THE ENGINEERING PROFESSION

A Statistical Overview

Fourth Edition March 2006

ENGINEERS
AUSTRALIA

ISBN 0858258137

Engineers Australia
11 National Circuit
Barton ACT 2600
tel 02 6270 6581
fax 02 62734200
email policy@engineersaustralia.org.au
www http://www.engineersaustralia.org.au

ENGINEERS
AUSTRALIA

1. INTRODUCTION

Engineering is one of the key enabling professions in the Australian economy. Examples of engineering design, products and services permeate all aspects of everyday life. Engineers apply their skills in numerous ways, in specialist technical occupations, in design, in management and in entrepreneurship.

Engineers Australia is the peak body for engineering practitioners in Australia, representing all disciplines and branches of engineering. All *Engineers Australia* members are bound by a common commitment to promote engineering and to facilitate its practice for the common good. In December 2005 *Engineers Australia* membership had grown to 75,798. Almost two-thirds of these members were degree qualified professional engineers or engineering technologists. *Engineers Australia's* members are relatively younger than the broad spectrum of professional occupations in Australia[1].

Understanding the characteristics, size and scope of any profession is a fundamental aspect of understanding that profession's role in the development of Australian society and the economy. The most discussed present day engineering topic is whether the available supply of engineers is sufficient to meet present day requirements. While frequently discussed in the context of the minerals export boom, large numbers of engineers are involved and/or required in the building and construction sector, in the construction of infrastructure and the delivery of infrastructure services which are the hallmark of a modern, sophisticated society. Less well known, but equally important, engineers are critical to the management of water supplies, the achievement of energy efficiency and development of renewable energy sources, resource management, the development of medical and rehabilitation technologies and tools. Engineers are increasingly becoming more critical to the management of the quality of Australia's environment, oil, gas and electricity industries, mining, manufacturing and to infrastructure investment projects across the board.

This Handbook is designed to provide an overview of the engineering profession in Australia. In many spheres of life ideal statistics to achieve such a task are not available. This proved to be the case for the engineering profession. To overcome this limitation statistics from a wide variety of sources have been combined to provide the best available overview. Gaps remain and in coming years *Engineers Australia* will endeavour to remedy these by negotiating with responsible authorities, refining existing collections and analyses and, where possible, considering new ways to obtain the necessary information.

2. THE ENGINEERING PROFESSION

2.1 WHAT IS ENGINEERING?

Engineering is the art and science of production. It is a pragmatic activity that draws on imagination, judgement, integrity, and intellectual discipline to apply science, mathematics and practical experience to design and operate useful objects and/or processes that meet the needs and expectations of people. Engineering is pragmatic because solutions to real world problems cannot always wait until the phenomena which influence them are completely understood using rigorous scientific methodologies.[2] Most engineering problems cannot wait and engineers are required to find solutions even when aspects of the underlying science have not been resolved.

Although there is overlap between fundamental and applied science, on the one hand, and engineering, on the other, the two fields are quite distinct. Scientists attempt to explain phenomena, and engineers use any knowledge, including that produced by scientists, to construct solutions to problems. Engineering research is different to scientific research because it typically deals with problems in which the basic science is well understood, but the problems are too complex to be solved exactly. What engineering research does is find approximations to the problems that can be solved, for example, by using semi-empirical methods such as parameter variation. Put simply, "scientists build in order to learn, but the engineer learns in order to build."[3]

The internal structure of engineering comprises the following elements; engineering science, design and development and management and organisation. Engineering science draws together the results of different scientific disciplines to provide the intellectual foundation of engineering. It sets out in an integrative way principles and mechanisms from several academic disciplines to systematically resolve broad classes of problems. Design and development relies on experience, intuition and scientific training to apply these resolutions to particular problems. Problem resolutions are transformed into practise through the management and organisation of available resources, including personnel, physical and social constraints and economics. Indeed, engineers pioneered modern business administration.[4] Besides the close links to science, the external structure of engineering is closely related to industry in its broadest sense and taken together science, industry and engineering are the principle drivers of technology.[5]

2.2 ENGINEERS AND ENGINEERING SPECIALISATIONS

Professional engineers are required to take responsibility for engineering projects and programs in the most far reaching sense. This includes the reliable functioning of all materials and technologies used; their integration to form a complete and internally consistent whole; and the relationship between technical systems and the environment in which it functions. The latter includes understanding the requirements of clients and of society as a whole; working to optimise social, environmental and economic outcomes over the lifetime of the product or program; interacting effectively with the other disciplines, professions and people involved; and ensuring that the engineering contribution is properly integrated into the totality of the undertaking.

The work of professional engineers is predominantly intellectual in nature. In the technical domain, they are primarily concerned with the advancement of technologies and with the development of new technologies and their applications through innovation, creativity and change. Engineers may conduct research concerned with advancing the science of engineering and with developing new engineering principles and technologies. Alternatively, they may contribute to continual improvement in the practice of engineering, and in devising and updating the rules that govern it.

Professional engineers have a particular responsibility for ensuring that all aspects of projects are soundly based in theory and fundamental principle, and for understanding clearly how new developments relate to established practice and experience and to other disciplines with which they may interact.

Engineers by their nature are managers. Engineering projects require the integration of technology, physical and human resources, financial considerations and factors external to the project itself. This feature of engineering applies to all projects, but increases in complexity with project scale. Just as is the case in other disciplines, engineers accumulate experience as their careers progress. Experienced engineers accumulate both technical and managerial and organisational skills and it is this bundle of attributes which characterize engineers` career paths. It should not surprise anyone that engineers move into positions, including the formation of their own enterprises, associated with engineering management and general management.[6]

Engineering and engineers permeate every aspect of modern industrial economies. As societies have increased in the sophistication of their evolution and development, different fields of engineering have also been developed to deal with new and emerging problems. Australian Universities now offer courses in such diverse fields as the following.

- Manufacturing Engineering
- Process and Resources Engineering
- Chemical Engineering
- Mining Engineering
- Materials Engineering
- Automotive Engineering
- Mechanical Engineering
- Industrial Engineering
- Civil Engineering
- Construction Engineering
- Building Services Engineering
- Geotechnical Engineering
- Ocean Engineering
- Geomatic Engineering
- Electrical Engineering
- Electronic Engineering
- Computer Engineering
- Aerospace Engineering
- Maritime Engineering
- Environmental Engineering
- Biomedical Engineering
- Transport Engineering

2.3 THE ENGINEERING PROFESSION

Engineers Australia regards the engineering profession as all individuals formally qualified as engineers and utilising these skills in engineering practices, in engineering research, in teaching engineering and in general management of engineering related enterprises. There is no formal, official definition of the engineering profession, or for that matter, any profession, that is used in Australian official statistics. In the absence of an official definition, this section uses the *Engineers Australia* definition to estimate the size and distribution of the engineering profession in Australia.

Before continuing it is essential to draw out the distinction between the *Engineers Australia* definition of the engineering profession and the concept of *occupation* as used by the Australian Bureau of Statistics (ABS). The *Engineers Australia* definition emphasizes the attributes of particular individuals, in particular, the training and skills in engineering theory and practice acquired and accumulated by them. In contrast, the concept of occupation used by the ABS attributes skills and skill levels to the *tasks* and *jobs* which build into occupations.

