PERCEPTION OF BARRIERS TO CAREER PROGRESSION BY WOMEN ENGINEERS AND ENGINEERING STUDENTS

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ABSTRACT

Although the common view that engineering is best suited for men is changing, there is anecdotal evidence suggesting gender imbalance in the engineering industry. Efforts take place throughout New Zealand to encourage participation and career progression of females in engineering. These occur through the formation and activities of societies such as Women in Engineering(WIE) in NZ Universities and provision of support by Institution of Professional Engineers of New Zealand(IPENZ). These enable networking opportunities and celebrate achievements of women engineers. However despite these, a small sample of female engineers revealed that they feel the presence of more barriers to them than for their male counterparts to be able to accomplish in the profession. This in turn may discourage prospective students who value a good balance between their role as an engineer, mother and a home-maker.

A survey was conducted to assess the perception by female engineers/engineering students of these barriers, and how prepared the engineering industries/educational institutes are to cater for the specific needs of a woman as she progresses through the career, balancing the familial responsibilities.

Based on findings some measures are proposed to encourage female participation and retention in engineering industry; implementing them can be invaluable in preventing the loss of highly skilled engineers to the industry especially when a young female engineer chooses family over engineering work – either by changing her career path to obtain more flexible working conditions or by stopping work all together. Both of these scenarios are equally detrimental to the individual and the industry.

BACKGROUND

Women have been under-represented in Engineering and therefore are accustomed to being in the minority. The engineering profession has always had the somewhat unsavoury standing as the most male-dominated profession. Numerous studies have high-lighted this under-representation in many countries throughout the world, such as USA(Reardon, 2004 ; SWE, 2004), UK (EngineeringUK, 2010a, 2010b) and India (Pareek, 2007).

From a 2006 census of population and dwellings by Statistics in 2006 the Department of Labour in New Zealand (DoL, 2006), revealed that on average for all occupations there is a 47% female participation. However, only 16% females work as architects, engineering related professionals, and technicians in New Zealand. It also reported that female enrolment of engineering students at tertiary level was just under 18%. Their report "Engineers in the labour market" (DoL, 2006) stated the need to widen the pool of future potential engineers and identified that Maori and pacific populations were not well-represented. The report did not mention considering ways of increasing female participation in engineering.

According to an IPENZ report (IPENZ, 2011) only 6% of the registered chartered professional engineers in New Zealand are women (Fig. 1). This is in line with internationally well-known fact that women participation in engineering is low with perhaps the only exception of China (40%) and the former USSR (58%) (CERT, 2010).

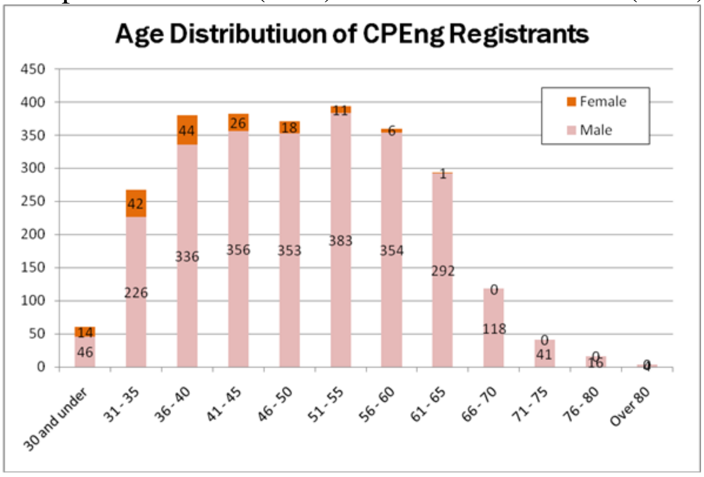


Fig. 1: Distribution of female CPEng registrants in New Zealand (IPENZ, 2011)

While attracting females to a profession perceived to be one of male domination is one great challenge, retaining those who do enter the industry is another. Out of concern that female engineers do not seem to continue in their engineering careers as long as their male counterparts, IPENZ carried out a comprehensive survey in 2008 to find out what happens to them in the work force. The data revealed gender-based prejudices in sexual harassment, gender discrimination, and remuneration. The report also acknowledged that women engineers left their professional status for travel, to undertake further study, or for maternity or childcare reasons (IPENZ, 2009). Although a pay disparity was observed in the data, it was not reported as a reason for departure. In contrast, a report (Kiviat, 2010) based on a survey of women engineers in Canada by Prof. Jennifer Hunt, an engineer turned economist, concluded that although more women than men left engineering for family-related reasons, the gender gap was similar to that in non-engineering professions. In fact, it found that more than 60% of the women leaving engineering did so because of dissatisfaction with pay and promotion opportunities.

