2 February 2012

Chief Scientist

Committee Secretary
Senate Education, Employment and Workplace Relations
Committees
PO Box 6100
Parliament House
Canberra ACT 2600

Re: Enquiry into the shortage of engineering and related employment skills.

This submission is to inform the Senate Education, Employment and Workplace Relations References committee of a major project being undertaken by the Office of the Chief Scientist (OCS) that is relevant to the abovementioned enquiry.

The *Health of Australian Science* (*HAS*) project will be completed in late March 2012 and it is anticipated that the findings will be delivered to the Prime Minister's Science, Engineering and Innovation Council at its next meeting.

The *HAS* project is a comprehensive assessment of available data to profile the strengths and vulnerabilities of Australia's present science capability. This profile is being analysed in the contexts of emerging science areas and the increasing internationalisation of science.

Key questions that are being addressed include:

1. What is the breadth and quality of Australian science across all disciplines and sectors and how does it compare internationally?
2. What are the emerging science areas and does Australia have the necessary skills in those areas?
3. What does Australian science need to look like in 2020 to drive innovation across all sectors of the economy, deliver health and well-being outcomes for all citizens, underpin sufficient defence capability, and generate the breadth of evidence required for sound decision-making across government, business and community?

The project's scope incorporates the entire system from the supply side in the schools sector, through higher education and research sectors, to the demand side in government and private sectors. I expect that the project outcomes will be of considerable interest to the committee, particularly with respect to the supply of engineering graduates and researchers.

Providing recommendations from the project to the enquiry at this point in time would be premature. Engineering is a discipline firmly in the national interest and is therefore under detailed investigation. To illustrate partially the breadth of information being considered a brief overview of the Engineering component of the *HAS* project is included at Attachment A.

Yours sincerely

Professor Ian Chubb AC
Australia's Chief Scientist

ATTACHMENT A: BRIEF OVERVIEW OF THE ENGINEERING DISCIPLINE

Headlining this overview of the engineering discipline is:

1. 9149 bachelor (pass and honours) completions in engineering in 2010[i]
2. 2857 full time equivalent teaching/research staff in 2009[ii]
3. $10.3 billion total R&D spend on *Engineering* in 2008-09[iii]
4. 80% or more engineering graduates across most sub-disciplines are in full time employment within 4 months of graduating[iv]

1. University students enrolled in engineering

The broad field of education representing engineering is *Engineering & Related Technologies (ASCED Code 03)*. Completions information for this field of education in 2010 is listed in Table 1. The trend of student completions for engineering sub-disciplines is shown in Figure 1. There has been a steady increase in bachelor degree completions over the period 2002-10; the total engineering bachelor completions (pass and honours) increased from 7467 in 2002 to 9149 in 2010[v]. This represents a modest decline in engineering completions as a proportion of total bachelor completions across all fields of education from 6.1% to 5.8%. In the first part of this period international students grew as a proportion of the total cohort from 31% to 42%, but since 2005 the proportion has remained roughly constant (43.4% in 2010) (Figure 1).

Table 1: *Completions information for the broad field of education (FOE) Engineering & Related Technologies (ASCED Code 03) for 2010[vi].*

Course level	Completions for ASCED Code 03	% of completions across all FOE
Bachelors (inc. Honours)	9149	5.8
Postgraduate coursework	3684	5.5
Higher degree research	985	15.8
All course levels	13818	6.0

