set of values that allow them to fit into the existing culture with minimum stress, however much of these values stem from having to minimise the personal risk of being different. Although the number of women who became involved in these research projects were limited due to overall numbers of female students, it does seem strange that even slight differences in attitudes and behaviours were not highlighted by these researchers. This area of research is, after all, seeking to identify difference between genders as well as individuals.

A much larger more comprehensive research project was undertaken by a group of researchers across a number of academic institutions in Australia during the late 1990s to explore women's experiences of engineering [McLean, Lewis, Copland, Lintern, O'Neill 1996, 1997; Lewis, McLean, Copland and Lintern, 1997; Lewis and Copland, 1998; Copland and Lewis, 1998a]. In particular, the research investigated how women were working and fitting into the existing engineering education environment by interviewing hundreds of engineering students (both male and female) and engineering academic staff. Most notable researchers in this group were Sue Lewis (Swinburne University of Technology) and Jane Copland (University of Adelaide) who have through this research, made a significant impact on the profession in Australia. The important outcome of this research was that it confirmed the necessity to change the culture rather than changing the individuals. The theoretical approach taken in this research used contemporary theories of masculinity, in particular those of Connell [1995] and Segal [1990] that stressed the active and dynamic nature of gender construction. These researchers focused on the individual and suggest that their identity is not constructed in a fully conscious process but is an active and ongoing process of meaning making in which people interact with available cultural material to create identities which work for them. In this process the researchers have identified the symbols of the culture and the set of norms which determine acceptable behaviours.

The first stage of the research by Lewis et al [1997] and McLean et al [1996, 1997] was to identify the main characteristics of this dominant masculine environment and then illustrate how these characteristics are played out in the social and learning environments of engineering faculties. The research has found that there was a strong sense amongst male engineering students of belonging to a group that had a special and valued identity. Thus the dominant discourse of engineering is attributed to the formation and maintenance of the group. This group sets the norms and determines what is acceptable behaviour. To belong to the group it is recognised by students that there are certain rules or rituals that need to be followed. The dominant masculine culture thus effectively marks who belongs and who is excluded.

The research argues that taking on acceptable roles and behaviours still does not result in complete acceptance within the group. To be a fully accepted member of the dominant group, one must be Anglo, male and heterosexual. This group importantly provides the mateship/camaraderie, which is so highly valued within an engineering environment. The two features to mateship which have been identified [Godfrey and Parker, 1998] are the social interaction that promotes and encourages the acceptable behaviour of the dominant group and the value of friendships as necessary for academic support. The friendship feature identifies the importance of being a part of the social scene and belonging to the dominant group to enjoy the advantages of peer academic support that is influential for success within the course. The former feature of social interaction has been identified by McLean et al [1996, 1997], Lewis and Copland [1997], Godfrey and Parker [1998] and Jolly [1996]. These behaviours include a high attendance at, and support for, pub crawls, binge drinking, drinking tournaments and engineering songs. Also, the culture of joking, 'put downs' and sexist and sexual comments are not only accepted but are expected of members of the group. McLean [1996, 1997] found that male students insist that they are all done in good fun and that no-one ever gets upset. Female students are put in a very difficult position in this regard regularly being exposed to, and sometimes the object of, these 'jokes'.

Stonyer and Smith [1999] recognised that women need at a minimum to ignore the banter and should preferably get involved 'giving as good as they get' to demonstrate allegiance to the group and adhere to its rules and behaviours. Most women went out of their way to explain that they did not find this to be any more than they expected and that the excuse of 'just a joke' regularly glossed over harassment [Jolly, 1996; Stonyer and Smith, 1999]. Copeland [1995] had suggested that female engineering students were relatively uninformed about feminism and what constitutes harassment, although it does seem reasonable to assume that challenging harassment would not be an acceptable response within this dominant discourse.

In addition, mateship, which is an intimate part of the dominant group culture, has had a long tradition within engineering of providing a facade of unity to outsiders of engineering. Godfrey and Parker [1998] found that even with the increasing number of women (above 20% at the University of Auckland) and other minority groups within engineering, there was still significant importance placed on the appearance of unity. Thus, whether included or excluded from the dominant group, to outsiders engineering students appear as a singular unified mass.

Within the engineering classroom Jolly [1996] and Stonyer and Smith [1999] identified that the 'mucking around in class' was associated with the requirement of individuals to demonstrate that they were 'real men'. This mucking around also showed that they did not take or need to take their studies seriously, which would seem contradictory to the previous research findings on the work hard/play hard philosophy. Neither piece of research explained this contradiction. Jolly's [1996] study went on to further define this negative male behaviour in class to include paper plane throwing, rowdiness and making rude and derogatory remarks. For women in this environment it can be difficult to contribute as one female student remarked 'you make a female comment and they just look at you and go awww, okay' [Jolly, 1996, p55]. There is an implication that women's contribution is not considered important and often simply ignored and that their interests and values are discounted or disallowed.

Lewis and Copeland's research went on to describe ways in which female engineering students responded to this dominant male culture and identified a limited number of options available for female students. The female students were judged based on the dominant group values and as such were found to show three alternative responses [Lewis et al, 1997; Copeland et al, 1998a]:

- 'one of the boys'
- 'compliant helper', a traditional female role or
- resist the dominant culture by expressing and acting out feminist views.

It was recognised by both male and female students that the last alternative, the feminist response, is virtually untenable for female students. It was rarely if at all attempted in the current environment, even though a majority of female students had expressed these values. Taking on this position as a female student would be the ultimate threat to the dominant group because it challenges and questions all their assumptions and would undermine their social power. The first two responses, however, were both identified as non-threatening to the dominant group and in fact maintained the status quo with no challenges to it. These were the responses that women worked within, often alternating between them to suit different situations. The traditional female role response reinforces the conventional heterosexual male-female relationship and places the female student in the supportive or 'compliant role'. The first response available to women was to become 'one of the boys' and to mimic the male behaviour. Linda Jean Shepherd described how women scientists and engineers are essentially not only forced to acquire masculine ways but need to continue in later life in order to survive, stating:

> Through long years of training and work, women scientists and engineers have assimilated the 'masculine' capacities for discrimination, analysis, rational thinking, and abstraction necessary to do science. Sometimes the feminine is lost in the process, because science defines itself in such masculine terms that the Feminine seems irrelevant. [Shepherd, 1993]

This response, although excusable as a survival technique, not only shows acceptance of the dominant culture but also participation in it. As the most common of the responses, it is easy to understand why women within this environment are seen to reject attempts to change the culture. Unfortunately, for female students, taking on either of the acceptable roles will not result in complete acceptance or membership of the dominant group, which is dependent on being male.

Contradictions in women's experiences were regularly found in the responses given during these research projects. These contradictions appeared to stem from individual responses differing from the 'normal' response attested by the research findings. For example, in Stonyer's study [1999] female students on the whole identified closely with the 'one of the boys' responses however a female student also stated that the male students helped her a lot because 'you are a girl'. Similarly, Jolly [1996] found that most female students claimed to have no problem with the fact that so many of their fellow students were male, although one female student also said: *'You just don't take any notice …. of the shit they give you constantly'*. Also Jolly found some female students felt membership in Engineering Societies was synonymous with being a 'real engineer', even when they expressed disgust at the behaviour.

Not only does the research identify what is being experienced within engineering, it also matches the perceptions that prospective students have about engineering from the outside. The general culture and ambience confronting first year students is one that is likely to be seen as 'difficult' by most women for its impersonality and the apparent need to be 'one of the boys'. Jolly [1996] cites research by Smeaton which shows that Year 12 girls who have the qualifications to enter engineering expect to find that entering the profession would require a loss of femininity and a willingness to think and act like their male compatriots, which most of them find unappealing. Smeaton also found that workload and the reputation for the difficulty of the course was an issue for potential students. As previously highlighted, the perception that engineering is a 'thing' orientated profession, not 'people' orientated has also kept women from choosing it as a career. Godfrey and Parker's [1998] research into mateship and camaraderie in engineering illustrates that male students in the study showed just as much 'people' orientation as did the women and questions the adage that males entering engineering are 'thing' oriented. No other research was found to support this claim and it would appear to have mistaken a friendship 'people' orientation for the concerns of 'people' and society as a whole. As Steven Biddulph [1997] says 'boys are sensitive and passionate' amongst themselves however this behaviour can and will change in a group.

More recent research by Copeland and Lewis [1998], Lewis et al [1998] and Stonyer [1997] has begun to use a poststructural theoretical approach to provide a framework to investigate the process necessary to move towards the desired cultural changes required in engineering. Bronwyn Davis [1989; cited in Lewis et al, 1998] defines poststructural theory as providing '…a radical framework for understanding the relationship between people and their social world and for conceptualizing change'. In a similar manner to the approach of contemporary theories of masculinity, poststructuralist theory views the individual as not being fixed but constructed from an ongoing process of interaction and responses to the world around them. It is from this work that one can argue that a liberal feminist view or deficit model, which was being used into the 1990s, will never be able to achieve true cultural change. Despite some uncertainty about how to progress and how to act on their findings, Copeland and Lewis have begun to incorporate the shift to include working with men, both inside and outside engineering [Copeland and Lewis 1998, Lewis et al, 1998]. It was stated that there was universal consensus that constructive collaboration between women and men to change engineering culture is an essential place to start from. This would limit the risks of backlash and of being trivialized, put down and marginalised as well as providing connections to the way power is constituted and reconstituted within faculties. There seems to be much merit in this approach, not only to limit the risk for women but also to ensure that the broadest possible spectrum of perspectives is encapsulated to move engineering towards a desired genderless profession.

3.2 Gender Dynamics in the Engineering Classroom

Modern sociological theory has suggested that the gender roles, which we experience in society, are not in any way necessarily or inherently related to sex types or in other words biologically determined [Lovat, 1992 p71]. Ann Oakley [quoted in Crotty 1992 p75] wrote " *'Sex' refers to the biological division into female and male; 'gender' to the parallel and socially unequal division into femininity and masculinity*". Simone de Beauvoir [1994] defines the terms masculine and feminine further. She declares that the terms are used "*symmetrically only as a matter of form, as on legal papers but in actuality, the relation of the two sexes is not quite like that of two electrical poles*" [ibid, p7]. For 'man' represents both positive and neutral, as the use of 'man' is commonly used to define human beings in general, whereas women represent only the negative. This leads to the conclusion that the dominant gender roles in our society today reflect the values and beliefs of men. We can also interpret from Oakley and Simone de Beauvoir that gender roles are not necessarily or inherently related to sex types or biologically determined, but are the result of particular values and beliefs of particular societies. Evans [1988] wrote; *"…., femininity and masculinity are seen to mean partly different things in different societies because of variations in the social structures and in the ways people have constructed their meanings of these terms."* Gender understood in this way is conveyed through images of masculinity and femininity, and is thus a social construct based on cultural features associated with being male or female. Recent anthropological theory has demonstrated that different cultures have created different constructions of gender, and that masculinity and femininity are subjects with seemingly endless variations [Crotty, 1992]. If this is the case, then it is gender where we find real differences, not sex, and that gender roles can in fact be changed if the dominant values and beliefs are changed.

Thus, it is within the teaching-learning environment of a classroom where individual values and belief systems can be influenced and therefore stereotypes can be broken down. For this reason, teachers have a very important part to play in the environment and thus their understanding of the gender dynamics and interactions that are happening in the educational environments in engineering faculties is critical in supporting cultural change. 'Gender dynamics' has been a term used within gender studies at primary and secondary school levels to refer to these overt and covert happenings between teachers and students in the classroom in relation to gender. Much of these covert happenings are influenced by the culture of the faculty itself, which has been described in the previous section. It does raise an important unanswered question in engineering faculties: to what extent does the culture affect the classroom environment? The overt actions however have been documented to a greater extent and are presented below.

3.2.1 Gendered behaviour in an engineering classroom

It is hard to imagine that any teacher deliberately sets out to treat males and females in their class differently [Connell et al, 1982], yet Seymore [1992] and Sanders [1995] have documented that girls continue to exhibit lower achievement, aspirations and persistence in the mathematics and science disciplines. A report *How Schools*

Shortchange Girls [AAUW, 1992; cited in Sanders, 1995] identified biased teacher behaviour as a significant factor in the gender gap in science and mathematics. Sanders speculated that although there were no comparable studies in computer science and engineering classrooms, it would seem likely that there are similar behaviours in these environments. This biased teacher behaviour documented by a number of researchers at High School level [Sanders, 1995; DEET, 1990a] and University Level [Mares et al, 1996; Brown University, 1996] included teacher time and attention; questioning techniques and responses; the nature of tasks distributed; and support received. A study undertaken by the Ministry of Education in Victoria, Australia found, when monitoring teacher/student interaction in a classroom, that as much as two-thirds of teacher time and attention was given to boys [DEET, 1990a] and that boys were given more positive and negative attention, which took teacher time away from girls. In a study done at Brown University in the USA [Brown University, 1996], the results obtained in introductory science classrooms correlated closely with the findings of gendered behaviour in science and mathematics classes at high school level as outlined above. It was found that female students were interrupted more frequently by both peers and teachers and given insufficient time to respond. The messages that these behaviours reinforce despite being unconscious and unintentional is that boys and their contribution are more valued by teachers than those of girls.

It has also been established [Seymore, 1992] that women tend to place a higher value on what others in society think of them and also have been more dependent on encouragement and personal feedback from teachers at High School. They have felt that learning is more difficult as a result of less close contact with their teachers at university. In a study, *Students' Perceptions of Problems in Undergraduate Teaching,* Hewitt [1991] found that 30% of women (0% of men) listed 'professors don't care about you' as a problem. Ware highlighted that women are also "more likely to fix the blame internally - to cite their own inadequacies as the source of difficulty" [Ware, 1985, pg 73-84] when encountering problems; whereas men tend "to place responsibility for difficulties outside themselves". In response to a poor exam mark or failure in a subject, women tend to believe that it is their poor preparation or intelligence that is the cause and therefore are generally much less confident of their performance and will even transfer out of the course and career. A male student is more likely to blame the system whether it be the academic who has not helped them in their preparation or the examination which was obviously a poor judge of their knowledge and will therefore persist and resit exams and subjects if given the opportunity. In fact, Seymore [1992] identified between 70% and 80% of females who transferred out of science tracks because they felt discouraged and suffered a loss of self-esteem even though their grades were the same as the men. Self esteem and expectation, particularly for first year university students who are coping with a new learning environment, have been well documented [DETYA, 2000b; Pfatteicher, S., 1999], however for women in sciences there are these added, often unexpected, pressures which can further reduce self confidence.

The question of how similar the experiences of students in science and maths classrooms are compared to engineering classrooms has not been explored. Despite setting out with the aim of comparing the engineering laboratory setting with patterns recorded for science and mathematics classes at school level, Mare and his team [1996] instead provided information for engineering academic staff to support gender inclusive practices. The study's findings did, however, indicate that there were some differences despite not making them explicit. For example, women engineering students in this study tended to take on the leader's role in the mixed laboratory groups and in fact dominated the question time. This was understood to come about not so much because of their self-confidence but because of their preparation and motivation. Other research [Lewis, 1995] has identified that many female students made a difficult decision to choose engineering as a career, often going against the advice of family and friends and as such feel that they have much more to lose if they fail. Both these factors appear to influence the behaviours and experiences of women in engineering and highlight a difference to women entering the science and mathematics area. Another finding which was identified in the study as a typical characteristics of women in an engineering classroom was that women saw themselves as being organised, studious and well prepared. They were much more interested in understanding the relationship between theory and practice and the contextual relevance of the material. They also saw themselves as more systematic and less inclined to 'jump in' without understanding the operation of the equipment and processes that were involved. They therefore would be the people in the group to ask the questions if any aspect of the explanation by the demonstrators was unclear, which is again contrary to research in the science and mathematics fields. The female students saw their male peers as being quite happy to 'muddle through' and were mainly interested in obtaining an outcome or answer so that they could "fill in the equation" [ibid, pg84]. Unfortunately, this research did not provide a male student perspective on these areas. However, it did point out the difficulty of getting male student volunteers to collaborate with the research. The research also highlighted that some women even took the responsibility of ensuring that their laboratory partners (mainly men) understood the material. This could be interpreted as either part of their leadership qualities or be demeaned as Tonso [1996] suggests as taking on a 'mother/teacher' role. In addition, despite the fact that female students established this leadership role in the groups in the laboratory, when it came to the practical aspects of handling the equipment the male students took over. Taking control of the technical equipment and relegating women to fit into the more traditional roles of 'report writing', for example, has been found in both engineering and science classrooms [Rosser, 1995, p9].

The study by Tonso [1996], in particular, focused on the different ways men and women students came to understand their learning environment, and concluded that a lack of female academics can potentially further emphasise gendered behaviour. It suggested that students through their interaction with a 'male' academic came to understand his actions as part of being an engineer, which sent narrow messages about who engineers are and what engineers might be. Unsurprisingly the classroom met the male student's expectation of the world whereas the study found women's viewpoints could only be injected under certain rarely existing conditions. The study also concluded that women students and academics trying to effect change were, at times, put down by their male colleagues, and quoted students comments such as women being "poor public speakers" or "school marms" ' [ibid, p 224]. Importantly, Tonso stated that if genuine communication is to occur, these detractions must be removed. If engineering is to attract and retain female academic staff, these detractions must be recognised since until very recently there have been very few if any female academics in engineering [MIT Report, 1999; Burrowes and Webster, 1998].

3.2.2 Prior Technical Knowledge, Experience and Course Expectations

Roberts and Lewis [1996, p8] in the National Position Paper for Women in Engineering commented that "for many women, engineering still presents a masculine culture associated with hands on skills, cars and sport". This was reiterated in the Review by the Institution of Engineers Australia [1996] where it was recognized that despite these interests having little connection with 'real engineering tasks' they were represented within engineering curricula. The emphasis on these masculine interest areas means that women (and some men) can be disadvantaged academically because of the assumption of prior technical experience and language interpretation. In Mares et al's study [1996, pg 85], women students' comments revealed their frustration with being "expected to mysteriously know the language and parts of mechanical apparatus" which were referred to in the laboratory manual. Mares et al [1996, pg85] states that "it appears as though the more usual informal background of the male students is relied on in a formal way within the curriculum". There still remains the need to understand the extent to which this informal prior knowledge and technical terminology effects students' experiences in the classroom.

3.3 Teaching - Learning Practices - Gender Inclusive Curriculum

> *More inclusive teaching is simply good teaching ……… but good teaching doesn't necessarily provide inclusive teaching. [Brown University, 1996]*

The teaching and learning environment has been identified as a critical part of the engineering education system which needs review and change to ensure equity for all within engineering. Jean Blackburn [1981] is credited with first using the expression 'sexually-inclusive curriculum'; more recently referred to as gender inclusive curriculum. Guidelines were developed for a gender inclusive curriculum in 1990 called *A Fair Go For All*. These guidelines were produced by the Office of School Administration, Ministry of Education, Victoria as a strategy in the Equal Opportunity Action Plan for Girls in Education which was a result of the 1989 National Policy for the Education of Girls. The definition used in this report stated that gender inclusive curriculum was "curriculum which by its content, language and methods gives value and validity to girls and women equally with boys' and men's knowledge and experiences". Gender inclusive curriculum is the area of theory and research that has offered the potential for major impacts in the education sector to champion this paradigm change. It has been supported at policy level on a national and statewide basis and is beginning to be supported at a grass roots level as practitioners implement changes in parts of the classroom environment.

The original framework of gender inclusive curriculum aimed to support teachers in the design of their subject material and presentation methods to become more gender inclusive. This framework is changing with two observable trends emerging during the last decade. Firstly, 'gender' is fading into the background as 'inclusivity' and 'cultural inclusivity' take over, and secondly, the research has been moving from a teacher focus to a student focus. In a higher education context, Barbara Brooks coordinated a gender inclusive curriculum project at Victoria University of Technology (VUT) in 1992 and specifically recognized that the focus was moving towards 'inclusivity' and that gender had simply been the catalyst. She wrote;

> "The basis of a gender inclusive curriculum is a commitment to improvement of teaching and learning to maximise the learning of all students. That is, it aims to remove practices and structures that entail the 'good student' fitting into an idealised and monolithic model that tends towards the anglo, heterosexual, middle-class male. What we are increasingly identifying is the narrowness of the teaching perspectives that reinforce and reproduce this model and which are resistant to individual and minority variations in approaches to learning. This has huge implications for staff development programs and for the need to equip academics with a range of teaching approaches - and, in some cases, with a commitment to teaching" [Brook, 1992].

The 1992 Project led to an 'inclusive curriculum project' at VUT which was conducted through to 1997. In the project's final report, women's participation in non-traditional areas was highlighted as a 'major challenge' area. In particular, it recognised that there was still a substantial amount of work required into the examination of the curriculum and experiences of women in particular at the undergraduate level. However, despite increasing understanding in this area, the report specifically prioritised the need for wider implementation of inclusive practices into the curriculum.

The second trend, which stems from some of the principles associated with gender inclusive curriculum, reflects the changing emphasis in the school system from PRODUCT, (what students learn) to PROCESS, (how students learn), with the aim of producing life-long and independent learners. This fundamental shift has been evolving, with the recognition and acceptance of the changing educational requirements as we have entered the information age. As Spender [2000, p5] states:

> "Our basic model of teaching and learning is a knowledge transfer one. ….. The cult of the right answer. And it is of limited value in a knowledge economy, where it is precisely what is not known - where it is, what is new, what is a creative solution - which is the outcome that we should be looking for".

Thus, the emphasis is shifting to examination of the learning process and of the different learning styles of individual students. This area will be reviewed primarily as part of 'teaching methods' a category of gender inclusive curriculum.

Approaches to gender inclusive curriculum have thus moved from a model which has focused on a teacher controlled teaching and learning environment to an approach where students are to take responsibility for their learning. Despite this newer framework which concentrates on a student perspective, the appropriate teacher attitude and gender bias are critical to the successful implementation of inclusive curriculum programs. This research will concentrate on the learning process in relation to students' conceptions of learning, their perceptions of the learning environment and their approaches to learning in an engineering classroom.

Gender inclusive curriculum has been a focus of gender studies in engineering pedagogy of the last decade. The Institution of Engineers, Australia Review of Engineering Education, despite not being prescriptive in terms of inclusive curriculum, stated that "learning programs will be customised to suit the personal, educational, and professional needs of the individual" [1996, p15]. As a result of the review, the new generic graduate attributes [IEAUST, 1997] for engineers were developed. These attributes are now a requirement of the Institution of Engineers, Australia course accreditation process which identifies the need to evaluate learning outcomes at both course and subject level. The higher education quality assurance procedures, which are currently being put in place in the tertiary sector, will also have huge ramifications for engineering education in terms of the discipline's ability to demonstrate its quality of teaching and learning and of learning outcomes.

Research into gender inclusive curriculum and 'quality learning' has been taking place recently but despite strong rhetoric for change, implementation of gender inclusivity has been slow. This is partly due to the complexity of concepts needing integration within the learning and teaching environment as well as to the need to implement on a system wide basis as the VUT report has highlighted. Implementation has been piecemeal, as individual academics have attempted to change their classroom environment. It is difficult to evaluate success until a broader system-wide implementation takes place, since students are unfamiliar with these teaching and learning practices. It is thus important not only to understand the principles involved in gender inclusive curriculum and learning approaches but also the implementation issues to allow the system to move in this direction.

The most significant system wide work found to date in an engineering faculty at an Australian university has been at the University of South Australia [University of SA, 1998] and at the University of Technology (UTS), Sydney. The project at the University of South Australia has developed a university wide guideline on inclusive curriculum using the work of Sue Willis [1996]. Willis uses a model which identifies four perspectives on inclusivity: the remedial - supporting disadvantaged students; the non-discriminatory - changing pedagogic and assessment practices; the inclusive - accommodating diverse backgrounds; and the socially critical - encouraging student to self reflect. The guidelines, which have been backed up by seminars and workshops for engineering academics, continue to push the original framework of providing suggestions of alternative teaching and assessment methods for academics only. The project has achieved the highest recognition by winning the 'Engineering 2000' award in 1998. UTS Faculty of Engineering has also implemented major changes to improve the learning environment for students. It has facilitated this process by moving towards an integrated faculty structure which breaks down barriers between disciplines. The changes have attempted to provide students with a broader engineering education by developing new interdisciplinary approaches to the course as well as by moving towards a student focused curriculum.

A Gender Inclusive Curriculum booklet [Moxham and Roberts, 1995], designed specifically for engineering educators, was published by advocates of Women in Engineering and widely distributed throughout Australia in the mid 1990s. Its definition states that "a gender inclusive curriculum avoids gender bias in both the content and the presentation of the curriculum" with the definition of presentation expanded to include "the way language is used, the interactions that occur in the classroom, and the teaching and assessment methods" [ibid, p1]. A brief review of each of the categories identified within the definitions of gender inclusive curriculum above will follow with a review of literature associated with each category in an engineering context. The categories which will be used here are: content; language; and teaching and learning. The depth and breadth of each of these categories is large and there are major topic themes which overlap between categories.

3.3.1 Content

"Curriculum materials are gender-inclusive in content when the content is equally representative of the experiences and interests of women and men, when women's experience is recognised and valued equally with men's and is represented as an integral part of each area of study, subject, topic and theme" [DEET, 1990a, p16]. Engineering course content, however, has been deemed sex-exclusive, which has been identified as a reason for lack of participation in non-traditional courses by both Byrne [1985] and Powles [1986]. Rosser also confirms the impact of non-inclusive curriculum in the science disciplines by stating that: "the presence of sexism in language and classroom behaviours, combined with the absence of information about the achievements, roles and experiences of women from most curricula content, leaves many female students feeling somewhat distant, different and alienated from what they are learning" [1990, p20].

The choice of what content is used by teachers within the discipline reflects their own experiences, values and priorities. Therefore, to be inclusive these values and assumptions need to be reexamined to ensure the curriculum represents the full range of human experience. There appear to be three major themes that need to be evaluated in this category. These are: the exclusion of women's experiences and contribution in engineering material, the need to expand the content of engineering courses to consider the broader context of engineering in terms of both its social and historical context; and the construction of knowledge and the way we represent this knowledge within engineering.

The exclusion of women from texts, examples and general classroom discussion in engineering would lead one to believe that women have played no significant role in the developmental advances of the human race and have made few, if any, contributions to engineering history and culture. It is true that our history and culture has indeed constrained women in ways that have prevented most of them from participation in the broader public sphere to the same degree as men. Women have contributed in major ways to technological developments. These developments have often been in the areas which directly affect the well being of society [Moxham and Roberts, 1995] and tend not to be the large-scale prestigious public sphere projects where men have dominated. It needs to be recognised that texts and examples that include women are difficult to find and thus caution needs to be taken when incorporating women. Depicting women in stereotypical roles merely reinforces sexist exclusion and thus biased material may need to be used to create the opportunity to discuss the issue of sex role stereotyping. Mere inclusion can actually be detrimental. Yet it is important to ensure that future developments in course content must include resource material that includes reference to women's contributions, concerns and to non-sexist examples.

Environmental concerns and wider community needs have also been highlighted as integral to engineering practice and the engineering curriculum still needs to move towards incorporating this information. Research has shown that female students frequently prefer to have material presented in its context so as to reflect the social value of technology [Harding, 1994] and thus more conscious integration of social and environmental issues into the curriculum would support a change of image and potentially an increasing interest by women. The present curriculum must therefore include greater emphasis on social problems [DEET, 1990] and the effects of social and technological change and the inter-relationship of the discipline and community needs [IEAust Review, 1996]. Despite strong rhetoric from the profession itself, environmental issues have had limited integration into engineering curricula. It is interesting however that environmental engineering degrees have been successfully developed as isolated programs. Stonyer [1997] suggests that the adjunct nature of environmental engineering and society's identification of the environment with 'femaleness' provides an understanding of its subordinate position within the discipline. Environmental Engineering has in fact been referred to as the female engineering [Duane et al, 1995]. Communication skills for engineers have similarly been absent from curriculum content or at most, as with environmental engineering knowledge, remain as an 'add-on' to the core (sic) technical material.

The final theme and possibly the most complex is the area of the construction of knowledge. That is how knowledge is structured within the discipline and what assumptions and practices are developed and maintained by which the knowledge of engineering is captured. This area extends seamlessly into the domain of teaching methods and in particular learning styles, which will be covered in more detail in the final section of this chapter. Modern engineering has been based in science. Which means that engineering concepts are almost entirely based on the so-called scientific method and represented in a mathematical form. Although there are areas of science which have been informed and changed to reflect the changing understanding of scientific methodology, engineering curriculum in particular has not moved to the same extent. This has been highlighted by much feminist input in science and engineering pedagogy to date and has demonstrated that this scientific approach and its perpetuating nature within the construction of engineering knowledge has tended to alienate women [Lee and Taylor, 1996]. There has also been the dimension of power and its relationship to knowledge and education, however, this goes beyond the scope of this project. Also much of the research on determining the differences between the ways women and men think, learn, and aquire knowledge is important in understanding how humans construct knowledge and what the differences are between us. This will be covered in the final section.

Much of the practical research within this theme has been done within design subjects, which have been seen as one of the most dynamic elements in engineering courses [Stonyer, 1997]. The current arguments surrounding the structure of teaching design seem polarised around dualisms associated with this topic. These dualisms are technical rationality versus intuition and critical reflection which highlight the tension between engineering design as a science or an art. However, some of the more recent work engages with the contemporary theorising around gender and science and in particular providing 'deconstructive' and 'metaphorical' approaches to an alternative way of thinking and redefining engineering knowledge and its forms of practice. This research is beginning to take a holistic approach to redesigning the curriculum and is attempting to move away from finding and incorporating 'add-on' solutions.

An investigation by Holt and Solomon [1996] has attempted to demonstrate how an understanding of learning styles provides a perspective on the changes needed to the course structure and content. This work is a major advance in Australia because it takes a holistic approach in redesigning the curriculum. The investigation uses the work of Kolb [1984] who drew on the research of Dewey, Lewin and Piaget, to propose a model for the structure of the learning process by developing a topological model. Holt and Solomon use this model to chart the directions engineering education might take in the future. The premise on which this work is based develops out of the dilemma in engineering education which the researchers specified as the fact that "engineers fit into society in a great variety of ways and that these various practices of engineering might lead to some tension, if not mutual exclusivity, between educational policies and goals that derive from them" [ibid, p3]. The research matched the ontological foundation of engineering using the work by Ferguson [1977] in *Engineering and the Mind's Eye* to the epistemological basis of the learning process developed by Kolb.

3.3.2 Language

Language is a guide to social reality [Wittengstein, 1961, cited in Wilson, 1992] – inextricably linked with culture. Language creates a reality, which is gender biased, and it both shapes and reflects the way we think [Wilson, 1992; Pauwels, 1991]. Language is sexist because it does two things: it excludes women and it treats women and men unequally. The assumptions that our language makes are that the male is the 'norm', female is the 'other'. Sexist language is thus inaccurate and misleading. It is ambiguous and it is unjust to women and girls. In changing our language we can challenge these unspoken assumptions and more accurately reflect the reality of the culture since a democratic society should not exclude more than half of its citizens.