This study was conducted to assess the perception by female engineers and engineering students of the barriers, and how well or badly prepared the engineering industries and educational institutes currently are to cater for the specific needs of a woman as she progresses through the career while balancing familial responsibilities.

An anonymous survey was conducted to collect data from female engineers and engineering students through a questionnaire (conducted in Survey Monkey®). The data were analysed and findings summarised.

THE SURVEY

The recipients of the survey were females who were academics/students tertiary engineering education or working in the engineering industry in New Zealand. Participation in the survey was voluntary and was initially distributed to a total of 37 female civil engineers/academics/engineering students (5 students) known to the researcher with a request to forward the survey link to other female engineers fitting the given description. The total number of respondents was 47. The survey comprised of 5 sections with a total of 38 questions.

Section 1 – Identifying the status

The composition of the participants is shown in Fig. 2. The numbers add up to 54 rather than 47 as some of the participants fall into more than one group. The majority (74.5% or 35 participants) are engaged in full time work in engineering industry; of these, three are studying part time. Similarly there are 6 who are full time students out of which two are working part time. Four are taking a break away from work.

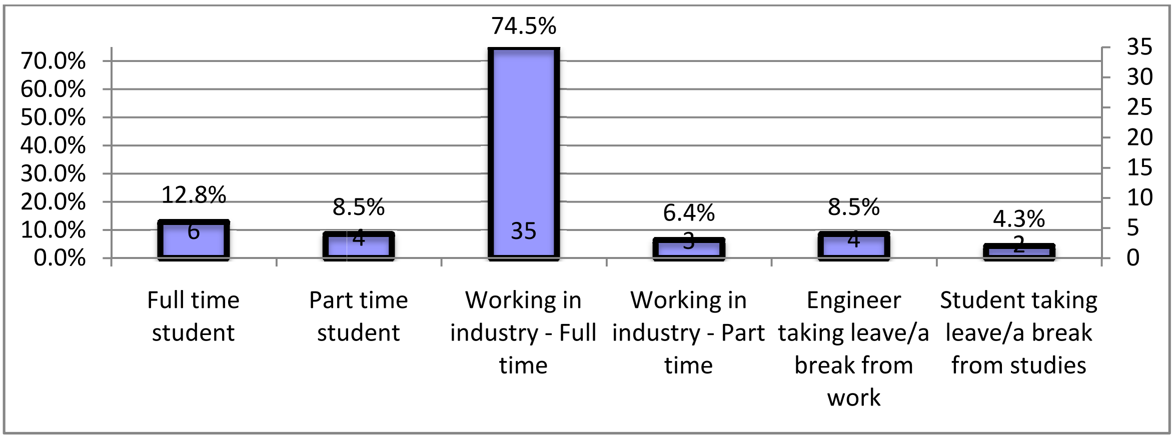


Fig. 2: The composition (number and %) of the surveyed sample

Analysis of Section 1

The overall sample is medium-sized. Judging from the number in sub-classes, it should be acknowledged that the samples representing categories other than full-time employed are very small. As such, sub-sample analyses of information were not done. It should also be noted that all the percentage values represent extrapolations to 100 from a smaller sample, are indicative but suffice for the purpose of this study.

Section 2 – Perception of engineering as a profession and the place of women in Engineering

There were five questions in this section. It is noted that the widely held view that "Engineering is a man's world" is fading with 70% thinking it is not (Fig. 3). As expected 89% see that the women:men ratio is not balanced in their place of work/study (Fig. 4).