The ABS emphatically emphasizes that occupational skills are not attributes of individuals.[7] An example will help clarify this. The skill level required for the occupation ASCO 2124 Civil Engineer is a Bachelor degree or higher in civil engineering and, an individual is said to be a Civil Engineer when he or she is predominantly engaged with a set of tasks associated with ASCO 2124. An individual who holds a Bachelor degree in civil engineering, and who has at least 5 years practical experience and is in charge of a major construction company is unlikely to be predominantly engaged with the tasks associated with ASCO 2124. It is more likely that he or she would be allocated to ASCO 1112 General Manager if the tasks undertaken are predominantly to do with running the company, or to ASCO 1221 Engineering Manager, if the tasks undertaken are predominantly to do with running one of the company's large construction sites.

The three occupations, ASCO 2124, ASCO 1112 and ASCO 1221, have the common skill level requirement, a Bachelors Degree in civil engineering, but are differentiated by the nature of the tasks predominantly undertaken, and in the case of the two management occupations, by having at least 5 years experience. This example illustrates a common career path for Civil Engineers. There are many corresponding examples in other disciplines and occupational fields. The characteristic feature of all these situations is that the individuals concerned remain part of the Engineering Profession. Unfortunately, this distinction between the Engineering Profession and ABS engineering occupations is not always understood and may result in inappropriate analyses and conclusions; that is, neither the General Manager nor the Engineering Manager would be classified as an engineer, even though an essential qualification for these positions is that the individuals occupying them must be professional engineers.

2.4 ESTIMATES OF THE SIZE OF THE ENGINEERING PROFESSION

The size of the engineering profession in Australia has been estimated by *Engineers Australia* from ABS Census data[8]. This is not the preferred way to do this. Given the opportunity, *Engineers Australia* would emulate the specialised survey methods used by the National Science Board in the United States[9]. This sophisticated data set enables comprehensive analyses of the education, employment and career paths of engineers and scientists to be undertaken. The Survey is part of the United States Science, Engineering and Innovation policy. However, given Australian circumstances, data of this sophistication is not available and it is necessary to estimate the best available surrogate.

Table 2.1 sets out estimates of the size of the engineering profession in Australia. The engineering profession in 2001 numbered 150,409 individuals qualified at the Bachelor Degree level. This measure is unable to discriminate between four year Bachelor in Engineering Degrees and three year Bachelor in Engineering Technology

Degrees and accordingly, Professional Engineers and Engineering Technologists are both included. The Engineering Team, which also includes Engineering Associates who hold Undergraduate Diplomas and Associate Degrees, numbered 267,538 in 2001.

TABLE 2.1
THE ENGINEERING PROFESSION, 2001

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRAD.	4564	13626	9636	27826
BACHELOR	23368	50471	48744	122583
SUB TOTAL	27932	64097	58380	150409
UNDERGRAD.	5869	36119	75141	117129
TOTAL	33801	100216	133521	267538

Source: Estimated unpublished 2001 Census data supplied by the ABS

Engineering home occupations are those closely associated with the essential qualification for that occupation. In the example of the previous sub-section, a Degree in civil engineering is a requirement for the occupation ASCO 2124 Civil Engineering, thus ASCO 2124 is the home occupation for civil engineers. Similarly, in the example ASCO 1112 General Manager and ASCO 1221 Engineering Manager are related occupations, that is, occupations in which engineering qualifications and experience are necessary, but where predominantly the tasks undertaken are not solely related to these qualifications and skills.

Engineers Australia specified the related occupations in Table 2.1 using the outcomes of the research sponsored by the United States National Science Board[10]. Support for this selection was the Engineers job functions reported by the Association of Professional Engineers, Scientists and Managers (APESMA) in its twice annual surveys of engineering salaries[11]. Table 2.2 shows the range and distribution of job functions for the decade 1996 to 2005. This Table shows how complex engineering positions are and provides some insight into the difficulties inherent in defining and classifying them. Table 2.1 still has a relatively high number of engineers in the "other occupations" category. Many of these occupy position not unlike the examples of the General Manager and the Engineering Manager discussed above, for example, a sales and marketing executive specialising in engineering equipment. However, it is also likely that some included in the "other occupations" category are qualified engineers not employed in ways in the least part relevant to the skills they hold. This requires further research.

TABLE 2.2
JOB FUNCTIONS UNDERTAKEN BY ENGINEERS 1996 TO 2005

FUNCTION	Jun-96	Jun-97	Jun-98	Jun-99	Jun-00	Jun-01	Jun-02	Jun-03	Jun-04	Jun-05
CONSTRUCTION SUPERVISION	204	229	261	199	207	188	171	211	214	185
DESIGN OF EQUIP./ PROCESSES	469	455	538	455	406	412	367	355	385	361
MANAGEMENT	938	1224	1136	1081	906	976	1021	1005	1105	947
PRODUCTION QUALITY ETC	406	392	406	373	306	324	299	290	301	290
PROJECT STUDY & ANALYSIS	330	363	394	323	290	310	303	327	353	308
RESEARCH & DEVELOPMENT	330	294	356	295	313	311	273	283	271	247
SALES & MARKETING	104	89	123	109	82	84	90	58	51	57
TEACHING & TRAINING	48	46	44	22	16	18	18	22	24	21
OTHER	363	317	330	277	225	274	264	283	300	276
TOTAL	3192	3409	3588	3134	2751	2897	2806	2834	3004	2692

FUNCTION	Jun-96	Jun-97	Jun-98	Jun-99	Jun-00	Jun-01	Jun-02	Jun-03	Jun-04	Jun-05
CONSTRUCTION SUPERVISION	6.4	6.7	7.3	6.3	7.5	6.5	6.1	7.4	7.1	6.9
DESIGN OF EQUIP./PROCESSES	14.7	13.3	15.0	14.5	14.8	14.2	13.1	12.5	12.8	13.4
MANAGEMENT	29.4	35.9	31.7	34.5	32.9	33.7	36.4	35.5	36.8	35.2
PRODUCTIO QUALITY ETC	12.7	11.5	11.3	11.9	11.1	11.2	10.7	10.2	10.0	10.8
PROJECT STUDY & ANALYSIS	10.3	10.6	11.0	10.3	10.5	10.7	10.8	11.5	11.8	11.4
RESEARCH & DEVELOPMENT	10.3	8.6	9.9	9.4	11.4	10.7	9.7	10.0	9.0	9.2
SALES & MARKETING	3.3	2.6	3.4	3.5	3.0	2.9	3.2	2.0	1.7	2.1
TEACHING & TRAINING	1.5	1.3	1.2	0.7	0.6	0.6	0.6	0.8	0.8	0.8
OTHER	11.4	9.3	9.2	8.8	8.2	9.5	9.4	10.0	10.0	10.3
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: APESMA, Professional Engineer Remuneration Survey Report, various issues

Some of the issues which further research into the “other occupations” category may clarify include.

- Some related occupations have not been adequately identified and are included in the other occupations group.

- Some qualified engineers may have accepted non-engineering occupations, but should be considered part of the profession for targeted policy addressing engineering skill shortages.

- Some individuals may be overseas qualified engineers whose qualifications have not been recognised and could be considered as potentially part of the profession with remedial training. At a time of skills shortage, this is a second target group for retraining policy action.