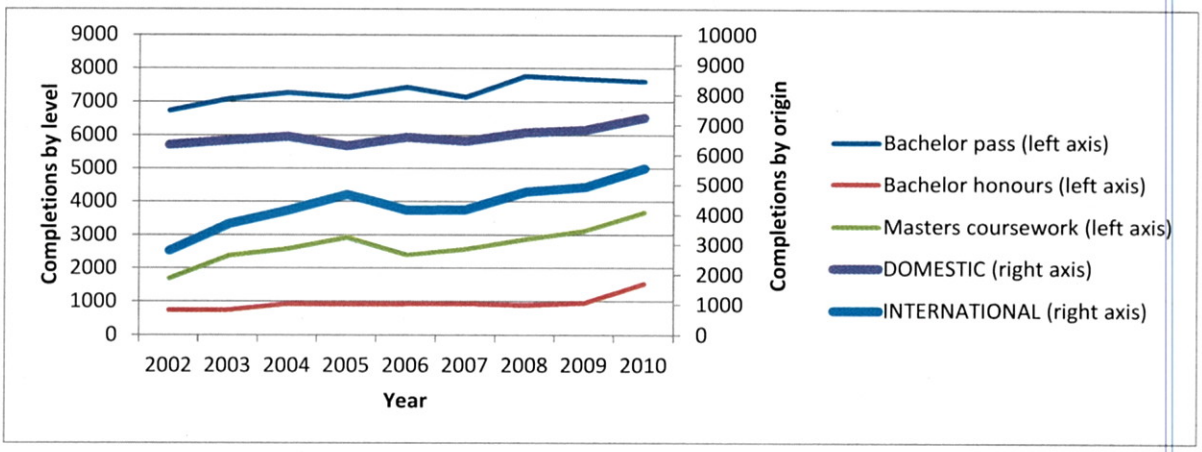


Figure 1: *Bachelor and Masters Course work completions for the period 2002-10 for engineering sub-disciplines. Also shown is the aggregate of Bachelor and Masters Course work completions split into domestic and international components[vii].*

2. University teaching and research in engineering

The broad field of research representing engineering is *Engineering (ANZSRC Code 09)*. The full-time equivalent staffing profile of the entire *Engineering* discipline in 2009 was similar to the overall staffing profile with most staff at Level B (Figure 2). There is, however, noticeably less staff at Level B as a proportion of the engineering staff cohort compared with the overall staffing profile (Figure 2).

Over the period 2002-10 there were a total of 7789 higher degree research (HDR) completions in engineering, with the annual completion rate increasing from 666 at the start of the period to 985 at the end[viii]. In 2002 the proportion of domestic HDR completions was 79%, but by 2010 this had decreased to 58%[ix].

The total number of competitive ARC research grants awarded to engineering in 2010 was 239, with a total funding value of $91 million[x]. This represented approximately 14.9% of the total number of grants and 17.1% of the total funding value awarded across all fields of research. Over the period 2002-10 engineering's proportion of the total competitive ARC research grants was smallest in 2006, but since then it has been steadily increasing back toward the maximum that it enjoyed in 2002 (Figure 3).

One measure of research excellence in engineering is the ERA rating; where an ERA rating of 3 or above indicates performance at world standard or above. For the reporting period 2006-08 all but two engineering sub-disciplines for which sufficient outputs were submitted for consideration were performing at or above world standard; with Aerospace, Environmental, Manufacturing, Resources and Interdisciplinary Engineering all performing significantly above world standard[xi] (Table 2).

