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It's a man's world: the academic staff gender disparity in engineering in 21st Century Australia

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ABSTRACT: This article examines the academic staff gender disparity in engineering in the 21st Century through an analysis of Australian university staff statistics. The proportion of female academics in engineering is rising, but at a slow rate. In addition, women are more likely to be in junior classifications and less likely to be tenured than their male colleagues. Female engineering academics also tend to be younger than their male counterparts. Although the proportion of the engineering academic workforce made up by women is likely to increase beyond the current rate of about 16%, it will be a long time before engineering ceases to be a male-dominated discipline.

Keywords: Engineering, academic staff, faculty, female engineers, gender disparity

INTRODUCTION

The relative paucity of female involvement in engineering and technology is a common experience in the west, particularly so in the Anglo world. For example, women represent only 11% of the engineering workforce in the US [1], 10.5% in Canada [2] and 8.5% in the United Kingdom [3].

The gender disparity is less marked in some European countries, with the proportion of the engineering workforce exceeding 25% in Bulgaria, Croatia, Cyprus, Latvia, Lithuania and Romania [3]. However, in addition to the low female proportion in the United Kingdom, countries such as Switzerland, Austria, Finland and Ireland also have an engineering workforce in which women make up less than 15% [3]. The gender disparity in Australia is also emphatically male-oriented with women occupying less than 10% of engineering jobs [4]. Further, it has been reported that women who do become engineers are more likely to leave the profession [5].

Several reasons have been put forward for women and girls' apparent avoidance of engineering, including societal beliefs and the learning environment that tends to limit female interest in science and mathematics; differences in cognitive abilities in the area of spatial skills; and bias limiting women's progress in the scientific and engineering fields [6]. Hill et al note that

> *...to diversify the STEM [science, technology, engineering and mathematics] fields, we must take a hard look at the stereotypes and biases that still pervade our culture. Encouraging more girls and women to enter these vital fields will require careful attention to the environment in our classrooms and workplaces and throughout our culture* [6].

A potential problem that can arise from such a gender imbalance is having the engineering workforce drawn from only about half of the potential skilled labour force. In the context of the United Kingdom, it has been noted that

> *...as the skills gap begins to bite, it is vital that the UK capitalises on the skills of all of its available talent. Failure to promote careers in engineering for women will mean that we will continue to miss out on 50 per cent of the available talent, an oversight which could have serious repercussions for society and the future strength of the economy* [7].

The same arguments hold for Australia or any country with a gender imbalance in any workforce segment.

Just as women are under-represented in the Australian engineering workforce overall, so they are in the engineering academic workforce. Although the female proportion is increasing, the distribution remains lopsided. The female under-representation in engineering faculties should not be unexpected, because women and girls are also under-represented in the earlier sections of the pipeline. The fact that fewer girls than boys do science, mathematics and technology subjects at school, means fewer young women studying engineering programmes at university, with the consequential numerical imbalance in all sections of the engineering workforce, including in the staff rooms of universities' engineering faculties.

DATA SOURCE

Australian universities are required to supply the Commonwealth education ministry with a range of student and staff data each year. From the unit record files supplied by each university, education ministry staff compile and publish a range of statistical summaries and aggregated data sets that can be used by researchers and others to suit their specific purposes. This article is based on analysis of aggregated data files for the period 2001 to 2009. The ministry changed the manner in which it releases statistical information during 2011, and unfortunately, the data available for 2010 and 2011 do not provide any way of separating out engineering staff from staff in other disciplines.

The specific population analysed was of university academic staff in ranks from associate lecturer to professor (Levels A to E, respectively) working in academic departments. Academics working in administration or in academic support roles were not included in this analysis. The staff members enumerated were either full-time, or fractional full-time. Fractional full-time refers to staff with on-going positions that are for less than the whole week. The tables measure *full-time equivalence* (FTE), not the number of people. That is, a full-time academic has a full-time equivalence of 1.0, as would two half-time academics. Staff with casual (hourly paid) positions were not included in this study because the data on casual staff are not as thorough as those for full-time and fractional full-time staff. However, it is known that there has been a rapid growth in the use of casual academic staff, particularly for teaching [8][9]. The academic staff members this article is about are formally described as being in the discipline of Engineering and Related Technologies, mostly truncated to *engineering* in the text hereafter.

WOMEN AND THE ENGINEERING ACADEMY

Enrolments by women have predominated in Australian higher education since 1987 [10], and by 2009, women represented 55.4% of the 1.13 million university population [11]. Women are in the majority among students in all but the fields of engineering (15.7% are women), information technology (19.6%), architecture and building (40.1%), and management and commerce (49.5%) [11]. In university academic staffing overall, women are not in the majority, but their proportion is increasing. By 2009, women represented about 45% of all academic staff in Australian universities.