- There will be some over-estimation of the profession as a result of inappropriate self-identification in the Census and some genuine non-practicing engineers.

Some of these may result in over-estimation of the size of the Engineering Profession. However, the Census data also contains a major source of underestimation of the Engineering Profession. Census respondents are asked to state their highest post-school qualification and assignment to educational field is based on the response. This approach appears to assume that higher education in the engineering profession will be undertaken only within the engineering discipline. This is a poor assumption because Engineers frequently undertake post-graduate courses in non-engineering subjects, for example, Post- graduate Diplomas or Masters Degrees in business related disciplines. An engineer who does this would cite these as the highest post-school qualification and be assigned to the business education field rather than to engineering. In the USA 48% of engineering graduates who earned Masters degrees did so in either business or science[12]. The APESMA salary surveys[13] show that in June 2001, 21.1% of Australian Engineers had qualifications higher than a Bachelors Degree in a non-engineering discipline. While the proportion is not as high as in the USA, it serves to illustrate how serious the under-estimate is.

In summary, the estimates made by *Engineers Australia* are not a preferred approach. However, these estimates are more credible, from a policy perspective, than reliance on the numbers occupying ABS engineering occupations. Further research is needed to refine sources of under-estimation and over-estimation.

2.5 WOMEN IN THE ENGINEERING PROFESSION

Table 2.3 shows the gender composition of the estimates of the engineering profession presented in the previous sub-section. The broad pattern across occupational groups is much the same as in Table 2.1. At just under 10% women are a relatively small proportion of the engineering profession. The proportion of women engineers is higher at the professional level than at the associate level. Women are also a higher proportion of the *other occupations* group.

2.6 THE ENGINEERING PROFESSION IN THE STATES AND TERRITORIES

Tables 2.4 through to 2.11 present estimates of the engineering profession in all States and Territories consistent with the estimates in Table 2.1.One measure of distribution is to compare State shares of the engineering profession to States shares of GDP. NSW and Victoria had shares of the engineering profession in excess of State GDP share. Queensland, South Australia, Tasmania and the Northern Territory had engineering profession shares lower than GDP share. Western Australia and the ACT were in line with GDP shares. Nearly three-quarters of women engineers were in either NSW or Victoria. In all other cases the share of women engineers was appreciably lower than State GDP shares.

TABLE 2.3
THE ENGINEERING PROFESSION, 2001, BY GENDER

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	4256	12404	8346	25006
BACHELOR	21476	46277	41551	109304
SUB TOTAL	25732	58681	49897	134310
UNDERGRAD. QUAL.	5773	34548	67141	107462
TOTAL	31505	93229	117038	241772

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	308	1222	1290	2820
BACHELOR	1892	4194	7193	13279
SUB TOTAL	2200	5416	8483	16099
UNDERGRAD. QUAL.	96	1571	8000	9667
TOTAL	2296	6987	16483	25766

FEMALE SHARE

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	6.7	9	13.4	10.1
BACHELOR	8.1	8.3	14.8	10.8
SUB TOTAL	7.9	8.4	14.5	10.7
UNDERGRAD. QUAL.	1.6	4.3	10.6	8.3
TOTAL	6.8	7	12.3	9.6

Source: Estimated from unpublished 2001 Census data supplied by the ABS

TABLE 2.4
THE ENGINEERING PROFESSION IN NSW IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	1641	4891	3457	9989
BACHELOR	6523	17728	16770	41021
SUB TOTAL	8164	22619	20227	51010
UNDERGRAD. QUAL.	1932	10606	22081	34619
TOTAL	10096	33225	42308	85629

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	130	479	542	1151
BACHELOR	535	1732	3231	5498
SUB TOTAL	665	2211	3773	6649
UNDERGRAD. QUAL.	47	585	2961	3593
TOTAL	712	2796	6734	10242

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	1771	5370	3999	11140
BACHELOR	7058	19460	20001	46519
SUB TOTAL	8829	24830	24000	57659
UNDERGRAD. QUAL.	1979	11191	25042	38212
TOTAL	10808	36021	49042	95871

Source: Estimated fom unpublished 2001 Census data supplied by the ABS

TABLE 2.5
THE ENGINEERING PROFESSION IN VICTORIA IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	999	3564	2398	6961
BACHELOR	5505	12855	11235	29595
SUB-TOTAL	6504	16419	13633	36556
UNDERGRAD. QUAL.	1795	9192	17578	28565
TOTAL	8299	25611	31211	65121

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	70	388	409	867
BACHELOR	590	1399	2253	4242
SUB-TOTAL	660	1787	2662	5109
UNDERGRAD. QUAL.	27	409	2479	2915
TOTAL	687	2196	5141	8024

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	1069	3952	2807	7828
BACHELOR	6095	14254	13488	33837
SUB-TOTAL	7164	18206	16295	41665
UNDERGRAD. QUAL.	1822	9601	20057	31480
TOTAL	8986	27807	36352	73145

Source: Estimated unpublished 2001 Census data supplied by the ABS

TABLE 2.6
THE ENGINEERING PROFESSION IN QUEENSLAND IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	751	1618	1066	3435
BACHELOR	4130	6365	5768	16263
SUB-TOTAL	4881	7983	6834	19698
UNDERGRAD. QUAL.	856	6046	12526	19428
TOTAL	5737	14029	19360	39126

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	49	134	132	315
BACHELOR	328	409	681	1418
SUB-TOTAL	377	543	813	1733
UNDERGRAD. QUAL.	8	210	965	1183
TOTAL	385	753	1778	2916

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	800	1752	1198	3750
BACHELOR	4458	6774	6449	17681
SUB-TOTAL	5258	8526	7647	21431
UNDERGRAD. QUAL.	864	6256	13491	20611
TOTAL	6122	14782	21138	42042

Source: Estimated unpublished 2001 Census data supplied by the ABS

TABLE 2.7
THE ENGINEERING PROFESSION IN SOUTH AUSTRALIA IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	186	677	462	1325
BACHELOR	1468	2753	2608	6829
SUB-TOTAL	1654	3430	3070	8154
UNDERGRAD. QUAL.	335	2454	4540	7329
TOTAL	1989	5884	7610	15483

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	9	61	47	117
BACHELOR	104	196	333	633
SUB-TOTAL	113	257	380	750
UNDERGRAD. QUAL.	7	74	419	500
TOTAL	120	331	799	1250

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	195	738	509	1442
BACHELOR	1572	2949	2941	7462
SUB-TOTAL	1767	3687	3450	8904
UNDERGRAD. QUAL.	342	2528	4959	7829
TOTAL	2109	6215	8409	16733

Source: Estimated unpublished 2001 Census data supplied by the ABS

TABLE 2.8
THE ENGINEERING PROFESSION IN WESTERN AUSTRALIA IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	489	1023	573	2085
BACHELOR	3045	4756	3573	11374
SUB-TOTAL	3534	5779	4146	13459
UNDERGRAD. QUAL.	627	4270	7023	11920
TOTAL	4161	10049	11169	25379

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	40	97	101	238
BACHELOR	270	325	494	1089
SUB-TOTAL	310	422	595	1327
UNDERGRAD. QUAL.	4	212	856	1072
TOTAL	314	634	1451	2399