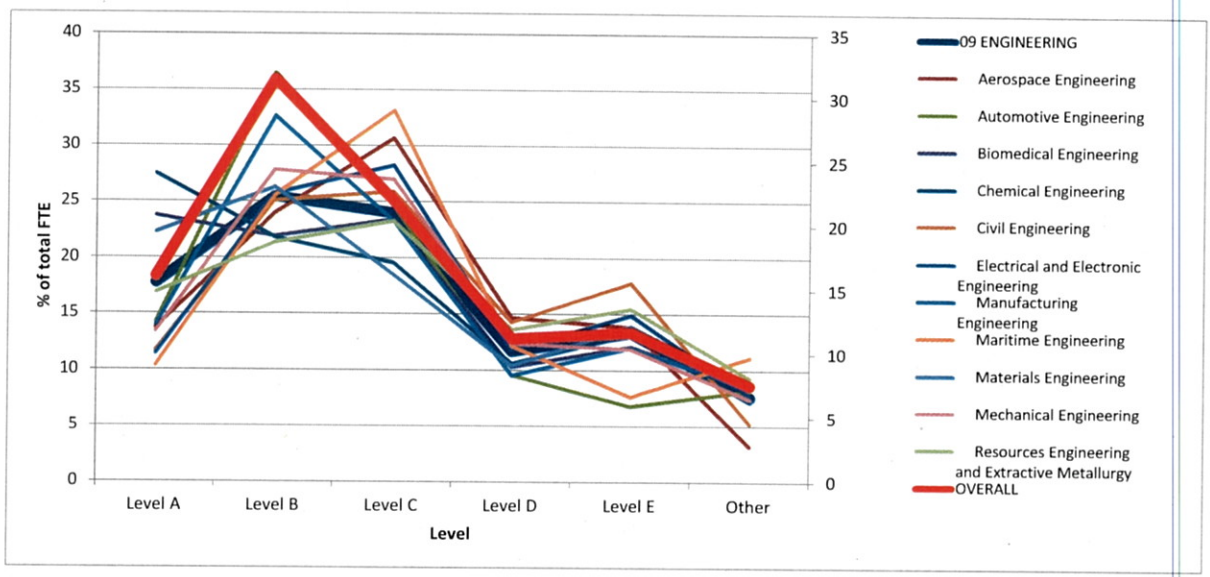


Figure 2: *Staffing profiles for the broad field of research Engineering (ANZSRC Code 09), engineering sub-disciplines, and the overall staffing profile across all academic disciplines*[xii].

Table 2: *ERA ratings for the broad field of research Engineering (ANZSRC Code 09) and the engineering sub-disciplines for 2010*[xiii].

Field of Research	ERA Rating	Field of Research	ERA Rating
09 Engineering	3.6	Geomatic engineering	2.7
Aerospace engineering	5.0	Manufacturing engineering	4.0
Automotive engineering	n/a	Maritime engineering	n/a
Biomedical engineering	3.3	Materials engineering	3.5
Chemical engineering	2.9	Mechanical engineering	3.8
Civil engineering	3.7	Resources engineering	4.1
Electrical & electronic engineering	3.7	Interdisciplinary engineering	4.5
Environmental engineering	4.0	Other engineering	n/a
Food sciences	3.3		

3. R&D spend on engineering

In 1996-97 the total gross expenditure on Engineering R&D as a proportion of the total R&D across all research disciplines was 17.3%, but this figure doubled in 2000-01 when Engineering and Technology combined in the reporting of R&D spend[xiv]. Since 2000-01 there has been a steady increase in the percentage of R&D spend on Engineering & Technology to a value of 42.3% in 2008-09[xv]. The largest contributor to gross expenditure on R&D in engineering, and the sector accounting for most of the recent increase, is the business sector (Figure 4).

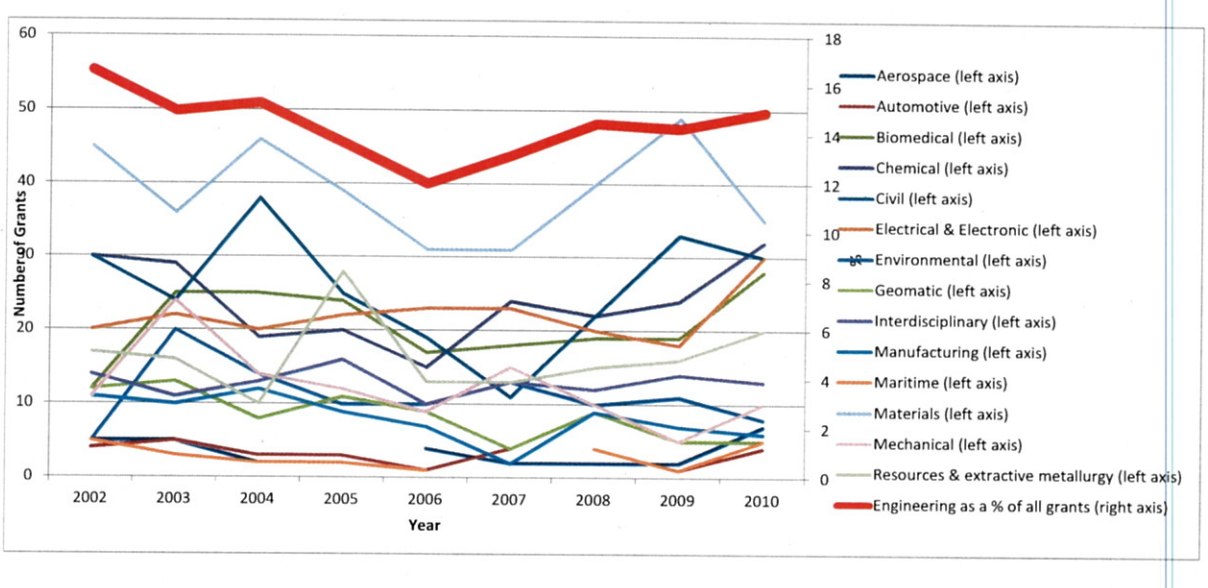


Figure 3: *Number of competitive grants (ARC Discovery, Linkage, Networks and Fellowships) for engineering sub-disciplines, and these as a proportion of all grants across all fields of research*[xvi].