Table 1 provides a summary of academic staff numbers from 2001 to 2009, comparing those in Engineering and Related Technologies with all other disciplines. Looking first at engineering, it can be seen that there has been strong growth in the number of women in engineering (84.6%), but this has been off a low base. In the same period, the number of male engineering academics increased by 28.3%, but in absolute terms, there were 582 more male engineering academics, but only an extra 222 female academics. However, by 2009, women made up only 15.5% of the Australian academic engineering workforce, up from 11.3% in 2001. From the table, it can be calculated that the engineering proportion of the overall university academic workforce was relatively stable, increasing its proportion marginally from 8.0% to 8.4%.

Table 1: Academic staff 2001-2009. Engineering all other disciplines by gender.

	2001	2003	2005	2007	2009	Growth	
	FTE No.	FTE No.	FTE No.	FTE No.	FTE No.	FTE No.	%
Engineering and Related Technologies							
Female	262	306	342	389	484	222	84.6%
Male	2058	2167	2299	2423	2640	582	28.3%
Total	2320	2473	2641	2812	3124	804	34.6%
Female % of Sub-total	11.3%	12.4%	13.0%	13.8%	15.5%		
Other Disciplines							
Female	10250	11139	12446	13766	15118	4868	47.5%
Male	16432	16767	17653	18408	18840	2408	14.7%
Total	26682	27906	30099	32174	33958	7276	27.3%
Female % of Sub-total	38.4%	39.9%	41.4%	42.8%	44.5%		
All Academic Staff	29002	30380	32740	34986	37082	8079	27.9%

Source: DEEWR Aggregated Data Sets 2001-2009. FTE = *full-time equivalent*

The female proportion is increasing slowly, with the biggest jump occurring between 2008 and 2009 (+95). The number of male engineering academics also increased by more between 2008 and 2009 than between other years (+217). In fact, a closer examination of the increase in the number of female academics in engineering between 2008 and 2009 reveals that 45 of the 95 increase came from expansion at two universities, including 32 from just one university.

Without further information on why half of the increase in women is so focussed on two institutions, one could imagine that either or both of the universities in question established a new engineering teaching unit or research centre, or perhaps corrected coding errors from the past. The annual increase in the number of female academics into the future is more likely to revert to the average of 40 or so extra women that joined engineering faculties in the years 2001 to 2008. The growth in the number of male academics also increased more between 2008 and 2009, with greater-than-would-normally-be-expected growth at three universities.

If the growth in the engineering academic workforce of 34.6% seems to have been quite strong, it should be remembered that not all of the staff involved are involved in teaching; many are hired by universities not to teach, but to spend all of their time undertaking research projects. In fact, staff involved in teaching engineering increased by only 190 FTE, or 10.8%, rather less than the growth in student numbers of around 30% [12]. The number of academic *research only* staff in engineering increased by 613 FTE, nearly 70% [12].

The gender disparity in the engineering academic workforce is made even plainer by Figure 1, which shows the number of women and men (expressed as full-time equivalents) (stacked columns, left axis), and the proportion of women (line, right axis).

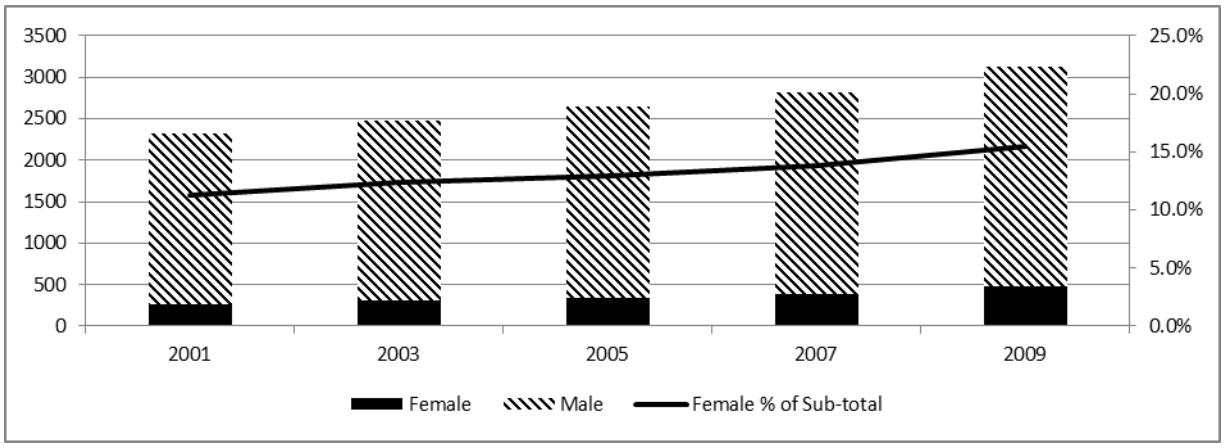

Figure 1: Academic staff 2001-2009 (full-time equivalent) Engineering and Related Technologies by gender and proportion of women.