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	529	1120	674	2323
BACHELOR	3315	5081	4067	12463
SUB-TOTAL	3844	6201	4741	14786
UNDERGRAD. QUAL.	631	4482	7879	12992
TOTAL	4475	10683	12620	27778

Source: Estimated unpublished 2001 Census data supplied by the ABS

TABLE 2.9

THE ENGINEERING PROFESSION IN TASMANIA IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	53	123	102	278
BACHELOR	320	518	580	1418
SUB-TOTAL	373	641	682	1696
UNDERGRAD. QUAL.	105	778	1447	2330
TOTAL	478	1419	2129	4026

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	3	9	9	21
BACHELOR	27	27	49	103
SUB-TOTAL	30	36	58	124
UNDERGRAD. QUAL.	3	22	126	151
TOTAL	33	58	184	275

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	56	132	111	299
BACHELOR	347	545	629	1521
SUB-TOTAL	403	677	740	1820
UNDERGRAD. QUAL.	108	800	1573	2481
TOTAL	511	1477	2313	4301

Source: Estimated unpublished 2001 Census data supplied by the ABS

TABLE 2.10
THE ENGINEERING PROFESSION IN THE NORTHERN TERRITORY IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	26	73	39	138
BACHELOR	177	288	233	698
SUB-TOTAL	203	361	272	836
UNDERGRAD. QUAL.	42	336	762	1140
TOTAL	245	697	1034	1976

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	-	16	9	25
BACHELOR	14	27	42	83
SUB-TOTAL	14	43	51	108
UNDERGRAD. QUAL.	-	21	61	82
TOTAL	14	64	112	190

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	26	89	48	163
BACHELOR	191	315	275	781
SUB-TOTAL	217	404	323	944
UNDERGRAD. QUAL.	42	357	823	1222
TOTAL	259	761	1146	2166

Source: Estimated unpublished 2001 Census data supplied by the ABS

TABLE 2.11

THE ENGINEERING PROFESSION IN THE AUSTRALIAN CAPITAL TERRITORY IN 2001

MALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	111	435	249	795
BACHELOR	308	1014	784	2106
SUB-TOTAL	419	1449	1033	2901
UNDERGRAD. QUAL.	81	866	1184	2131
TOTAL	500	2315	2217	5032

FEMALES

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	7	38	41	86
BACHELOR	24	79	110	213
SUB-TOTAL	31	117	151	299
UNDERGRAD. QUAL.	-	38	133	171
TOTAL	31	155	284	470

TOTAL

QUALIFICATION	ENGINEERING HOME OCCUPATIONS	ENGINEERING RELATED OCCUPATIONS	OTHER OCCUPATIONS	TOTAL
POST-GRADUATE	118	473	290	881
BACHELOR	332	1093	894	2319
SUB-TOTAL	450	1566	1184	3200
UNDERGRAD. QUAL.	81	904	1317	2302
TOTAL	531	2470	2501	5502

Source: Estimated unpublished 2001 Census data supplied by the ABS

3. ENGINEERING EDUCATION

3.1 YEAR 12 ENROLMENTS IN ENGINEERING ENABLING SUBJECTS

Engineering education typically begins with subject choice in senior High School years. University Degrees in Engineering normally require, among other things, Higher School Certificate, or equivalent, English, Mathematics, Physics and Chemistry. Table 3.1 presents data collated by the Department of Education, Science and Training as part of its administration of Schools Funding Programs.

TABLE 3.1
YEAR 12 SUBJECT ENROLMENTS, AUSTRALIA, 1995 TO 2004

SUBJECT	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
ENGLISH	158027	165278	165863	164378	167381	170544	180276	182758	185163	184789
MATHEMATICS	152019	154534	156903	152794	155722	162488	171185	173330	174042	174060
SOCIETY & ENVIRONMENT	191427	198497	195338	185981	191195	202180	191533	194303	196740	196651
PHYSICS & CHEMISTRY	67130	67235	68008	65405	65387	66504	65199	64271	66283	67401
OTHER SCIENCES	80020	79423	79158	77921	78955	80098	78398	78652	79770	80356
ARTS	56420	59544	61210	60944	63980	69653	73276	75322	76543	76387
LOTE	24198	24670	24741	23806	24051	24562	26102	26143	26719	27551
ICT	31353	34182	35452	36087	37822	42640	47464	45844	42330	35698
OTHER TECHNOLOGY	39674	34283	35313	34556	36103	42124	48903	35170	51938	50970
PHYSICAL EDUCATION	25389	36055	37432	37120	37596	39983	45142	47832	49221	50359

Source: Department of Education, Science and Training, Literature Review in Support of DEST SET Skills Audit, 2006, forthcoming

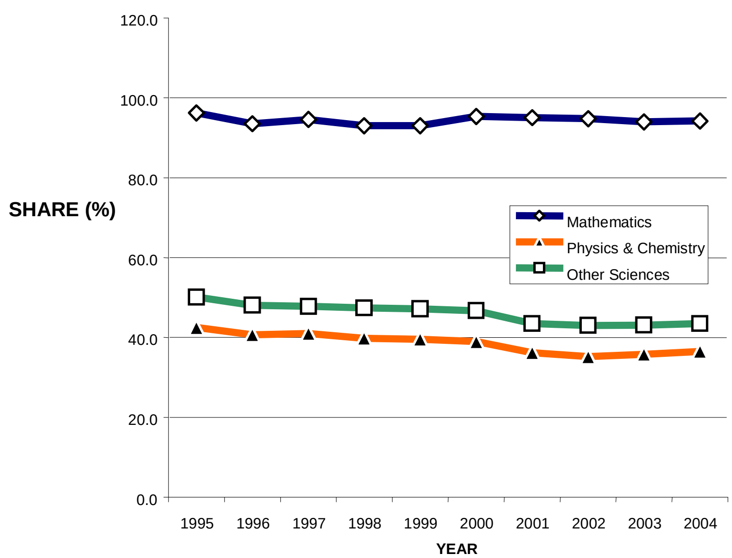


FIGURE 3.1: SHARES OF YEAR 12 STUDENTS STUDYING ENGINEERING ENABLING SUBJECTS

One of the difficulties with these data is that the level of study within any given discipline is not evident and accordingly they should only be seen as indicative of broad trends. Figure 3.1 illustrates the trends over the past decade for the share of students studying engineering enabling courses. For comparative purposes the base line for this proportion has been taken as the number studying English. When compared to enrolments in engineering courses the trend in Physics and Chemistry enrolments may become a concern in the future.

3.2 UNIVERSITIES OFFERING ENGINEERING COURSES

In 1994, there were 34 Australian Universities that offered engineering courses to Australian domestic students. Overall enrolment of domestic engineering students was 42,644 and this was 7.8% of the enrolment of domestic students in all courses. By 1999, Macquarie University in NSW had begun offering engineering, increasing institutional numbers by one. Enrolments of domestic students increased marginally to 43,370 which was less than one-half percent annually, and the share of domestic engineering students fell to 7.2%. Over the next five years, Charles Sturt University and Southern Cross University in NSW commenced engineering courses, as did the University of Notre Dame in Western Australia. Domestic engineering enrolment grew by just under 4000; largely through growth in the established Universities in NSW and Western Australia. Even so, the share of domestic engineering students fell to 6.6%. The Universities offering engineering courses to domestic students and their enrolments in 1994, 1999 and 2004 are set out in Table 3.2A.