So how do girls feel when they appear not to be included in our written and oral language? Research has shown that children younger than the age of 10 or 11 are unable to make sense of generic terms such as the use of 'man' to include women as well as men or the pronoun 'he' to represent both male and female. What it does, however, is reinforce the concept of the male as the dominant member of our society and this continues into adulthood. Although adults know logically that 'he' is a generic term, they tend to think of 'he' as meaning male. Research [Schneider and Hacker, 1983] using 300 college students showed between 30% to 40% difference in what they thought of when asked to find examples of 'social man' compared to 'society', 'political man' compared to 'political behaviour' and 'industrial man' compared to 'industrial life'. An example which clearly demonstrates the deliberate exclusion that language can create is reiterated by Miller and Swift : a British Act of Parliament in 1850 gave official sanction to the invented concept of the generic 'he' and the concept was adopted by English-speaking-countries. Yet, on the other hand, this same pronoun 'he' has been used as the justification for excluding females from admission to or membership of institutions whose constitution or bylaws used the generic 'he' to refer to members. [Miller and Swift, 1981 pg 33-38]

Further exclusion lies in the use of certain terms as though they apply to or target only adult males. Examples here are: 'the farmers and their wives' or 'wine, women and song' which was used as an advertising slogan for a recruitment drive of a rugby club. The logical implication of these statements is that women are not farmers, or people! Common forms of verbal abuse, which further denigrate females use female sexuality and even female sexual organs as labels for people for whom contempt is being expressed. There are very few equivalent male references and those that do exist are not considered as derogatory as using the female reference. Friedman [1977, cited Wilson, 1992] provides illustrative examples on language used by male engineers which are replete with allusions to the male and female sexual organs as well as the sex act. Sally Hacker's [1989] research on engineering education showed how the images of gender were used in the making of an engineer's skill base and in fact went on to claim that the exclusion of women is part of the process of creating these skills. Supporting this notion is Tonso's [1996] work which collected evidence in an engineering design classroom of the mild but persistent use of profanity and attention to semi-sexual, double entendres by male students. This male peer behaviour combined with the male engineering lecturer's persistent use of images from military and hunter/warrior traditions, Tonso concluded, created an environment where women's social worth was undermined and established a context where a female student would find it difficult to coexist with the projected engineering professional values. The discourse, therefore, in this design classroom defined the tone of the classroom and reinforced engineering traditions and to a limited extent redefined customs.

The awareness of these issues in the engineering professional context has been demonstrated in a recent publication by the Institution of Engineers, Australia

[Roberts, 1999] which provides a guide to inclusive language use for engineers. Apart from its valuable awareness-raising function, it also provides practical alternatives to expressions that either exclude women or treat them unequally. As our language is not fixed but constantly evolving [Pauwels, 1991], it is important to have a greater awareness of these expressions and usages. New forms of expression can be developed to describe engineering functions and interactions within engineering in non-discriminatory ways. Most of the material covered, however, is not isolated to engineering but is accepted and expected as appropriate social and professional behaviour today. This does not mean that engineering does not have specific language-related issues which have been allowed to develop through the sub-cultures that operate within the engineering profession. In particular, there is the use of linguistic codes and practices including metaphors, which reflect the patriarchal power relations maintained in the profession.

Fiona Wilson in a paper *Language, technology, gender and power* [1992] argues that men seek, 'knowingly or unknowingly, to facilitate the technological change process by drawing upon linguistic resources which reproduce relations of power'. That is they can maintain dominance by controlling language and thus recreating reality as it evolves in a constantly gender biased way. Examples which illustrated this include the story retold by Miller and Swift [1981] above and Tonso [1996] and Jolly's [1996] findings of women's experience of overt and covert verbal 'put downs' as well as the persistence of sexist and sexual comments in engineering classrooms. Spender [1985] observed that while males insist that their views and values are the only real ones, then the 'male as norm' syndrome will persist. Miller and Swift [1975] argued that sexist language more often than not is not deliberate, yet as Wilson insists, the continuance of the 'male as norm' syndrome suggests that there needs to be a conscious questioning of its status instead of excuses.

Computers are a special and interesting subcase in the field of engineering and Wilson [1992] uses this field to illustrate some of the discussions surrounding women, technology, language and power. There has been increasing research into the marginalisation of women in computing as the percentage of women taking computer studies continues to fall. Historically, women have been involved with computers and computer programming. Ada Lovelace is considered the first computer programmer and during those early days of computer development computer programmers were often women. As an example of this women were employed by the armed forces during World War II and assigned computer programming jobs as it was initially viewed as of such 'low importance'. How then has the industry become sex-typed? The reasons are complex and align themselves with the current ways of thinking about technology. Edwards [1990, cited in Wilson, 1992] observed that men discovered its complexity and challenge -- and its cash value and therefore its power and control. Game and Pringle [1983] also argue that the maths/science image related to computing is maintained purely to keep women away and even the original close identity with the armed forces has now turned into a negative for women. Spender [1992] has also found that due to computers holding the key to an information-based future, the key representing power in this case means that the computer world has therefore been dominated by male behaviour. Computers and their associated language can be viewed on two levels. The first level is the educational courses themselves and their rigidity and inflexibility combined with the hostile vocabulary, for example words such as abort, execute, slave, crashed and killed. The second level is the programming language, where apart from finding similar use of terminology, there was little literature found discussing the issues associated with the program structure. Lloyd and Newell [1985, cited in Wilson, 1992] had however commented that the only commonly used programming language (COBOL) to be introduced by a woman - Captain Grace Hopper USN - has in general been sneered at by scientifically or technologically educated programmers. Thus, surprisingly computer language and programming style appears not to be free of gender bias and prompts interesting research questions.

Language has thus been demonstrated to be integral to the practice of power in technological fields, however it is often the use of metaphors which set the tone and direction of change by prefiguring and articulating the structure of a subject area. It is in this direction that some of the searching for a holistic model of gender-neutral engineering practice and knowledge has been moving. Metaphors are deep and pervasive in the English language and they are used to help make sense of reality by creating images to understand experiences and situations. Metaphors serve as models of the situation and models for the situation [Geertz, 1973 cited in Wilson]. Wilson has been instrumental in moving the debate on metaphors into technical fields. She argued that the selective use of metaphors has helped create the reality in these areas of inequality and male dominance. Wilson studied 18 company cases to explore how metaphors are used in organisations that are in the process of adopting new technical systems, and what their use achieves. She found that metaphors helped create and change new realities in this process however they continued to reinforce patterns of male dominance and power. Wilson also used Wittgenstein's [1961, cited Wilson, 1992] notions of the use of language as a game which are governed by a set of rules. Wittgenstein refers to grammar as the unwritten taken-for-granted rules which govern our language use. Wilson argues that there is a new language in organisations faced with technical change and this new language plays a different game and has its own set of unwritten rules. This new language has rules which govern the appropriatesness of metaphors used and is created from discourses of 'maleness' enhanced by metaphors from battle and religion. Many examples were illustrated from these two metaphor classifications and included in relation to battle: 'take no prisoners'; 'destroyed'; 'lead the charge'; 'so we had burned our boats'; 'biting the bullet'; 'shooting ourselves in the foot and from a religion perspective: 'evangelist'; 'spread the word'; and 'you have got to have faith'. Is this new language which has been found in organisations actually developed earlier and encouraged in the education sector? Tonso found not surprisingly that the language that was being used by the male staff was associated with 'maleness' and that their use of 'battle' imagery was persistent.

The concept of metaphors in engineering education has been explored by Stonyer [1997] in the context of a deconstruction methodology rather than the linguistic perspective which Wilson has taken. Stonyer draws on the work of Gilbert, Grosz and Scott [cited ibid] to explore and propose techniques for redirecting change in order to make the 'spaces' where new and different ways of 'doing' engineering can be developed. Deconstruction has been used by these researchers to unsettle the essential meanings of science and women by "interrupting the fundamental images and assumptions constituted in/by science which position women (in particular) in the margins of the discourse" [ibid]. The value seen in this methodology is that it can be viewed as both a technique for interruption or resistance as well as a way of thinking. Stonyer focuses on the discursive nature of engineering and suggests conversation as potentially a means to deconstruct engineering knowledge and practice an approach which has been usefully explored in other related disciplines. She has gone on to concentrate her work in the area of reflective journalling (practitioners reflecting on their approaches to the work and the work environment) and its value and impact in design work.

3.3.3 Teaching and Learning

The traditional education structure has not provided the best learning environment for women. Research by Belenky, Clinchy, Goldberger and Tarule [1986]; and Philbin, Meier, Huffman and Boverie [1995] has demonstrated that there are significant gender differences in learning styles and that the traditional education system is directed towards and appeals more to males since it is primarily abstract and reflective. Female students generally feel that they do not fit in with the traditional education learning styles [Philbin, et al, 1995] and in fact the more common modes of learning identified as 'female' have been devalued [Belenky et al, 1986]. The research suggests that women learn better in hands-on and practical settings. A female respondent in Philbin et al [1995 p 491] Study into Learning Styles commented that "I felt like I was talked at; no transfer of knowledge, really, just words spoken without meaning. I never saw much practical application of the words/topics being discussed". On the other hand, a male respondent said, "I believe my learning style of using logical steps to break down things and analyse them helped me in my studies of computer science and systems analysis." Traditionally, different sets of skills have been encouraged in the different sexes such as communication, cooperation and concern for others for girls whereas for boys risk taking, problem solving and a career focus. These are all human skills that potentially, with the right environment can be learnt by either sex. The question of how if at all, this is occurring in engineering classrooms still needs to be answered.

A project between Swinburne University of Technology and University of Technology Sydney (UTS) was begun in 1995 to develop an inclusive approach to an engineering design subject [Roberts, Chapman, Huckstep, Boman and Lewis, 1995]. This project reviewed gender inclusive models of curriculum and teaching and introduced a curriculum using problem solving, projects, interdisciplinary and group work rather than the traditional educational models characterized by lectures, separate disciplines and individual work. Major system-wide changes have since taken place at UTS in light of the developments in the mid 1990s. Outcomes from these changes have not yet been published.

Other gender inclusive approaches to teaching and learning styles include cooperative learning and negotiated curriculum. Cooperative Learning is based on group work where group members feel more confident to speak as they feel that group members will be more willing to listen. This technique changes the teaching function and requires teachers to have a different set of teaching strategies where they are no longer the centre of the learning environment but are the guides within it. Negotiated Curriculum is one which enables students to participate in selecting and planning their activities and therefore to empower themselves through the learning process. It enables all students to build upon their own interests, skills and knowledge in order to define their next stages of learning. Helping students to understand and monitor their own learning process assists them to become more efficient, effective and ultimately independent learners. This style helps learners to focus on *how* they learn as well as on *what* they learn.

3.4 Gender in Education in other Disciplines

Research into gender in education has been extensive over the last half century, and has highlighted the disadvantages faced by women. Yet there has been much less research on the perceptions of students and degree to which gender have determined experiences within the classroom. One study done at a postgraduate level in management education, in a Business Faculty of an Australian University [Smith, 1996; Smith 2000], investigated these issues. The findings suggested that the masculine ethos which was discernible within the environment of the classroom put female students at a disadvantage. Male language and examples gave little credibility to female involvement and perspectives in both the materials used in class and in their participation during class time. This causes discomfort to women learners but not to men. Male biased attitudes and jokes from some male staff were reported on by over a third of the women involved in the study. The women perceived a significantly more sex-biased attitude in male educators than did the male learners. Female learners were also found to be disadvantaged because they listened, noticed, share information and saw situations from a wider perspective. Inclusion of perspectives from both genders was identified as enhancing learning experiences for all learners. The study also emphasized that the environment was also likely to disadvantage some male students in different ways. In particular, it would disadvantage male learners because they "tended to have a narrower field of perception".

3.5 Summary

There are clearly significant gaps in the literature in the area of gender in the engineering classroom with much of the recent work in engineering education using the results of studies in the Science and Mathematics classroom. Even these studies have tended to be more extensive at the high school level rather than at the tertiary level. There is a need to establish what the similarities and differences are with the Science and Mathematics studies and also illustrate the extent to which gender is a factor in classroom experiences in engineering.

Chapter 3 has presented an overview of the research that has taken place into gender issues in engineering and in education. It has specifically reviewed the results of research that has combined both discipline areas. In particular the presentation of the masculine culture of the faculty has left little doubt that there are significant issues for women in choosing and studying in the engineering environment and in general these issues are unfavorable for women. Research into gender inclusive curriculum has also been presented and has highlighted the different concerns that women face in the conventional learning environment and the ways in which this environment has tended to disadvantage women. Science, mathematics and management courses at tertiary level have been discussed in terms of gender factors in a classroom, yet little has been done in an engineering classroom. This study will present findings from a students perspective of gendered behaviours in an engineering classroom .

Chapter 4 - Research Methodology for the Study

> *'New findings cannot always be fitted into existing categories and concepts and the qualitative method, with its open minded approach, encourages other ways of looking at the data' [Burns, 1997, p294].*

4.1 The Research Question

The study investigates the learning environment and social world of an engineering classroom and the complex interactions between human behaviour, knowledge, and learning experiences within that classroom. The research question this study has asked is:

To what extent is the gender of a student a determinant of different classroom experiences within engineering?

In particular, it has focused on three sub questions;

a. *How is student classroom experience effected by gender?*
b. *What influence does prior knowledge and technical terminology have on student classroom experience?*
c. *What are the different learning experiences of students?*

To answer the above questions it is necessary to obtain an understanding of the behaviours and socio-cultural activities and patterns of a group of engineering students, from their perspective, in a 'typical' engineering classroom setting. An ethnographic research methodology has been used. Ethnographic research is designed to present a dynamic picture of the student group and their interactions and provide an alternative, more humanistic research paradigm to the traditional empirical scientific approaches.

Ethnographic research has been defined as a "research process used in the scientific study of human interactions in social settings" [Charles,1998, p214] yet it takes a very different approach to the traditional scientific methodology. The scientific mode of enquiry attempts to maximise objectivity and prediction and typically establishes and deals solely with highly defined segments of the research setting. Ethnographic methodology on the other hand provides a holistic picture of the social environment of the study and stresses the importance of culture within the general context of the classroom as well as the sub cultures and organisations that make up the whole classroom environment. This premise is based on the fact that the actions of individuals are motivated by events related to the whole environment and thus cannot be understood if broken up and analysed in parts. By the same token the social environment studied is situated within a wider cultural and social landscape which in this study has been defined as the culture of the engineering faculty, and broader still, the engineering profession.

4.2 The Context of the Study - The Engineering Classroom

The local empirical setting chosen to do this study was a first year, second semester subject; MECH102, Introduction to Engineering Computing. This subject was chosen for several reasons:

1. MECH 102 is taken by a broad range of discipline areas including Surveying, Mechanical, Civil and Environmental Engineering degree streams. In 1999 when this study was conducted the initial enrolment for the subject was 198 students, dropping to 152 taking the final exam.
2. As a second semester subject in first year, most students had experienced a minimum of one semester at university although they have not, by that stage, been immersed in the system for too long a period. It was hoped that this would give them enough experience to comment on the system and environment of university teaching and learning yet still be able to distinguish and compare critical and peculiar aspects of that environment.

3. As a mainstream computer related subject it was also my intention to investigate the peculiarities of the structure and environment created when teaching computing as a tool for engineers and the subtleties of gender based experiences in a computer classroom.
4. Finally, when designing the research process there was a need to find a 'natural' and nonintrusive place within the research setting from which observations could take place. The computer classroom environment in MECH102 provided the opportunity to do this as it was not only a subject in which the researcher was able and confident to tutor, thus allowing the dual role of both tutor and observer, but also was the place where the students had an opportunity to convert into practice what had been taught during the lecture in an informal setting which encouraged student-tutor interaction.

The aim of MECH102 is to teach a computer programming language (FORTRAN), which enables engineers to design and analyse complex and diverse problems. As such, it is a critical tool that needs to be mastered by engineers. The subject was timetabled with a one-hour lecture and a two-hour tutorial each week. The subject came with a comprehensive set of class notes, which were followed during the lecture. The tutorials were held in computer laboratories where students were required to work on five computer assignments which were to be completed sequentially during the semester. The final 2 assignments could be completed individually or as a group. Tutorial groups were usually made up of 20 to 25 students. However, one computer laboratory had 40 computer stations and therefore one tutorial group was assigned with 40 students. It was in this tutorial group that the researcher spent the semester. There was also another tutor assigned to this group, thus allowing more flexibility and time for observation. There was some flexibility for students to attend other tutorial groups so it was noticed that there was a transient student population as well as the regular group. Tutorial attendance was generally high with the average participation estimated for this tutorial group at over 75%.

4.3 Ethnographic & Triangulation Research Techniques

The process of ethnographic research is essentially to collect descriptive data as the basis for interpretation and analysis in order to answer the research question. Data for this research study was obtained primarily through fieldwork, which involved both observations of the engineering classroom setting and interviews of participants within that setting. Other documentation associated with the setting, in particular the class notes and class assessment information supplemented the field notes. However, surveys were also used to provide some quantitative measures to improve reliability of the results. Thus, three data collection techniques were used to produce the empirical findings: observation, focus groups and surveys. The use of (generally three) different techniques to collect data is referred to as triangulation.

The predominantly qualitative approach of data collection and analysis was used to interrupt patterns of behaviour observed in the classroom and from discussions in the focus groups. This overall approach was essential, as the final evaluation of the research needed to reflect the multiple realities of the social environment of the classroom in order to illuminate the complexities of human behaviour within that setting. This seemed a formidable task at the outset of the project with the basic question of "*How is it possible to determine what data is valid and reliable when the data collected is based on interviews, general conversations and observations?* "

Triangulation is an important technique, which supports the improvement of the validity and reliability of results and thus provides an answer to this question. The studies of human interactions are complex. The use of multiple but complementary data collection techniques offers this improvement by providing cross checking and the elimination of potential bias which may result from the use of only one method. This therefore contributes to the verification and validation of the qualitative analysis.

Triangulation also helps reduce the potential for accepting too readily the initial impressions that the observer/interviewer may gain if using only one method. Yet, despite using several methods of data collection, the task of determining the truth in a particular social context is not always obvious. As a researcher and observer it is impossible to approach a setting without some preconceptions about the nature of that setting and this bias needs to be recognised. In this case the researcher is qualified as an electrical engineer at an Australian University and has worked as an engineer in industry for six years. It has thus been essential to separate her own experiences and prejudices from those of the students that are studying in courses today. Seeking opinions from a broader population has also been necessary to provide a check on the interpretation of the results. Not having a research team involved in this study, my supervisors and colleagues were relied upon to provide this broader cross section of perspectives and therefore to mitigate any singular bias. In any social situation, there will be multiple realities or multiple perspectives and this is an important concept in ethnographic research. Thus not only does the researcher need to be aware of her perspectives but she must also recognize that different participants will view the circumstances and events within a context differently and it is these differences in particular that need to be interpreted. These different views were thus gathered and analysed from participants' actions, perceptions, interpretations and beliefs during data collection and generally became less difficult to understand when more than one method was used. As with the expectation of multiple perspectives of the situation studied, so it can be expected that each participant will react and interpret different techniques in different ways and therefore having quite different techniques is a way to improve validity and avoid misinterpretations.

The three methods of data collection employed were utilized for slightly different purposes. These are described in Table 4.1, which summarises the foci of each of the surveys, focus group sessions and the informal observations taken during the tutorial sessions. Where appropriate correlations of data from the different sources are identified in this table.

4.3.1 Surveys

The two surveys [Appendix 1; a and b] were completed in the lecture in week 1 and week 12. These surveys were designed using a questionnaire which was utilized in a management education study [Smith, 2000] that investigated perceptions of gender issues in the management curriculum and their effects on learning experiences. The findings from this management study have also been used as part of the analysis of the results of the engineering surveys. Despite being in different discipline areas the comparison has provided some insight into the generalisation of this study.

A low response rate is a common problem and a significant limitation when using surveys as a data collection tool. To overcome this problem in this study the surveys were filled out during the lectures. The response rate was thus extremely high with an estimate of over 90% response from the students in the lecture at the time of the survey. However if the actual enrolment figures are used the response rate was 69% in week 1 and 68% in week 12. Despite the gender balance in the surveys being within a couple of percent of the average for the faculty, the number of female students was statistically small and therefore results of the surveys have been carefully interpreted using information obtained through the focus group sessions (an advantage of the ethnographic research methodology).

Table 4.1 Foci of the Surveys, Focus Group Sessions and Observations

Survey 1	**Interview 1**	**Observations**
- Exposure to engineering - Prior knowledge of engineering terms/concepts - Experiences so far in the course - Learning experiences - Gendered language experiences in the course	- Background of interviewees - Expectations of the course - Understanding of the career and the course structure to get to that career - Extent of comfort with terminology being used - What assumed knowledge is apparent in the course - Attitudes to learning - What is their approach to learning - How do they work and interact with other students in the course	- Motivations to do course - Monitoring type and quantity of questions asked - Note confidence of asking questions - Note confidence in discussion of their solution to problems - Question what the feelings are of students marked assignments - Watch individuals and groups on the process of work patterns during the tutorial sessions
Survey 2	**Interview 2**	**Observations**
- What changes to their experiences in the course - Group work vs. individual work - Approach to computer programming based on their experiences in MECH 102 - Evaluation of assessment method used in MECH 102	- Approach to technical tasks, computer tasks, assessment tasks - Engagement with material needed in this subject - Groupwork assessments, what role members played	- Response to - Approach taken to assignment problems - How students interacted in teams - Group work experience

The data from the surveys was entered into a Microsoft Excel Program spread sheet with each row identifying a student response. Columns were used to distinguish between questions in the survey. Statistical analysis was then performed on this data and results presented in Chapter 5. All the raw data from the Excel sheets are provided in Appendix 2a for Survey 1 and Appendix 2b for Survey 2.

4.3.2 Participant Observation

Participant observation is one of the most common techniques used for data collection in ethnographic research and this was done during the weekly 2 hour tutorial sessions in weeks 3 to 12. The researcher was able to ensure as 'natural' a research setting as possible by being a tutor during the tutorial sessions. This meant that the researcher was there to respond to technical questions throughout the two hours. The significant advantage this provided was the opportunity to speak intimately with students about the problems that they were facing with the material and to some extend interview them about their experiences and the methods they were using to approach the problems. The disadvantage was primarily not being able to record the discussions and observations that were happening in the classroom and the need to rely on recording of field notes following each session. There are other limitations that need to be recognised when using this research method and this will be expanded upon further in Section 4.6.

4.3.3 Focus Groups

The focus groups provided the final method to triangulate the data. Students were questioned to gain deeper understanding of their interpretation of particular areas of the learning environment highlighted in the surveys and also verification of the researcher's interpretation of the results of the surveys. The interviews were conducted as a combination of set questions and open-ended questions, which were established during the sessions. The lists of set questions are provided in Appendix 3.

Three focus groups of 6 students each were organised following each of the two surveys. The same group of students were asked back to the second focus group session following the second survey. Unfortunately not all students returned for the second interview and in particular it was the male students who did not participate. This meant that an all women group formed for one of the second focus group sessions. There was a good mix of genders and disciplines within the focus groups. Interestingly, there was a greater proportion of mature age students who participated in the focus groups compared to the proportion in the class. Table 4.2 illustrates the make up of each of the focus groups.

Interviews were tape-recorded and transcripts were produced which students were offered to review. This opportunity was not taken up by any of the students. From the transcripts responses to questions were grouped according to topics raised and correlation to the findings of the survey data.

Table 4.2 Focus Group Attendance

	Group 1		Group 2		Group 3	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
Female	1	0	3	4*	2	2
Male	5	4	3	0	4	2
Mechanical	4	3	2	2	3	1
Civil	0	0	2	1	3	3
Environmental	2	1	2	1	0	0
Mature Age	2	1	3	2	1	1

* A female student from Group 1 Session 1 attended this session

4.3.4 Research Stages

The research involved several stages. Firstly, the preliminary results of the first survey were used to initiate the discussions in the first set of focus group sessions. This meant that the first task of the focus group session was to expand on the comments and results of the survey. The second task was to allow the participants to talk about other related issues and expand if possible on them. The transcripts of the focus group sessions were subsequently divided up into sections based on the questions in the survey and the results of the two data collection methods combined. A similar process also took place at the end of the semester with the second survey and set of focus groups. From these question groupings, themes were established and categories developed based in part on the foundations of the literature classifications. Some of the additional sections of the focus group transcripts that did not fit directly under any of the questions were more readily able to fit into the literature classifications. The field notes were generally helpful to further expand on the survey questions. They also provided a valuable opportunity to look at the whole classroom in operation in the light of the results and comments being gathered by the surveys and focus groups.

4.4 Demographics

Demographic information about the participants involved in this study was collected primarily through the surveys, however some information was also obtained from enrolment data as well as during the focus group sessions. The total number of returned forms from Survey 1 was 136 and from Survey 2 was 104. Survey 1 found that 10 female students' (71%) and 93 male students (76%) were aged between 17 and 19 years. All the female students were studying full time and so were 115 or 94% of male students. Table 4.3 and 4.4 shows the break up of students by gender and degree stream in the two surveys and compares them with enrolment figures at each stage. Table 4.5 provides the final results of students enrolled in MECH102 by gender.

Table 4.3 Survey 1 Participant Information by Gender and Degree

Female					Male				
Enrolled: 17					181				
Surveyed: 14					122				
Env	Mech	Surv	Civil	Other[32]	Env	Mech	Surv	Civil	Other
5 (36%)	5 (36%)	[31]	3 (21%)	1 (7%)	17 (14%)	40 (33%)	20 (16%)	41 (34%)	4 (3%)

Table 4.4 Survey 2 Participant Information by Gender and Degree

Female					Male				
Enrolled: 12					140				
Surveyed: 10					94				
Env	Mech	Surv	Civil	Other	Env	Mech	Surv	Civil	Other
5 (50%)	1 (10%)	1 (10%)	3 (30%)	[33]	13 (14%)	27 (29%)	12 (13%)	38 (40%)	4 (4%)

Table 4.5 Student Final Results by Gender

	Female	Male	Female (%)	Male (%)
Failed	1	32	8	23
Pass	3	51	25	36
Credit	5	21	42	15
Distinction	1	24	8	17
HDistinction	2	12	17	9
Enrolled	**12**	**140**	**100**	**100**

[32] This is a students who is doing science and intending to transfer to engineering
[31] The only female surveying student in the course did not participate in the first survey
[33] Students from this category did not participate in the second survey

4.5 Ethics

Ethics approval was sought and gained from the University of Newcastle's Human Research Ethics Committee as the research involved the participation of students in interactive sessions. The students were recruited following the first survey by filling out a participation form enclosed with the survey. These forms were collected separately to ensure all surveys remained anonymous. An information sheet was circulated with the participation form which informed participants of their rights in a research study. Students were then required to sign a consent form following a discussion of the information sheet as well as associated matters including schedules, procedures and avenues for complaint. A presentation was also given to the lecture in week 1 on the aims and objectives of the research to explain the researcher's role as an observer in the tutorial sessions.

All focus group sessions were tape-recorded from which transcripts were produced. There are no names or identifying information recorded in any of the transcripts. Students were offered the opportunity to review the transcripts and edit or erase their contribution. This was not taken up by any of the students. The tapes were destroyed once the transcripts were completed and the 'paper' transcripts will be destroyed within 5 years.

4.6 Limitations of Methodology

As with any research methodology, there are potential limitations that must be recognised and understood. Firstly it has been mentioned that obtaining a natural setting is very important for this research as it is based on a social world of interpretations and meanings, which may be different among individual participants and is also likely to change over time and thus over the course of study. Despite the effort to create a natural setting where the researcher is immersed in the setting, there are limitations which will occur simply because of the study being conducted. These have been referred to as the epistemological paradox and the 'Hawthorne effect'. The epistemological paradox which Brown describes as "the act of making your experience explicit of necessity entails its transformation" [1998, p8] suggests that the act of placing yourself as an observer in a 'natural' setting will automatically change that 'natural' setting. To avoid the problem in this study the researcher became a 'natural' participant in the setting by being a tutor in the classroom chosen.

The advantages as mentioned above that this provided to the study outweighed the disadvantage outlined. The Hawthorne effect is similar and could be seen as an extension to the epistemological paradox in that it approaches this problem from a participant viewpoint where the participants are affected as a consequence of being studied. In medical research, this is alleviated to some extent by the use of placebos and double-blind design studies. In educational research, a control group can be used however this can produce additional problems. The fact that the study extended over a semester meant that to a certain extent the setting was one in which the students became used to being observed. Anecdotal observation suggests that participants became oblivious to the researcher due to the researcher's position and the work that was required of them.

Potential limitations can also be categorised as three essential properties of the data: reliability, validity and the ability to generalise the data. Reliability of data is concerned with guaranteeing that the same results can be reproduced consistently under the same conditions whereas validity is concerned with ensuring that what is measured is actually measured. Ethnographic research is not able to employ the conventional judgments of reliability and validity as in quantitative research. The tools involved in ethnographic research and in this study included observations and focus groups, which result in the likelihood of the researcher becoming personally involved in the study compared to a quantitative research methodology, which attempts to maintain some separation and neutrality of the researcher so as to avoid bias. The human factor is, however, both a great strength and a fundamental weakness of qualitative inquiry and analysis.

The fundamental judgment thus reduces to evaluating how realistic the 'artificial' conditions created for quantitative methods are compared to the repeatability of results from a 'natural' setting. Brown [1998, p83] argues from a different perspective that "with some justification, what quantitative methods gain in reliability, they lose in respect of validity". Burn's [1997] classic example of why school students were absent from school, clearly explains the complexities of ensuring reliability and validity of results and provides some insight into the differences between methodologies. The survey used to find the answer appeared reliable due to the consistency of the response *'due to illness'*. However, on closer inspection with the use of interview it was discovered that in fact, many of the responses were not true and that student stayed away for a variety of reasons. Therefore, despite the survey being reliable the data was not 100% valid. Consequently, reliability, or the reproducibility of findings can be relatively easy in scientific methods, but much more difficult in ethnographic research. Validity is critical, yet can be obscure in both methodologies.

The triangular approach taken in this study, which has combined both a quantitative and qualitative approach, has attempted to find an appropriate compromise to increase both the reliability and validity of the findings. During the analysis phase, topics were identified and a classification system was created – Figure 6.1. This provided a framework, in which the findings from each of the different data collection methods could be classified and combined, and consistencies could be established, which allowed for evaluation of the reliability of the data.

Finally, the concern of the ability to generalise the findings, which is a measure of how transferable those findings are to other similar settings, is crucial, as it could limit the practical value of the research. This is a weakness of ethnographic research as there will always be some differences between the group being studied and other groups and settings. Thus, some of the conclusions drawn based on this group may not be applicable to another engineering classroom group [Charles, 1998]. Critical to ensuring that results find wider acceptance was to determine the validity of the findings of this group and find the consistancy with the literature and surveys done elsewhere. The extensive literature research that has been done was used to illustrate the similarities and differences in outcomes with the research and therefore determine the generalisation of the research conclusions detailed in Chapter 6. These comparisons will also highlight unique aspects of the research setting at Newcastle and provide the opportunity to open discussion and further research into these unique areas in a broader setting.