When asked whether the ratio is balanced in engineering industry in general, an overwhelming 96% responded with a "No". As to what the women:men ratio would they like it to be, the most common response was 50:50. While the responses varied widely, there were five who did not have any specific preference (Fig. 5).

With respect to working hours, 61% say that there is a need to dedicate long hours to work to succeed in the engineering industry in general. A specific question whether they have to spend long hours in their *own* workplace comes up later in Section 5.

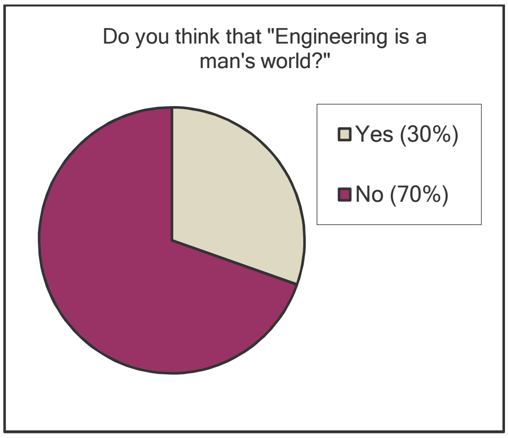


Fig. 3: Engineering a “man’s world?”

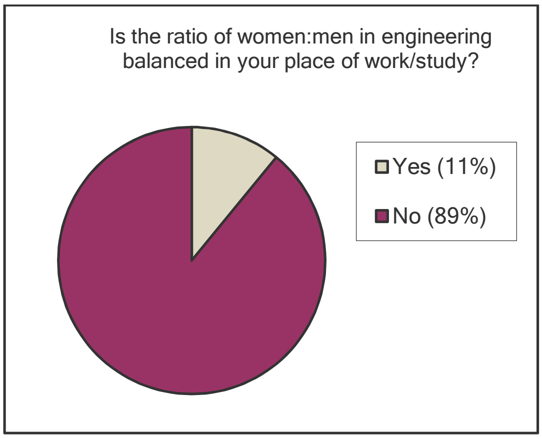


Fig. 4: Gender imbalance in work place/study

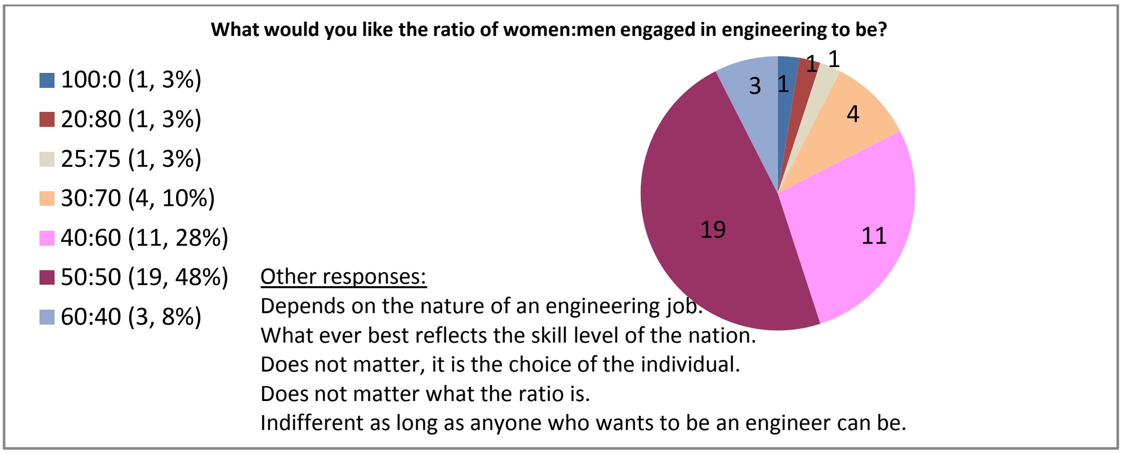


Fig. 5: Preference of women:men ratio in engineering

Analysis of Section 2

The perception that the ratio should be more balanced aligns with the global view.

Section 3 – Identifying inhibitors

This comprised six questions drawn from existing literature supported by observed anecdotal evidence to check whether the views that inhibit the advancement of women engineers were widely shared by the NZ sample.