Most Universities expanded their enrolments of engineering students by accepting overseas students. Only a handful chose not to go in this direction. The enrolments of overseas students by universities offering engineering courses are presented in Table 3.2B and the impact of the combined enrolment of domestic and overseas students is presented in Table 3.2C. In 1994, there were 4503 overseas students enrolled in Australian engineering courses. This was some 9.6% of the total enrolment in engineering, while overseas engineering students comprised 11.1% of all overseas students in Australia.

Over the next 5 years, the number of overseas engineering students grew by nearly two-thirds and accounted for most of the growth in the engineering student population. The growth of overseas student enrolment in other disciplines, however, was stronger and the proportion of engineering students among overseas students fell from 11.1% in 1994 to 8.7% in 1999.

The numbers of overseas engineering students grew rapidly in the five years to 2004, rising to 18,202. This accounted for about three-quarters of the growth of engineering enrolments in Australian Universities. The more rapid pace of enrolling overseas students in non-engineering disciplines continued and the engineering share of overseas students fell further to 8.0%.

TABLE 3.2A
UNIVERSITIES OFFERING ENGINEERING, STUDENTS ENROLLED, 1994, 1999 AND 2004

DOMESTIC STUDENTS

INSTITUTION	1994	1999	2004
Avondale College	0	0	0
Charles Sturt University	0	0	31
Macquarie University	0	7	86
Southern Cross University	0	0	3
University of New England	73	90	49
University of NSW	3750	3748	5160
University of Newcastle	1402	1370	1182
University of Sydney	2168	2019	2471
University of Technology, Sydney	3086	2978	2749
University of Western Sydney	609	863	1202
University of Wollongong	1566	1259	1285
NEW SOUTH WALES	12654	12334	14218
Deakin University	330	906	955
La Trobe University	752	543	500
Monash University	3492	2969	2773
Royal Melbourne Institute of Technology	3379	3650	3134
Swinbourne University of Technology	2162	1695	2486
University of Melbourne	2206	3076	2974
University of Ballarat	417	224	207
Victoria University of Technology	1587	1174	985
VICTORIA	14325	14237	14014
Central Queensland University	509	820	722
Griffith University	555	873	1004
James Cook University	411	472	494
Queensland University of Technology	2371	1833	2293
University of Queensland	2057	2194	2332
University of Southern Queensland	1881	1865	1961
QUEENSLAND	7784	8057	8806
Curtin University of Technology	1534	2031	2194
Edith Cowan University	102	219	359
Murdock University	104	200	220
University of Notre Dame	0	0	8
University of Western Australia	1534	1768	1928
WESTERN AUSTRALIA	3274	4218	4709
Flinders University	135	244	219
University of Adelaide	1005	1233	1662
Univerity of South Australia	1841	1263	1152
SOUTH AUSTRALIA	2981	2740	3033
Australian Maritime College	180	234	707
University of Tasmania	455	405	442
TASMANIA	635	639	1149
Charles Darwin University	60	80	70
NORTHERN TERRITORY	60	80	70
Australian Defense Force Academy	359	509	609
Australian National University	305	384	647
University of Canberra	267	172	70
AUSTRALIAN CAPITAL TERRITORY	931	1065	1326
Australian Domestic Engineering Students	42644	43370	47325
Total Australian Domestic Students	544941	603156	716422

Source: Unpublished DEST statistics supplied to Engineers Australia

TABLE 3.2B
UNIVERSITIES OFFERING ENGINEERING, STUDENTS ENROLLED, 1994, 1999 AND 2004

OVERSEAS STUDENTS

INSTITUTION	1994	1999	2004
Charles Sturt University	0	0	0
Macquarie University	0	0	17
Southern Cross University	0	0	0
University of New England	3	23	2
University of NSW	922	1126	2136
University of Newcastle	90	110	914
University of Sydney	177	313	755
University of Technology, Sydney	45	205	798
University of Western Sydney	27	144	378
University of Wollongong	237	211	525
NEW SOUTH WALES	1521	2132	5525
Deakin University	2	95	325
La Trobe University	23	51	211
Monash University	589	637	1478
Royal Melbourne Institute of Technology	600	1083	1599
Swinbourne Institute of Technology	103	251	958
University of Melbourne	272	742	1261
University of Ballarat	23	4	98
Victoria University of Technology	52	53	423
VICTORIA	1664	2916	6353
Central Queensland University	35	83	7
Griffith University	21	84	364
James Cook University	15	25	76
Queensland University of Technology	222	439	758
University of Queensland	126	214	573
University of Soutern Queensland	41	160	692
QUEENSLAND	460	1005	2470
Curtin University of Technology	173	291	1181
Edith Cowan University	8	35	81
Murdock University	0	1	25
University of Notre Dame	0	0	0
University of Western Australia	155	170	329
WESTERN AUSTRALIA	336	497	1616
Flinders University	6	9	66
University of Adelaide	103	320	647
University of South Australia	180	129	1099
SOUTH AUSTRALIA	289	458	1812
Australian Maritime College	7	36	70
University of Tasmania	127	104	179
TASMANIA	134	140	249
Charles Darwin University	4	4	5
NORTHERN TERRITORY	4	4	5
Australian Defense Force Academy	26	27	28
Australian National University	53	36	138
University of Canberra	16	11	6
AUSTRALIAN CAPITAL TERRITORY	95	74	172
Total Overseas Engineering Students	4503	7226	18202
All Overseas Students	40494	83111	228555

TABLE 3.2C
UNIVERSITIES OFFERING ENGINEERING, STUDENTS ENROLLED 1994, 1999 AND 2004

ALL STUDENTS

INSTITUTION	1994	1999	2004
Avondale College	0	0	0
Charles Sturt University	0	0	31
Macquarie University	0	7	103
Southern Cross University	0	0	3
University of New England	76	113	51
University of NSW	4672	4874	7296
University of Newcastle	1492	1480	2096
University of Sydney	2345	2332	3226
University of Technology, Sydney	3131	3183	3547
University of Western Sydney	636	1007	1580
University of Wollongong	1803	1470	1810
NEW SOUTH WALES	14175	14466	19743
Deakin University	332	1001	1280
La Trobe University	775	594	711
Monash University	4081	3606	4251
Royal Melbourne Institute of Technology	3979	4733	4733
Swinbourne University of Technology	2265	1946	3444
University of Melbourne	2478	3818	4235
University of Ballarat	440	228	305
Victoria University of Technology	1639	1227	1408
VICTORIA	15989	17153	20367
Central Queensland University	544	903	729
Griffith University	576	957	1368
James Cook University	426	497	570
Queensland University of Technology	2593	2272	3051
University of Queensland	2183	2408	2905
University of Southern Queensland	1922	2025	2653
QUEENSLAND	8244	9062	11276
Curtin University of Technology	1707	2322	3375
Edith Cowan University	110	254	440
Murdock University	104	201	245
University of Notre Dame	0	0	8
University of Western Australia	1689	1938	2257
WESTERN AUSTRALIA	3610	4715	6325
Flinders University	141	253	285
University of Adelaide	1108	1553	2309
University of South Australia	2021	1392	2251
SOUTH AUSTRALIA	3270	3198	4845
Australian Maritime College	187	270	777
University of Tasmania	582	509	621
TASMANIA	769	779	1398
Charles Darwin University	64	84	75
NORTHERN TERRITORY	64	84	75
Australian Defense Force Academy	385	536	637
Australian National University	358	420	785
University of Canberra	283	183	76
AUSTRALIAN CAPITAL TERRITORTY	1026	1139	1498
Total Australian Engineering Students	47147	50596	65527
Total All Australian Students	585435	686267	944977