4.7 Summary

This chapter has provided the details of the research framework adopted and the methods used to carry out the triangulation study. The ratio of the groups selected was judged to be reasonably representative of a typical engineering cohort and appropriate for the exploratory study. Verification of results has been based on the cross-referencing of information that was collected from the three data collection methods in order to provide the most accurate picture of the practices and experiences within the engineering classroom setting. These results are presented in Chapter 5 using the classifications developed by the literature and adopted in the methods of data collection. Chapter 6 then analyses and discusses the results to find answers to the research question posed. In addition, the outcomes of the literature that has been reviewed in Chapter 3 are compared to the research outcomes of the study to determine the extent to which generalisation are appropriate.

Chapter 5 – Research Findings

> *"Don't hide your feminist outlooks. This just seems as an attempt to have a go at women's rights. The advantage of chicks being in engineering is that it keeps me occupied." [Male student, Survey 1999]*

5.1 Response To The Research

The responses to the research topic varied from ones of interest and acceptance through to a negative extreme. This extreme was concentrated in the surveys, where responses were anonymous and the survey was orchestrated to be completed by a captive audience in a lecture which appeared to encourage the discomfort and frustration that many students had when asked to confront this topic. These responses were unsolicited and reflected approximately 10% of the male student population in each of the surveys. The neutral position taken by a number of students included those that were unaffected by the issues raised, as well as those who appeared to be disinterested. *"Does (the) gender really matter? I don't think it does academically speaking (or professionally)"* [Female Student, Survey 1] and *"irrelevant to everything. Why am I wasting my time with this."* [Male Student, Survey 1]. However, the stronger negative responses come from a number of male students who rejected the concept of the need to question or deal with gender issues within their environment. The comments ranged from putting down the discussion: *"The questions on domination are stupid. Everyone should look after themselves not whinge."* [Male Student, Survey 2] to questioning the researcher's motives "*With regards to inequality between genders you may be reading into it a little too far. Also, I think you are pushing a bit hard to express your obvious feminist motives, to the point of jeopardising your dignity"* [Male Student, Survey 1]. Finally, to comments which indicated support for another male working in the environment, in this case the lecturer: *"Although (the researcher) may feel that her surveys may be relevant, I say they are not – especially when it takes up the time of a very important lecture such as that of MECH102. This survey is obviously a waste of (the lecturer's) time also the engineering student body's time".* [Male Student, Survey 2]

The fact that the researcher was being identified by some participants as one of the 'problems' within the topic by showing a feminist outlook, highlighted the need to deal with this when active within the research setting as well as when analysing survey results. This response, however, was again concentrated in the survey where anonymity provided protection. When this topic was raised and discussed by the researcher in the focus group sessions, despite there being significant discomfort within the group, it was generally felt that this was a very immature response. In the classroom, the researcher monitored the interactions between students and herself. The interaction with individual students and the development of relationships appeared to be influenced more from the power balance of teacher/student than as a researcher/observer in their environment. In addition, however, it needs to be noted that there is also potentially some influence on the student interactions based on the researcher's faculty role as co-ordinator of a Diversity in Engineering Project. A comment by a male student later in the semester illustrates the change over the semester "*I had forgotten that you were doing this research. I was scared to talk to you at first because you were an equity person*". The interaction with students also altered during the semester based on the group work that was encouraged in the last two assignments. The researcher's field notes showed that there where fewer requests for help from male students during this stage despite the fact that students commented that there was a substantial jump in difficulty at this stage.

There were also a number of questions, particularly in the later section of both surveys that were not answered at all or were obviously contradictory to previous answers given, which appeared to be a 'protest' vote or what some students would consider a humorous thing to do. The low number of male students who volunteered for the focus groups also illustrated this lack of interest in this topic area. The male students who did attend the focus groups generally recognised that they were different to the males with this disinterested attitude.

5.2 Previous Engineering Exposure

Previous experience and exposure to engineering and engineering concepts have been suggested in the literature as critical to gendered responses in the classroom. As such, the survey and some question time in the focus groups investigated the degree of exposure to engineering and what form that exposure took prior to enrolment. In the survey students were asked to select from a list of eleven alternatives (Appendix 1a, Question 1) and could select more than one. The question did not ask explicitly whether this exposure was necessarily influential in making a career decision however, this connection was made by the students who attended the focus group sessions. Therefore, the results are interpreted as influential in choosing an engineering career. The data suggests that with this cohort of students the major category of influence for women was 'visiting engineering sites' where 6 out of 14 or 43% of women indicated that this was the major exposure to engineering prior to enrolling. This was confirmed in the focus group sessions where the female students felt that visiting engineering sites and (often) accidentally finding out about engineering was a major influence for women choosing engineering careers. The next most important categories for female students were family connections and using computers as tools, with 29% of female students in each category indicating these areas as influential in their prior exposure to

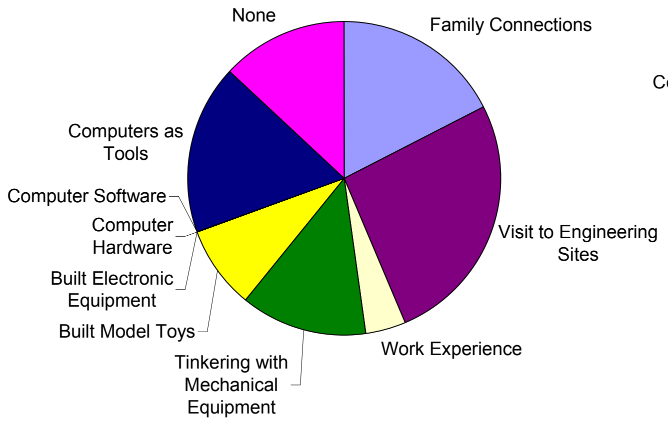

Figure 5.1a Engineering Exposure Prior to Enrolment for <u>Female</u> Students

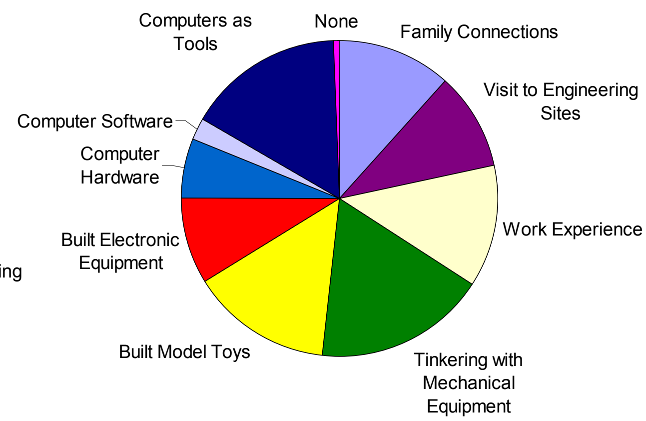

Figure 5.1b Engineering Exposure Prior to Enrolment for <u>Male</u> Students

engineering. Families were specifically seen as helpful in supporting the gathering of information about engineering courses and careers and less related to actually being influential to career choice. Figure 5.1a illustrates the responses for all female students compared to Figure 5.1b which shows the male student responses.

These factors which female students highlighted as influential where also seen as important to male students with 'visiting engineering sites' at 39% (47 out of 122), 'family connections' at 45% (55 out of 122), and 'using computers as tools' at 61% (75 out of 122). However when you combine the 'using computers as tools' with 'computer software' and 'computer hardware' there was a clearer and stronger trend in the male students to choosing these alternatives. It was a male student however in the focus group session who expressed surprise that students would connect the use of '*computers as a tool for engineering work'* as exposure to engineering prior to enrolment. It *"surprised me, that so many of the students indicated that was sort of a factor in their choosing engineering*" [Male Student, Focus Group 2]. There was a notable debate in the focus group sessions regarding the connection of computers and engineering. There appeared to be a clear split between those female students who saw computers as associated tools of engineering and those who did not. It would seem that this split is also valid in the male cohort. The majority of students, however, as indicated in the survey, did not see any connection.

The most significant influencing factor for male students and the most distinctive difference between the genders was reflected in the stereotypical 'tinkering' options. Tinkering here refers to the categories of 'tinkering with mechanical equipment', 'built model toys' and 'built electronic equipment'. For male students 68% (83 out of 122) selected 'tinkering', 56% (68 out of 122) selected 'built model toys' and 34% (42 out of 122) selected 'built electronic equipment'. Only three out of 14 (21%) of the female students selected the 'tinkering' categories. The female students in the focus group said that they were either keen on Lego as a child or came from a farm where it was expected that they help out in the 'machinery' shed. The connection to engineering was clearly not made by these students. As may have been expected, the breakdown by discipline showed that 75% of the mechanical engineering students selected this category with only 55% of the civil engineering students and 50% of environmental and surveying students selecting this 'tinkering' category.

The 'work experience' category also stood out as an area of distinct difference between genders with only one female student indicating some exposure to engineering through work experience as compared to 58 (out of 122) or 48% of male students who had had some prior experience.

Interestingly, three male and three female students indicated that they had no previous exposure to engineering. My understanding from one of these female students was that it was a love of mathematics and science that led her to engineering despite not having any exposure to it. This was confirmed on numerous occasions during the research by students who related their choice of engineering to the enjoyment of mathematics and science at school. A male student in the focus group session commented from his experience:

> "*if they (students) have done a high level of maths and a lot of science (at school), they automatically then look at the choices of science degrees or even engineering degrees. I suppose the engineering degree option I can understand for males I suppose, not trying to turn this into a sexist situation but I suppose historically I guess boys would go into that field if they have the educational prerequisites to follow that goal*".

Thus an interest in science and or mathematics at school was an important ingredient for both genders, however, due to the image of engineering as a male domain it was often seen only as a career option for men. For female students the love of mathematics and science needs to be combined with either the support and encouragement of a teacher or from some obvious but often-accidental exposure to engineering. However, also given as a high priority by all students was the prospect of a good job that was well paid and had interesting career opportunities. It was clearer in the comments from the female students that social issues and the impact of technology on the environment were much more important to them than for their male counterparts, which is supported by the literature in this area.

The categories which the female students did not select at all also had a low selection rate by male students as influential areas. These areas included 'computer software', 'computer hardware' and 'electronic equipment'. In particular, however computer software followed by computer hardware were particularly noticeably similar. It became apparent during the focus groups that there was a lack of understanding of these terms and that interest in these categories remained low. In fact, one male mechanical student commented that *"when I started here I didn't think there would be computer work in it*". A female student went on to say :

> "*I'm surprised that 62% of males, of these young guys connected engineering with computers because it means to me really heavy industry or mining and the computers have come in very late from my point of view and I still believe that*".

5.3 Expectations And General Experiences In Studying Engineering

> "*Everyone says engineering is incredibly difficult, but I don't know. I don't want to do anything else, …..it becomes a time management problem, …. there is so much work and there is only so much you can fit in*" [Female Student, Focus Group].

Workload was a continual topic of discussion among students as they tried to rationalise and find the 'balance' of work/study and social activities. There was considerable frustration based on their inexperience in time management and a need to find someone/something to blame "*you've got these semester assignments, laboratories due all in the one week usually*" and that "*if it (subject material) is not necessary then they shouldn't be teaching it*" [Male Student, Focus Group]. In fact there was a feeling from one student that there should be *"more humanities in engineering courses"* [Male Student, Focus Group]. However this raised concern among other students as to "*what is going to get the squeeze".* A suggestion from a male student was "*series. Get rid of series"* [Male Student, Focus Group]. ('Series' is a topic in mathematics for which this student had not yet found a use).

Students were asked in both Survey 1 and 2, at the beginning and end of the semester, what their expectation was of MECH102 and their rating of other subjects which they had completed. The change in their expectations of MECH102 is interesting to compare (Figure 5.2). The survey results showed that women and men thought differently at the initial stages of the subject yet ended the subject with similar responses. This is despite the trepidation which accompanies the rumors that are passed down from year to year of the difficulty of MECH102 and the subject which follows MECH102 in the following year. Female students' expectation of MECH102 at the beginning of semester was that it was going to be 'difficult' (44%) or 'reasonably difficult' (50%), thus a total of 94% of female students were prepared for a difficult topic area. This compares to only 16% of male student indicating 'difficult' at this stage and 62% saying 'reasonably difficult', combining to a total of 78%. Only one female student felt that it was going to be 'relatively easy' compared with 21% (or 26) male students. By the end of the semester, 97% of male students indicated that the subject was 'difficult' or 'reasonably difficult' which brings it in line with the female students. A total of only three male students indicated that it was 'relatively easy' or 'easy'. The distribution between easy and difficult remained unchanged for the female students however, as with the male students there was a shift to 70% of both sexes indicating that the subject was 'difficult'. The response to what their comfort level was in attempting MECH102, women generally felt uncomfortable in the initial stages of the

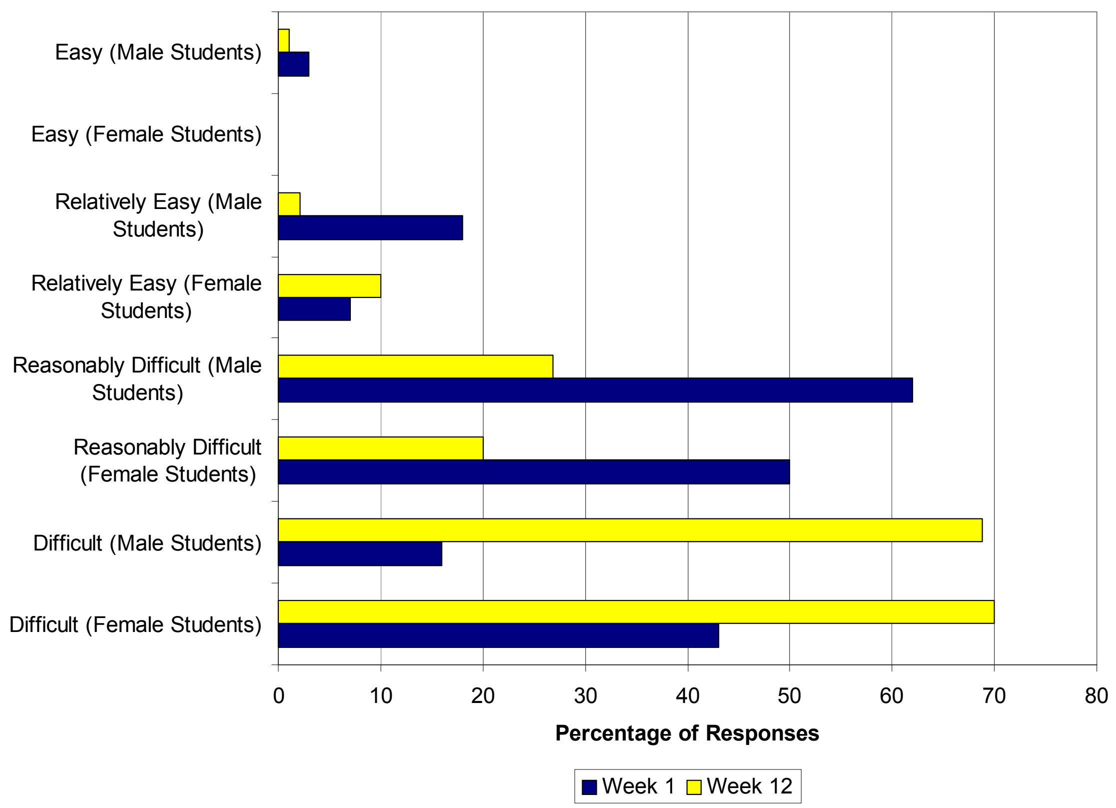

Figure 5.2 Comparison of Students Expectation of Difficulty of MECH102 by Gender and by Time of Semester

subject becoming more comfortable by the end of the semester. Male students perceptions were reversed, with a transition from a comfortable position to an uncomfortable position at the end of semester.

As a comparison, students clearly nominated MECH102, as the subject considered most difficult in their course at this stage of their studies with other subjects being rated generally between 'reasonably difficult' and 'relatively easy'. When discussing what is 'difficult' about the subject a number of aspects of the learning environment were highlighted. In particular, the reputation of the subject as a 'difficult' subject to pass appeared to have a strong influence deterring many students who were continually expecting the worst.

5.4 The Learning Environment

The learning environment has been identified in this study to have a significant impact not only on the feeling that students have about the subject and course but also about themselves. The expectations and experiences within the learning environment have been classified in Table 5.1.

5.4.1 Assumed Knowledge

A significant factor which students related when asked about the difficulties that they were having in the learning environment of MECH102 was that the material that they were expected to learn was 'new' to them and that there was too much assumed knowledge. To a certain extent this factor influences several of the other factors identified here. On deeper consideration of the comments in the focus group sessions, the concern about the 'new' material focused primarily on the unfamiliar approach that was taken to teaching the new material and the expectation and responsibility placed on students in a university system. There was some discussion and agreement that prior knowledge of computers and the computing environment helped in overcoming this 'fear' of the unknown however, it was not necessarily important in helping with understanding the material in the subject. Many students, both male and female, felt that the assumed knowledge of computers and computer concepts was unreasonable and made the subject not only difficult but unenjoyable and uninteresting. One female student stated "*MECH102 assumes too much* *knowledge of computers and computer programming. It is very difficult for someone without prior computer knowledge to understand the terminology and concepts associated*" [Female Student, Survey 2]. Similarly a male student commented that "*Having to start from scratch with computer programming made it difficult*" [Male Student, Survey 2].

Table 5.1 Factors which students identify as problematic in their learning environment

Classification	Response Rate*	Typical Comments
Assumed Knowledge *Unfamiliar content and knowledge of and about computers*	45%	"FORTRAN is very complex and totally different to anything I have done before" [F] "Very new concepts never used to" [M]
Speed of Delivery	74%	"The volume of information you need (to get) a firm understanding of immediately" [M]
Relevancy of Information	2%	"expected to learn programming ….. that really doesn't need to be learnt" [M]
Explanations of Material	45%	"MECH102 is too fast - need more teaching what stuff does in that language" [M] "Examples in text should have more explanation of what or why something was done in the program" [M]
Approach to Assignments	20%	"Sometimes I write out whatever I can of the program then go back to a structure plan" [M]
Teaching Staff	37%	"condescending tone - just because they understand the material doesn't mean they're able to explain it well" [F] "tutor expected me to know what I was doing" [M]
Feedback	60%	"Too hard, too quickly, not enough feedback"

* Response rate has been determined based on the frequency of comments raised in each classification area in the Surveys as a percentage of number of the students who filled out each Survey (No. of individual comments related to classification / no. of students who answered surveys). This has been done to provide an indication of the level of importance placed on the different classification areas. [M] - Male Student, [F] - Female Student

A surprising finding of the research was the number of students who indicated either during the tutorial sessions or in the focus groups that they had not expected the amount of computer work that they were doing in their course. One mature age student commented in the focus group session "*my experience to date of them (computers) has been nightmarish and everyone over 30 has the same experience*." This theme was very prevalent throughout the group discussion. It partly related to not understanding the different aspects of computer use related to engineering work, that is, using computers as a user, as a programmer, or as a designer of computer hardware. It was also related, in this subject, to not picking up computer terminology and jargon, which made for an unsatisfying introduction to computers.

Buried further down, and potentially more interesting to engineering subjects outside the computing area, was the need for students to gain a considerable amount of confidence when approaching problems and assignments and even learning how to take risks when trying to solve these problems in engineering. This appears to be very unfamiliar territory for most students who have experienced a much more structured methodology to solving problems in their previous schooling experience. This will be covered further in Section 5.4.4.

5.4.2 Speed Of Delivery

As a consequence of the 'new' and unfamiliar material that many students faced in this subject there was a significant level of concern with the amount of information that they felt they needed to understand in a short time period. This appeared more significant for male students who felt that "*MECH102 is unlike anything I've done and is too fast*" [Male Student, Survey 2]. Another male student explained further, "*Prior knowledge and the speed at which the subject progresses, makes it (MECH102) hard. The volume of information you need (to establish) a firm understanding (of) immediately makes it very difficult. Also, less bigger steps between assignments would help. They just don't le(a)d into each other*". In fact, Question 4 Survey 2 showed 65% of male students felt that the pace of the subject affected the progress that they made in this subject. Only 40% of female students felt the same. This difference was also illustrated during observation with the number of complaints about what was expected of them much higher by the male students.

5.4.3 Relevance Of Information

Survey 1, question 7.3 (Appendix 1a) questioned students to find out how relevant they felt MECH102 is in terms of career importance. Female and male students responded similarly, with 80% of female students saying that it was 'relevant' or 'reasonably relevant' compared to 70% of male students. The relevance was however continually questioned with the feeling by many at the end of the semester of "*Why learn to make programs when a professional programmer can better do it, which would be much better than something that I could produce*" [Male Student, Survey 2]. This frustration was channelled differently for a female student who said *"We need more time to let lecturers help us understand what we are doing and how it helps us in our chosen profession".*

There were a number of mature age students who participated in the focus group sessions and most of them had in fact had engineering-related work experiences. This,

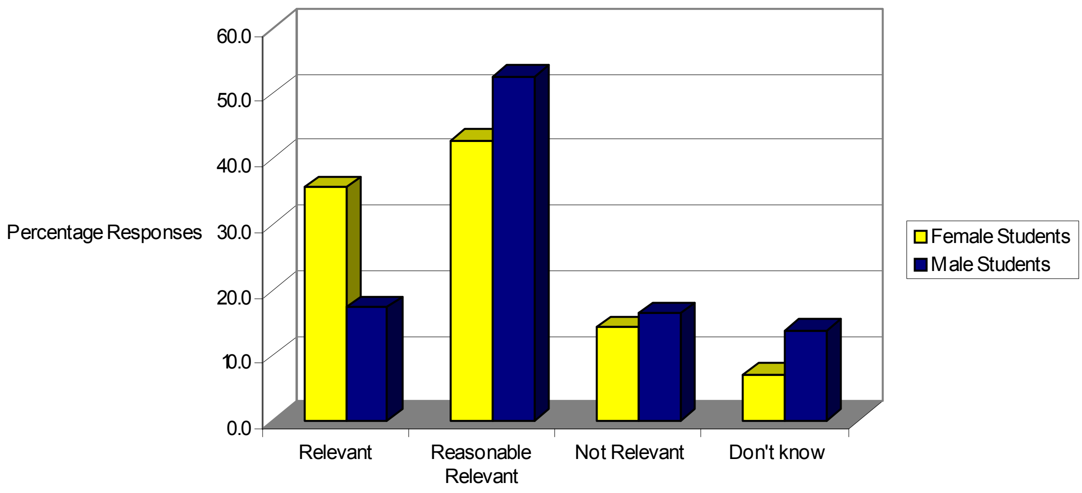

Figure 5.3 Comparison of Students Expectation of Relevance of MECH102 by Gender

however, did not mean that they felt comfortable with the material and structure that they were expected to learn or the concepts to which they were being introduced. They
also questioned the relevance of the subject and the relevance to the wider course due to the fact that it did not appear to relate to their experiences in the engineering workplaces to which they had been exposed.

5.4.4 Explanation Of Material

During the collection of data particularly in the focus groups and observations, there was a significant level of complaint about poor explanation of subject material. One male student accusingly stated "*Different tutors have different ideas on how to write the program"* [Male Student, Focus Group]. Another student felt that there were *"Not enough examples. The examples in (the) text should have more explanations of what or why something was done in the program*" [Female Student, Observation]. A student in the focus group session tried to explain; *"All examples given (are) as* *complete programs, no examples are shown in progress*". Therefore, it was felt that it was learning based on *"trial and error"* rather than teaching a structured approach to writing programs. Teaching was generally seen as a one way flow of information often unrelated to the solving of the problems that were set. "*In MECH102 all I would have liked was a lecturer or tutor to go through basic steps on how to solve a standard problem, instead of just giving us a sheet and letting us stumble and fumble our way through it like a blind man in an orgy.*" [Male Student, Survey 2] Similarly a female student felt that she needed "*more direction as to how to approach assignments*" [Female Student, Survey 2].

Nonetheless, confidence and risk taking in solving problems in engineering became evident in the tutorial observations as students who appeared more confident in their ability were able to discuss the process of solving the problem rather than simply trying to find the right formula. Often the methodology or process needed to solve a problem is not specified. Each problem brings with it a different approach, which subsequently does not fit the current teaching method. A male student's comment highlights this *"Math's is logical and easy to remember due to set formulas. MECH102 is not easy to remember …"* [Male Student, Focus Group] as there are no formulas to use to answer each problem set in MECH102. The different perspective here highlights the strong desire by students to simply take a 'plug in' formula approach. This results in surface rather than deep learning and needs to be picked up by teaching staff who need to recognise the need to teach process rather than focusing on the product of the problem. A male student felt that approaching assignments was based on "*more a trial and error approach using examples from the text book*" with "*No advice given in laymen's terms, on how to solve assignment questions as a whole*" [Male Student, Focus Group].

5.4.5 Approach To Solving Assignment Problems

Interestingly the major concern appears to relate to the writing of computer code compared to learning how to use computers and the computer system. Both male and female students at the end of the semester indicated that writing computer code was 'difficult' or 'reasonably difficult' with 50% of both genders saying 'difficult'. The 'Learning to use Computers' question illustrated a similiar transition for female students (as discussed in Section 5.3) from being very cautious and not overly confident at the beginning of the semester, but changing with experience and understanding to give a much more average response, Figure 5.4. This was confirmed in a chi-square test on the data which showed that the observed and expected frequency of responses between the genders was much closer in week 12 indicating gender difference was much less significant later in the semester than in week 1.

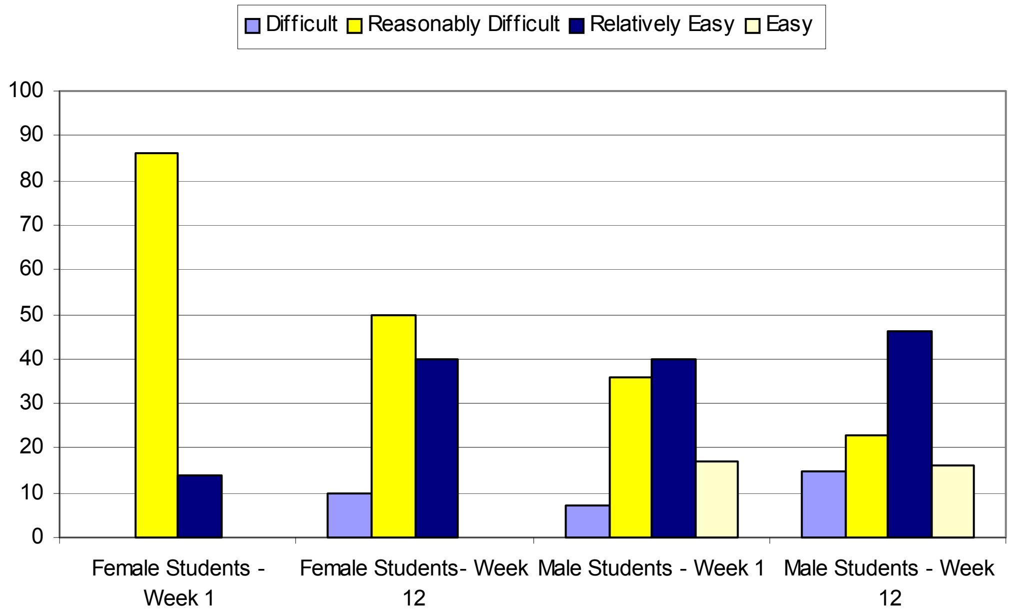

Figure 5.4 Percentage Student Response by Gender of their Perception of Learning to Use Computers at the Beginning and End of Semester

The different approaches taken by different students to understanding and solving the assignment problems became clear as different explanations were trialled in the tutorial sessions by the observer with the same student or sets of students in the last two group assignments. In the first three assignments, due to their generally agreed lower degree of difficulty, there was no noticeable difference as many students could plan the solution in their head and were able to start writing code directly. "*The programming assignments start off very easy (assign 1 and 2) but there is a big jump in Assign 4 and 5*" [Male Student, Survey 2]. It was when working with the later two assignments that students appeared to need more help with the methodology of solving the problems. Once this methodological issue was raised with them and discussed during the tutorial session, it clearly made a difference in their understanding of what they were doing.

Differences in approach on gender lines during the sessions were not apparent. However, the results of the question on ways to approach problem solving in Survey 2, illustrated in Figure 5.5, showed a preference by gender. That is, almost 80% of the female students said that they would develop a program structure first and then break the problem into parts before writing code. A female student states: "*I wasn't given any advice on how to go about the assignments – have since found information on flow charts*" [Female Student, Survey 2]. Approximately 30% of the male students also indicate that this is the approach that they would take. On the other hand almost 60% of male students indicated that they would first break up the problem into parts to solve before looking at the program structure. "*I write out whatever I can of the program then go back to a structure plan*" and *"In programming I feel time is needed to breakdown and analyze the problem"* [Male Students, Survey 2].

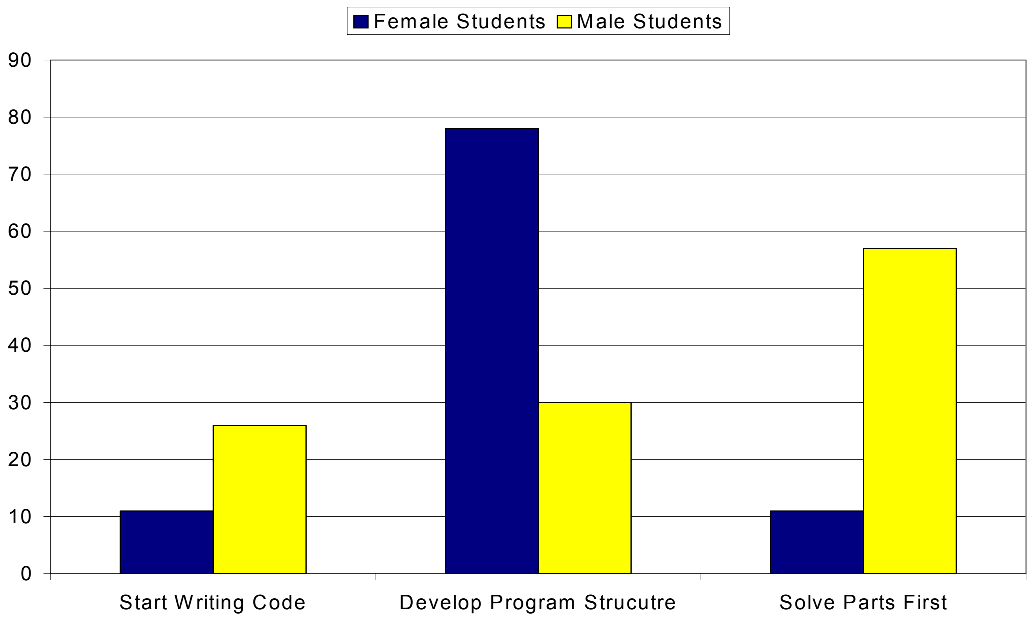

Figure 5.5 Distribution of first preferences by Gender to how students would approach a problem

At the end of the semester the comfort level in approaching assignments in MECH102 was low (Figure 5.6) with both female and male students remaining reasonably 'uncomfortable' to 'neutral' about their comfort of approaching assignment problems. Importantly here is the fact that just over 20% of male students indicated that they were 'very uncomfortable' about doing their assignments at the end of the semester compared to no female students.