The results summarised in Table 1(with highest percentage underlined), show that the respondents largely share these views with the only exception of pay parity. However, 31% still perceive pay parity as a concern. It should be noted that the participants are very likely to be unaware of the actual salary their male counterparts draw. A survey on actual remuneration with a small sample size of females over 35 years and conducted by IPENZ (IPENZ, 2009), showed that women with Chartered Professional Engineer (CPEng) status got paid consistently lower than their male counterparts across all age groups. Similarly a survey carried out in the UK in 2008 (Whitelaw, 2008) showed that women who were Members of the Institution of Civil Engineers (MICE) received 32% less pay than MICE males.

Tab. 1: Agreement with prevalence of obstacles to career progression

Obstacle	Disagree	Neutral	Agree
Women face more opposition in leadership roles than men.	22%	26%	52%
Some men do not feel comfortable with having to report to women.	17%	24%	60%
Female engineers have to work harder to get ahead in the work place.	24%	17%	59%
Women engineers are smart people; but they still have to put in more time, deliver better quality to earn the status/ reputation/ appreciation a man gets by doing less.	29%	26%	45%
There is no pay parity between women and men in engineering for similar work. Women get paid less.	33%	36%	31%
An assertive woman is perceived to be strong-willed while a man is expected to be assertive.	19%	29%	52%

Analysis of Section 3

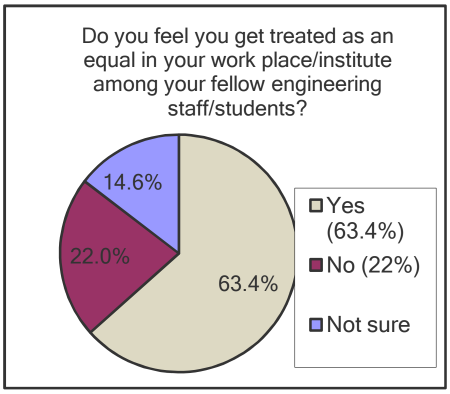
A very interesting finding from a survey carried out in Canada is that women leave engineering for the same reason that a man leaves a job, i.e. pay and promotion concerns or opportunities (Flynn, 2010; Kiviat, 2010). It deduces that women seem to disproportionately leave male-dominated fields one of which is Engineering.

The factors in the table above also seem to suggest that females here do feel that they have obstacles to getting ahead in the work place. Although they have not been found to be leading factors in any survey done so far, the cumulative effect of these factors are bound to have *some* influence on feeling justified of leaving work when family and other reasons surface.

Section 4 – Engineering education

This section attempted to gather information regarding the perception of equal treatment in engineering education and if co-education or girls-only education is likely to promote equal treatment. All the respondents (100%) confirmed the worldwide accepted worrying trend of being in the minority during tertiary education (all less than 40%). Data revealed that there was no intentional difference (positive or negative) in the manner in which male and female academics treated the female students compared to their male counterparts. This confirms the view that the educationalists by and large treat the female minority with equity.

When it comes to treatment by work colleagues however, the data (Fig. 6) suggests that while a majority (63.4%) felt they were treated as equals, 22% (9) of the 41 respondents said they did not which is concerning. None of these 9 are students, five are working full time, three working part time and one taking a break away from work.



The data supports correction of such an imbalance through co-education, as this promotes mutual understanding at an early age. Fig. 7 clearly shows that only a small minority (7%) see co-education not being the better option. Fig. 8 on the other hand, indicates ambivalence of all-girls education up to secondary schools although supposedly it leads to gender issues never surfacing and girls growing up believing they can do anything.