Source: Unpublished DEST statistics supplied to Engineers Australia

3.3 STUDENTS COMMENCING ENGINEERING COURSES

This sub-section considers commencing, or new enrolments in engineering courses in contrast to the focus on total enrolments, or student populations in engineering covered in the previous sub-section. Table 3.3 presents commencing engineering enrolments, by States and Territories and citizenship, for the period 1994 to 2004. The dominant trends in this Table are illustrated in Figure 3.2. Commencing enrolments for domestic students was relatively stagnant over this decade. The distribution of commencing enrolments varied by State and Territory and by the growth in overseas students studying in Australia.

TABLE 3.3
COMMENCING ENGINEERING STUDENTS BY STATE AND CITIZENSHIP, 1994 TO 2004

DOMESTIC STUDENTS

STATE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
NEW SOUTH WALES	3679	3815	3694	3765	3796	3702	3802	3962	3896	3832	3729
VICTORIA	4568	4677	4601	4711	4358	4207	4024	4435	4198	4031	3781
QUEENSLAND	2610	2462	2660	2691	2673	2814	2654	2837	2740	2755	2812
WESTERN AUSTRALIA	991	1045	1032	1263	1277	1307	1217	1186	1261	1325	1369
SOUTH AUSTRALIA	920	863	851	907	853	897	816	936	907	918	887
TASMANIA	235	210	180	204	211	256	211	332	727	738	698
NORTHERN TERRITORY	20	29	52	38	38	33	24	21	26	26	57
AUSTRALIAN CAPITAL TERRITORY	340	346	423	381	314	266	286	322	416	408	409
AUSTRALIA	13363	13447	13493	13960	13520	13482	13034	14031	14171	14033	13742

OVERSEAS STUDENTS

STATE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
NEW SOUTH WALES	562	684	783	832	822	982	1227	1709	2179	2410	2150
VICTORIA	554	763	875	984	850	1218	1275	1819	2039	2926	2549
QUEENSLAND	229	302	365	404	457	499	538	968	1052	1136	1011
WESTERN AUSTRALIA	122	161	156	171	139	177	218	263	374	526	701
SOUTH AUSTRALIA	108	119	140	129	115	98	180	402	513	621	814
TASMANIA	50	43	36	40	51	56	70	85	107	95	124
NORTHERN TERRITORY	1	1	1	1	2	1	1	0	1	1	5
AUSTRALIAN CAPITAL TERRITORY	40	37	41	24	30	27	32	34	49	58	79
AUSTRALIA	1666	2110	2397	2585	2467	3058	3541	5280	6314	7783	7436

ALL STUDENTS

STATE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
NEW SOUTH WALES	4241	4499	4477	4597	4618	4684	5029	5671	6075	6242	5879
VICTORIA	5122	5440	5476	5695	5208	5425	5299	6254	6237	6957	6330
QUEENSLAND	2839	2764	3025	3095	3130	3313	3192	3805	3792	3891	3823
WESTERN AUSTRALIA	1113	1206	1188	1434	1416	1484	1435	1449	1635	1851	2070
SOUTH AUSTRALIA	1028	982	991	1036	968	995	996	1338	1420	1539	1704
TASMANIA	285	253	216	244	262	312	281	417	834	833	822
NORTHERN TERRITORY	21	30	53	39	41	34	25	21	27	27	62
AUSTRALIAN CAPITAL TERRITORY	380	383	464	405	344	293	318	356	465	466	488
AUSTRALIA	15029	15557	15890	16545	15987	16540	16575	19311	20485	21816	21178

Source: Unpublished DEST statistics supplied to Engineers Australia

FIGURE 3.2 COMMENCING ENGINEERING ENROLMENTS

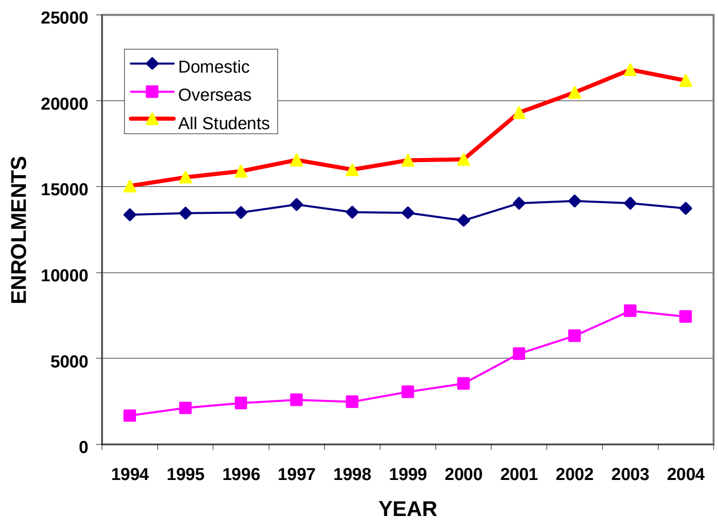


Figure 3.2 shows that the trend in commencing engineering enrolments primarily reflects the trend in overseas students. The trend in new enrolments for domestic students is static.

A better appreciation of engineering enrolment trends is found by rearranging the data in Table 3.3 by type of course studied. This is shown in Table 3.4. The most significant trends in this Table relate to commencements in Bachelor and Coursework Masters Degrees. These are highlighted in Figures 3.3 and 3.4. Figure 3.3 shows the commencements in Bachelor degree courses which for the domestic population are the entry level qualification for professional engineering. For the engineering profession this is the most appropriate measure of supply than overall engineering completions.

Figure 3.3 shows that until about 1999 there was a small upward trend in the commencement of domestic students in engineering Bachelors degree courses. However, since then the trend has reversed and commencements of domestic students have fallen. In contrast, there has been significant growth in the numbers of overseas students commencing Bachelor degree courses and this has been the driver which has determined the trend in Bachelor degree commencements.

The second important set of changes is shown in Figure 3.4 which shows the trends in enrolments in Coursework Masters degrees. While there has been a modest increase in the number of domestic students commencing these courses, the predominant source of growth has once again come from commencements of overseas students. In the case of domestic students, Masters Degrees deepen engineering knowledge and so improve the quality of the engineering profession, but do not increase the supply of engineers. For overseas students Coursework Masters degrees will have a similar effect, but, because such degrees also provide an avenue for the degree recipient to utilise Australia's on-shore visa process for permanent migration, may also lead to increases in the supply of engineers.