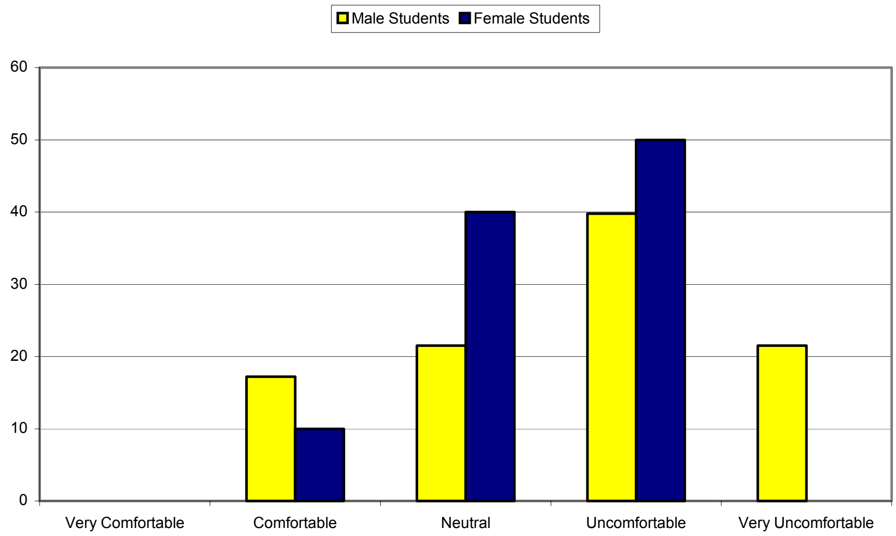

Figure 5.6 Percentage of Students Response to Degree of Comfort in Attempting Assignment Problem

5.4.6 Student Perceptions And Expectations

Students perception of lectures were that they were not an important part of the learning process in the subject. A number of male students actually suggested that "*lectures make the difficult subjects harder*" [Male Student, Survey 2]. They also felt very intimidated in asking questions or giving technical opinions during the lectures. Figure 5.7 provides the results of the confidence that each gender had in giving technical opinions in lectures and tutorials. Female and male students were approximately equally lacking in confidence in giving technical opinions in lectures with 70% of female and 75% of male students indicating this feeling of apprehension. For MECH102 the problem with lectures was compounded by the fact that the lecture basically followed the lecture notes given out to students and did not expand on these significantly. "*It is the tutorial where you learn everything*" [Male Student, Survey 2]. "*I don't think they are tutorials, I think they are lifesavers*" [Female Student, Survey 2]. Despite this, even the tutorials were not formats in which students felt confident to participate fully. This is illustrated in Figure 5.7 where 70% of female students and 48% of male students felt 'not very confident' to give a technical opinion during the tutorial session. A female student did say she felt that *"Help from tutors was always there when required. It was just a matter of overcoming an initial feeling of being stupid"* [Female Student, Survey 2]. This was also illustrated during the observation sessions where it was often difficult to get students to explain what they had done because usually they did not appear confident to do so. Whether this was a result of not being confident in their solution or their approach was unclear. In many cases however by explaining what they had done so far was enough for them to work out where to go next and how to improve or solve the problem that they were working on. This was a positive process for many students but in a number of cases identified during observation did not follow through to the next time they were in trouble.

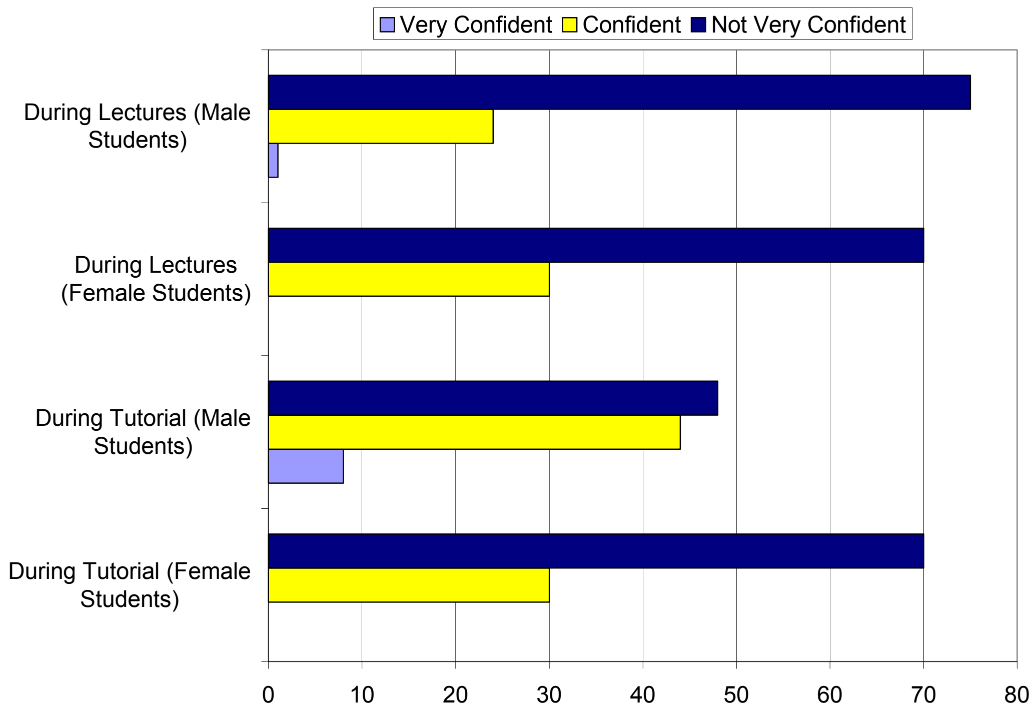

Figure 5.7 Confidence Level By Gender In Giving Opinions In Lectures And Tutorials

When investigating the similar percentage of female students feeling unconfident in both lectures and tutorial it was confirmed that it was the same group of female students who felt unconfident in both environments. During the focus group discussion and tutorial observations the mature age women appeared to be more confident to speak up in general and felt confident to raise technical issues in a larger forum. The difference between the confidence level in the tutorials and lectures by male students was expected with higher confidence levels when speaking out in smaller groups. It is interesting to note also that it is only male students who felt 'very confident' in either environment with 8% being very confident in tutorials.

Students were also perplexed by the assumption that if students pass a subject that they should know it. Mathematics was used as a typical example, although one, which had the worst repercussions. Mathematics subjects *"create a lot of difficulties further on which reflect in a lot of other unhealthy situations and low marks. They assume that because we passed Maths we got 70 or 80 percent but we haven't"* [Male Student, Focus Group].

There was also a feeling that academics were not interested in students' progress and in fact suggested that *"the topic level is well above first year standard and the lecturer seems to have fun and enjoys exploiting this fact"* [Male Student, Survey 2]

5.4.7 Feedback

Poor or no feedback was stated by both male and female students as a factor that affected their progress in this subject. Sixty one percent (61%) of male students and 50% of female students indicated that they received no feedback during the semester. There were obviously different interpretations of what constitutes feedback, however a mark on an assignment was not enough and many students did not feel comfortable or 'mature' enough to ask more directly for help and feedback.

5.5 Study Patterns

Approximately half the statements made in Question 3, Survey 1, (Appendix 2a) indicated that they preferred to study alone. One comment went as follows, *"I study best in my own time at my own pace. If I study at all*". A competitive atmosphere was evident in discussions relating to study patterns for both individuals and when working with other students. The '*if I study at all*' comment is stereotypical of the importance male students place on underestimating how hard they work in relation to the marks they got. In the focus group sessions, women indicated how focused they were towards their studies and would work long hours to understand the material and "*do a good job in the assessments*". They felt male students generally did not put in the same effort and, in fact, would underestimate the time they spent studying to try and indicate that they didn't really have to study. This was a sincere frustration for the women who had been told by their male colleagues "*that the only reason they got a good mark was because they wore a skirt"* and that there was no recognition by the males of the work that female students put in. This comment and comments like it have been a constant burden for women in the faculty who feel as though they are required to justify their performance. Often these comments are reported to be presented in a joking fashion, however, it is the repetition of these sorts of comments that tends to indicate the underlining sentiment by some male peers, as well as adding to the lower confidence level shown by some female students.

The issue of commitment and enthusiasm by individuals to their studies was discussed at length during the focus group sessions in relation to the influence they have on study patterns. Many factors were highlighted, however the financial commitment to their studies and career aspirations seemed to be strong practical influences on study patterns. Although these factors were not necessarily the important ones for women, they did feel that women engineering students as a group had a quite different motivation to study engineering which flowed through to their day to day commitment. A number of mature age students felt that on the whole the students that entered engineering directly from school had very different motivations and therefore study patterns. These mature age students preferred to work slowly and steadily and keep up with the work whereas their understanding of many of the younger students was that they used a 'just in time' approach. The ability to work 'just in time' was actually seen by a number of the younger students as a positive approach demonstrating a high intellectual ability. There did seem a strong dichotomy between the 'don't care' group of students and the 'want to learn' group of students which was not always divided along the mature age or gender lines, but there were some rare exceptions. An excuse used by one male 'don't care' student suggested that *"Australians are too laid back, we are our own worst enemies I think".*

Also, in the search to find information, female students would question academic staff. Male students saw this as asking for preferential treatment. Female students did not always find asking easy, as one student commented "*Help from tutors was always there when required. It was just a matter of overcoming an initial feeling of being stupid*". They did, however, recognise that often they had no alternative as male students seemed to be able to find out things through their 'networks' which many female students did not feel they had access to. There were some male students who did not access this information pool and some female students who did.

5.6 Teamwork

Teamwork was investigated from the perspective of both formal and informal team practices that students develop in engineering. When asked in Survey 1, with whom students might team up with for study purposes on an informal basis, male students did not show any preference for any of the categories, sex, age and experience that were given as alternative choices. Figures 5.8a and 5.8b show the percentage breakdown of responses to Question 3 Survey 1. The response for male students was 50% saying that they would team up based on sex and 55% based on background or experience (students were able to pick more that one alternative). Similar background and experiences was interpreted by many students in the focus groups as similar levels of intelligence, enthusiasm, and commitment to their studies. During the observation and discussion with teams in the tutorial sessions, students suggested that it was important that each member of the study team participated and contributed equally. This criterion seemed less important with friends and flatmates, who were also seen as alternative possibilities for study partners. In the focus group session the male students indicated a preference to work with female students but said that there were obviously not enough female students to go around. The two main reasons given by male students in the focus groups for this preference was that female students were considered good team players and "more interesting to have in a group". This was taken quite seriously by some male students who were genuinely interested in a more diverse work environment compared with other male students who suggested that it was an opportunity to find a 'girlfriend'. Two male students indicated that they hadn't yet met any female mechanical engineering students in their classes and that there were *"not many females to work with (wish it was different)"* [Male Student, Survey 2]. On the other hand there was a group of male students who were supporting the maintenance of the macho culture with the attitude that *"the advantage of chicks being in engineering is that it keeps me occupied*" [Male Student, Survey 2]. There was evidence in the focus groups of an attitude which did not allow some of the male students to work with women, as though they would be validating female student existence in engineering if they did.

For female students, on the other hand, their preference for a study partner was to team up with male students and students from different backgrounds. Most female students (93% or 13/14) said they would team up with someone of the opposite sex, (Figure 5.8a) and 62% said they would team up with someone of a different background (Figure 5.8b). The female students in the focus groups felt that the sex of a person and their background were related facts and despite there not being many female students, they would not go out of their way to find them for study support. This was shown in practice in MECH102, where all female students who were in teams, teamed up with male students in both assignment questions 4 and 5. That is, female students did not seek out all-girl teams.

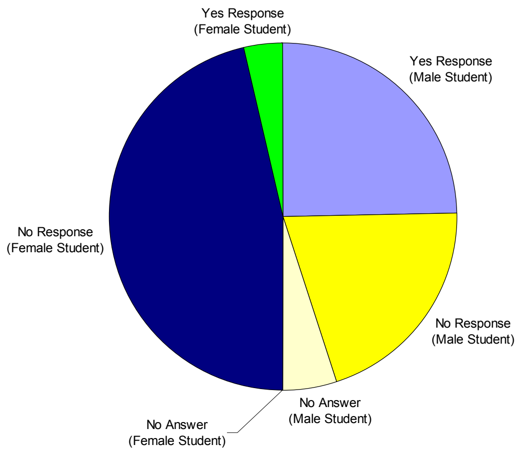

Figure 5.8a Preference for Same Sex Study Partners by Gender

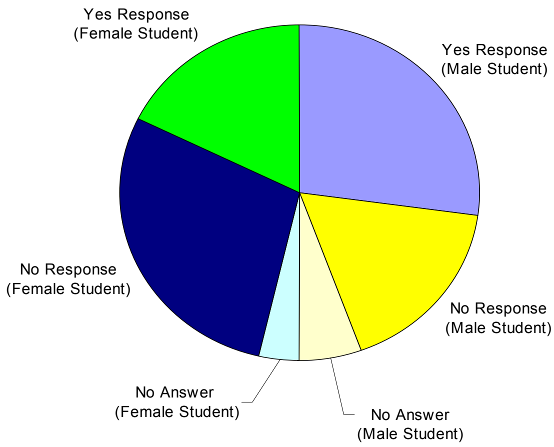

Figure 5.8b Preference for Same Background Study Partners by Gender

Being able to achieve gender balance in teams has its difficulties due to the low number of female students currently in the courses. It is interesting however that 50% or 61 male students said that they would usually team up with someone of the opposite sex as would most of the female students (13 out of the 14 female students) who put this as a preference. Thus we can see from Survey 2 that only 11 males were in teams with female students in Assignment 4 (out of 67 males in teams) and 5 males were in teams with female students in Assignment 5 (out of 59). This is a dilemma for male students in engineering as many of them would like to work with women however the current numbers do not allow this.

Assignments 4 and 5 were offered as projects to be completed by individuals or teams. Figure 5.9 shows the percentage of students who worked in teams in each of these assignments. Assignment 4 showed that most students, 60% of females and 72% of males, decided to work in teams. Assignment 5 showed a drop off in teamwork with 40% of females and 66% of males opting to work as a team. The survey showed that 2 females out of the 10 surveyed (20%) and 8 out of 94 males students surveyed (9%) moved from being in a team in assignment 4 to working on their own in assignment 5. There was no movement in the other direction.

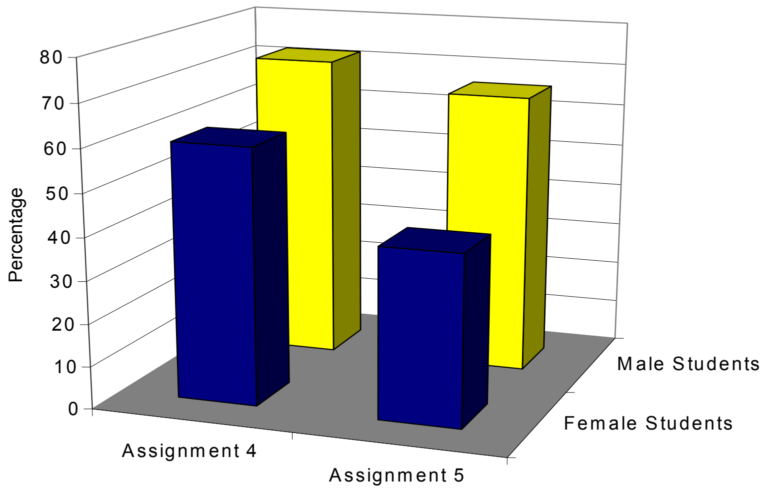

Figure 5.9 Percentages of Students in Teams in Assignments 4 and 5 by Gender

The benefits of teamwork appeared to be focused on easing the workload and pressure that many students felt. Typical comments were "*because I couldn't have got it out myself*" [Male Student, Survey 2], *"since others could help in more difficult areas*" [Male Student, Survey 2] and "*it allowed me to draw on other people's ideas, even though they too had no idea how to do it*" [Male Student, Survey 2]. Female students had a different perspective on this with "*we all threw together ideas and* *made it easier to understand process*" and "*I understood something about that assignment*". Thus despite students believing that they did not know the work, they bounced ideas around in the team and got it done where otherwise individually they might not have. A male student just saw it as an opportunity to make life easier *"I skipped straight to copying off my friends"* [Male Student, Survey 2]. The survey data, Figure 5.10, actually showed that most students and a similar proportion of male and female students felt that they did not experience difficulties in agreeing to approach problems in teamwork. This is interesting in the light of the above comments and highlights an important area of future work which was not able to be completed in this study.

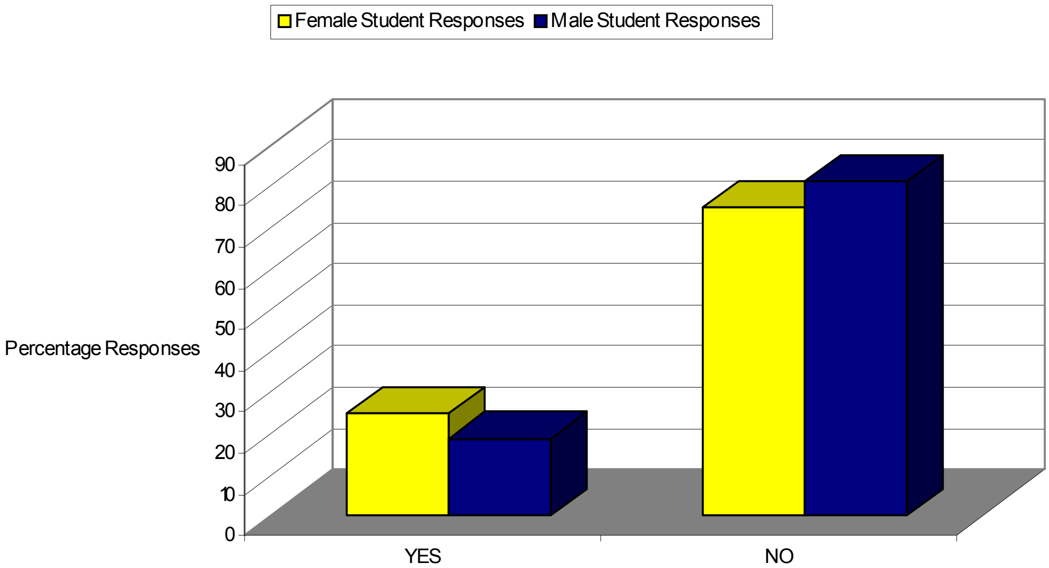

Figure 5.10 Whether Students Experienced Any Difficulties In Agreeing To A Way Of Approaching Problems In A Team Environment

There was some variation in the responses of students by gender to the question 10a Survey 2 on communication difficulties when working in a team. Over 85% of male students indicated that they had no difficulty with communication with other members of a team compared to only 60% of female students feeling the same shown in Figure 5.11. Only one female student and 16 male students indicated in Survey 2 that they had experienced dominating behaviour by a male student. Of these students the female student and 9 of the male students said that they just ignored this dominating behaviour. The other male students said that they would deal with this person by speaking to them directly. This was supported by the male students in the focus group sessions who said that they would make some attempt at dealing with any dominating behaviour if it was having an impact on the group dynamics. On the other hand, the female students suggested that it was not worth their time in confronting this behaviour and would simply put up with it.

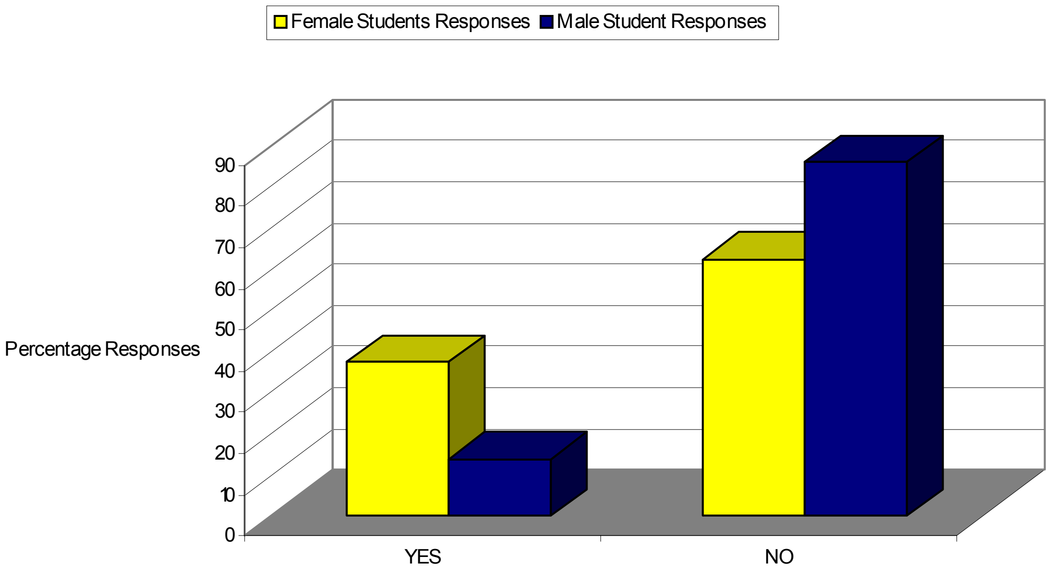

Figure 5.11 Whether Students Experienced Any Difficulties In Communication With Other Members Of A Team

There were several comments from students in the focus groups and surveys who had not made friends or found study partners because they assumed that it would be unlikely to happen in their first year of their studies. In fact the focus groups sessions established that there were a number of students who indicated that they had a low expectation of finding peers who would be interested in becoming study partners and that the only option was to study alone. There are some relationship in the survey data between the students indicating that it was unlikely to find a study partner and those who indicated that they preferred to study alone but this was not consistent across all these students and some had simply found it hard to find a study partner.

5.7 Awareness And Implications Of Gendered Language Or Examples

There was a perception among the students that the use of gendered language was not an important or relevant issue to consider in their study environment. In fact a

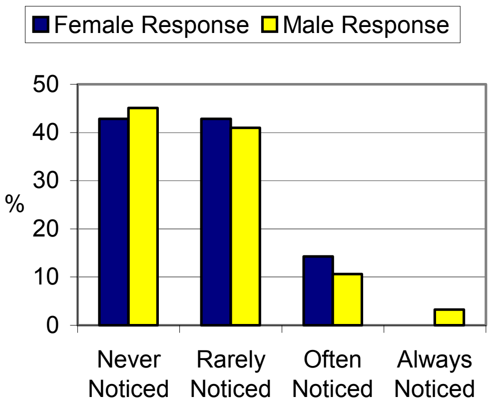

Figure 5.12a Percentage Response to Male/Female Language or Examples Noticed in Textbooks by Gender

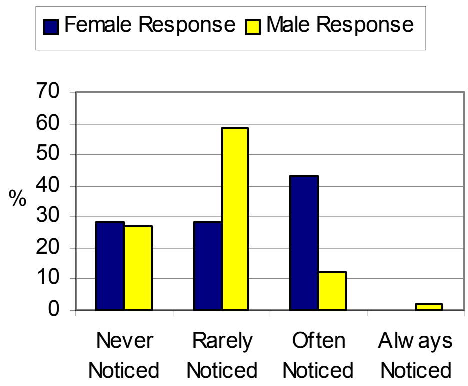

Figure 5.12b Percentage Response to Male/Female Language or Examples Noticed in Lectures by Gender

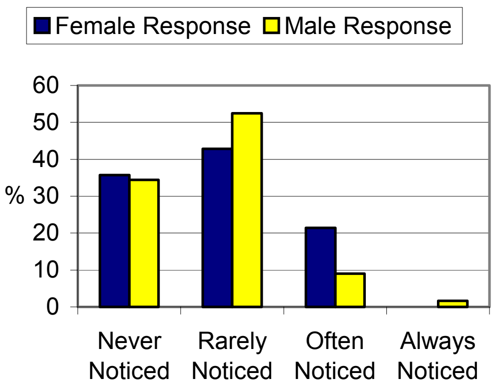

Figure 5.12c Percentage Response to Male/Female Language or Examples Noticed in Tutorials by Gender

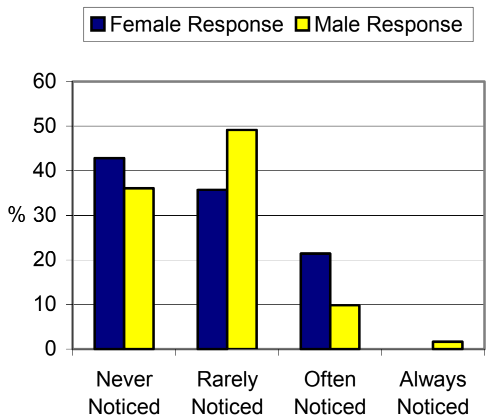

Figure 5.12d Percentage Response to Male/Female Language or Examples Noticed in Laboratories by Gender

large proportion of students said in response to Question 4 (Figures 5.12) and 5 (Figure 5.13) in Survey 1 and during the focus group sessions that it is *"irrelevant", "not an issue",* that they *"don't care"* as well as it *"doesn't bother me, can't understand why it would".* Female students appeared slightly more aware in the focus groups and during tutorial sessions but not willing or able to do anything. As one female student stated; *"mostly males are referred to but I don't think this is deliberate or has any bearing on my education or (that of) someone of the opposite sex"* [Female Student, Survey 2]. A male student also inferred that the occurrences of gendered language were not intentional with *"as if it matters, as long as they don't go overboard. It's usually just a slip of the tongue"* [Male Student, Survey 2].

Despite being careful with the terminology which was used in the survey and in the focus group questions there remained an immediate negative or defensive response to these questions. Comments such as *"give feminism a rest, will you" to "it is not really an issue if you don't let it be one" to "it can't be helped. The majority of classes are made up of males anyway"* illustrate these feelings. Also, *"changing the name of things like manhole cover to say people cover and many other various things (to) equal the different sexes in (the) work place makes me sick, its all just a waste of time".*

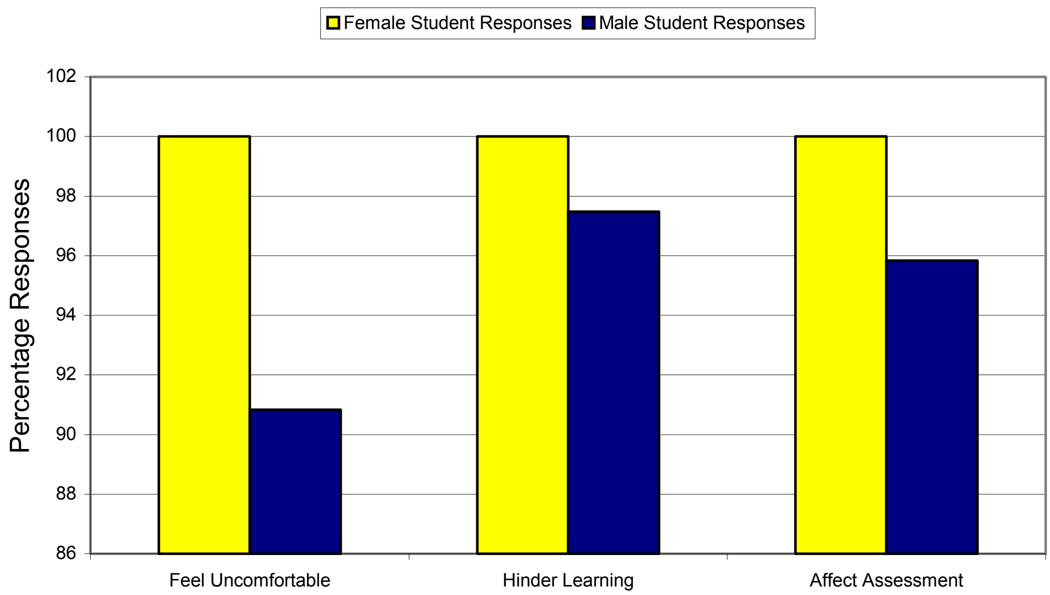

Figure 5.13 The NO response by Gender of Whether The Use Of Single-Sex Language or Examples will make them:

Question 4 in Survey 1 asked how often students noticed the use of male/female specific language or examples. The results showed an interesting variation in the response by the male and female students. The greater majority of male students indicated that there was never or rarely any male/female specific language or examples in texts, lectures, tutorials or laboratories. The results are illustrated in Figure 5.12a to 5.12d. There was a consistent group of 12 male students (10%) who did specify that male/female language was used in these contexts. Whilst women's responses were also supportive of the 'never' or 'rarely' responses in tutorials, texts or laboratories a response of 44% of the female students said that gendered language 'often' occurred during lectures, Figure 5.12b.
In the focus group sessions when asked which gender this language referred to, male student response did not highlight one area but instead had 45% saying 'I don't know' and 45% saying it was 'male' with the remaining 10% saying that it was 'female' language/examples. Female students on the other hand were surer with 82% saying that the language was 'male' with the other 18% saying 'I don't know' with none of them saying it was female. These figures are presented in Figure 5.14.

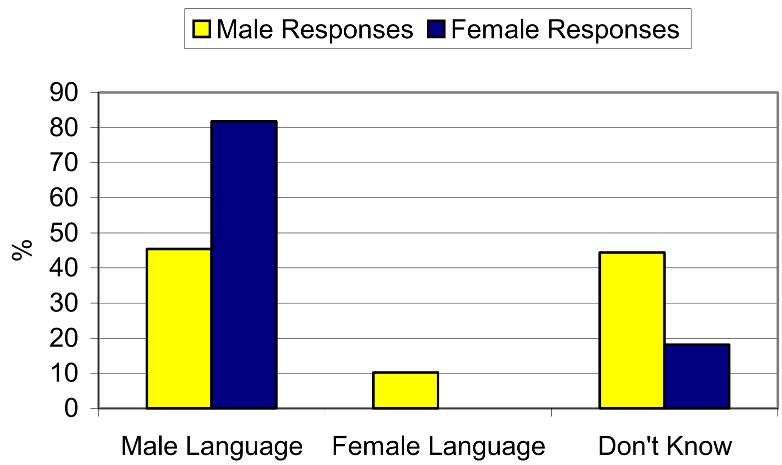

Figure 5.14 Percentage Responses by Gender to whether Male or Female Language is Used

When asked if the use of gendered language made them feel uncomfortable or if it affected their learning or assessment both male and female students felt quite strongly that it did not affect these things. These results are presented in Figure 5.13.