Fig. 6: Perceived treatment as an equal by colleagues

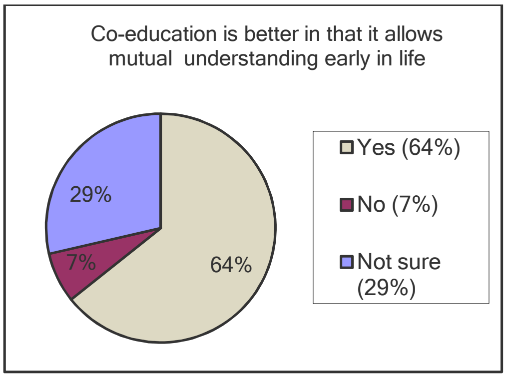


Fig. 7: Benefits of co-education

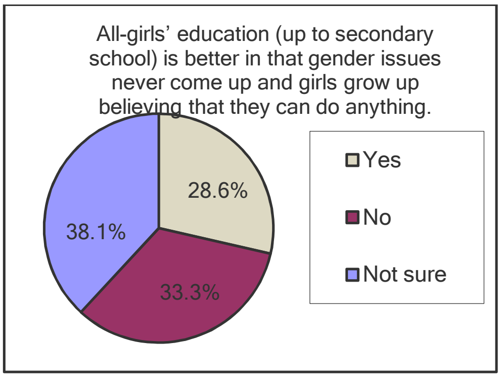


Fig. 8: Benefits of early education for girls-only

Analysis of Section 4

Co-education is key to promoting confidence and understanding between opposite sexes as both academic confidence and self-efficacy are essential for academic success. Back in late 90s, women in the US criticised engineering educators for being rigid, closed, and condescending (Seymour & Hewitt, 1997) which seemingly lowered women's self confidence and self-efficacy. It is comforting to know that none in this study felt they were treated differently by their educators. It is possible that some of the participants were educated overseas. Overall, gender inequities would have undoubtedly reduced over the decades, but it is crucial not to abandon the educational efforts in the light of favourable recent statistics.

This survey did not query if the females experienced gender discrimination by their fellow students. However, an excellent analysis on determining students' success in engineering programs in the USA (Vogt, Hocevar, & Hagedorn, 2007) revealed that female students there reported greater perceived gender discrimination than the male sub samples. It also showed that women students had lower engineering self-efficacy and lower levels of critical thinking. They conclude that it may be the cumulative effect of these variables that dissuade some females from engineering and in to other majors.

With the need to retain those who choose to study engineering, it is paramount that the educators adapt their delivery to take advantage of the female traits such as such as willingness to seek help (Shachaf & Snyder, 2007) and preference to ask questions after or outside of a class, rather than *in* class [(Margolis, Fisher, & Miller, 2011) and personal observations].

Section 5 – Identifying work place issues

This section was designed to capture what reinforcements would encourage the females to succeed more. While it is clear that having mere large numbers in the study group/work place is not necessarily a great encouragement (Fig. 9), having more females in leadership positions would help (Fig.10).

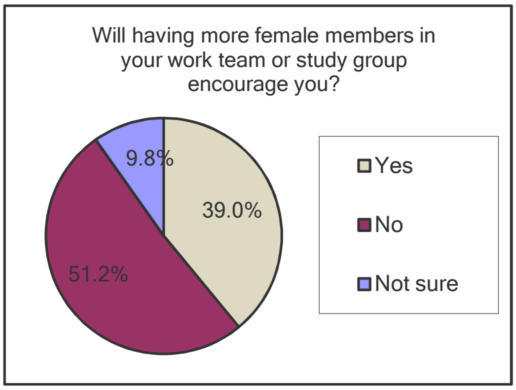


Fig. 9: Benefit of more female members

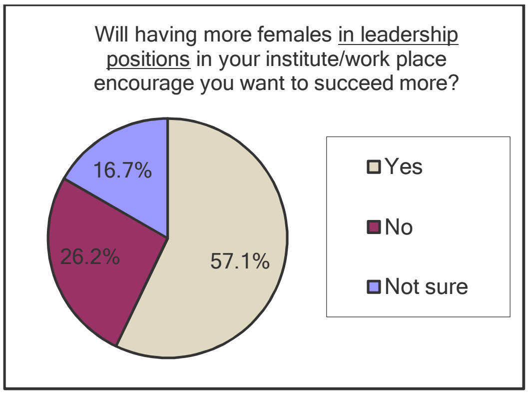


Fig. 10: Benefit of more females as leaders

At their own work places, 50% of the participants feel they have to work long hours to succeed. While 74% of the participants feel that there was(will be) a time in their engineering career when they had (will have) to choose between family and career (Fig. 11), only 12% would prioritise career (Fig. 12).