TABLE 3.4
COMMENCING ENGINEERING STUDENTS, BY LEVEL OF COURSE, 1994 TO 2004

DOMESTIC STUDENTS

LEVEL OF COURSE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Doctorates	464	437	449	511	491	490	556	534	614	615	687
Research Masters	517	457	396	455	363	362	330	324	366	322	347
Coursework Masters	778	804	720	696	695	659	681	798	1007	1007	964
Graduate Diplomas	878	1022	980	987	702	706	714	1100	998	1106	1017
Bachelors	10236	10337	10596	10982	10895	10921	10442	10786	10278	10089	9910
Other Undergraduate	490	390	352	329	374	351	311	489	908	894	817
TOTAL	13363	13447	13493	13960	13520	13489	13034	14031	14171	14033	13742

OVERSEAS STUDENTS

LEVEL OF COURSE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Doctorates	197	172	143	160	164	165	176	237	226	257	264
Research Masters	115	146	129	111	114	98	112	121	140	158	203
Coursework Masters	228	355	361	411	435	641	816	1305	1745	2850	2787
Graduate Diplomas	85	129	119	117	121	91	183	221	257	148	162
Bachelors	1031	1297	1637	1781	1619	2053	2234	3374	3859	4280	3936
Other Undergraduate	10	11	8	5	14	12	20	22	87	90	84
TOTAL	1666	2110	2397	2585	2467	3060	3541	5280	6314	7783	7436

ALL STUDENTS

LEVEL OF COURSE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Doctorates	661	609	592	671	655	655	732	771	840	872	951
Research Masters	632	603	525	566	477	460	442	445	506	480	550
Coursework Masters	1006	1159	1081	1107	1130	1300	1497	2103	2752	3857	3751
Graduate Diplomas	963	1151	1099	1104	823	797	897	1321	1255	1254	1179
Bachelors	11267	11634	12233	12763	12514	12974	12676	14160	14137	14369	13846
Other Undergraduate	500	401	360	334	388	363	331	511	995	984	901
TOTAL	15029	15557	15890	16545	15987	16549	16575	19311	20485	21816	21178

Source: Unpublished DEST statistics supplied to Engineers Australia

FIGURE 3.3: BACHELOR DEGREE COMMENCEMENTS

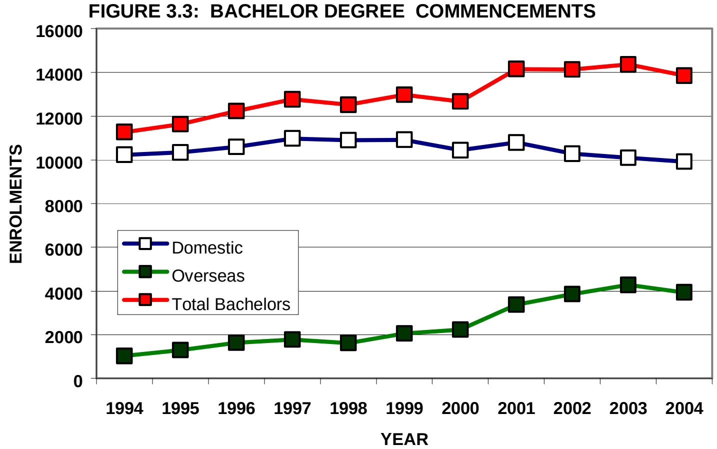


FIGURE 3.4: COURSEWORK MASTERS COMMENCEMENTS

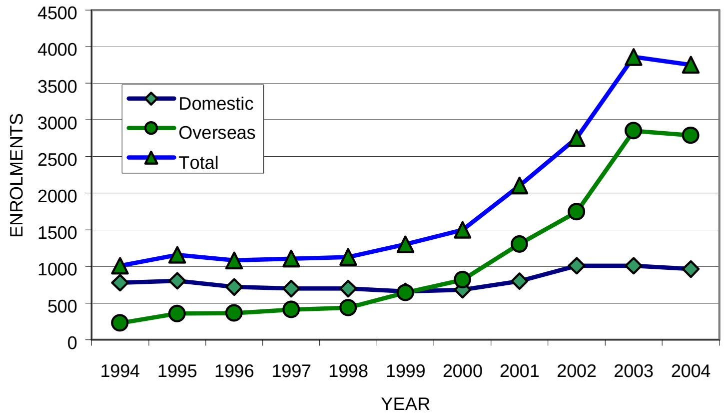


TABLE 3.5
COMMENCING DOMESTIC ENGINEERING STUDENTS, BY EQUITY GROUPS

EQUITY GROUP (Number)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Non-English Background	2035	2119	2046	1900	1651	1428	1310	1242	1174	1184	1086
Students with Disabilities	0	0	206	266	236	252	262	258	290	298	277
Women	1870	1891	1927	2067	2023	2054	2034	2203	2054	1948	1851
Indigenous	33	30	36	40	39	50	39	30	53	51	61
Rural	2437	2416	2387	2521	2414	2426	2260	2217	2286	2175	2096
Isolated	268	284	286	325	322	329	291	203	238	220	206
Low Socio-economic status	2317	2336	2438	2374	2379	2373	2120	2352	2284	2306	2067
All Equity Groups	8960	9076	9326	9493	9064	8912	8316	8505	8379	8182	7583
All Commencing Students	13363	13447	13493	13960	13520	13482	13034	14031	14171	14033	13742
Equity group share (%)	67.1	67.3	69.1	68	67	66.1	63.8	60.6	59.1	58.3	55.2

Source: Unpublished DEST statistics supplied to Engineers Australia

Table 3.5 presents the numbers of domestic students commencing engineering courses from different social groups. These data relate to total commencements and may include elements of double-counting because some individuals could be categorised to more than one group. The new enrolment of women has fluctuated around 14% with a peak of 15.7% in 2001.

TABLE 3.6
TOTAL ENGINEERING STUDENT ENROLMENT, BY LEVEL OF COURSE, 1994 TO 2004

DOMESTIC STUDENTS

Level of award	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Doctorates by Research	1581	1748	1770	1806	1865	1948	2009	2551	2620	2838	3001
Master`s by Research	1290	1212	1077	1043	973	941	858	937	968	914	934
Master`s by Coursework	1794	1823	1751	1692	1550	1430	1356	1773	2056	2250	2295
Other post-graduate	1496	1613	1569	1626	1183	1148	1100	1836	1840	2016	2006
Bachelor	34992	35506	35958	36764	37075	37194	36793	38830	38711	38444	37819
Other under-graduate	1456	1152	930	795	690	667	613	879	1313	1249	1180
Enabling courses	35	30	13	46	63	42	56	111	91	99	90
TOTAL	42644	43084	43068	43772	43399	43370	42785	46917	47599	47810	47325

OVERSEAS STUDENTS

Level of Award	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Doctorates by Research	637	609	548	514	505	501	482	694	754	861	984
Master`s by Research	252	231	255	233	217	204	193	235	260	281	360
Master`s by Coursework	329	490	563	624	650	816	1058	2026	2650	4334	4809
Other post-graduate	100	151	144	139	137	100	219	321	383	252	240
Bachelor	3165	3581	4129	4716	5005	5589	6021	8067	9497	10964	11640
Other under-graduate	20	23	26	15	18	16	22	38	112	168	169
Enabling courses	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4503	5085	5665	6241	6533	7226	7995	11381	13656	16860	18202

ALL STUDENTS

Level of Award	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Doctorates by Courses	2218	2357	2318	2320	2370	2449	2491	3245	3374	3699	3985
Master`s by Master`s	1542	1443	1332	1276	1190	1145	1051	1172	1228	1195	1294
Master`s by Course	2123	2313	2314	2316	2200	2246	2414	3799	4706	6584	7104
Other post-graduate	1596	1764	1713	1765	1320	1248	1319	2157	2223	2268	2246
Bachelor	38157	39087	40087	41480	42480	42783	42814	46897	48208	49408	49459
Other under-graduate	1476	1175	956	810	709	683	635	917	1425	1417	1349
Enabling courses	35	30	13	46	63	42	56	111	91	99	90
TOTAL	47147	48169	48133	50013	49932	50596	50780	58298	61255	64670	65527

Source: Unpublished DEST statistics supplied to Engineers Australia

Finally in this sub-section Table 3.6 sets out data for the engineering student population, that is, total enrolments, by the level of courses studied. The totals in this Table correspond to the totals in Tables 3.2A to 3.2C.