All of the female students in Survey 1 said that this (male) language and examples did not make them 'feel uncomfortable' nor did it 'hinder their learning' or 'affect their assessment'. More specifically in terms of making them feel uncomfortable there were comments such as *'depending on the context'* and *'I merely feel this unfair'* (not uncomfortable). However, contrary to these results and the comments which a number of the female students made, 30% of them responded to the fact that there was a need to challenge the bias (Figure 5.15). The male students on the other hand also generally felt that gendered language and examples did not adversely affect their learning with only a small percentage of male students indicating some issues. Four male students selected 'yes' response to all which I suspect from later discussions was a protest to the survey. One male student commented in the survey "*if I was a female, I would probably challenge the bias, but the language usually assumes male. If it were to assume female most of the time I certainly would challenge it"* [Male Student, Survey 1]

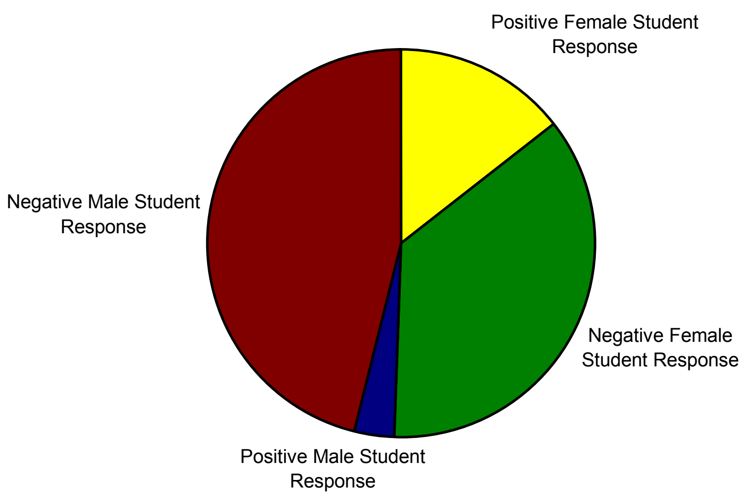

Figure 5.15 Responses By Gender Of Whether They Would Challenge Any Gender Language Bias

Comments from female students in the focus group sessions supported the need to challenge the bias, however, most were accepting of the environment *'I am a female and I don't really see it as an issue, as long as I can understand it I don't care'.* Also, on several occasions, female students would make excuses for the males despite not being happy about it *"in the context that they are completely unable to understand"* and *"seems to make them feel more acceptable. It gives me the shits"* [Female Students, Survey 1]

During the focus groups sessions there was a genuine feeling from a small percentage of males in the overall group that women did have a difficult time in this area and that they felt most males were not interested or didn't understand or didn't care. A comment by a male student supported this feeling '*Occasionally a female will be given greater attention but they usually work harder in any case*'. The conversation went on (MS male student and FS female student):

MS: *"Well I think women add a real separate tone to the group. If there are women present, in a study group or tutorial, they normally set the standard of language"*
FS: *"So it doesn't sink down to the gutter, is that what you are saying?"*
MS: *"Well, yeah. Some blokes can get pretty crude"*
FS: *"And some of the lecturers as well. You can see them stopping themselves before they say something smart because there are females in the audience."*
MS: *"Sometimes it is just a bit of a joke or a bit of play on words but everyone laughs at it. Gee, you could get in a lot of trouble if anyone objected but no one ever has."*

5.8 Perceived Advantages Caused By Gender

Again the overwhelming response from both female and male students to Question 6 Survey 1 was that there was NO perception that any group of students were currently advantaged (Figure 5.16 a & b). Students felt that they were on an '*equal footing*' had '*equal opportunity'*, '*equal attention'*, and '*everyone has a fair chance*'. Basically they 'can't see any bias'.

Male student responses, however, showed that they felt somewhat advantaged by being heard in class and that they showed more assertive behaviour, whereas female students were given more support and were given more generous marks and that the teaching was biased for them.

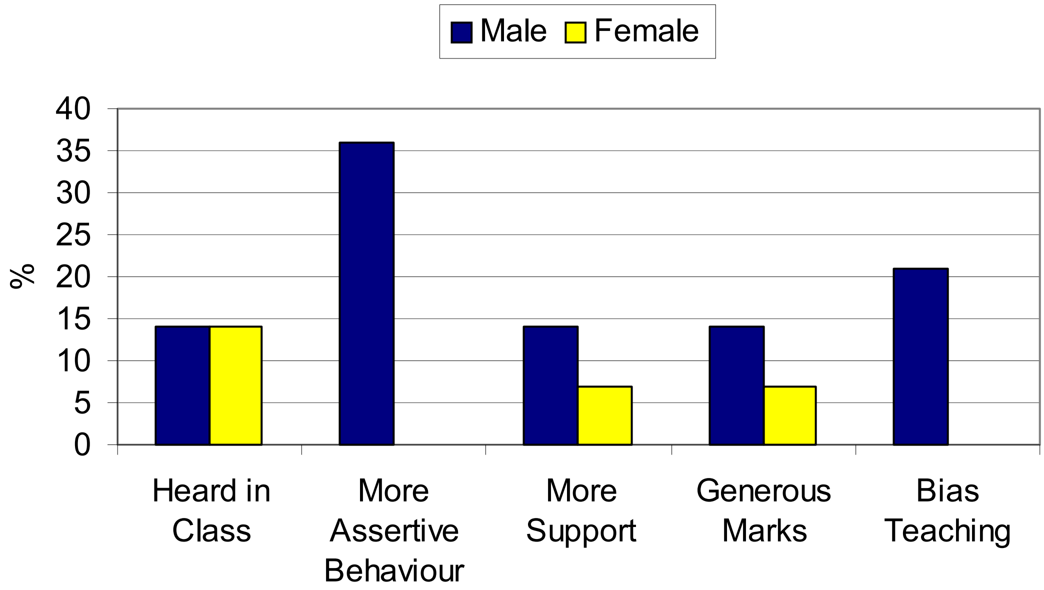

Figure 5.1a Female Response to: Do you feel that a particular group of students is currently more advantaged through:

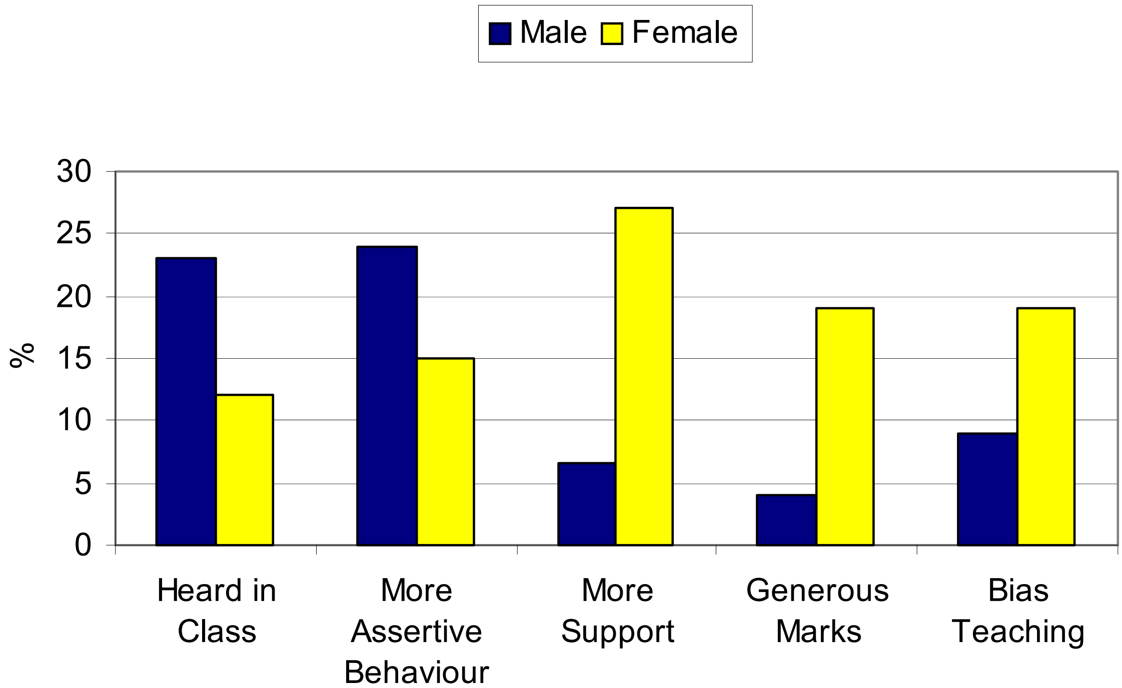

Figure 5.16b Male Response to: Do you feel that a particular group of students is currently more advantaged through:

All the female students indicated that they believed male students had much more assertive behaviour in the classroom, which correlated with the male responses. Yet, contrary to the male student perception, female students felt that they were equally heard in class. Male students generally believed that they were heard in class above the female students. In addition female students felt that males were given more support and more generous marks than they were given which was in direct disagreement with the male students. As with assertive behaviour, all female responses said that the teaching was biased towards the male students.

> *"…male students do not want to put their hand up because they are too macho. If you're female you can ask anything. They don't expect you to know it, they have this low low picture of your intelligence level so you can ask anything and they just go yeah, yeah, really condescending of course, but you just use it to your advantage. Which is bad and I mean, I'm sure all the males do get annoyed about that but it is what you do"* [Female Student, Focus Group]

A female student recited a story in the focus group session of a male student upset at her for getting a higher mark. She asked him how long had he spent on the assignment and his answer was 'a couple of hours not much', although she believed that he had spent more time on it than he admitted. She declared that she had worked solidly for two weeks on it and had enjoyed understanding it. The male student's response was that she must be unintelligent to have to spend so much time on it.

Female students did feel that the male students would try and find other ways of getting around their studies and assessment tasks and believed that *"advantage is only gained by students working hard on the subject".* A supportive male student admitted that *"occasionally a female will be given greater attention but they usually work harder in any case."*

A number of male students recalled stories and situation where female students used their gender advantage.

> "*It may seem sexist, but as most lecturers are male, female students are generally treated better*' and "*the lecturer was present in the*

> *tutorials and these two young ladies were very attractive so I mean he's only human so he is going to hang around isn't he. We got a bit cheesed off, but I thought well he's doing his job and he's letting his personal feelings come into it a bit and they were using their gender to their advantage. That's life."* [Male Student, Focus Group]

A male student also suggested that it was worth giving female students a bit of a helping hand: " *Well I think that the guys in mechanical think that (because) there are so few women doing the course that they like to give them a bit of extra chance so (that) they keep hanging around, and (also that) they are easy on the eye*" [Male Student, Focus Group].

5.9 Summary

The results of the data collected in the MECH102 classroom have in this chapter been categorised and presented to describe how the students perceive and interpret their experiences in an engineering classroom. The major outcomes described in this chapter include that:

- for most male and female students there was a considerable amount of discomfort when discussing gender issues,
- students felt that there was gender balance and that there was no perception of advantage gained by either gender
- the stereotypical 'tinkering' was seen by a majority of male students as the most dominant factor considered as exposure to engineering prior to enrolment,
- 'visiting engineering sites' was found to be the most dominant factor for female students exposure to engineering prior to enrollment,
- 'work experience' opportunities appear to be a major difference between genders,
- computers and computing were generally not connected to engineering by either gender,
- workload was an emotive topic amongst all students and that students often felt uncomfortable with what was expected of them,

- female students tended to approach the subject and subject material with much more caution and expectations of a challenge than male students did,
- male students were more likely to reserve their judgment of a subjects level of difficulty until the end of the semester,
- the assumed knowledge and confidence in using computers was unreasonable,
- students in general needed more confidence and needed to learn to take risks when approaching problems and assignments. Male students were more uncomfortable about attempting assignment problems,
- male students were more concerned at the pace of delivery of subject material which reflected in a more negative outlook on the subject
- mature age students questioned the relevance of the subject to their career,
- having exposure to different ways of explaining processes to solve problems was considered a negative aspect and this negativity was usually reflected back at the teaching staff,
- lectures were considered a one way flow of information rather than a learning environment. Students saw themselves as inactive members in this environment,
- there was a preference for a 'plug in' formula approach to solving problems,
- female students were more willing to help themselves in obtaining missing information whereas there was an expectation that it should be given or made clear to some male students,
- female students preferred to take a system wide approach to solving problems by developing a program structure before breaking the problem into parts and writing code. Male students preferred solving parts of the problem first before trying to develop program structure.
- both female and male students felt not very confident in asking questions or giving technical opinions in lectures and tutorials. However, there was a small proportion of male students who felt very confident in giving their opinion in tutorials
- student perception of teaching staff was that they were not interested in student progress,
- poor or no feedback was seen as problematic to students progress for both genders,

- a very competitive atmosphere was encouraged in the learning environment which tended to cause problems in group project work,
- female students felt male students underestimated the time spend on study when discussing marks obtained for pieced of work,
- female students often had a different motivation to study engineering which reflected in their commitment to study,
- a 'just in time' approach to work was more common amongst school leavers,
- asking for help was not easy for students in general, however, female students who did not have access to student networks (mostly male) would need to ask.
- male students would associate female students asking for help as asking for preferential treatment,
- female students clearly preferred working with the opposite sex in team projects, this was also true for male students however lack of female student numbers meant that this was not able to be confirmed,
- teamwork was seen as beneficial to both genders, but for different reasons,
- dominating behaviour in a team was experienced by both genders and in general students would simple ignore it,
- female students were slightly more aware of gendered language but were not willing or able to do anything,
- gender language discussions were very emotive,
- female students felt that gendered language 'often' occurred during lectures,
- female students specified that gendered language did not make them feel uncomfortable, nor did it hinder their learning or affect their assessment,
- a small group of female student felt that gendered language and practices should be challenged,
- both female and male students believed that male students were more assertive in class which could advantage them,
- female students felt that they were equally heard in class whereas male students felt that they were more advantaged by being heard in class,
- both genders believe that the other is advantaged with more support and generous marks.

Chapter 6 will use these findings and compare them with the literature which has been reviewed in Chapter 3 to draw more global conclusions and to answer the research question discussed in Chapter 4.

Chapter 6 – Discussion of Findings: Student Experiences in an Engineering Classroom

The majority of the literature drawn upon in this thesis has taken a poststructural feminist framework or used contemporary theories of masculinity as tools for analysing and unraveling the social and institutional structures within the educational sector and classroom environments. The emerging analysis in this thesis confronts the complexity of describing and interpreting the social and educational construction of gendered relationships within a classroom setting. This complexity is highlighted by the fact that the theoretical and analytical tools that are available within the sphere of post structural feminist theory and contemporary theories of masculinity account predominantly for the macro cultural levels and not the micro sociological level. This research has been an exploratory study using an ethnographic methodology to begin to understand the experiences of female and male students within an engineering classroom at a micro level. Gender issues have tended in the past to relate to women predominantly and women's disadvantages. This study has investigated both female and male experiences and perceptions of advantage to develop a fuller picture of the classroom environment in engineering. Thus, it has focused on students' perceptions of gender and educational issues in an engineering classroom and the influences these issues have on their learning experiences.

The main research question has asked to what 'extent' is gender a determinate of classroom experiences. That is, in what ways does gender determine or affect the experiences of students within an engineering classroom and what are the resulting consequences of these experiences in the current education system? To determine the extent of difference that gender makes, there is an implication that a weighting needs to be associated with the different aspects of the students perceptions of their environment. In each of the sections below the results are presented and discussed in terms of the literature. Weightings are assigned to each theme or sub theme depending on the extent of difference between genders which has been emphasized by the students during the study. This will then provide an understanding of what areas of the classroom are of greatest concern to students in terms of inequitable experiences. It is also important to understand what form this differential experience takes within the engineering classroom and whether this differential experience has a discriminatory nature to either gender. It has been establish by many studies that men and women are treated differently from birth [Connell et al 1982] and that this differential treatment has been experienced at the tertiary level of education and into the professional arena. Thus, it is not unexpected that male and female students are likely to be treated differently in the engineering environment of universities [Lewis,1997] and in the professional world where these engineers practice [Lewis, Harris, Cox, 2000]. It follows then that this differential treatment will be happening in the engineering classroom.

This chapter will thus present an analysis of its findings using the literature as a comparison. This analysis is presented based on the model (Figure 6.1) of the external and internal classroom factors found to be influential on gendered behaviours and responses. This model, presented in Figure 6.1, provides a framework for discussion of findings. There are many more layers of complexity that will be described in this analysis.

6.1 External Factors Influencing Classroom Experiences

Social conditioning and established gender paradigms have been recognized in the literature [Beder, 1998, Roberts, 1996] and in this study as being influential to an individual's ways of acting and thinking. The external factors identified here, including students past experiences and previous exposure to engineering, are not only influential in the reasons for choosing engineering as a career but influence their experiences within the classroom.

6.1.1 Social Stereotypes and Previous Experiences

It has been recognised [Beder, 1998; Brown, 1996] that the image of engineering continues to be presented as a career for males and only attracts women who are still willing and comfortable to challenge or accept this 'norm'. All the women interviewed in the focus group sessions indicated that they were aware of the non-traditional nature of engineering, some from an early age, and were none-the-less prepared and determined to become engineers despite this fact. As other research

has also suggested [Stonyer, 1999; Lewis, 1996] there was clearly a feeling among the female students in this study that they would be able to 'handle' this non-traditional area, as after all they had already spent a number of years in a similar environment at school having chosen non-traditional subjects for this career path. This attitude of being able to 'handle' it was clearly expressed by these women about their classroom experiences also. They were able to overcome their fears and seek academic help more readily than their male peers however they were much less inclined to seek out other support, as they did not see the necessity. This highlights a significant issue which needs to be addressed in engineering education as there were times when female students expressed frustration with the attitudes of men which they simple accept as the norm. The result of this is that women have to deal with an additional dimension in their learning environment which effectively questions their presence in engineering classrooms and their ability to fit in.

It was established from the discussion in the focus groups that female students did find choosing engineering a more stressful decision than for male students. This is despite the fact that they did not generally feel as through they had gone through any extra hurdles to choose engineering as a career and that they felt able to 'handle' this non-traditional area. These choices and the resulting motivations have an important impact on individuals within the classroom and the approach that students take with the workload that they are required to handle. Male students' discussion in the focus groups did not show the same level of anxiety when choosing engineering. In fact, male students did not seem to feel that they went through an arduous process to choose engineering as a career despite the fact that in the broader sense they had similar interests in mathematics and science and had participated in some form of 'tinkering' during childhood. As one male student explained *"boys would go into that field if they have the educational prerequisites"* as if it were the normal thing to do.

A greater proportion of female students to male students had sought after some exposure to engineering prior to enrolling. This included site visits, work experience or through family/friend connections to engineering. There were, however, four female students who indicated in the survey that they had no exposure to engineering prior to enrolling and had simply made the choice based on their love of mathematics and science at school despite their awareness of engineering's non-traditional nature. It was interesting that a large number of women students in the focus group sessions recognised their love of playing with Lego and /or time spent in the farm shed, or their confidence in using computers but this only surfaced after a similar admission by a fellow female student. These interests and skills were clearly not the obvious connection to engineering that the male students professed. These female students still had a strong love of mathematics and science as their main reason for choosing engineering. On the other hand, many male students still choose engineering based on their love of 'tinkering'. Many of the male students admitted that mathematics and science was not their most enjoyable or strongest subjects but had taken these subjects for career purposes. This fact has an interesting consequence that was not so clearly established in MECH102 but was evident in students comments when discussing other subject areas. The first year of engineering courses in particular and later years also have a strong mathematics and science foundation, often being extensions of mathematics and science subjects at school. This clearly gives female students an advantage academically, which has been illustrated on a more general basis at the University of Newcastle with up to 70% of female students graduating with honours over the last 5 years.

Family connections and in particular fathers and brothers or uncles has long been seen anecdotally as a strong influence, especially on women, in making choices about engineering as a career but this was not reflected in this study. Other literature [Smeaton, 1996; Lewis, 1995] in this area has suggested that many women in engineering have in fact gone against the advice of family and friends which might be true on a broader social level however in this study it was not found to be true at an individual level. To some extent this was due to a high proportion of mature age women in the focus group sessions who indicated that their decision to study engineering was based on broader experiences beyond the school yard and family spheres. In fact, the female students suggested it was critical that they had a mentor or role model who was supportive of their decision. Role models are extremely important for inspiration as they provide someone to look up to as well as someone that can mentor you in the new environment to provide ongoing encouragement. For these women the lack of role models in the engineering classrooms was clearly evident from the observer's viewpoint but was not identified by the female students. As they do not accept the need for non-academic support they clearly do not recognise the importance of female role models. It was interesting that in general female students did find it hard to describe themselves as engineers or see themselves in an engineering position. There was not one student who knew of a women engineer when asked in the focus groups.

Despite choosing engineering so effortlessly many male students did admit that they did not have a good understanding of what engineers did either but clearly appeared far more comfortable with their ability to be an engineer. The results showed that two-thirds of male students referred to 'tinkering' and hands on practical experience, which was described as playing with computers, building model toys or working on mechanical equipment found in the garage and farm shed, as important to their career choice. This supports the literature [Roberts, 1996] that suggested that having these skills and interests is continually being reinforced as beneficial to doing engineering despite them not necessarily being related to what engineers actually do.

The positive exposure to engineering which female students obtained prior to enrolling, however, was necessary to give them confidence when using equipment or in keeping up with the jargon. The Mare et al [1996] study showed the hesitation and lack of confidence that woman students had towards laboratory equipment. Results of this study have shown female students definitely admitting that they were more hesitant about approaching subjects and computer assignments than their male peers however they clearly believed in themselves and in fact would end up feeling more confident by the end of the semester in both areas. Thus female students awareness of the difficulty of engineering courses is a determinate of the more positive application to their study.

6.1.2 Engineering Classroom Culture

There has been a significant amount of research into the culture of engineering faculties at Australian Universities and it is clear that it remains dominated by masculine values and attitudes [IEAust. Review, 1996; Tonso, 1996; Johnson, 1999]. This study has found the same masculine culture that these bodies of work describe. It is important here to establish the aspects of this culture that need to be taken into account when understanding the experiences within an engineering classroom. Engineering has been the domain of men since its inception and thus as would be expected their perspectives and paradigms have dominated its practices. Yet today even if unintentionally, the promotion of masculine values, experiences and interests within the engineering education system has left women feeling uncomfortable and different. The important issue for this study, however, is that these masculine values continue to be reinforced in the classroom where individuals are at their most vunerable, as women need to prove their academic ability to a male academic in a male system. Details of different aspects of the classroom studied here are presented to illustrate gender differences in the next sections. The remainder of this section illustrates examples where the values of this masculine faculty culture result in different classroom experiences.

Of significance here is the clarity with which both female and male students did not want to engage in the discussion of gender in an engineering classroom. In fact it was clear that both genders remain unable to comfortably engage with the topic to the extent of denying that there is a problem as discussed in Section 5.2. This is typical of other research that has focused on gender in engineering more generally [Jolly, 96; Stonyer, 98]. It was thus difficult to unravel some of the different and contradicting comments which were collected in the study due in part to this denial factor.

Female students generally felt that there was no option but to deal with the environment as it is. One female student felt compelled to act like her peers to fit in. This has been identified in the literature as a standard coping mechanism for women operating in an engineering environment. Some female students indicated that they in fact *"liked it like it is"* recognising that they were unusual and therefore special. They enjoyed the shocked response of people who had asked them what they were studying and felt that it was particularly men in the community who struggled to comprehend the fact that women can do engineering. This appears to give women engineering students a strength that reinforces their determination to succeed.

For most of the male students in the focus group sessions there was a considerable amount of trepidation about the discussion of gender, despite these male volunteers clearly being willing to participate. There was, however, a more disturbing response from approximately 10% of the male students in the surveys (rather than the focus group), which appeared to have an underlying feeling of fear of change and possible loss of status among their peers if they were to support women as equals. The pressures of acceptance for both male and female students within the environment have been explored more extensively in other research [Godfrey, 1998; Lewis, 1996] and have illustrated that this produces these generally automatic and unthinking statements which undoubtedly create an unstable environment for women. Such negative comments from male students have been recorded in other research studies in engineering [Lewis, 1996; Copeland, 1998] and the following comment illustrates this negativity towards women that was encountered in this study, *"The only advantage of chicks in engineering is that it keeps me occupied"* [Male Student, Survey 1]. No male student during the observation periods gave any impression that they would feel comfortable to make these statements to the researcher or other female students, except possibly covered up as a joke. Yet the attitudes are there albeit subtler in nature.

Two male students made comments which indicated that it wasn't their problem and in fact felt that the researcher was to blame. As the literature has indicated [Lewis and Copeland, 1997] women taking on a feminist view (from the male perspective) is a threat to them. A minority of male students in this study attempted to 'put down' the researcher personally by indicating that she was only wasting her time and that her feministic views were not welcomed in the environment.

The students also stressed the opinion that there were no inequalities between genders yet contradictions within the results gave the impression that this was simply a result of not wanting to engage in the discussion. There were however high ideals espoused relating to 'fairness' when it affected them personally but this did not emerge in terms of gender 'fairness'. Students were unable to challenge paradigms, which reflected the gender topics and attitudes because they simply could not or would not see them. This was particularly due to individuals feeling unable to speak up in the group situations due to fear of being laughed at or put down. This was also what was felt when having to ask teaching staff for help.

Often students, and in particular male students, took on a negative approach to their studies. They felt that they would achieve in spite of the teaching staff and the system. There was no theme of a 'working together' relationship but instead an 'us against them' mentality. The educational environment was a battle to be fought and won. This combined with the competitive atmosphere of the classroom blended to enhance a military attitude. A male student felt that, *"Everyone should look after themselves and not winge*". It was therefore surprising to hear so much 'wingeing' about the poor teaching environment and staff. In an unusual twist these factors actually emerge as a positive environment for male students, as men were able to motivate themselves within this framework.

There was a perspective from some students that the course was a set of disjointed subjects, where individual subjects were not connected in any way. The system thus expected students to negotiate their own way through the system with the guidance given by the teaching staff only being within the boundaries of the subject and not across the course. Despite this issue being raised by a male student there was more agreement among the female students that this did not create a positive learning environment for all students. As educational literature has suggested, female students prefer to understand the broader context of the subject material and therefore are at more of a disadvantage in this disjointed subject/course structure.

6.2 Internal Factors Influencing Classroom Experiences

The factors included in this section have been interpreted from student responses in this study as influential to the experiences that they have had within an engineering classroom.

6.2.1 Language

The importance of language both in written and oral form has been underestimated in engineering and engineering education due in the main to the emphasis on the scientific foundation of the profession. This sentiment continues to be glorified with the saying... "six munce ago I couldn't spell injineur and now I are one". Observation of the classroom environment identified persistent use of comments with sexual connotations and examples of sexist language both in terms of treating women as objects as well as excluding them from an engineering world. This has also been illustrated in a number of studies in other engineering environments [Tonso, 1996; Roberts, 2000]. Yet the student body in this study clearly did not identify that there was a problem with biased language and its affect on them. However, in both the surveys and the focus groups the questions on language created the strongest reactions from both sexes in relation to the whole discussion on possible gender differences in engineering. This supports the importance and power of language and the need to address its use.

There was a significant amount of acceptance amongst female students that this was 'the way it was' and that they were not willing or able to do anything about it. In general female students felt that they just didn't notice the use of male language and therefore it didn't make them feel uncomfortable. If it did occur they made excuses that it wasn't meant to mean anything. Women are socialized to gender language and therefore they have already developed mechanisms to deal with the use of gendered language in the broader social context and in non-traditional areas of mathematics and science subjects at school. As gendered language is accepted there is no perceived disadvantage and therefore the suspected erosion of their confidence and comfort in the environment is not clearly seen. All female students answered that they never or rarely noticed the use of male/female language in textbooks, tutorials or laboratories however 50% said that they noticed biased language in lectures. It was not clear from the discussion in the focus groups as to why lectures were felt to be different. One female student related a story of an academic in another lecture putting down a woman on a committee of a professional body as being just a 'token'. This academic went on to make a joke about the fact that she was from a different ethnic background which made her a token square (token to the power of 2). This example was not specifically based on the use of language itself, but on the metaphor which paints the picture of the woman in a subordinate position. The tone of the metaphor articulates the attitudes of this academic who has continued to reinforce patterns of male dominance as has been illustrated in the literature [Wilson, 1992]. It is unfortunate that these incidents occur, as teaching staff are in an important position of influencing both male and female students in the development of their professional values.

Male students similarly claimed not to notice the use of male/female language in either lectures, textbooks, tutorials or laboratories. Contrasting this they clearly spoke out and would challenge any changes or bias if female language was to be used. Several male students indicated that they felt that it was ridiculous that women should have a problem with male language and would simple put it down to it being an irrelevant issue (irrelevant to them of course).

Computers caused concern in to many an unsuspecting student both male and female, and both mature age and school leaver. This study showed that those students that seemed to cope were ones who had extensive prior experience with computers. These students tended to be male. The fear was to a large extent due to the technical terms or jargon that are used extensively in the area of computer studies. There are two ways that the use of jargon appears to affect students based on gender: in terms of students' confidence in the subject and therefore their ultimate success; and also in terms of the gendered nature of the language or jargon used. Students regularly expressed frustration with the use of jargon in suggesting that the subject was not taught using terms that they clearly understood.

This denial of language use and its power to devalue women is an important issue for the engineering classroom. It has a negative effect on women who are coping subconsciously with the often unintentional questioning of their place in the engineering classroom. Language is one of the strongest determinants of the classroom experience yet potentially one of the hardest aspects to address as students in general trivialise it and claim not to recognise it. On the other hand its importance is highlighted by the significant emotive discussion that was generated when gendered language was raised.

6.2.2 Curriculum

Evaluating the curriculum content and material presented was not a major focus within the study and therefore not explored fully. Some aspects however were established as being important to the experiences of individuals within the classroom. There remains a clear need for curriculum content to be studied more fully. A consensus was found between the findings in this study and previous research that identified that for curriculum content to become gender neutral it needs to include the contributions of women. It also needs to incorporate references to the broader relevance of the material including environmental and social impact considerations. It can be difficult, in some areas of engineering, to include women's contributions in the material presented due to the scarcity of female engineers in past engineering endeavours however computing in the past has been a discipline dominated by women [Wilson, 1992; Spender, 1992]. There were limited references made to the context of computing and computer programs during this subject and when reference was make there were none which featured women.

These issues are extremely important for both male and female students as it helps them see the relevance of the subject to their course and to their profession and to identify with role models in their field. At the start of the subject female and male students responses indicated that they both believed the course was relevant or reasonably relevant to their career. This was not the case at the end of the semester. A number of male students at the end of the semester clearly understood what was involved with programming and felt that they knew where to go and how to deal with programming problems in a professional context. This is a positive result for these students. However other male students didn't see it this way, and felt very negative about the subject because they had to learn to program when they felt there was no reason for it. Students success or otherwise in the subject appear to be in part the reason for this difference in opinion however this was not able to be confirmed in this study. There was a different response from female students who accepted the subject as something that had to be done and did not question the system or the 'powers' that determined the subjects necessity and relevance. This becomes a serious problem for women who are stuck between putting their faith in the system on the one hand and needing to find the acceptance that they have a place in the environment which they subconsciously look for within the material on the other.