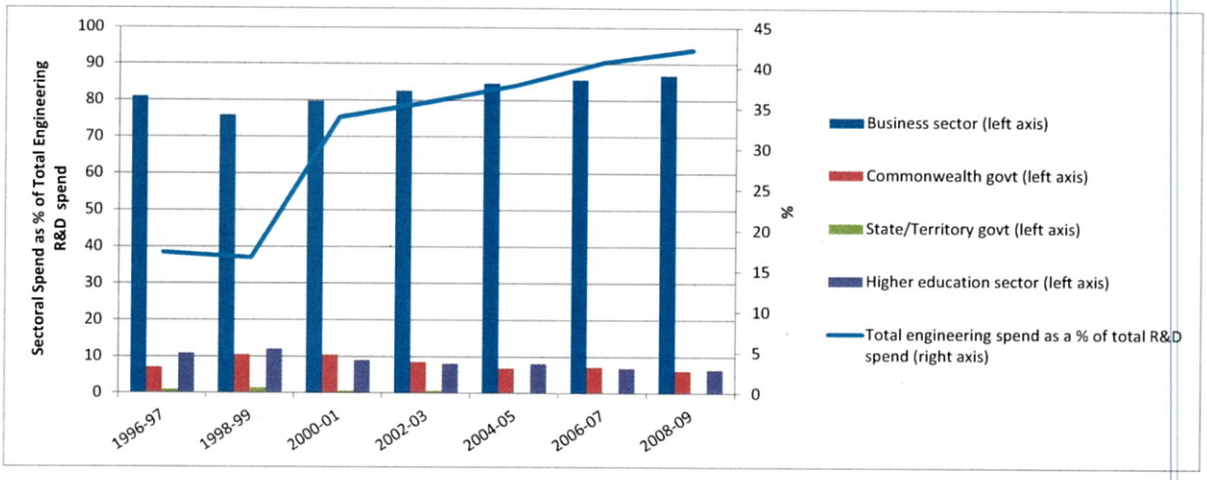
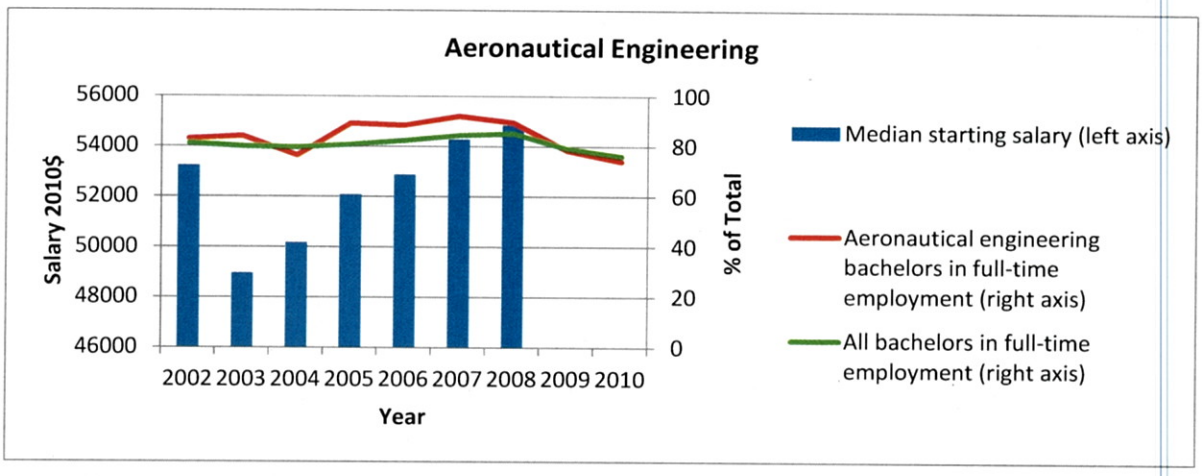
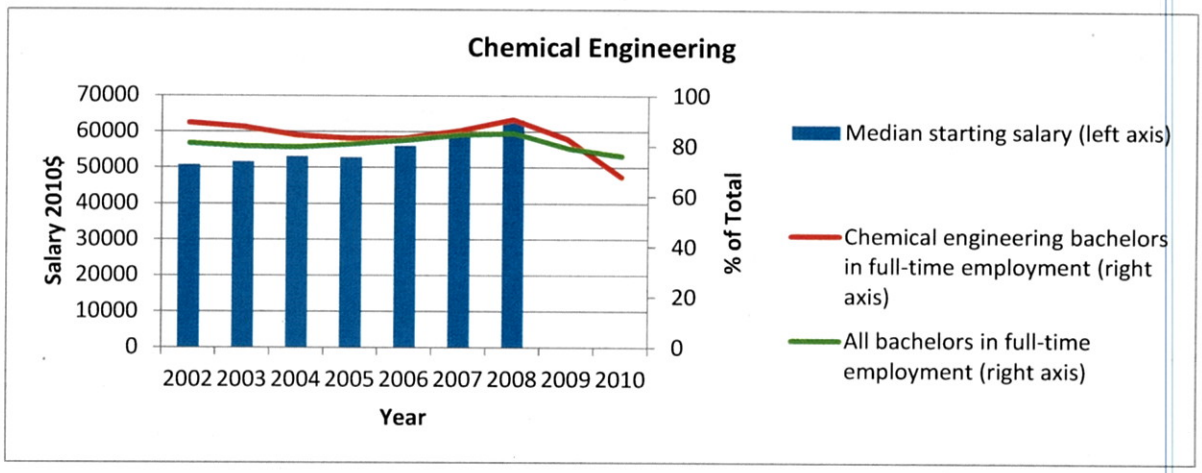