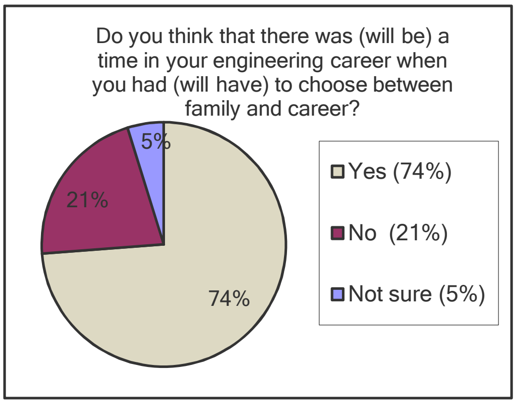


Fig. 11: Having to choose Family/career

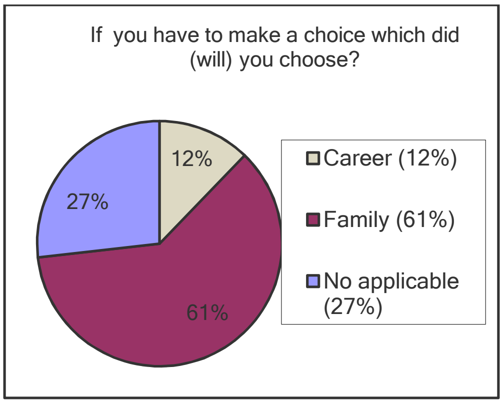


Fig. 12: Choice of Family/Career

One of the main concerns is the the loss of women engineers all together from engineering industry. Fig. 13 shows that while a vast majority wish to eventually return to engineering, 10% intend to leave engineering for another line of work. This must be related to, among other things, the desire to prioritise family, the need for investing long hours to engineering work, and the perceived difficulties in balancing life and work in an engineering career as opposed in other work/trades.

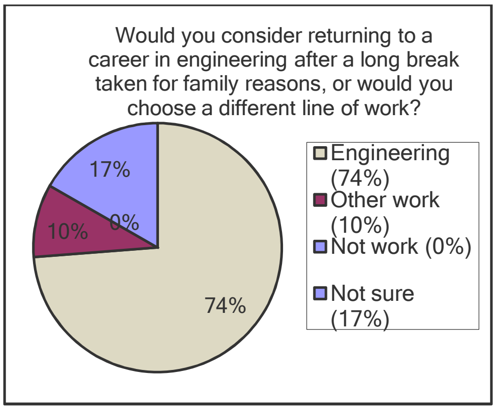


Fig. 13: Desire to return to Engineering

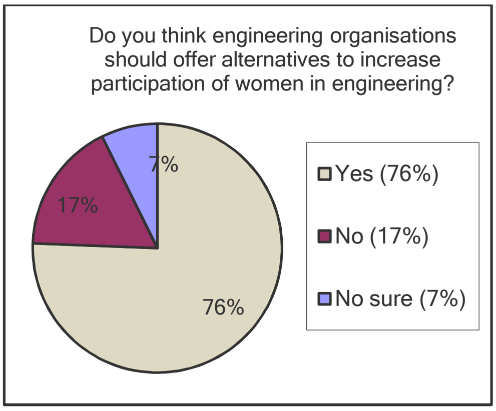


Fig. 14: Organisations offer alternatives?

A vast majority (76%) considers that engineering organisations should offer alternatives to increase participation of women in engineering while 17% say no (Fig. 14). Given a few choices of helpful alternatives, the participants voted as shown in Tab. 2.

Tab. 2: Provisions already available in some organisations (from a given list)

Provision by organisation	Number of votes
Flexible Longer breaks for those who have children	15
Flexible work hours	30
Opportunities to work from home	26
Provision of childcare at work place	13
Not sure	1
Not applicable	6