When female students do not see the relevance of the curriculum or are unable to find their position in it, they become uncomfortable within the environment and would eventually make the choice to take themselves out of the subject and not continue with the degree. This decision not to continue with the subject is the final straw as once they have made the decision they have also made the choice not to continue with the course as there are no choices within the degree streams at this stage. This lack of choice is obviously the same for male students however they do not often find themselves feeling uncomfortable or out of place to the same extent as women experience in this environment. Curriculum content thus has an important role to play in recognising women's contributions and their acceptance in the profession and thus their experiences in the classroom.

6.2.3 Teaching Methods and Learning Styles

The 'newness' or unfamiliarity of the teaching environment compounded by the speed of delivery of the material was considered by both male and female students as an important factor which affected their progress in this subject. The speed of delivery of material was of a slightly greater concern to the male students but was generally used as an excuse by both groups for not keeping up. This difference is partly due to the fact that female students were considered by themselves as well as by some male student to generally be more willing to put extra work into the subject. These complaints about their expectations in the teaching environment highlighted the struggle that all students were facing with the new learning environment including the overall workload pressures and personal desires to maintain academic success. Despite these issues affecting both male and female students similarly, it would appear that the more subtle differences that occurred at the personal learning level therefore became more acute.

To understand this more fully the study concentrated on selected aspects of individual learning styles as opposed to teaching methods. The study focused on the way students approached their assignments and it is here that gender differences became more prominent. Almost 80% of female students said that they chose to develop a program structure first before writing code or solving parts of the assignment problem. On the other hand, male students were less sure as a group about any one option, showed preference for the approach of breaking the problem into its parts and solving each part first before developing a program structure or writing code. This information is presented in Figure 5.4. Previous research into learning styles [Belenky, 1986; Philbin, 1995] supports these results and has shown that female students are disadvantaged by this difference. Their different style of approaching problems is devalued by their peers and the teaching staff who do not understand or value these differences. This is illustrated further in this study in the factors related to study patterns and teamwork interactions, which will be presented later in this chapter.

These results also illustrate that the teaching methods used in this subject focused very much on the actual computer code and the code structures within the lines of code rather than the process of solving a computer software problem. There were several comments made by students which suggested that they were left to use a 'trial and error' method of solving the programming problems. This problem then compounded itself as students sought to find formulae, as they have learnt in Mathematics subjects, to solve problems. It is thus important to identify that problems in the subject cannot be solved simply by finding the right formula and that the need to understand the process of solving problems, by either developing a program structure or working out the parts of the problem, is now critical for students. The current teaching method focuses predominately on the transfer of information which will potentially cause problems for both male and female learners. It can, however, be seen that this approach will be more of a problem for female learners as the male student approach to solving problems by solving the parts is more closely aligned with the mechanism and content of the information currently being presented.

By the end of the semester male students generally felt uncomfortable about approaching assignments whereas female students were neutral, Figure 5.4. Female students seem to have benefited as a group from their personal approach to solving problems being self-taught via experiential learning. In general, however, it appeared that all students, both male and female, felt uninspired by the experience and their confidence in themselves was generally weaker. Thus teaching methods have a significant impact on students' experiences in the classroom and this is more significant for women in engineering whose learning styles tend to be more contrary to current practice and therefore is more of a barrier than for male students.

6.2.4 Student Interaction With Teaching Staff

There is a considerable amount of literature available [Connell et al, 1982, Seymore, 1992; Sanders, 1995] which highlights the potentially biased behaviour of teaching staff towards the different sexes in the school system and science and mathematics areas in particular. It has been hypothesized that this might apply in the engineering classroom. In this study there was no observed intentional biased behaviour by the teaching staff towards either sex during lectures or tutorial sessions however interpretation of student responses indicated that they felt there was some bias. The interactions that occurred appeared to be predominantly a function of individual personalities rather than their sex. The observer for example developed relationships with all the female students in the tutorial class and two of these students would seek additional assistance outside tutorial times. In these cases the students said that they felt comfortable to ask all questions, even ones that were felt to be trivial. Another female student felt that in general you needed to get over the feeling that you would appear stupid if you ask the wrong question and therefore felt as though you were being put down. A mature age male student agreed with this comment and felt that particularly for the male school leavers this was definitely a barrier.

The lack of confidence which students showed in participating in the learning environment highlights an issue for engineering classrooms in general but also for female students in particular. Student's response to their level of confidence in speaking up in lectures and tutorials was generally low. Over 70% of male students and 70% of female students were not very confident to speak up in lecturers. The same proportion of female students was also unconfident to speak up in tutorials. The exception here was male students feeling more confident to speak up in tutorials with over 50% of them saying that they felt confident to give their technical opinion in the tutorial environment. There was an interesting difference in the kind of questions that male students would ask in the tutorial sessions compared to those that would be asked by female students. Male students tended to focus on a solution to a particular line of code and not want to venture to other parts of the program. Several of the male students would become agitated when instead of answering their particular question I began to seek further information (for my own understanding) before I answered. In other cases this would be accepted and even thought of positively when solutions beyond what they asked were found. This could happen as other issues associated with the solution that they had initially request help for were expressed but this only happened when the student or students were prepared to spend the time. In other cases still, male students would use the questions as part of a game to put me on trial and continually question my competence. The impression is that the way male students ask questions is considered to be the more acceptable and that women felt that they reinforced the notion that they were stupid by the way they asked questions. When female students got stuck they would ask a question by trying to explain the reason that they got stuck. In general, it was observed that students who did not feel comfortable about asking for help would rather waste time and talk to friends instead of concentrating on the task at hand. Most students both male and female did seem to realise that asking questions and being responsible about their learning would mean that they would be treated well in return, but few practiced this philosophy. The learning environment that teaching staff actively create is thus critical to the experiences that students have in an engineering classroom. Current practices, however, disadvantage women, making them more uncomfortable to operate than male students.

The expectations that teaching staff have of students have been shown in this study to affect students response in their learning environment. Female students felt that teaching staffs' expectation of their academic ability was of a lower standard and therefore felt that their contributions were often considered to be of less value. Most of them quite openly admitted to using this to their advantage by getting information from teaching staff. This obviously enraged a number of male students who felt women were using their femininity to gain attention and additional help. In fact, male students generally believed that women were advantaged by additional support and more generous marks. Women agreed that they would use what they could to their advantage but felt that they worked on their assignments much longer and harder to gets those marks. Female students felt that there were male students who would try and use whatever shortcuts they could find and still expect maximum marks. This was achieved by copying past assignments which they obtained from their extensive network. Some male students themselves glorified this practice and in fact admitted that they would happily copy of friends if the opportunity presented itself. The response by both female and male students to what was expected of them by teaching staff tended to be negative and therefore disadvantaged them in different ways.

Lack of feedback was highlighted by both male and female students as a factor affecting their progress. Students were clearly used to obtaining more individual support and encouragement in their studies, which is a reflection of their High School experiences. This has been shown to be a particular problem for women in the sciences [Brown University, 1996] however there did not appear to be a major difference in opinion on this from either gender in this study.

6.2.5 Student Behaviour in and Perceptions of the Learning Environment

Several students from both sexes expressed the view that they thought all students were accepted as equal members of the course and that they were all on an equal footing. Yet in the surveys male students did feel that they were advantaged by being more assertive and being heard in class and disadvantaged by female students being given more attention and more generous marks. They did believe that in general female students had advantages and that the teaching was biased towards women. No male student was able to give me details of any of these advantages except by suggesting that women used their femininity to obtain these favours.

Male students appeared to be disadvantaged by their self-confessed hesitation to seek help or ask questions of teaching staff (it being seen as a sign of weakness and that they were asking for preferential treatment). The 'macho' culture and group mentality were clearly influential here with a comment suggesting that it would be a "girlie sort of thing to do". As an observer it was noted that male students asked less questions when they were in 'groups' compared to when they were working individually despite the group assignment questions becoming substantially harder (recognised by them in the survey). Male students accessed quite a wide network of past student work and this was a highly prized aspect of the 'mateship' which has been discussed in other studies [Godfrey, 1998; Lewis, 1996].

Female students agreed with the fact that male students were more assertive in class but they felt as though they were equally heard in class. Female students also found it uncomfortable to ask for help but felt it was easier for them as the lecturers did not expect as high an academic standard from them. Female students however felt male students were given more support and more generous marks and that the teaching was biased towards male students. Yet they insisted that they did not feel uncomfortable about this, and were quite happy, it seems, to put up with these differences. Female students did however think that they should challenge 'the' bias. This situation is not unexpected as women feel strongly about fitting into the culture, which means that they are required to accept any bias. On the other hand, they tend to have strong feminist views and therefore will anonymously challenge the bias.

The female students involved in the focus group had a strong desire to succeed and do well academically however there were some female students who felt a conflict with the desire to be popular and attractive to men. For this reason women underrated their own performances. There have been similar findings in a study by Goldberg [1968] and others who predicted that female students would show a tendency to under rate their own academic performance relative to the class as a whole and both sexes would underrate the academic performance of women relative to the performance of men. The results however in this study showed that the final grades for the female students were better than for the male student with a 92% completion rate compared to 77% for male students and that women maintained equivalent or higher levels of performance.

6.2.6 Student Expectations of Their Course

Students' expectation and confidence in MECH102, was dominated by the fear that students had from its reputation as one of the most difficult subjects in their course.

Female students approached the subject quite differently to their male counterparts and were less influenced by these external accounts and impressions of the subject. They were still, however, very unconfident at the beginning of the semester and most female students were expecting the subject to be difficult. By the end of the semester however female students had increased their confidence about the subject. This confidence level and the degree of difficulty felt by students about the subject was at the same level as the male students at this time. The female students had a similar change in expectation of the assignment questions with a lower level of confidence in the early stages of the subject and fewer expectations but these changed over the duration of the subject. Not having the opportunity to evaluate other subjects it cannot be established if this trend is a result of the computer related topic or if this is similar in other engineering subject areas.

Male students, on the other hand, indicated in the survey that they were reasonably confident of succeeding in the subject at the beginning of the semester, with the majority of male students believing the subject to be relatively easy to reasonably difficult, which was in fact similar to other subjects which they had completed in first semester. This result did not comply with the feeling by the male students in the focus group sessions who felt that the subject's reputation was a serious consideration by them. The subject's reputation did, however, exert a more obvious impact on their confidence level by the end of the semester after they had experienced it for themselves. Their confidence level had dwindled over the semester and 70% of male students were saying that the subject was difficult compared to 16% in the early weeks of semester. This change in confidence by male students appeared to evolve from the subjects' reputation as well as their own decision to not ask questions which resulted in building barriers to learning. Thus, in terms of students' expectation of their success in a subject, this was more of a concern for male students than female students.

6.2.7 Study and Work Patterns

Workload emerges as an unavoidable topic when discussions occur with students regarding engineering education [Godfrey, 1998;IEAust. Review, 1996] and this study was no different. However, for female students there was a frustration that their considerable efforts and time spent on their studies were undermined by a student faculty culture that does not value these efforts. The repeated, often jokingly delivered comment that female students only got the good marks because they wear a skirt is tiresome for many female students. Women are achieving good marks in engineering studies but not at the expense of male students. Male students appear to be influenced by the competitive nature of the environment and will underestimate how hard they work. But this practice is detrimental as it leads to a belief that just in time learning is a demonstration of high intellectual ability. In fact, there is it seems a narrow understanding of learning among male students who are not interested in the broader context of the learning environment.

Teamwork was an option in assignments 4 and 5 of this subject and provided this study with an environment in which to investigate aspects of the interaction and different experiences that male and female students have when working in a group. It was interesting in this study to see that firstly women did not seek out other women to work with in a team and said that this was not an issue for them. Men, however, said that they would seek out women to have in their team if there were more of them. Some male students meant this seriously and considered that women had different skills that would be useful in a team; others however suggested that having women in their group was a way of finding a girlfriend. Some male students were actually intimidated by their female peers and the competitive environment that they feel exists within some groups. Women saw this opportunity as a means of accessing the boys network and would work to obtain any advantages that they could gain from it.

Teamwork was reasonably popular among both male and female students as a means of reducing the workload. Many male students felt that they learnt less with this approach and did not see the benefits of teamwork in terms of their learning. This seemed to reduce their confidence and they did not fully appreciate the end result of a team effort. Most of the women appreciated the distribution of the burden that teamwork gave them and saw positive learning benefits out of the team approach. All students felt it was important that all team members contributed equally to a successful team, however it was not easy to evaluate what different team members contributions were. In particular, female students felt that their contributions were not valued to the same extent as that of the male students in the group. There was a substantial shift from students working in teams in assignment 4 to students working in teams in assignment 5. No students changed from working individually to working in a team, all the movement was in students opting out of teams to work on their own. This was particularly the case for women where there was a 20% change in female student numbers in teams (only 10% for male students).

Division of labour in teams along sexist lines has been identified in the literature where men typically manipulate equipment and women observe and take notes. This was less obvious in a computer classroom. Male students were noted to be more impatient to get on with writing code and would be more likely to be sitting at the computer terminal than a female student in the group. Generally the male student had logged on first and so the group huddled around them. This potentially comes back to the more cautious approach which women take in the initial stages of approaching problems generally being less likely to jump in and looking at the overall solution first.

6.3 Analysis Limitations

As in any research study there are limitations, which need to be recognised when interpreting the results and presenting the analysis. As an exploratory study, however, the limitations are determined to be within acceptable boundaries and the conclusions are significant in highlighting areas needing further study and analysis. Determining an appropriate number of participants is always of concern in these studies. The number of students involved with this study (136) was felt large enough to be confident that the breadth of opinions presented by this cohort of students would be representative of a 'standard' group of engineering students. The proportion of males to females in the study (10.3%) approximately reflects the proportion of women in engineering courses in Australia. This means therefore that there were only a small number of female students (14) involved in the study. This was counterbalanced to a certain extent by the fact that there was a more equal representation of both sexes in the focus group sessions.

The study was conducted in the context of a single second-semester first-year subject. This context has placed some limitations upon the conclusions of the analysis due to students still adapting to tertiary study conditions and therefore in many cases still out of their 'comfort zone' and therefore vulnerable to defensive perspectives on topics discussed. This defensive approach appears to be inflamed by the topic itself with the discuss on 'gender' differences being emotive. The subject in which the study was conducted introduced Mechanical, Civil, Surveying and Environmental Engineering students to computers and the writing of computer code which gave the study an additional dimension of gendered learning responses in the Information Technology area.

Presenting and analysing data in itself finds additional constraints in that trying to develop a framework in which to discuss and present the results requires some ordering and therefore partitioning of data which restricts to some extent the description of the complexity of the whole environment. Individual comments for example can span a number of important issues and their allocation to certain areas may therefore over simplify the interpretation. Also, the challenge of unraveling the 'truth' can be difficult, with individuals and groups covering up deeper feelings. Women in this environment will go out of their way to condone practices which they disagree with on a personal philosophical level. Thus contradictions found during the study need to be examined carefully. Some of these contradictions, however, will come about due to the broad range of opinions within a gender group, so interpretation is again critical.

6.4 Summary

This study's results have illustrated that engineering education from a student's perspective is not gender neutral despite being defended by both female and male students as being fair and equitable. It is important to note that there are strong influences beyond the classroom on students experience in the classroom and in particular the faculty culture itself. The engineering classroom has been shown to be dominated by a masculine culture that reflects and reinforces the male values, beliefs and practices. This marginalises the contribution of women by judging them on male terms by male standards. Without realizing it, women are adapting to this set of male values that in turn supports the masculine environment that currently exists. Thus gender is clearly a determinate of classroom experience in engineering with advantages and disadvantages for both genders being identified in this study.

Chapter 7 - Conclusion

Gender has clearly been highlighted as a determinant of students' experiences from a students' perspective in an engineering classroom. The differences found between male and female experiences need to take into account that student themselves evaluate their environment from a gender centric perspective and that their environment has been, up until very recently, primarily designed, development, and implemented by men. Women who have entered and remain in this environment have done so with preparedness for a non-traditional area and are themselves victims of their own circumstances struggling for acceptance and therefore unable or unprepared to challenge the status quo. The experiences for male students were not always positive and in fact male students can be considered victims themselves of the masculine environment. When viewing these results it is important to note that the male perspective has not been used as the norm and that identified advantages and equal treatment are taken in the sense of being appropriate different treatment rather that simply the same treatment.

One of the most significant factors that was established by this research was the determination by students not to engage in any topic related to gender. Students, both female and male felt that there were no inequities despite regular contradictions throughout the study. In fact they would espouse high ideals related to 'fairness' when it affected them personally but the connections were not made to gender 'fairness'. Students are therefore unable to challenge paradigms that reflected these gender topics and attitudes because they simply could not or would not see them.

The most noticeable differences between female and male student experiences found in this study stemmed from four factors: their previous experiences; their learning approaches; the language used within the classroom and the lack of role models. In these areas there was found to be various levels of advantage and disadvantage experienced by women and men.

The different classroom experiences which have arisen from previous knowledge and experiences relate partially to prior knowledge but also to the motivation and desire to want to be an engineer. The motivation and determination to succeed in engineering is considered here to be an extremely important ingredient for women to be successful as an engineering student yet it seems to add to the barriers that they create to survive in the environment. That is, having had to make a decision to go into a non-traditional area (which is not an easy decision), female students have entered the environment with a preparedness not only to cope with the masculine environment but to fit in, and therefore through their actions, condone the environment. The result is a system which can not find ways to change from within as there is too few voices who are seeking change.

Women's reasons for choosing engineering are actually not substantially different to men's. However, the pressures and unique conditions which women have had to deal with have meant that as a group they have a different mental resolve to male students in approaching their studies which, in general, is far more focused and prepared. Women who have chosen to do engineering have tended to be very strong in mathematics and science and have been less influenced by 'tinkering' and this, in fact, has advantaged them in the engineering course which remains strongly mathematically orientated. For male students this discrepancy between the more hands-on aspects of the course and the theoretical approach has tended to alienate them. It is interesting thus to find the ongoing dilemma for engineering education which struggles to find the right mix between the practice or professional aspects required to be an engineer and the theoretical scientific education which is its foundation and has a gender bias. This bias is also not what would be expected. Male students have focused more on the hands-on practical activities which they see are important for engineers while the female students' perspective is that they are happy to do the mathematics and science which is the love that led them into engineering. Literature has suggested that women prefer 'hands on' activities as a learning style [Philbin, 1995], but from this study it would seem that women choosing engineering felt more comfortable in the theoretical aspects of the course rather than the practical application of the subject, which in this case was the writing of computer code. It was found that female engineering students were generally uncomfortable with hands on activities in the laboratories and the computer classroom but these sessions were not frequent enough to seem to substantially hinder their academic progress. This is a unique feature to engineering classrooms.

Once in the environment, the major concern for women is the lack of encouragement. Female students are unable to gain on-going nourishment within an environment which lacks role models, uses non-inclusive language, contains masculine attitudes and values and has low expectation of their academic performance. This tends to exclude their contributions and renders them not only invisible but starved of encouragement and support. The learning styles and approaches to solving assignment problems, which female students preferred, were not present in the current teaching methodologies. This illustrates the marginalisation of women's perspectives and approaches in the current engineering classroom. On the other hand many male students flourish within the competitive atmosphere that is evident at the subject level yet this can also set up barriers to their learning that do not affect female students. This competitive 'macho' learning environment seemed to support a self-reliant approach to learning that creates a negative attitude that is 'us against them'. This, in turn, excludes a positive learning environment through lack of interactions such as not asking questions, despite individual students recognising the benefits in doing so.

Thus the influence of the faculty culture on students' experiences in the classroom was seen as substantial for both female and male students but for different reasons as summarised above. The factors associated with the influence of faculty culture in the classroom appear to highlight the major unique aspects of gender-based behaviour in engineering compared to what has been found in other non-traditional areas. These internal factors include language, curriculum content and learning approaches. Much of the uniqueness stems from the unfamiliarity of working with women both as staff and as students and thus they find themselves isolated as different in an overt manner.

As long as there remains a gendered perspective to engineering education there will remain a major impediment to more equitable participation of women and lower completion rates for men. Until there is more equitable participation in the engineering classroom allowing female and male students to equally achieve the two genders will need to receive different treatment for a successful outcome. Therefore, more flexible learning environments in engineering are essential to support this change.

7.1 Future Work

As an exploratory study this research has completed the first stage of investigation into the impact of gender on classroom experiences in engineering from a students' perspective. There is still need to do further work on this question on a broader range of subjects in engineering and also at different levels of the course as there maybe differences between discipline areas and / or year levels.

It would also be necessary to examine this question from an academic perspective as well as a course accreditation and quality assurance perspective to build a more comprehensive picture of gender differences within the whole engineering education environment.

From this study and any further studies undertaken in this area, there would also be a need to focus on methods of implementation of changes within the classroom and at faculty level to move towards a genderless classroom environment in engineering. More detailed studies into the areas of non-inclusive language, teacher behaviour, role of teamwork, curriculum content and learning styles in the engineering classroom would need to proceed to support this process of change.

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Appendix 1a

The UNIVERSITY of NEWCASTLE
AUSTRALIA

FACULTY OF ENGINEERING

Research Project on Students' Learning Experience in an Engineering Curriculum[1] (First year engineering subject)

This survey is to gather information on Student Learning Experiences in engineering. It is intended that the data collected will help identify areas in which students may be advantaged or disadvantaged in their learning experiences. The results will be used to inform, and shape the process of academic courses – for your benefit, the benefit of other students and for academic staff.

We value your opinions, whatever they may be. Each question allows you to comment and provide further information and examples, if you would like to do so. Space is also provided for more detailed general comments at the end of the survey, such as areas you think require greater attention.

All replies will be treated in strict confidence and the results used in aggregate form only.

Gunilla Burrowes
Coordinator: Diversity in Engineering Project
Room: EA G24
(P) 4921 6352

[1] This survey is based on one developed for Business Students at another Australian University, by Prof. C. Smith

Survey on Students' Learning Experience in an Engineering Curriculum

Your name is **NOT** required.

Please **TICK** the appropriate box.

Age: ❑ 17-19 ❑ 20-24 ❑ 25-29 ❑ 30-39 ❑ 40 +

Sex: ❑ female ❑ male

Course: ❑ Environmental ❑ Mechanical ❑ Surveying ❑ Civil ❑ Other

Status: ❑ full time ❑ part time

Student: ❑ International ❑ Australian

Are you attempting this subject for the first time? ❑ YES ❑ NO

1. What engineering exposure have you had prior to enrolling in your engineering course? (you may tick more than one response)

❑ Family connections

❑ Visit to an engineering site(s)

❑ Work experience

❑ Tinkered with mechanical equipment such as home appliances / motor vehicles / bicycles / etc.

❑ Built model toys such as planes / boats / trains etc.

❑ Built electronic equipment such as radios / speakers / Dick Smith kits etc.

❑ Implemented computer hardware changes

❑ Developed computer software programs

❑ Used computers as a tool for work including school work

❑ None

Others (please specify) ____

2. How would you rate the following subjects:

2.1	MATH 111 / 121	Difficult	Reasonable Difficult	Relatively Easy	Easy
2.2	CIVL 111	Difficult	Reasonable Difficult	Relatively Easy	Easy
2.3	MECH 111 / 121	Difficult	Reasonable Difficult	Relatively Easy	Easy
2.4	MECH 104	Difficult	Reasonable Difficult	Relatively Easy	Easy
2.5	ELEC 130 (if applicable)	Difficult	Reasonable Difficult	Relatively Easy	Easy

3. For study purposes, do you usually team up with someone:

	YES	NO
(a) of the same sex?	❑	❑
(b) of a similar age?	❑	❑
(c) of a similar background / experience	❑	❑

Any comments or reasons for your answers. ______________________

____

____

4. How often have you noticed the use of male/female specific language or examples:

	Never	Rarely	Often	Always
(a) in your prescribed texts?	❑	❑	❑	❑
(b) in your lectures?	❑	❑	❑	❑
(c) in your tutorials?	❑	❑	❑	❑
(d) in your laboratories?	❑	❑	❑	❑

4.1 Which gender does this language/example usually relate to:

Males ❑ Females ❑ Don't Know ❑

Comments ______________________________________

____

____

5. Does the use of male/female specific language or examples:

	YES	NO
(a) make you feel uncomfortable?	☐	☐
(b) hinder your learning?	☐	☐
(c) affect your assessment outcomes?	☐	☐
(d) prompt you to challenge this bias?	☐	☐

Comments ______________________________

____

____

6. Do you feel that a particular group of students is currently more <u>advantaged</u> through:

	Male	Female
(a) being heard in class?	☐	☐
(b) more assertive behaviour?	☐	☐
(c) being given more lecturer / tutor support?	☐	☐
(d) generous assessment marks?	☐	☐
(e) gender bias teaching?	☐	☐

Comments ______________________________

____

____

7. What are your current expectations of:

7.1	MECH 102	Difficult	Reasonably Difficult	Relatively Easy	Easy
7.2	Learning to use computers	Difficult	Reasonably Difficult	Relatively Easy	Easy
7.3	MECH 102 in terms of career importance	Relevant	Reasonably relevant	Not relevant	Don't Know

Please add any other comments you feel are relevant to this survey.

Thank you very much for taking the time to complete this survey. Its results will be available to you in due course.

If you are willing to take part in two focus group sessions (for about one hour in week 2 and 14 of this semester) in connection with this research project, please complete the details overleaf, and return to Gunilla Burrowes, EA G24 or the box marked "Students' Learning Experience Research" in the Foyer of the EA Building.
Thank you.

Appendix 1b

The UNIVERSITY of NEWCASTLE
AUSTRALIA

FACULTY OF ENGINEERING

Research Project on Students' Learning Experience in an Engineering Curriculum (MECH 102) Survey 2 1999

This survey is to gather information on Student Learning Experiences in engineering. It is intended that the data collected will help identify areas in which students may be advantaged or disadvantaged in their learning experiences. The results will be used to inform, and shape the process of academic courses – for your benefit, the benefit of other students and for academic staff.

We value your opinions, whatever they may be. Each question allows you to comment and provide further information and examples, if you would like to do so. Space is also provided for more detailed general comments at the end of the survey, such as areas you think require greater attention.

All replies will be treated in strict confidence and the results used in aggregate form only.

Gunilla Burrowes
Coordinator: Diversity in Engineering Project
Room: EA G24
(P) 4921 6352

Survey on Students' Learning Experience in an Engineering Curriculum

Your name is **NOT** required.

Please **TICK** the appropriate box.

Age: ❑ 17-19 ❑ 20-24 ❑ 25-29 ❑ 30-39 ❑ 40 +

Sex: ❑ female ❑ male

Course: ❑ Environmental ❑ Mechanical ❑ Surveying ❑ Civil ❑ Other

Status: ❑ full time ❑ part time

Student: ❑ International ❑ Australian

Is this the first time you have attempted MECH 102? ❑ YES ❑ NO

3. How would you rate the following subjects (answer those that are applicable):

1.1	MATH 112	Difficult	Reasonably Difficult	Relatively Easy	Easy
1.2	MATH 122	Difficult	Reasonably Difficult	Relatively Easy	Easy
1.3	CIVL 131	Difficult	Reasonably Difficult	Relatively Easy	Easy
1.4	MECH 111	Difficult	Reasonably Difficult	Relatively Easy	Easy
1.4	MECH 121	Difficult	Reasonably Difficult	Relatively Easy	Easy
1.6	MECH 102	Difficult	Reasonably Difficult	Relatively Easy	Easy

Comments (What factors do you believe make these subjects more or less difficult?)

____

____

____

2. What was your initial feeling about attempting MECH102?

very comfortable	comfortable	neutral	uncomfortable	very uncomfortable
❑	❑	❑	❑	❑

3. How do you currently feel about working with the material covered in MECH102?

very comfortable	comfortable	neutral	uncomfortable	very uncomfortable
❑	❑	❑	❑	❑

4. What factors have affected your progress in this subject? (you may tick more than one response)

❑ The aims and objectives of the subject were not made clear

❑ It wasn't clear what was expected of you

❑ Having had previous experience with computers made this subject easier

❑ The pace of the subject was too fast

❑ The course covered too many topics

❑ The problems that were set were too open ended

❑ There was not enough feedback on assignments

❑ Workload in this subject was too heavy

❑ Workload across the course was too heavy

❑ Had language difficulties

❑ Had problems outside the course

❑ Others (please specify) ____

____

____

5. How did you feel about attempting the assignments in MECH 102?

very comfortable	comfortable	neutral	uncomfortable	very uncomfortable
❑	❑	❑	❑	❑

6. When approaching the computer assignments in MECH 102, did you:

Order your response (1,2,3)

(a) start writing code? ❑

(b) spend time developing a program structure before writing any code ? ❑

(c) start by breaking the problem up into parts and solving each part before integrating the parts as a whole? ❑

Any comments or reasons for your answer. ______________________

____

____

7.0 For the 4th assignment, were you in a team?:

YES	NO
❑	❑

7.1 If you answered YES, did the team involvement benefit you? ____________

____

____

7.2 If you teamed up, how many were in your team?

2	3	4	more(pl specify)
❑	❑	❑	❑

7.3 If you teamed up, were your team members:

	YES	NO
(a) of a similar age to you?	❑	❑
(b) of a similar background or experience to you?	❑	❑

(c) of the same sex as you? ❑ ❑

8. For the final assignment, were you in a team?:

	YES	NO
	❑	❑

8.1 If you answered YES, did the team involvement benefit you? ____________

____

____

	2	3	4	more (pl. specify)
8.2 If you teamed up, how many were in your team?	❑	❑	❑	❑

8.3 If you teamed up, were your team members:

	YES	NO
(a) of a similar age to you?	❑	❑
(b) of a similar background or experience to you?	❑	❑
(c) of the same sex as you?	❑	❑

9. How confident do you feel in giving your technical opinion:

	Very Confident	Confident	Not Very Confident
(a) when working in teams?	❑	❑	❑
(b) during tutorial sessions?	❑	❑	❑
(c) during lectures?	❑	❑	❑

Any comments or reasons for your answers. ____________

____

____

10. When working in teams, have you experienced difficulties

	YES	NO
(a) in communication with other members of the team?	❑	❑
(b) in agreeing to a way of approaching the problem?	❑	❑

11. When working in teams, have you experienced difficulties with dominating behaviour by a student?

YES	NO
❑	❑

11.1 If you answered YES, what did you do in response to the dominating behaviour? (you may tick more than one response)

❑ Ignore their behaviour

❑ Give body language signals to communicate your disapproval

❑ Comment cautiously on their behaviour

❑ Tell them frankly to stop their behaviour

❑ Others (please specify) ______________________________

____

____

12. How easy did you find the following:

12.1	Learning to use computers	Difficult	Reasonably Difficult	Relatively Easy	Easy
12.2	Writing computer code	Difficult	Reasonably Difficult	Relatively Easy	Easy

Please add any other comments you feel are relevant to this survey.

Thank you very much for taking the time to complete this survey. Its results will be available to you in due course.