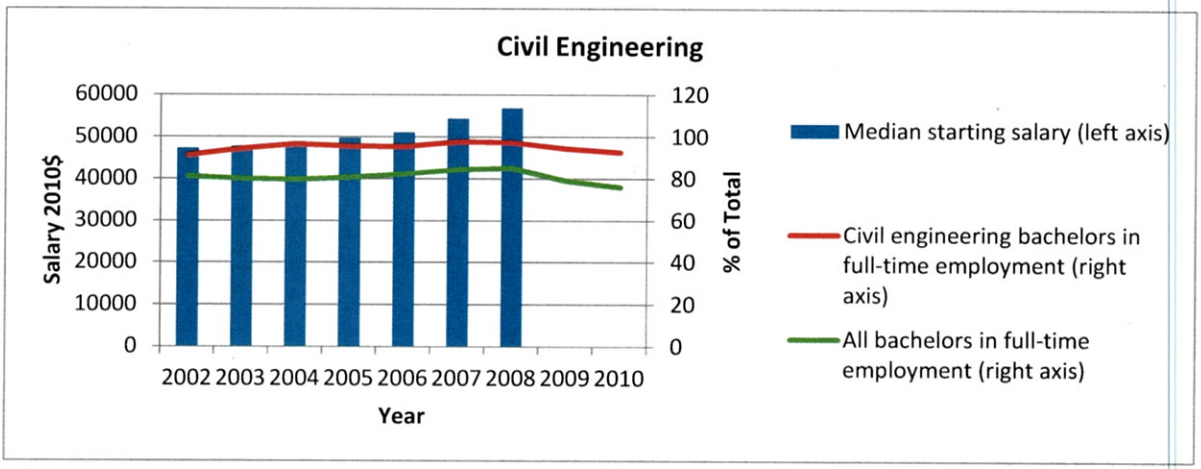
Figure 4: *Sectoral spend as a percentage of total spend on Engineering & Technology R&D, and the total spend on Engineering & Technology R&D as a percentage of total spend on all R&D*[xvii].