Table 2 presents a distribution of engineering academic staff by gender and academic rank for 2001, 2005 and 2009, the proportions of total for each level, and the distribution within genders. In the three years shown, men numerically dominate women at all ranks, occupying 75.0% of associate lecturer positions, to 93.4% of professorships in 2009, for example.

Table 2: Academic Staff 2001, 2005 and 2009. Engineering and Related Technologies by gender and academic rank.

Gender/Level	2001			2005			2009		
Female	FTE No.	% of Level	% of Gender	FTE No.	% of Level	% of Gender	FTE No.	% of Level	% of Gender
Professor (E)	8	3.0%	3.1%	13	4.1%	3.9%	30	6.6%	6.2%
Associate Professor (D)	13	3.7%	4.8%	23	6.1%	6.6%	39	9.8%	8.0%
Senior Lecture (C)	51	7.4%	19.6%	77	10.7%	22.6%	91	11.5%	18.9%
Lecturer (B)	93	15.6%	35.6%	125	16.8%	36.5%	178	19.7%	36.8%
Associate Lecturer (A)	97	23.0%	36.9%	104	21.7%	30.4%	146	25.0%	30.2%
Sub-total	262	11.3%	100.0%	342	13.0%	100.0%	484	15.5%	100.0%
Male									
Professor (E)	256	97.0%	12.5%	307	95.9%	13.4%	423	93.4%	16.0%
Associate Professor (D)	332	96.3%	16.1%	351	93.9%	15.3%	354	90.2%	13.4%
Senior Lecture (C)	639	92.6%	31.0%	647	89.3%	28.1%	699	88.5%	26.5%
Lecturer (B)	507	84.4%	24.6%	620	83.2%	27.0%	726	80.3%	27.5%
Associate Lecturer (A)	324	77.0%	15.8%	374	78.3%	16.3%	439	75.0%	16.6%
Sub-total	2058	88.7%	100.0%	2299	87.0%	100.0%	2640	84.5%	100.0%

Source: DEEWR Aggregated Data Sets 2001, 2005 and 2009. FTE = *full-time equivalent*

One thing that can be noted from Table 2 is that women tend to be clumped in the less senior ranks of associate lecturer and lecturer. Whereas 36.8% and 30.2% of female engineering academics in 2009 occupied lecturer and associate lecturer positions, respectively, the proportions of their male colleagues were 27.5% and 16.6%, respectively. In the senior ranks, 6.2% of women held professor posts, compared with 16.0% of men. In fact, 93.4% of professors in engineering were men. The situation was also unbalanced at the associate professor level: 8.0% women held this rank, compared with 13.4% of men. The median rank for women in engineering was at the lecturer level (Level B) in 2009, whereas for men it was senior lecturer (Level C).

Although academic engineering is clearly male-dominated, the proportion of women at each level and overall is slowly increasing. The situation in 2009 was clearly improved in all respects compared with 2001.

Table 3 considers the gender and tenure mix of academic staff in Engineering and Related Technologies at Australian universities. Women are less-well represented in tenured positions compared with their male colleagues. In 2009, 1,567 academics occupied tenured positions in engineering, but 37.3% of women had tenure, compared with 52.5% of men.

Table 3: Academic staff 2003-2009. Engineering and Related Technologies by tenure and gender.

	2001			2005			2009		
Tenured	FTE No.	% of Gender	% of Tenure	FTE No.	% of Gender	% of Tenure	FTE No.	% of Gender	% of Tenure
Female	100	38.0%	7.3%	140	41.1%	9.6%	180	37.3%	11.5%
Male	1261	61.3%	92.7%	1324	57.6%	90.4%	1387	52.5%	88.5%
Sub-total	1360	58.6%	100.0%	1464	55.4%	100.0%	1567	50.2%	100.0%
Untenured									
Female	162	62.0%	16.9%	202	58.9%	17.1%	303	62.7%	19.5%
Male	798	38.7%	83.1%	975	42.4%	82.9%	1253	47.5%	80.5%
Sub-total	960	41.4%	100.0%	1177	44.6%	100.0%	1557	49.8%	100.0%

Source: DEEWR Aggregated Data Sets 2001, 2005 and 2009. FTE = *full-time equivalent*

The reciprocal proportions for untenured positions in 2009 were 62.7% and 47.5% for women and men, respectively. The proportion of women in tenured and untenured positions respectively changed little between 2001 and 2009, but the proportion of male engineering academics with tenure declined from 61.3% to 52.5% over the period. The situation for untenured posts is that there has been little change in the situation for women, but an increase in the proportion of untenured male engineering academics.