Appendix 2a

Survey 1 Raw Data

No.	Sex	Course	1	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j	1k	2.1	2.2	2.3	2.4	2.5
1	1	1	1		1										3	2	2		
2	1	1	1										1		3	2	2		
3	1	1	1										1		4	3	3		
4	1	1	1	1								1			4	1	2		
5	1	1	2		1										2	3	3		
6	1	2	1	1	1										2	2	3	2	2
7	1	2	2		1		1	1				1			2	3	3	3	2
8	1	2	1										1		3		2	3	1
9	1	2	1		1		1					1			2	2	2	2	2
10	1	2	1	1		1						1			2	2	3	4	1
11	1	4	1	1										1	4	4	3		
12	1	4	1		1										2	2	3		
13	1	4	1												2	3	2		
14	1	6	1				1	1							3	2	3		
1	2	2	2			1						1			2	3	4	4	
2	2	1	1					1	1	1		1			2	2	2		
3	2	4	1	1			1	1							3	2	3		
4	2	2	2				1							1	2	3	3	2	1
5	2	4		1	1		1	1	1						4	2	2		
6	2	1	1			1	1					1			3	2	2		
7	2	1	1		1	1	1	1			1	1			3	4	2		
8	2	4	1	1		1									2	3	2		
9	2	2	1		1	1	1	1	1			1			2	2	2	2	2
10	2	2		1	1		1	1		1		1			4	4	4	4	3
11	2	4	1				1	1	1						2	2	3		
12	2	2	1	1	1	1	1	1	1			1			1	2	3	2	1
13	2	2	1			1	1	1		1		1			2	2	3	3	1
14	2	1	1	1			1	1	1			1			3	3	2		
15	2	3	1		1	1	1			1		1			2	3			
16	2	4	1		1		1		1	1					1	3	3		
17	2	1	1	1	1	1	1					1			3	3	2		
18	2	2	1	1	1		1		1	1		1			2	3	4	2	2
19	2	2	1		1	1	1	1	1			1			3	2	4	3	1
20	2	2	1				1	1	1	1	1	1			1	2	4	4	2
21	2	3	1	1		1		1							3	2	2		

No.	Sex	Course	1	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j	1k	2.1	2.2	2.3	2.4	2.5
22			1			1		1							2	3	3		
23	2	3	1	1		1	1								1	2	2		
24	2	1				1	1	1							2	2	2		
25	2	2	1	1	1		1	1	1			1			2	3	3	3	1
26	2	4	1	1		1	1								2	2	2		
27	2	4	1		1							1			2	2	2		
28	2	4	1	1	1	1		1				1			2	2	2		
29	2	1	1				1	1				1			2	1	1		
30	2	4	1										1		2	2	2		
31	2	4	1		1	1	1	1				1			2	2	2		
32	2	2	1		1	1	1	1	1			1			2				
33	2	4	1	1			1	1	1			1			2	2	2		
34	2	2	1				1		1			1			3	3	4	4	1
35	2	4			1	1	1	1							2	2	2		
36	2	2	1		1		1					1			4	2	4	4	
37	2	2	1	1			1	1							1				
38	2	2		1		1	1	1							2	3	2	3	1
39	2	2	1	1	1	1	1		1			1			2	3	4	3	1
40	2	4	1				1					1			3	3	2		
41	2	4	1				1	1							2	2	3		
42	2	2	1										1		3	2	3	3	2
43	2	2	1		1	1	1			1		1							2
44	2	4	1			1		1							3	2	3		
45	2	2	1	1			1	1				1			2	3	3	3	1
46	2	2	1	1	1		1	1							3	2	2	3	1
47	2	2	1		1	1	1	1	1			1			3	2	3	3	1
48	2	3	1	1		1	1	1				1			3	3	3		
49	2	2	1		1														
50	2	4				1	1	1	1	1		1			3	2	2		
51	2	3	1				1	1				1		1	1	2	3		
52	2	4	1				1		1			1			2	3	3		
53	2	3	1	1			1	1	1			1			3	1	3		
54	2	4	2								1	1			3	3	4		
55	2	4	1					1							3	3	3		
56	2	2	1			1	1					1			2	3	4	3	1
57	2	1	1									1			3	1	2		
58	2	1	1				1	1		1	1	1	1		4	2	3		
59	2	2	1				1	1	1	1		1			2	3	3	3	1
60	2	2	1			1									3	4	4	3	1
61	2	4	1			1	1							1	2	1	3		
62	2	4	2			1	1	1	1						2	3			
63	2	2	1		1	1	1					1			3		4		3
64	2	2	1	1	1	1	1	1	1	1		1			3	4	3	3	1
65	2	4	1				1	1	1	1	1	1			3	2	3		

No.	Sex	Course	1	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j	1k	2.1	2.2	2.3	2.4	2.5
66	2	1	1	1	1	1	1					1			3	2	3		
67	2	3	1		1	1				1		1			1	2	2		
68	2	5	1				1	1		1		1			3	2	4	3	
69	2	2	1				1												3
70	2	2	1	1	1	1	1	1	1	1		1			3	3	3	3	2
71	2	1	1	1	1	1	1								2	3			
72	2	2	1	1	1	1	1	1	1	1	1	1		1					
73	2	2	1	1	1	1	1	1		1		1							
74	2	3	1				1	1	1	1	1	1			2	4	4		
75	2	2	1					1				1			4	3	3	3	1
76	2	2	1			1	1	1	1			1			3	3	4	3	1
77	2	2	1	1	1		1	1	1						3	3	4	4	2
78	2	2	1	1			1		1	1		1			2	3		3	1
79	2	3	1			1				1		1			3	4	4		
80	2	2	1				1	1	1	1	1	1							
81	2	2	1	1	1	1	1	1	1			1			2	3	3	4	1
82	2	4	1	1	1										1	2	2	1	
83	2	3	1			1								1	2	4	2		
84	2	4	1	1				1							3	3	4		
85	2	4	1					1				1			4	3	3		
86	2	4	1	1	1	1	1							1	2	3	3		
87	2	3	1	1	1	1	1	1				1			2	2	4		
88	2	1		1				1			1	1		1	2	3	2		
89	2	3	1			1	1	1				1			3	3	3		
90	2	4	1				1								1	3	3		
91	2	5	2			1	1											3	1
92	2	4	1	1			1								2	2	3		
93	2	3	1			1						1			3	4	2	3	
94	2	4	1		1	1						1			2	3	2		
95	2	2	1	1			1												
96	2	3	1			1									1	2	3		
97	2	3	1	1	1		1	1	1	1		1			2	2	3		
98	2	3	1				1	1				1			2	2	2		
99	2	5	1	1						1	1	1			4	3	2		
100	2	4	1				1	1	1			1			2	2	4		
101	2	3	2	1	1	1		1							3	3	3		
102	2	4	1	1											2	3	2		
103	2	4	1	1											2	3	2		
104	2	3	1	1											1	2			
105	2	5	1	1	1	1	1	1	1			1			3	2	3		
106	2	3,4	1	1				1							2	2	1		
107	2	1	1	1											1	3	1		
108	2	4	1	1	1	1	1	1	1			1			2	3	3		
109	2	1	1		1	1						1			3	2	2		

No.	Sex	Course	1	1a	1b	1c	1d	1e	1f	1g	1h	1i	1j	1k	2.1	2.2	2.3	2.4	2.5
110	2	1	1	1		1		1	1			1			4	4	4		
111	2	3	1											1	2	3	4	4	4
112	2	4	1	1	1		1	1	1	1		1			4	4	4		
113	2	2	1				1	1	1	1		1			3	4	4	3	2
114	2	1	1	1			1	1	1	1	1	1			2	1	2		
115	2	3	1											1	1	3	4	4	4
116	2	2	1	1	1		1	1	1	1		1			3	3	3	2	2
117	2	4	1	1											2	3	3		
118	2	4	1	1		1		1							3	4	4		
119	2	2	1		1	1			1			1			2			3	1
120	2	4			1	1	1					1			2	2	2	2	
121	2	4	1	1	1	1	1	1	1			1			2	2	3		
122	2	4	1	1			1								2	2	2		
123	2	1	1		1		1								3	3	3		

Data Continues …

No.	3a	3b	3c	4a	4b	4c	4d	4.1	5a	5b	5c	5d	6a	6b	6c	6d	6e	7.1	7.2	7.3
1	2	2	2	1	1	1	1		2	2	2	2						2	2	1
2	2	1	1	1	1	1	1		2	2	2	2						1	2	2
3	2	1	2	1	1	1	1	3	2	2	2	2						2	3	2
4	2	1		2	3	2	2	1	2	2	2	2						2	3	2
5	2	2	1	3	3	3	3	1	2	2	2	1	1	1				2	2	3
6	2	1	2	2	3	2	2	1	2	2	2	1	2	1	1	1	1	1	2	1
7	1	1	2	3	3	3	3	1,2	2	2	2	2						1	2	2
8	2	1	1	1	1	1	1		2	2	2	2						1	2	1
9	2	1	2	2	3	3	3	1	2	2	2	2		1				2	2	1
10	2	2	2	2	2	2	2	3	2	2	2	2						2	2	2
11	2	2	2	1	2	1	1	1	2	2	2	1						1	2	3
12	2	2	1	2	3	2	1	1	2	2	2	1	2	1	2	2	1	1	2	1
13	2	2	2	2	2	2	2	1	2	2	2	2						2	2	2
14	2	1	1	1	2	2	2	1	2	2	2	2	1	1	1	1	1	3	2	4

No.	3a	3b	3c	4a	4b	4c	4d	4.1	5a	5b	5c	5d	6a	6b	6c	6d	6e	7.1	7.2	7.3
1	1			1	2	2	2	2	2	2	2	2	1	1	2			1	1	1
2	1	1	1	4	4	4	4	1	2	2	2	2						1	1	1
3	2	2	2	1	2	2	2	2	2	2	2	2	1	2	2	2	1	2	1	1
4	2	2	2	1	2	2	2	1	1	2	2	2		1				1	2	1
5	1	1	1	1	1	1	1	3	2	2	2	2						2	2	1
6	2	2	2	1	1	1	1	3	2	2	2	2						2	2	1
7	2	2	2	1	1	1	1		2	2	2	2						2	2	1
8	1	1	2	2	2	2	2	1	2	2	2	2						2	2	1
9	2	1	2	2	2	2	2	3	2	2	2	2						2	2	1
10				2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	1
11	2	2	2	2	3	2	2	1	2	2	2	2	2	2	2			2	2	1
12	1	1	1	1	1	1	1	3	2	2	2	2						2	3	1
13	1	1	1	1	2	1	1	2	2	2	2	1						2	3	1
14	1	1	2	1	2	1	1	1	2	2	2	1	1	2	2	1	2	2	3	1
15	1	1	1	2	2	2	2	3	2	2	2	2						2	3	1
16	1	1		2	2	2	2		2	2	2	2						2	3	1
17	1	1	1	1	3	3	3	1	2	2	2	2	1	1	1		1	2	3	1
18	1	1		1	1	1	1		2	2	2	2						3	3	1
19	1	1	1	1	1	1	1											2	4	1
20	1	1	1	2	3	1	1	1	2	2	2	2	1	1	2	2	2	4	4	1
21	1	1	1	2	2	2	2	1	2	2	2	2						1	1	2
22	1	1	1	1	1	1	1	3	2	2	2	2						2	1	2
23	2	1	2	1	2	1	2	1	2	2	2	2		2				2	1	2
24	1	1	1	1	1	1	1	1	2	2	2	2						1	2	2
25	1	1	1	2	2	2	2	1	2	2	2	2						1	2	2
26	1	1	1	2	2	2	2	3	2	2	2	2	1,2	2			1,2	1	2	2
27	1	1	1	2	2	2	2	3	2	2	2	2	1	1	2	2	2	1	2	2
28	1	1	1	2	2	2	2	3	2	2	2	2						1	2	2
29	2	1	1	2	2	2	2	3	2	2	2	2						1	2	2
30	2	2	1	2	2	2	2	3	2	2	2	2	1	1	2	2	2	1	2	2
31	1	1	1	3	3	3	3	1	2	2	2	2	2	1	2	2	2	1	2	2
32				1	2			3	2	2	2	2						1	2	2
33	1	1	1	1	1	1	1	3	2	2	2	2						2	2	2
34	2	2	2	1	1	1	1	3	2	2	2	2			2		2	2	2	2
35	2	2	2	1	1	1	1		2	2	2	2						2	2	2
36			1	1	2	1	1	3	2	2	2	2						2	2	2
37	2	2	2	2	2	1	2	1	1	2	2	1		2				2	2	2
38	2	1	1	1	1	2	2	2		2	2	2						2	2	2
39	1,2	1,2	1,2	1	2	2	2	2	3	2	2	2	2					2	2	2
40	1	1	1	2	2	2	2	1	1	1	1	1	1	1	1			2	2	2
41	1	1	1	2	2	2	2	3	2	2	2	2	1	1	2	1	2	2	2	2
42	2	1	1	2	2	2	2	3	2	2	2	2						2	2	2
43	1	2	2	2	2	2	2	1	2	2	2	2						2	2	2
44	1	1	1	2	3	2	2	1	2	2	2	2						2	2	2

No.	3a	3b	3c	4a	4b	4c	4d	4.1	5a	5b	5c	5d	6a	6b	6c	6d	6e	7.1	7.2	7.3
45	1	1	1	2	3	3	3	1	2	2	2	2						2	2	2
46	2	2	2	3	3	3	3	1	2	2	2	2	1	1	1	1	1	2	2	2
47	2	2	2	3	3	3	3	1	2	2	2	2	1	1	1	1	1	2	2	2
48	1	1	1	1	2	2	2	1	2	2	2	2	1	1	2		2	3	2	2
49	1	1	1	2	2	2	2	2	2	2	2	2						1	3	2
50	1	1	1	1	1	1	1	3	2	2	2	2						2	3	2
51	1	1	2	1	1	1	1	3	2	2	2	2						2	3	2
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53	2	2	1	1	2	1	1	1	2	2	2	2		1				2	3	2
54	1	1	1	1	2	2	1	3	2	2	2	2		1				2	3	2
55	2	2	2	1	2	2	1	3	2	2	2	2						2	3	2
56	1	1	1	2	2	2	1	2	2	2	2	2						2	3	2
57	2	1		2	2	2	1	1	2	2	2	2						2	3	2
58	1	1	1	4	4	4	1	3	1	1	1	1	2	2	2	2	2	2	3	2
59	2	2	2	1	1	2	2	2	2	2	2	2	1				1	2	3	2
60	1	1	1	1	2	2	2	1	2	2	2	2			2		2	2	3	2
61	1	1	1	2	2	2	2	3	2	2	2			1				2	3	2
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65	1	1	1	3	2	2	2	1	2	2	2	2						2	3	2
66	2	2	2	3	2	2	2	1	2	2	2	2						2	3	2
67	1	1	1	3	3	2	2	1	2	2	2	2						2	3	2
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69			1	1	2	3	3	3	1						1			2	3	2
70				3	3	3	3	1	2	2	2	2						2	3	2
71									2	2	2	2						2	3	2
72	2	2	1	1	1	1	1		2	2	2	2						3	3	2
73	1	1	1	3	3	3	3		2	2	2	2						3	3	2
74	1	1	1	2	2	2	2	3	2	2	2	2						4	3	2
75	1	1	1	1	1	1	1		2	2	2	2						3	4	2
76	2	2	2	1	1	1	1		2	2	2	2						3	4	2
77	2	2	2	1	2	2	1	1	2	2	2	2						3	4	2
78	1	1	1	2	2	2	2	3	2	2	2	2						3	4	2
79	1	1	1	3	2	2	2	1	2	2	2	2						3	4	2
80	2	2	2	2	2			1	2	2	2	2						3	4	2
81	1	1	1	1	1	1	1	3	2	2	2	2						4	4	2
82	2	2	2	1	1	1	1	3	2	2	2	2						1	1	3
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84	2	2	2	1	2	1	2	1	2	2	2	2	1	1				2	2	3
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86	1	1		2	2	2	2	1	2	2	2	2						2	2	3
87	2	1	1	3	3	3	3	3	1	1	1	1	2	2	2	2	2	2	2	3
88		1	1	2	2	2	2	1	2	2	1	2	1	1	2	2	2	1	3	3

No.	3a	3b	3c	4a	4b	4c	4d	4.1	5a	5b	5c	5d	6a	6b	6c	6d	6e	7.1	7.2	7.3
89	1	2	1	2	3	2	2	1	2	2	2	2	1					1	3	3
90	2	2	2	1	1	1	1	3	2	2	2	2						2	3	3
91	2	2	2	1	1	1	1	3	1	1	1	1						2	3	3
92	1	1	1	2	2	2	1	1	2	2	2	2						2	3	3
93	2	2	1	2	2	2	2	1	2	2	2	2	1	1	2	2	1	2	3	3
94	2	2	2	2	2	2	2	1	2	2	2	2						2	3	3
95	1	1	1	1	1	1	1		2	2	2	2			2	2		3	3	3
96	2			1	1	1	1	3	2	2	2	2						3	3	3
97	1	1			1	1	1	1	3		2	2	2	2			2	3	3	3
98	2	2	2	2	2	2	2	1	2	2	2	2						3	3	3
99	2	2	2	1	2	2	2	1	2	2	2	2	1	1	2			2	4	3
100	2	1	1	3	2	1	3	1	2	2	2	2	2	1	2	2	2	2	4	3
101	1	1	1	2	2	2	2	3	2	2	2	2	1	2	1,2	1,2	1,2	2	2	4
102		1	1	2	2	2	2	3	2	2	2	2						2	2	4
103		1	1	2	2	2	2	3	2	2	2	2						2	2	4
104	2	2	2	2	2	2	2	3	2	2	2	2						2	2	4
105	2	2	2	1	1	1	1		2	2	2	2			2				2	4
106	1	1	1	1	2	1	1	3	2	2	2	2						1	3	4
107	2	2	2	1	1	1	1	3	2	2	2	2	2	1	2	2	2	2	3	4
108	2	2	2	1	2	2	2	3	2	2	2	2						2	4	4
109	2	2	2	1	1	1	1		2	2	2	2	1	1	2	2		3	4	4
110	2	2	2	1	1	1	1	3	2	2	2	2	2	2	2	2	2	3	4	4
111				1	1	1	1	3	2	2	2	2						3	4	4
112	2	2	2	2	2	2	2	3	2	2	2	2	1	1	2	2	1	3	4	4
113	1	1	1	3	3	2	2	2	2	2	2	2	1	1	2	2	2	3	4	4
114	1	1	1	2	2	1	3	2	2	2	2	1	1					3	4	4
115				1	2	3	4	3	2	2	2	2	1	2	1	2	1	3	4	4
116	2	1	2	2	2	2	2	3	1	2	1	2	1	2		2	2	4	4	4
117	1	1	1	1	2	1	1	3	2	2	2	2							2	
118	1	1	1	2	2	2	2	3	2	2	2	2		1	2				3	
119	1	1	1	1	1	1	1	1	2	2	2			1		2	3	1		
120	2	1	1	1	2	2	2	1	1	2	2	1	2	2						
121	1	1	1	2	2	2	2	1	2	2	2	2		1						
122	2	2	2	2	2	2	2	1	2	2	2	2								
123	1	1	1					1	2	2	2	2	1	1	2					

Comments

Survey 1	MECH102	Q3
Most people I know who study these subjects fall into these categories		
Usually team up with someone I get along with.		
Like to work on my own.		
Sadly male dominated, not many females to work with, also mostly similar age (wish it was different). Tend to like to be with different people with difference interests.		
I don't really team up with anyone.		
Not always sure sex, but mostly.		
Studying with others can only work if we are on the same (approx.) intelligence level.		
Usually study alone.		
I study alone.		
Varies depending on subject though mainly study by myself.		
Doesn't really matter		
Just starting course, do not know anyone, so by myself.		
I haven't met any female Mech. Engineers		
Mature age so work with students who are enthusiastic.		
Study alone		
Don't aim for same age or sex but same experience.		
Does vary, occasionally work with older people and of opposite sex.		
Not a great deal of study so far.		
Live in the same house.		
I study best in my own time at my own pace. If I study at all.		
Only people available.		
Most people I have studied with just happened to be these, I did not seek them out.		
I prefer to work alone.		
It is because the majority of people in the course are young mechanically minded males.		
I don't team up to study.		
I usually study by myself.		
I study better by myself usually.		
Friends I can handle studying with and study as much as I do.		
They are a friend.		
I always study alone.		

Survey 1	MECH102	Q4.1
Give the feminism a rest, will you.		
It can't be helped. The majority of classes are made up of males anyway.		
Very 'Engineering'.		
About 50/50 Male/Female. Gender specific examples are rather irrelevant to the focus of the examples.		
It is not really an issue if you don't let it be one.		
I really don't give a crap I'm here to learn, no analyse whether the language is male or female. Get a life.		
Seems very even to me.		
Don't think in those terms, don't care.		
It is hard to break the stereotype that the 'engineer' is male.		
Doesn't bother anyone		
I don't make a differentiation, I don't think its relevant to my study.		
Seems to make them feel more acceptable. It gives me the shits.		
Both male and female experience this language.		
Being a female in a 'male-dominated' field, brings various anomalies to my attention on a regular basis.		
That's whinging.		
What has this got to do with anything.		
In the context that they are completely unable to understand.		
Mostly males are referred to but I don't think this is deliberate or has any bearing on my education or someone of opposite sex.		
This is not an issue.		

Survey 1	MECH102	Q5
Depending on the context. (a)		
Does the gender really matter? I don't think it does academically speaking (or professionally)		
I am a female and I don't really see it as an issue.		
As long as I can understand it I don't care.		
Doesn't bother me, can't understand why it would.		
I think this is trivial, only an aspect with engineering is physical strength and there is plenty of ways around this.		
It I was female I would probably challenge the bias, but the language usually assumes male. It if were to assume female most of the time I certainly would challenge it.		
Occasionally a female will be given greater attention but they usually work harder in any case.		

As if it matters, as long as they don't go overboard. It's usually just a slip of the tongue.
I challenge the bias by not partaking in it.
Changing the name of things like manhole cover to say people cover and many other various things, especially equal us of different sex in work place's make me sick, its all just a waste of time.
Capable of challenging the views or opinions expressed by the person.
Irrelevant to everything. Why am I wasting my time with this.
No, what a ridiculous question.
(a) I merely feel this unfair.

Survey 1	MECH102	Q6
No		
It really doesn't make any difference. Marks I feel are awarded according to how well you did and not by your gender.		
I think that males and females are on equal footing and are in my experience treated as such.		
No		
No		
Illiterate people are more advantaged as they don't have to fill out shit like this.		
No		
Not relevant		
I feel that males and females receive an equal amount of attention and support in all subjects.		
I think it would be hard to have a group of students more advantaged due to class sizes being greater than 100.		
The fact that gender equality is now a major issue in society, and leaders are trying to break down stereotypes, particularly in engineering, tutors/lecturers seem to be more sensitive to the needs of females.		
Don't know, haven't seem sufficient to comment		
I think neither sex is advantaged.		
Males are discriminated against and females are worshipped.		
I don't feel there is a major advantage to either.		
Advantage is only gained by students working hard on the subject.		
Do we have to pick any? I haven't noticed any of these.		
I can't see any bias.		
I feel it is relatively equal, unlike other levels of schooling.		
Classes are generally highly populated by males yet females still receive attention it they ask.		

Not applicable. Each student is given fair support.
No, everyone has equal opportunity.
Your wasting your time.
Seems teachers think females need more help.
It may seem sexist, but as most lecturers are male, female students are generally treated better.
I don't feel anyone is advantaged in most environments.
Everybody should receive equal attention. Very few female lecturers.
This is a joke. As far as we see everyone has a fair chance.
I don't think there are any bias examples either male or female.

Survey 1	MECH102	Other Comments
With regards to inequality between genders you may be reading into it a little too far. Also, I think you are pushing a bit hard to express your obvious feminist motives, to the point of jeopardising your dignity.		
This survey is a waste of our time. We pay our HECS fees to learn not fill out shit for you so you can look good because you have done some research. Since this survey is about students learning experiences. This is what pisses me off: Non English speaking lecturers who have accents, lecturers who don't turn up on time, lecturers who ramble on with shit, the lack of available parking, lecturers who assume we know everything, this entire university in general and lecturers who have no time for you and who offer no assistance.		
I find computers difficult due to exposure late in life. FORTRAN 90 is repeatedly an obsolete program. Uni computers are too slow, tutor assistance is difficult to obtain due to uni cutbacks. Having arrived from industry, computer skills are jealously guarded within the workforce due to ambition and threat of unemployment. Most computer dealers are at least rapacious if not dishonest. All this gives computers an image of: "must be able to handle", "far too expensive", "lookout for crook dealers" and "network with your mates to survive". MECH102 is difficult and frustrating, inadequate tutor help and of no immediate apparent benefit. MECH205 is even more unpopular. MECH205 is the 2nd most dreaded subject in mechanical after MECH372 (Fluids 2)		
Overall I rate this survey as quite irrelevant and a bit of a waste of time. Although I can see that Gunilla is obviously spending a lot of time on this. Although I do think David Wood is a champion. Stni does not rate him and I can't for the life of me see why not.		
I am a little confused as to what some of the questions are trying to ask, or what points are trying to be assessed.		
Some tutors are biased on who they want to help. I found that I've been ignored		

quite often. Their part of the contract is to give everyone equal opportunity to learn. I would like to see this improve.
The reason some questions have been left unanswered is because this is my first week at University.
Don't hide your feministic outlooks. This just seems as an attempt to have a go at women's rights. The only advantage of chicks being in engineering is that it keeps me occupied.
We need more time to let lectures help us understand what we are doing and how it helps us in our chosen profession.

Appendix 2b

Survey 2 Raw Data

No.	Age	Sex	Course	Status	Student	1st Time	1.1	1.2	1.3	1.4	1.5	1.6	2	3
1	1	1	1	1	2		3				3	2	3	2
2	1	1	1	1	2	1	3		1		2	3	3	3
3	1	1	1	1	2	1	3				3	1	4	3
4	1	1	1	1	2		2		1			1	4	4
5	1	1	4	1	1	1	3		2	3	2	1	3	4
6	2	1	1	1	2	2	2		1		2	1	4	4
7	2	1	2	1	2	1	2					1	3	4
8	2	1	4	1	2	1	2		1	3	2	1	4	4
9	2	1	3,4	1	2			2	2	3	3	1	4	5
10	4	1	4	1	2	1	2		2	3	2	2	5	2
1	1	2	2	1	2		2			3	2	1	3	3
2	1	2	1	1	2	1	2		2	3	3	1	5	4
3	1	2	2	1	2	1	2			3	2	2	3	2
4	1	2	2	1	2		2			3	2	2	2	4
5	1	2	2	1	2	1	3			4	2	1	2	3
6	1	2	2	1	2	1	2			3	2	1	4	4
7	1	2	2	1	2		2			3	3	1	2	3
8	1	2	3	1	2	1	2	2	2		2	1	4	4
9	1	2	4	1	2	1	3		1	3	3	1	4	4
10	1	2	4	1	2	1	3		2	4	2	2	2	3
11	1	2	4	1	2	1	3		2	4	3	2	3	2
12	1	2	5	1	1	2	4	4		4	1	1	5	5
13	1	2	5	1	2	1	2		2	2	2	1	4	4
14	1	2	1,4	1	2	1	2	1	2	4		4	4	3
15	2	2	2	1	1	1							4	2
16	2	2	3	2	2	1	3				2	2	4	3
17	2	2	4	1	2	1	3		2	3	2	1	2	5
18	2	2	4	1	2	2	3	3	3	3	3	2	3	2
19	3	2	3	1	2	1	2	3	2	4	4	1	5	3
20	3	2	3	2	2	1	2	2	1	2	2	2	4	4
21	4	2	1	2	2	1	2	2	2	2	3	1	4	5
22	5	2	1	1	2	1			2	2	3	2	3	2
23	1	2	1	1	2	1	3		3	4	1	1	5	5
24	1	2	1	1	2	1	2		1		2	1	4	4
25	1	2	1	1	2	1	3		2	2	2	1	4	4
26	1	2	1	1	2	1	1		1		1	1	5	5
27	1	2	1	1	2	1	3	2	2	3	1	1	4	5
28	1	2	1	1	2	1	2		2		2	1	2	4
29	1	2	1	1	2		2		1		3	1	4	3
30	1	2	1	1	2	1	3		2		3	1	5	5
31	1	2	2	1	2		2			4	3	1	4	4

No.	Age	Sex	Course	Status	Student	1st Time	1.1	1.2	1.3	1.4	1.5	1.6	2	3
32	1	2	2	1	2	1	2			2	1	1	3	4
33	1	2	2	1	2		2				2	1	4	5
34	1	2	2	1	2	1	1				2	1	3	2
35	1	2	2	1	2	1	2				2	1	4	4
36	1	2	2	1	2	1	1			4	3	1	2	5
37	1	2	2	1	2	1	2			3	2	2	4	4
38	1	2	2	1	2		1				3	1	5	5
39	1	2	2	1	2	1	2			4	2	1	3	5
40	1	2	2	1	2	1	2			3	2	1	4	2
41	1	2	2	1	2	1	3			3	2	1	3	2
42	1	2	2	1	2	1	1			3	3	1	4	4
43	1	2	2	1	2	1		2		3		1	2	4
44	1	2	2	1	2	1		3		3		2	2	3
45	1	2	3	1	2	1	2		2	3	3	1	5	5
46	1	2	3	1	2	1	2		1	3	2	1	2	4
47	1	2	3	1	2	1	2		1	2	3	1	4	4
48	1	2	3	1	2	1	2		1		2	1	5	4
49	1	2	3	1	2	1	3		2	4	2	1	4	4
50	1	2	3	2	2	1	3		2	4	2	1	4	4
51	1	2	4	1	2	1	2		1	4	1	1	3	5
52	1	2	4	1	2		1		2	3	2	1	4	5
53	1	2	4	1	2	1	2		3	4	3	2	1	4
54	1	2	4	1	2	1	2		2		3	1	4	4
55	1	2	4	1	2	1	2		1	2	2	1	4	3
56	1	2	4	1	2	1	2		1	2	2	1	3	4
57	1	2	4	1	2	1	3		1	3	2	1	3	5
58	1	2	4	1	2	1	2		1	3	3	1	3	3
59	1	2	4	1	2	1	2		1	3	2	1	2	5
60	1	2	4	1	2	1	2		1	3	2	1	3	4
61	1	2	4	1	2	1	2		2	3	2	1	4	5
62	1	2	4	1	2		2		1	3	2	1	5	5
63	1	2	4	1	2	1	2		1	2	1	1	4	5
64	1	2	4	1	2	1	3		1	3	3	1	4	5
65	1	2	4	1	2	1	2		3	3	2	2	3	4
66	1	2	4	1	2	1	3		1	4	3	3	1	2
67	1	2	4	1	2	1	1		2	3	4	1	2	5
68	1	2	4	1	2	1		2	1	2	3	1	5	5
69	1	2	4	1	2		2		2	3	3	3	2	2
70	1	2	4	1	2	1	2	2	2	2	2	2	3	3
71	1	2	4	1	2	1	2		1		3	1	5	5
72	1	2	4	1	2	1	2		1	4	2	1	1	5
73	1	2	4	1	2	1	2	2	2	2	1	5	4	
74	1	2	4	1	2	1	4	4	1			2	2	4
75	1	2	4	1	2	1	2		1	3	1	1	5	5
76	1	2	4	1	2		4		3	4	2	1	5	5
77	1	2	5	1	2	1	4		3	4	2	1	4	4
78	1	2	5	1	2	1	3		2	3	2	2	2	3
79	2	2	1	1	2	1	3		1		3	2	3	2