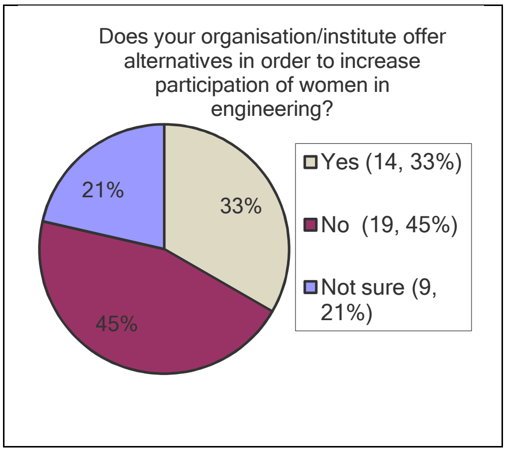


Fig.15: Organisations offering alternatives

As shown in Fig. 15, 17% of participants stated their organisation did not offer the provisions in Table 2 while 7% stated they are not sure if such alternatives were available to them.

Tab. 3: Provisions already available in some organisations

Provision by organisation	Number of votes
Flexible hours	13
Opportunities to work from home	10
Contracts arrangements	2
Part time work options	2
Opportunities to work from home for both men and women	1
Decreased work hours. eg 30 hr week instead of 40	1
Women only social events	1
Flexible work hours - manager dependent	1

The 14 individuals who said their organisations offer alternatives gave the provisions in the above table (Tab. 3) as the ones they get to enjoy.

Analysis of Section 5

Women engineers in leading positions capable of mentoring and acting as role models is clearly a motivator. There is inconsistency in providing alternative work arrangements across organisations. Flexible work hours and work from home are the most common offering and perhaps is a good start for those organisations who do not offer any.

There are other international surveys that reflect the same trends observed in this survey. Patricia (Lee, 2006) also found that the biggest obstacle for the aged between 31-40 was time management, specifically, that of balancing the demands of home/family against those of job/career ultimately having no time for themselves. Her respondents between the ages of 41-50 cited discrimination, primarily gender-based, as their biggest obstacle, some citing age discrimination as their career issue.

Section 6 – Identifying the wish list

When asked what provisions they would like organisations to offer in order to increase participation of women in engineering, the participants suggested the following options:

<u>From Academic institutes</u>: Distance learning

<u>From Professional bodies:</u> Competency evaluation holidays

<u>From employers:</u>

- Opportunities to work from home
- Flexi work hours
- Part time work arrangements
- Opportunities to provide "consultancy" to the company, for a few hours a week (for those with children)
- Paid/unpaid leave for extended periods
- Increased sick leave due to sickness of children
- Childcare facilities at workplace
- Leave during school holiday periods
- Information (e.g. interviews) on female engineering leaders
- More women in leadership positions for us to look up to
- Informal and formal mentoring
- Treat equally (for example some mangers are reluctant to hand over responsibilities to female counter parts)

Analysis of Section 6

Participants show that the organisations can do much more to increase participation of women in engineering industry. Most of the expectations are centred round flexibility, both in work place as well as in education.

SUMMARY AND RECOMMENDATIONS

In summary, the majority of the cohort of 47 female engineers/students confirmed that there is gender imbalance in the numbers and would like to see more women. They also perceive several obstacles to advancing their careers in this male-dominated industry and suggest number of actions the employers, institutes can take to encourage them to succeed more as well as to keep them in industry longer.

The following recommendations will assist with improving the number of women engineers:

Professional bodies such as IPENZ could consider making some exemptions to those who had taken time off within the 5 year evaluation period for retaining CPEng status. This will need further discussion, careful thought to ensure professional standards of the practitioner are maintained, and proper evaluation processes put in place; after all women engineers will not want to appear to be given special treatment but only fair treatment. A recent policy (Engineers-Australia-Council, 2008) aims to provide flexibility to those who take a career break of six months to five years, by altering the CPD requirements. This is one example of an engineering professional institute taking steps to prevent individuals taking a career break being disadvantaged when they choose to return to workforce.

Apart from flexible work arrangements, any positive action taken to nurture, mentor and support women engineers in a male dominated environment where there are perceptions of unequal treatment will definitely promote the confidence and hence the contribution of women engineers to industry.

Considering implementation of the suggestions, some of which need only a change of attitude, can be quite valuable as the loss of valuable workforce to engineering industry as a young female engineer chooses family over engineering work – either by changing career path that allows more flexible working conditions or by stopping work all together – can be equally wasteful to the individual and the engineering industry.

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