The overall decline in the rate of tenure in engineering (as in other disciplines) is related to the relative expansion in the number of short-term *research only* positions, as mentioned earlier. *Research only* staff tend to be hired to undertake projects that will last from one to five years, so in one sense it is understandable that the overall tenure rate among academics would drop in an environment in which much of the staff growth is for staff to work on specific research projects, but not to teach.

Table 4: Academic Staff 2003 - 2009. Engineering and Related Technologies by age group and gender.

	2001			2005			2009		
Tenured	No.	% of Gender	% of Age Group	No.	% of Gender	% of Age Group	No.	% of Gender	% of Age Group
Age < 35									
Female	86	32.8%	20.7%	107	31.3%	19.2%	169	35.0%	20.5%
Male	328	15.9%	79.3%	451	19.6%	80.8%	656	24.8%	79.5%
Sub-total	414	17.8%	100.0%	558	21.1%	100.0%	825	26.4%	100.0%
Age 35-54									
Female	166	63.4%	11.1%	213	62.3%	13.6%	277	57.2%	16.2%
Male	1333	64.8%	88.9%	1359	59.1%	86.4%	1435	54.4%	83.8%
Sub-total	1499	64.6%	100.0%	1573	59.5%	100.0%	1712	54.8%	100.0%
Age > 54									
Female	10	3.8%	2.5%	22	6.4%	4.3%	38	7.8%	6.4%
Male	397	19.3%	97.5%	488	21.2%	95.7%	549	20.8%	93.6%
Sub-total	407	17.5%	100.0%	510	19.3%	100.0%	587	18.8%	100.0%
Total	2320			2641			3124		

Source: DEEWR Aggregated Data Sets 2001, 2005 and 2009. FTE = *full-time equivalent*

The last point of investigation in this article is the age of the engineering academic workforce, by gender, as considered in Table 4. Overall, relatively more women are in younger age groups than their male counterparts. In 2009, 35.0% of women were younger than 35 years, compared with 24.8% of men. However, the proportion of male academics aged less than 35 years increased from 15.9% in 200. In fact, the number of academics in the youngest age group, whether male or female, doubled between 2001 and 2009.

Over half of both female and male academics were in the middle years between 35 and 54 years of age in 2009, whereas the proportion in this age bracket had been about 64% (female and male academics) in 2001. Among senior-aged engineering academics, there were only 10 women in 2001, and only 38 by 2009, but the proportion of women in this senior group increased from 3.8% to 7.8% over that period. The proportion of men in this senior group changed little between 2001 and 2009. In 2001, 19.3% of male engineering academics were older than 54, compared with 20.8% in 2009.

LOOKING INTO THE CRYSTAL BALL

Based on the information available about university engineering and the engineering workforce, what might be predicted for coming years? The number of women in academic engineering has increased this Century, and the proportion of women has also been increasing. As was shown in the first table, the proportion of female engineering academics increased from 11.3% to 15.5%, and about 28% of the increase in full-time and fractional full-time academics between 2001 and 2009 was produced by the increase in the number of women.

However, with this growth coming off such a small base, it is unlikely that women will make up anything like half the engineering academic workforce for many years to come. There is unlikely to be much improvement in the rate of tenure for women in engineering, because much of the growth in staffing has been of short-term *research only* positions.

The average increase for the period 2001 to 2009 was influence by the larger than normal growth between 2008 and 2009, particularly at three universities. Assuming this spurt to be a one-off occurrence, growth in engineering academic numbers into the future is unlikely to continue at the pace suggested by the growth between 2008 and 2009.

There is also a supply side issue. Assuming that a PhD degree represents a barrier to entry to an academic career, the Australian university system is probably not producing enough female PhD graduates in engineering to add to the existing stock of female engineering academics. Over the past four or five years, 700 or so engineering PhD graduates have been produced each year. Only about 20% of these are women, so there are around 150 new female PhD graduates in engineering per year. About one-third of these are international students, many of whom will leave Australia after their study [12].

It is, therefore, unlikely that Australian universities will see much change in the number of women in their engineering faculties, even though there will continue to be more women entering this male-dominated discipline than in the past. On the seniority front, the relatively younger female engineering academics will gradually move up the seniority ranks, and eventually to the ranks of associate professor and professor.

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BIOGRAPHY

Dr Ian R. Dobson was a career administrator, predominantly in strategic planning and statistical analysis. In his formal career he held posts at the Royal Melbourne Institute of Technology (RMIT), now RMIT University, the University of Melbourne and Monash University, between 1971 and 2005. Since then, he has been a freelance researcher, editor and consultant, and he is currently working as a research director with the University of Helsinki, Finland. He has authored or co-authored about 70 papers published in scholarly refereed journals and is editor of the Journal of Higher Education Policy and Management and the Australian Universities' Review. His PhD was on access to higher education, social mobility and higher education equity policy.