No.	Age	Sex	Course	Status	Student	1st Time	1.1	1.2	1.3	1.4	1.5	1.6	2	3
80	2	2	2	1	2	2						2	3	2
81	2	2	2	1	2	1	2					1	2	4
82	2	2	2	1	2	1	2			4		2	2	4
83	2	2	3	1	2	1	3		2		2	1	4	4
84	2	2	3	1	2	1	2		2		3	2	3	4
85	2	2	4	1	1	1	2		1	2	2	1	4	4
86	2	2	4	1	2	2	2	2	3	4		1	3	4
87	2	2	4	1	2	1	2		2	3	3	1	5	4
88	3	2	4	2	-1	1						2	2	2
89	1	2	1	1	2	1	2		1	3		2		
90	1	2	2	1	2	1	2	2			3	1	4	4
91	1	2	2	1	2	1	2			3	3	2	2	3
92	2	2	2	1	2	1					3	2	4	4
93	2	2	4	1	2	2	3	2	3	4		2	4	3
94	4	2	4	2	2	1						2	2	3

Data Continues …

No.	Sex	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	4k	5	6a	6b	6c	7	7.2	7.3.a	7.3.b	7.3.c	8	8.2	8.3.a	8.3.b	8.3.c
1	1			1									2	3	1	2	2					2				
2	1												3	3	1	2	1	1	1	1	2	1	1	1	1	2
3	1												4	3	1	2	2					2				
4	1	1			1		1			1			4	3	1	2	1	4	1	1	2	2				
5	1				1			1					3	3	1	2	1	1	1	1	1	2	2	1	1	2
6	1					1		1					4	3	2	1	2					2				
7	1				1			1	1				4	3	1	2	1	2	2	2	2	1	2	2	2	1
8	1			1			1	1	1	1			3	1	2	3	1	2	2	2	3	1	2	1	1	2
9	1			1				1					4				1	1	1	1	2	1	1	1	1	2
10	1	1			1						1		3	3	1	2	2					2				
1	2	1						1					4	1	2	3	2					2				
2	2	1			1			1	1	1			4	3	1	2	1	4	1	2	2	1	3	1	2	1
3	2			1									2	3	2	1	1	4	1	1	1	1	4	1	1	1
4	2				1			1					3	3	2	1	1	1	1	1	1	1	1	1	1	1
5	2				1			1					2		1	1	1	3	1	1	1	1	3	1	1	1
6	2		1		1		1	1	1				4	3	2	1	1	4	1	1	1	1	4	1	1	1
7	2				1			1					2	3	2	1	1	1	1	1	1	1	1	1	1	1
8	2				1			1	1				4	3	2	1	1	2	1	1	1		2	1	1	1
9	2			1	1	1				1			4	2	1	3	2					1	3	1	1	1

No.	Sex	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	4k	5	6a	6b	6c	7	7.2	7.3.a	7.3.b	7.3.c	8	8.2	8.3.a	8.3.b	8.3.c
10	2								1				3	3	2	1	1	1	1	1	1	1	3	1	1	1
11	2			1				1					2	3	1	2	1	1	1	2	1	1	3	1	2	1
12	2				1		1				1	1	5	3	2	1	1	4	1	1	2	1	4	1	1	2
13	2				1			1					4	1	3	2	1	4	1	1	2	1	2	1	1	1
14	2									1			5				1	2	1	1	1	1	3	1	1	1
15	2										1		3	2	1	3	2	2	2	1	2	2	2	2	1	2
16	2			1		1		1					3		1	1	2					2				
17	2	1	1	1	1	1		1			1		5	3	2	1	1	2	1	1	1	1	3	1	1	1
18	2				1								2	3	2	1	2					2				
19	2		1		1		1	1		1			3	3	2	1	1	1	1	1	1	1	1	1	1	1
20	2		1		1		1		1	1			3	3	2	1	1	1	1	1	1	1	1	1	1	1
21	2		1										5	3	2	1	2	2	2	2	1	2	2	2	2	1
22	2						1						2	2	3	1	2					2				
23	2	1			1	1	1		1				3	1	3	2	1	2	1	1	1	2				
24	2				1	1		1					3	3	1	2	1	4	1	1	2	2				
25	2	1	1	1	1		1	1					3	1	3	2	1	1	1	1	1	1	1	1	1	1
26	2	1			1			1					5		1		1	2	1	1	1					
27	2		1		1			1					5	1	2	3	1	2	1	1	1	1	2	1	1	1
28	2				1			1					4	1	3	2	2					2				
29	2	1	1			1		1		1			3	2	3	1	2					2				
30	2		1		1	1		1	1		1		5	2	3	1	1	2	1	2	1	2				
31	2												4	1	3	2	1	3	1	2	1	2				
32	2				1								4				1	4	1	1	1	1	4	1	1	1
33	2	1			1			1	1		1		4	3	1	2	2					2				
34	2							1				1	2	3	2	1	1	4	1	1	1	1	4	1	1	1
35	2	1			1	1							3	2	1	3	1	3	1	1	1	1	3	1	1	1
36	2				1		1	1	1				4	3	2	1	1	1	1	1	1	1	2	1	1	1
37	2				1			1	1	1			5	3	1	2	1	2	1	1	1	1	2	1	1	1
38	2				1	1		1	1				4	3	2	1	1	2	1	1	1	1	2	1	1	1
39	2	1	1		1			1					4	3	2	1	1	3	1	1	1	1	1	1	1	1
40	2		1										3	3	2	1	1	3	1	2	1	1	3			
41	2		1		1		1	1					3	3	1	2	1	4	1	1	1	1	4	1	1	1
42	2					1						1	5		1		1	2	1	2	1	2				
43	2				1	1		1					3	2	3	1	1	1	1	1	1	2				
44	2							1					2	1	3	2	2					2				
45	2	1			1	1	1		1	1	1		5				1	1	1	1	2	1	1	1	1	2
46	2				1	1	1		1	1	1		5	1	3	2	1	2	1	1	1	2				
47	2				1	1		1					4	1	1	1	1	3	1	1	1	1	3	1	1	1
48	2				1				1				4	1	2	3	1	2	1	1	1	1	1	1	1	1
49	2				1		1		1		1		5	3	2	1	1	4	1	2	2	1	2	1	1	1
50	2				1	1							3	3	2	1	2					1	3	1	1	1
51	2	1	1		1	1		1	1	1	1		5	2	1	3	1	2	1	1	2	1	2	1	1	2
52	2	1	1		1			1					4	1	2	3	1	2	1	1	2	1	2	1	1	2
53	2												3	3	2	1	1	2	1	1	1	1	2	1	1	1
54	2				1								4	2	1		1	1	1	1	1	1	1	1	1	1
55	2				1			1					3	1	3	2	1	1	1	1	1	1	1	1	1	1
56	2				1		1	1					4	3	2	1	1	1	1	1	1	1	1	1	1	1
57	2						1	1					4	3	2	1	2					1	1	1	1	1
58	2				1				1				3	3	2	1	1	3	1	1	1	1	3	1	1	1

No.	Sex	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	4k	5	6a	6b	6c	7	7.2	7.3.a	7.3.b	7.3.c	8	8.2	8.3.a	8.3.b	8.3.c
59	2			1	1						1		5	3	2	1	1	2	1	1	1	1	2	1	1	1
60	2				1			1					4	3	2	1	2					2				
61	2				1			1					4	3	2	1	2					2				
62	2	1			1			1	1	1			4	1	2	3	1	2	1	1	1	1	3	1	1	1
63	2	1	1		1	1	1	1	1	1			5	3	2	1	1	1	1	1	1	1	1	1	1	1
64	2				1	1		1					5	3	2	1	1	2	1	1	1	1	3	1	1	1
65	2		1		1	1	1	1	1				4	3	2	1	1	3	1	1	1	1	2	1	1	1
66	2			1				1		1			2	1	3	2	1	1	1	1	1	1	1	1	2	1
67	2												4	1	2	3	1	2	1	1	1					
68	2									1			4	3	2	1	1	2	1	1	2	1	2	1	1	1
69	2		1	1				1					2	2	3	1	1	1	1	1	1	1	3	1	1	1
70	2							1			1		4	1	3	2	2					2				
71	2	1	1		1	1		1	1	1	1		5	3	2	1	1	1	1	1	1	1	1	1	1	1
72	2				1								4	1	2	3	2					2				
73	2												5	1	2	3	1	3	1			1	3	1		
74	2							1					2	1			2					2				
75	2				1	1							5	3	1	2	1	4	1	1		1	4	1	1	
76	2				1			1	1	1			5	2	1	3	1	4	1	1	2	1	2	1	1	1
77	2							1					2	1			1	1	1	1	1	1	1	1	1	1
78	2		1										4	2	3	1	1	1	1	1	1	1	1	1	1	1
79	2												2	3	2	1	1	1	1	1	1	1	1	1	1	1
80	2		1	1									2	3	1	2	1	1	1	1	2	1	1	1	1	2
81	2				1			1	1				4	3	1	2	1	2	2	2	1	1	2	2	2	1
82	2			1	1						1		2	2	1		2					2				
83	2							1					4		1		2					2				
84	2						1						3	3	2	1	1	1	1	1	1	1	1	1	1	1
85	2							1			1		4		1		1	2	2	1	1	1	2	1	1	1
86	2				1			1		1			4	3	2	1	2					2				
87	2				1			1					4	3	1	2	1	3	1	2	1	1	3	1	2	1
88	2	1		1				1			1	1	2	3	2	1	2					2				
89	2																									
90	2				1	1		1					4	2	3	1	2					2				
91	2	1			1								4	1			2					2				
92	2				1	1		1					4	3	2	1	1					2				
93	2							1				1	3	3	1	2	2					2				
94	2				1			1					4	3	1	2	2					2				

Data Continues …

No.	Sex	9.a	9.b	9.c	10.a	10.b	11	11.1.a	11.1.b	11.1.c	11.1.d	11.1.e	12.1	12.2
1	1	2	2	2	2	2	2						3	2
2	1	2	3	2	2	2	2						2	2
3	1	2	2	2	2	2	2						2	2

No.	Sex	9.a	9.b	9.c	10.a	10.b	11	11.1.a	11.1.b	11.1.c	11.1.d	11.1.e	12.1	12.2
4	1	2	3	3	3	3	2						1	1
5	1	3	3	3	1	2	2						2	1
6	1	3	3	3									3	1
7	1	2	3	3	1	1	2						3	2
8	1	2	3	3	2	2	2						3	1
9	1	3	3	3	2	2	2						2	1
10	1	2	2	3	1	1	1	1					2	2
1	2	1	1	1	2	1	1						3	1
2	2	2	2	2	2	2	2						2	1
3	2	1	2	2	2	2	2						4	3
4	2	2	2	2	2	2	2						4	2
5	2	1	1	2	2	2	1						2	2
6	2	2	2	2	2	1	1			1	1		2	1
7	2	2	2	2	2	2	2						3	1
8	2	1	2	2	2	2	2						3	1
9	2	2	2	2	2	1	2						2	2
10	2	2	2	2	2	2	2						3	3
11	2	1	2	2	2	2	2						4	3
12	2	1	1	2	2	1	1		1		1		4	2
13	2	2	2	2	2	2	2						3	1
14	2	1	2	2	2	1	1,2						3	1
15	2		2	2										
16	2	2	2	2	2	2	1	1					3	2
17	2	3	3	2	1	1	2						1	1
18	2	2	2	2	2	2	1	1					3	1
19	2	2	2	2	2	2	2						3	3
20	2	2	2	2	2	2	2						3	2
21	2	2	1	2	1	2	2						2	1
22	2	1	1	2									2	3
23	2	1	3	3	2	2	2						3	1
24	2	1	2	3	2	1	2						3	1
25	2	2	3	3	2	2	2						3	2
26	2	3	3	3	2	2	2						1	1
27	2	3	3	3	2	1	2						2	1
28	2	3	3	3									3	2
29	2	2	3	3									3	3
30	2	2	3	3	2	2	2						2	1
31	2	3	3	3	1	1	1	1					4	1
32	2	3	3	3	2	2	2						3	1
33	2	3	3	3			1	1					3	1
34	2	1	2	3		2	2						2	2
35	2	2	2	3	2	2	2						3	2
36	2	2	2	3	2	2	2						4	2
37	2	2	2	3	2	1	2						2	1
38	2	2	2	3	2	2	2						3	1
39	2	2	2	3	2	2	1						3	1
40	2	1	2	3	2	2	2						3	2

No.	Sex	9.a	9.b	9.c	10.a	10.b	11	11.1.a	11.1.b	11.1.c	11.1.d	11.1.e	12.1	12.2
41	2	1	2	3	2	2	2						4	2
42	2	3	3	3	1	2	1	1					1	1
43	2	2	3	3	2	2	2						4	1
44	2	3	3	3									3	2
45	2	3	3	3	2	2	2						1	1
46	2	3	3	3	1	2	1	1					3	1
47	2	2	3	3	2	2	2						1	1
48	2	3	3	3	2	2	2						2	1
49	2	2	2	3	2	2	2						2	1
50	2	2	3	3	2	2	2						3	1
51	2	2	3	3	2	2	2						3	1
52	2	3	3	3	2	2	1						2	1
53	2	2	2	3	2	2	2						3	2
54	2	2	3	3	2	2	2						3	2
55	2	3	3	3	1	2	2						2	1
56	2	2	3	3	2	2	2						2	1
57	2	3	3	3	2	2	2						2	1
58	2	2	3	3	2	2	2						3	2
59	2	3	3	3	2	1	2						2	1
60	2		3	3									2	2
61	2	2	3	3	2	2	2						3	1
62	2	3	3	3	2	2	2						1	1
63	2	3	3	3	1	1	1	1					1	1
64	2	2	2	3	2	2	2						1	1
65	2	2		3	2	2	2						1	1
66	2	2	2	3	2	2	2						4	3
67	2	3	3	3	2	2	2						3	1
68	2	2	2	3	2	2	2						3	2
69	2	1	2	3	2	2	2						4	3
70	2	2	1	3	1	2	1	1		1			3	1
71	2	3	3	3	2	2	2						1	1
72	2	3	3	3	1	2	2						4	1
73	2	3	3	3	2	2	2						1	1
74	2	3	3	3									3	2
75	2	2	2	3	2	2	2						3	1
76	2	2	3	3	2	2	2						1	1
77	2	1	1	3	2	2	2						4	3
78	2	1	2	3	2	2	2						4	2
79	2	1	2	3	2	2	2						3	2
80	2	2	3	3	2	1	1			1			1	2
81	2	2	2	3	2	2	2						2	2
82	2	2	2	3	2	2	2						3	3
83	2	2	3	3	2	2	2				1		4	2
84	2	3	3	3	1	1	2						1	1
85	2	3	3	3	1	1	1	1					3	1
86	2	2	2	3	2	2	2						3	2
87	2	3	3	3	2	2	2						2	1
88	2	2	2	3									3	2
89	2													

No.	Sex	9.a	9.b	9.c	10.a	10.b	11	11.1.a	11.1.b	11.1.c	11.1.d	11.1.e	12.1	12.2
90	2												4	2
91	2				2	2	2						2	2
92	2												3	2
93	2												3	2
94	2												3	2

Comments

Survey 2	MECH102	Q 1.6
Poor resources - worked examples etc, cramming too much information, poorly explained into a lecture, arrogance from lecturers (condescending tone - just because they understand the material doesn't mean they're able to explain it well).		F
FORTRAN is very complex and totally different to anything I have done before.		F
Irrelevancy to course.		M
Computer jargon makes it difficult to understand major concepts.		M
131 was and is difficult due to bad lecturing technique, and failure to teach elementary things needed to understand more difficult concepts. 102 hard as it goes from easy - hard way too quick and notes are pathetic.		M
- Poor lecture notes - i.e. MECH102 - Bad lectures.		M
MECH102 is unlike anything I've ever done and is too fast.		M
Time spend learning the subject. e.g. lectures, tutorials		M
CIVL131 - Way subject is presented. MECH102 - Very new concepts never used to it, some tutors not very helpful		M
The lecturer - G. Willgoose does not seek the best for his CIVL131 Class		M
MECH102 moves too fast		M
Not being able to understand lectures.		M
What was expected in MECH102 became very different		M
It is very difficult - maybe too much crammed in.		M
New information.		M
In MECH102 they need to have less bigger steps between assignments. They just don't lead into each other. Need more helpful tutors. American dude is rude!		M
MECH102 - lots to learn, probably should be a 10cp subject. CIVL131 similar		M

situation.	
Lecturers, pace of learning. Being able to understand what lecturers are saying i.e. can't comprehend them.	M
The volume of information you need a firm understanding of immediately.	M
MECH102 difficulty in understanding of programming from first to last assignments.	M
Not enough examples or examples in text should have more explanations of what or why something was done in the program.	M
Poor lecture and tuts. If only somebody could explain half of all this crap.	M
Holidays - teachers strike, write or discuss details to students of first time.	M
Prior knowledge, the speed at which subject's progress - makes it hard.	M
Assumed knowledge.	M
New concepts, monotone voices.	M
Lack of communication of information, poor or no tutorial sessions.	M
Tutors working the way through a problem with you, new concepts.	M
The lectures make the difficult subjects harder.	M
The lack of feedback in CIVL131, just different (MECH102) language.	M
The individuals experience (or lack thereof) of the work involved.	M
MECH102 - complex, expected to know some background in computer programming.	M
FORTRAN 90 is extremely hard to understand the notes do not make it very easy either.	M
Never done any programming before.	M
No background with computers made MECH102 hard.	M
Subjects covered too fast poorly explained.	M
- Amount of tutorials - Lecturers that speak English as their first language.	M
Clear speaking lecturers	M
The lack of examples in CIVL131 (numerical) makes it VERY difficult	M
Computers assumed knowledge	M
MECH102 is too fast - need more teaching what stuff does in that language.	M
- CIVL131 - Poor lecturing - MECH102 - Poor course notes Both subjects had texts that were difficult to interpret and understand.	M
The lecture.	M
Lecturer for CIVL131 cannot teach compared with lecturer for MECH121	M
CIVL131 is easy but is made hard because Willgoose does not teach the principles.	M
Dropped into 'deep end' with MECH102 expected to learn programming and also write very difficult programs that really doesn't need to be learnt.	M
Computer programming and the fact that it is only a 5 credit point subject.	M
Maths is logical and easy to remember due to set formulas. MECH102 is not easy to remember, as I don't find it interesting, as with CIVL131.	M
MECH102 - complexity of the course notes.	M
MECH102 is too difficult - the assignments and test should be made easier.	M
MECH102 is too hard.	M
New concepts, not enough examples, speed of delivery of course.	M
Concepts in computers. Also a difficult FORTRAN code to learn and not enough examples.	M

Survey 2	MECH102	Q4	
Huge progression in knowledge and skills required in only a short time.			F
Help from tutors was always there when required. It was just a matter of overcoming an initial feeling of being stupid.			F
Assignments covering more than one whole chapter each plus the previous chapters. There wasn't enough intermediate working problems.			M
Did not do any work until last 2 weeks. The American Tutor was a real $#%*, he use to roll his eyes and groan with much discomfort when asked for help. (He is not a good choice for a helping hand tutorial role, sack him!)			M
No background in this.			M
Last two assignments seemed to be thrown in the deep end.			M
Tutors should spend more time with students and not be so lazy to help.			M
Having to start from scratch with computer programming made it difficult.			M
Tutors seemed to expect us to know everything and older tutors were reluctant to help. All they do is sit out the front and seem bothered when a question is asked.			M
Tutors not very helpful.			M
Poor lectures.			M
Lecture notes poorly set out - little explanatory notes.			M
Notes were unclear, not enough examples.			M
Not explained well. Programs should be written up and explained in lecture - not just reading the book we've got.			M
Questions set for assignments weren't easily understood what was to be done.			M
Badly worded questions.			M
Programming difficulty pushed too far and tutor expected me to know what I was doing.			M
Poor explanation in lectures.			M
Didn't understand about stuff like arrays, etc.			M
Tutors are not helpful enough - especially Carl.			M
The tutors are not specific enough when helping			M
I hate the F90 Compiler			M
Lecturer wasn't clear, not David Wood but Hans Grebe			M

Survey 2	MECH102	Q6	
Wasn't given any advice on how to go about the assignments - have since found information on flow charts.			F
I don't understand the language of this question.			F
I found that for the first 3 assignments I could just start by writing codes but for 4 and 5 I needed to use flow charts before I could write codes.			F
No advice was given, in Lamen terms, on how to solve assignment questions as a whole.			M
Don't even understand the language here.			M
I skipped straight to copying off my friends.			M
Didn't have much of an idea of the program until it was finished.			M

It is almost impossible to write a program directly into computer because of limited knowledge of computers overall.	M
In programming I feel time is needed to breakdown and analyse the problem, i.e. think about it.	M
For some, Assign 1 & 2 it was easier to do (a), for 4 & 5 it was better to do (c) & (d).	M
Very hard to understand.	M
Sometimes I write out whatever I can of the program then go back to a structure plan.	M
I had a mental plan in my head and basically just typed it out from there and developed it.	M
Didn't have much idea.	M
Didn't know enough about the FORTRAN language and its capabilities to start with (b)	M
Read the problem; work out what needs to be done and then do it.	M
More a trial and error approach using examples from text books.	M

Survey 2 — MECH102 — Q7.1	
I understood something about that assignment.	F
We all threw together ideas and made it easier to understand process.	F
Yes, it allowed me to draw on other people's ideas, even though they to had no idea how to do it.	M
It was good as it helped with understanding as we could discuss methods etc.	M
Yes, in some ways. No, in some ways.	M
Yes, benefit me a lot.	M
Not really	M
Not really, no one knew how to do it.	M
Yes, because I couldn't have got it out myself.	M
Yes, worked in group of 2, both members contributed and helped each other.	M
Yes, got done, but perhaps didn't learn as much as I could.	M
Not in such high numbers.	M
Yes, since others could help in more difficult areas.	M
Yes, I couldn't have done it alone.	M
Yes - help each other.	M
Two heads that don't know, isn't really better than one head that doesn't know.	M
It did not help in the understanding of the course.	M
Yes, we both did the work and when you had a problem you could work together.	M
Yes, we helped each other understand the programming.	M
Very much, I don't feel I could have done it myself.	M
Yes because you had a different view on the problem question.	M
No, the other members of the group did the assignment faster than I could follow and this has made the 5th assignment even harder.	M
Yes, there was only two of us but I believe that was better.	M
Not a lot but it made the setting down and doing it less daunting/tiresome.	M
Yes able to get more information.	M
Yes, I could see different approaches from other people.	M
Yes, because bits that I could not do they helped me.	M
It helped by gaining other people's views of how to solve the problem.	M

Yes - we all helped each other.	M

Survey 2	MECH102	Q8.1
By again poding ideas.		F
Yes, more ideas to draw upon.		M
Yes but it was still too hard.		M
Yes, I knew more then, so I was able to help as well.		M
Same as before, we need more hints and direction.		M
Don't know yet.		M
Yes, same as last question.		M
Yes, more input.		M
No it did not help in the understanding of the course.		M
No - no one knew anything.		M
Yes it helped having more people.		M
I haven't done it yet.		M
Yes, still unable to answer assignment 5.		M
Yes, we gained other views and it was easier to find mistakes.		M
Don't know yet, haven't finished.		M
Yes but none of us could do it still.		M

Survey 2	MECH102	Q9
Not very confident due to lack of understanding of the subject.		M
Couldn't be bothered giving my opinion to the tall American tutor with the glasses because he was an arrogant, totally unhelpful and I don't know why Newcastle Uni is wasting money paying him so that he can sit in a room eating apples and answering students questions with a more complete, unnecessary question all day.		M
This subject is so hard it's difficult to know if you are giving the right or wrong answer.		M
Lecturer with English as a second language makes it very hard in a subject that pretty much uses its own language.		M
Course was rushed and wasn't explained in enough detail, also assignment quite difficult and sort of "threw us in the deep end".		M
Can't understand lecturers.		M
I don't feel that I understand the computer language or what each thing does.		M
Poor knowledge		M
I try not to look stupid in front of larger groups of people		M
I would if I had a clue.		M
Don't know enough yet.		M
Cannot feel confident talking to the lecturer and only one tutor explains things properly.		M
I don't feel the need to inflict my views on others.		M
Risky to speak up during a lecture!		M

Survey 2	MECH102	Q11.1
Let them go, they have good ideas.		M
I was the dominant one.		M

Survey 2	MECH102	Other Comments
Give more direction as to how to approach assignments, maybe more helpful tutors.		F
MECH102 assumes too much knowledge of computer and computer programming. It is very difficult for someone without prior computer knowledge to understand the terminology and concepts associated.		F
I feel that the tutorial sessions were not as helpful as they could have been. The tutors do not seem to understand that when a lot of students being MECH102 we do not immediately understand the concepts. I found that when I asked for help, most tutors did not seem to be able to explain clearly to me what was wrong with my problem.		F
- Civil 131 Fluids 1 is very poorly taught. - More time should be spent on teaching the course rather than talking about himself. - Programming is ok, but its relevance to surveying ???? - Generally subject ok.		M
Surveying course structure needs to be re-vamped as there are some subjects which should be scraped, i.e. high level of Maths, Civil141, Civil 131 very poorly taught.		M
Need a different approach to teaching entirely. The notes provided were in adequate and not simple enough to give understanding of basic concepts on which to build on. The lectures did not build upon these notes, rather they rehashed them poorly.		M
In MECH102 all I would have liked was a lecturer or tutor to go through basic steps on how to solve a standard problem, instead of just giving us a sheet and letting us stumble and fumble our way through it like a blind man in an orgy.		M
You have not asked why people choose not to work in groups. I have chosen not to work in groups in MECH102 because my workload across the course is great and if I did not force myself to do the assignments I would not develop an understanding of the course, that is, I would bludge.		M
CIVL131 - The lecturer is not setting final exams within the first year capabilities for the majority of his students. - Not enough relevance for lecture, tutorial and assignment material towards final exam. MECH102 - Final test is largely on Arrays - not enough time spent explaining this area.		M
Last two assignments were rather difficult, but no specific lectures seemed to make the material covered in these assignments easier to understand. Arrays wasn't made clear.		M
I think more time should have been spent with students by the tutors. There is one particular group of tut classes. (Fri 11-1)		M
Just because lecturers are comfortable with material doesn't mean we are. They expect us to be awesome on computers after only a few weeks. I understood the first few weeks than jumps became too big and understanding was almost impossible.		M
Why is the American tutor so arrogant?		M
I found it difficult during lectures to understand the lecturer's accent, let alone		M

spending time on the content, which is covered. This should be looked at.	
The change in degrees of difficulty between the first and last assignments was too great.	M
I feel that some tutors (particularly a certain American gentleman) are arrogant and self-righteous to the point of saying, when asked a question, "surely you know how to do that, your joking aren't you?" This comment in the second tutorial and complete lack of help/assistance later during tutorials made learning very hard. I feel that perhaps if there was more help for those with no computer background the course may be easier and less daunting for some.	M
Tutors could be improved.	M
CIVL131 Fluid Mechanics - the topic level is well above first year standard and the lecturer seems to have fun and enjoys exploiting this fact.	M
Difficulties in gaining help from certain tutors, i.e. most either leave early or separate themselves from the class (sit up front and converse/talk between themselves with two tutors).	M
Different tutors have different ideas on how to write the program.	M
- For those who have had no experience with computers were at a distinct disadvantage. - Some tutors come across as arrogant and unwilling to help and turned you off the tut session (particularly the tall American)	M
Basically, I had the lecturer who has the most experience, honestly I should think that I have the best lecturer for this course. David Wood explains this course very well but I though Ed Sybecki was just reading off the notes. I gained more from self-reading than turning up to lectures and felt that Ed's knowledge was inadequate in explaining the course. I am not bagging Ed but I feel the course co-ordinator is always best not just for this subject but every, we need the best and most qualified lecturer otherwise we will not have to fill out this survey.	M
Tutors expect too much of use and treat us poorly. Found it difficult to understand complexity in the way we were shown.	M
I really feel that more examples could be given during lectures to help us understand particular functions of the program. Maybe more in depth notes or more tutorial sessions to help us understand the program (FORTRAN 90). I really feel this was very hard, I put in a lot of effort but still find it hard.	M
I feel some questions seem discriminating, i.e. gender background? I fail to see the relevance of this despite your explanation.	M
The course was described as needing minimal computer experience however the pace was too fast for someone who has little knowledge. If there was more time perhaps the leaving of FORTRAN would be easier but the heavy load of other engineering subjects did not allow this.	M
The questions on domination are stupid. Everyone should look after themselves not whinge.	M
The tut should be longer and the tutor should cover the material we would otherwise listen to in the lecture.	M
Work through examples in lecture on computer. Lectures/Lecturer are too hard to understand.	M
The programming assignments start off very easy (Assign 1 & 2) but there is a big jump in Assign 4 & 5. The terminal test is given before the 5th assign is even handed	M

back.	
Too hard, too quickly, not enough feedback	M
Although Gunilla Burrowes may feel that her surveys may be relevant I say they are not - especially when it takes up the time of a very important lecture such as that of MECH102. This survey is obviously a waste of David Wood's time also the engineering student body's time.	M
MECH102 is a well run subject however my only complaint would be the terminal test format. Time is limited in the test and if in the stress of the moment you make a blunder then it could be too late! Irrespective to how well you know the subject matter.	M
What happens when you make the electrical course (130) easier as a result of your first survey? Does the standard gradually decline? Can you compare results from someone who did the course (say) 5 years previous with someone …..	M
Why learn to make programs when a professional programmer can better do it, which would be much better than something that I could produce.	M
We should learn how to use programs rather than write them because computer engineers etc can be utilised to write the programs.	M

Appendix 3

Focus Groups – semi structured interview question areas

Session 1 – July 1999

Question Areas:

1. Background and Motivations to do course
2. Expectations of course and current perceptions
3. Understanding perceptions of course structure and delivery
4. Expectations of assumed knowledge in course content
5. Terminology and language used in course
6. Computers & using computers in engineering

Session 2 – October 1999

Question Areas:

1. Review of questions from session one.
2. Changes in expectation of course
3. Re-evaluating language issues
4. Approaches to technical tasks (including computer tasks)
5. Approaches to problem solving
6. Evaluation of assessment tasks
7. Approaches to team work – study purposes & assignment groups
    a. How often would you study with other students?
    b. Do you choose to do group assignments
    c. In group assignments: How often do you experience difficulties between female & male students in your group?
    d. How often did students expect you to contribute to group assignments on the basis of sex stereotypes?
    e. If you are unhappy with dominating behaviour by a student in your group meetings, what did you do?
8. Factors affecting progress