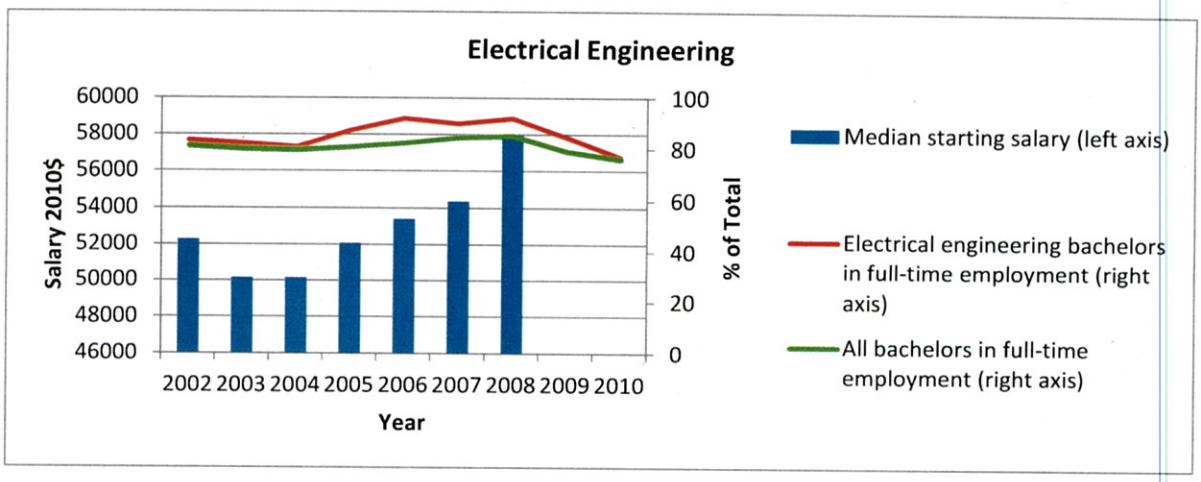
4. Demand for graduates in engineering

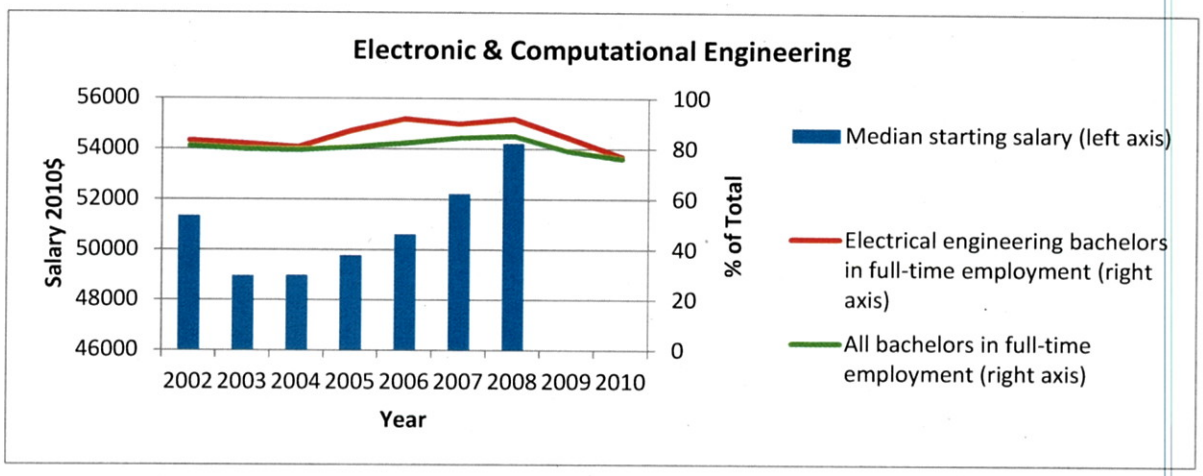
One measure of the demand for graduates is the percentage of bachelor degree graduates seeking full-time employment that were in full-time employment within 4 months of completing their degree. For the period 2002-10 the percentage uptake for engineering graduates within 4 months was generally above 80% for all fields of engineering, and was almost always higher than that for bachelor degree graduates generally (Figure 5).

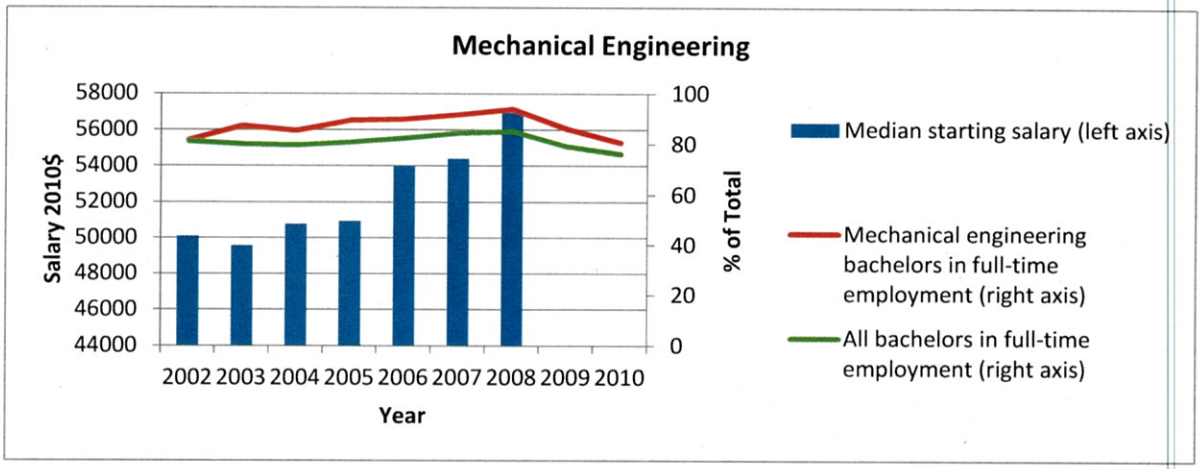







Electrical Engineering
Salary 2010$
60000
58000
56000
54000
52000
50000
48000
46000
100
80
60
40
20
0
% of Total
2002 2003 2004 2005 2006 2007 2008 2009 2010
Year
Median starting salary (left axis)
Electrical engineering bachelors in full-time employment (right axis)
All bachelors in full-time employment (right axis)


Electronic & Computational Engineering
Salary 2010$
56000
54000
52000
50000
48000
46000
100
80
60
40
20
0
% of Total
2002 2003 2004 2005 2006 2007 2008 2009 2010
Year
Median starting salary (left axis)
Electrical engineering bachelors in full-time employment (right axis)
All bachelors in full-time employment (right axis)


Mechanical Engineering
Salary 2010$
58000
56000
54000
52000
50000
48000
46000
44000
100
80
60
40
20
0
% of Total
2002 2003 2004 2005 2006 2007 2008 2009 2010
Year
Median starting salary (left axis)
Mechanical engineering bachelors in full-time employment (right axis)
All bachelors in full-time employment (right axis)

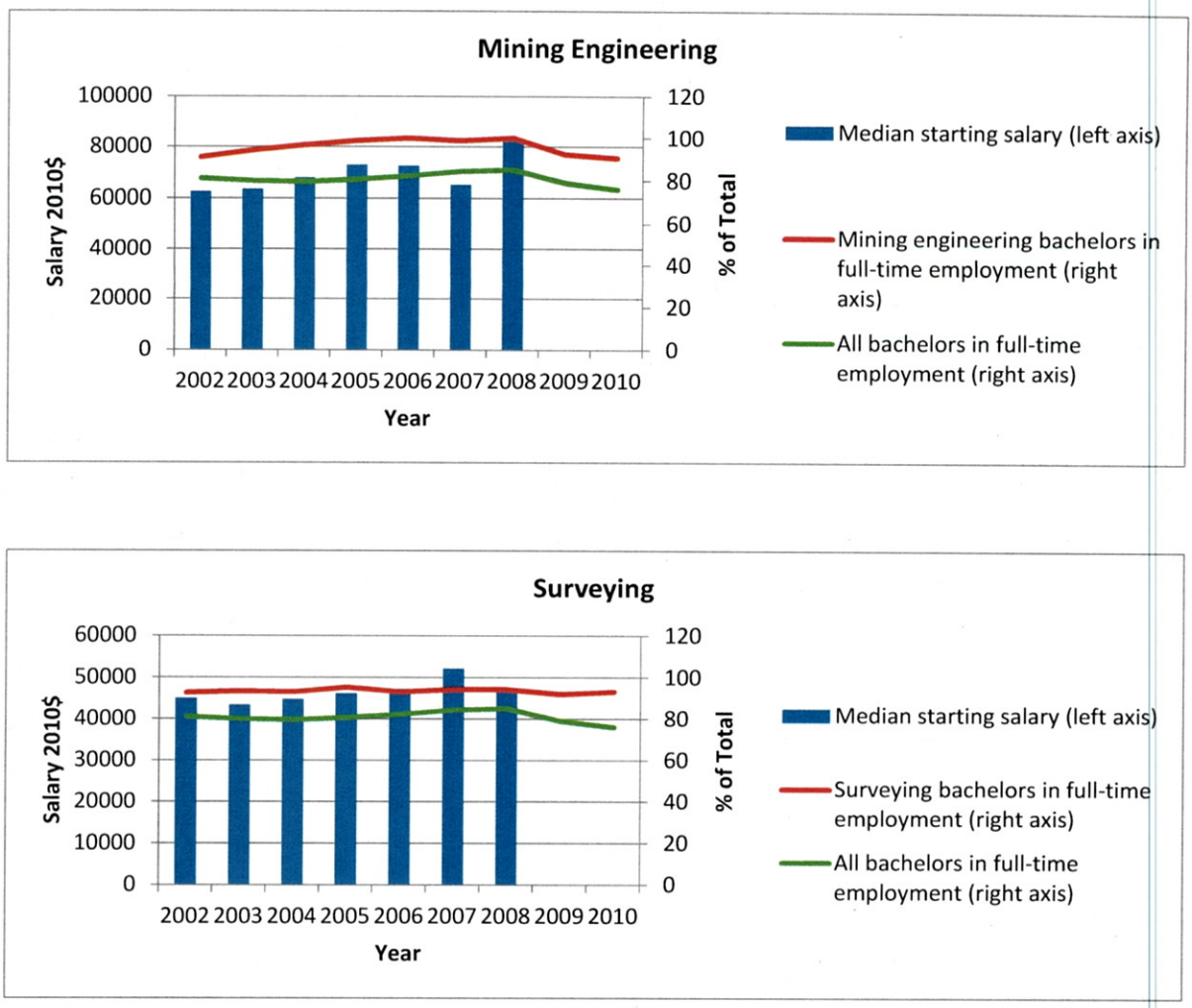


Figure 5: *Percentage of bachelor degree graduates in full-time employment in engineering sub-disciplines four months after completion, compared with the percentage of all bachelor degree graduates in full-time employment. The median starting salary for engineering bachelor graduates is also shown*[xviii].

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[i] Source: Original data from DEEWR Higher Education census.
[ii] Source: Original data from Australian Research Council, 2010. *ERA 2010 National Report*, Australian Government.
[iii] Source: Original data from Australian Bureau of Statistics, Gross expenditure on R&D by sector-by field of research, 2008-09; including business, commonwealth, state and territory government, and higher education sectors.
[iv] Source: Original data from Graduates Careers Australia, accessed at http://start.graduatecareers.com.au/Resourcelibrary/GradStatsandGradFiles/index.htm on 30 January 2012.
[v] See 1.
[vi] ibid.
[vii] ibid.
[viii] ibid.
[ix] ibid.
[x] Source: Original data from the Australian Research Council national competitive grants data base.
[xi] Australian Research Council, 2010. *ERA 2010 National Report*, Australian Government.
[xii] Source: Original data from Australian Research Council, 2010. *ERA 2010 National Report*, Australian Government.

[xiii] See 11.
[xiv] Australian Bureau of Statistics, Gross expenditure on R&D by sector-by field of research, 1996-97 to 2008-09; including business, commonwealth, state and territory government, higher education and private non-profit sectors.
[xv] ibid. Note that there was a change in accounting in 2000-01 (and subsequent) so that the engineering category also included technology.
[xvi] See 10.
[xvii] See 14 and 15.
[xviii] Source: See 4. Salaries have been converted to 2010 dollars.