3.4 GRADUATES FROM ENGINEERING COURSES

The trends in engineering course commencements are mirrored in course completions, albeit at lower levels. Table 3.7 shows completions in engineering courses by level and citizenship for the years 1994 to 2003. The key trends, for graduations at Bachelors Degree and Coursework Masters Degree level, are illustrated in Figures 3.5 and 3.6 respectively.

TABLE 3.7
ENGINEERING COURSE COMPLETIONS BY LEVEL OF COURSE AND CITIZENSHIP, 1994 TO 2

DOMESTIC STUDENTS

LEVEL OF COURSE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Doctorates	168	199	291	329	325	320	356	324	379	422
Research Masters	167	177	180	201	164	144	144	147	147	148
Coursework Masters	452	458	508	593	567	541	458	636	624	663
Graduate Diplomas	541	542	545	539	523	518	424	409	334	411
Bachelors	4859	5292	5289	5524	5550	5264	5190	6061	5721	5831
Undergraduate Diplomas	345	340	205	170	141	159	121	279	478	368
TOTAL	6532	7008	7018	7356	7270	6946	6693	7856	7686	7843

OVERSEAS STUDENTS

LEVEL OF COURSE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Doctorate	122	111	122	142	113	116	119	97	99	109
Research Masters	94	72	59	60	66	51	46	60	41	46
Coursework Masters	175	251	323	356	405	518	594	916	1071	1716
Graduate Diplomas	33	40	856	159	127	36	89	108	150	145
Bachelors	559	631	719	806	1009	1243	1423	1658	1748	1997
Undergraduate Diplomas	5	9	12	5	9	11	8	18	40	87
TOTAL	988	1114	1320	1528	1729	1975	2279	2857	3150	4100

ALLSTUDENTS

LEVEL OF COURSE	1994	1995	1996	1997	1998	1999	2000	2001	2001	2003
Doctorates	300	310	413	471	438	436	475	421	481	531
Research Masters	261	249	239	261	230	195	190	207	188	194
Coursework Masters	627	709	831	949	972	1059	1052	1552	1695	2379
Graduate Diplomas	574	582	630	698	650	554	513	517	484	556
Bachelors	5418	5923	6008	6330	6559	6507	6613	7470	7469	7828
Undergraduate Diplomas	350	349	217	175	150	170	129	297	519	455
TOTAL	7520	8122	8338	8884	8999	8921	8972	10713	10836	11943

Source: Unpublished DEST statistics supplied to Engineers Australia

FIGURE 3.5: BACHELOR DEGREE COMPLETIONS

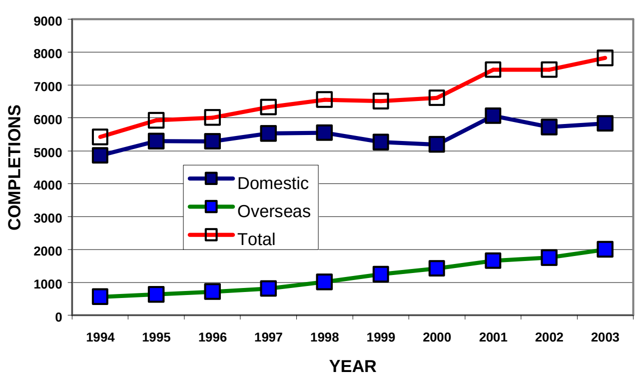
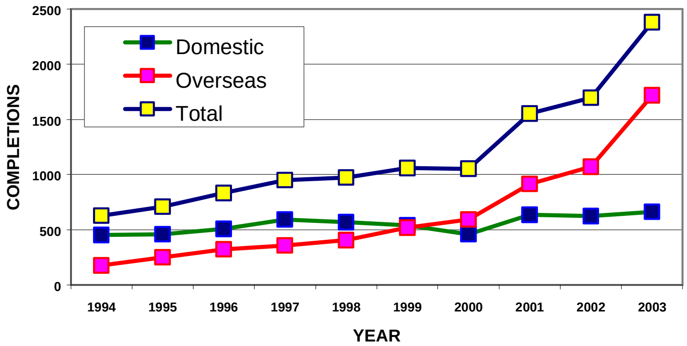


FIGURE 3.6: COURSEWORK MASTERS COMPLETIONS



The number of domestic students graduating with a Bachelors Degree in Engineering increased from 4859 in 1994 to 5831 in 2003, an increase of 972 despite the static trend in commencements for these courses. However, the average annual increase was only about 2.0% at a time when the growth of the Australian economy was typically in the range 3-4%.

In 1994, only 559 overseas students graduated with a Bachelors Degree in Engineering. By 2003, this had grown to 1997, an increase of 1438 or an average 25% annually. When evaluating this outcome, one needs to take into account the low starting base, but even so this is strong growth.

Domestic students graduating with Coursework Masters Degrees in Engineering increased from 452 in 1994 to 663 in 2003, an average annual growth rate of about 4.7%. However, during this period graduation of overseas students from these courses grew from 175 in 1994 to 1716 in 2003, an average annual growth rate of 88%. The most rapid growth occurred since 2001, when the Department of Immigration commenced accepting on-shore applications from overseas students in Australia for permanent migration visas. More information on this issue is provided in Section 6 below.

These changes dominate total graduations from engineering courses. They show a significant change in the character of Australian Engineering schools has taken place. In 1994, overseas student graduation at Bachelor and Coursework Masters level was 9.8% of all engineering course completions. By 2003 this had grown to 31.1%.

TABLE 3.8
ENGINEERING AWARD COMPLETIONS, BY STATE, 1994 TO 2003

DOMESTIC STUDENTS

STATE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NSW	2023	2129	2230	2169	2127	2053	1936	2352	2166	2284
Victoria	2084	2018	2100	2455	2325	2137	2109	2593	2258	2333
Queensland	1260	1390	1330	1313	1384	1357	1302	1285	1292	1293
WA	496	566	592	564	618	566	595	688	749	798
SA	468	499	434	500	498	438	409	474	533	578
Tasmania	68	143	142	136	107	138	126	212	448	315
NT	3	11	7	12	11	14	9	5	11	2
ACT	130	185	183	207	200	243	207	247	229	240
Australia	6532	7008	7018	7356	7270	6946	6693	7856	7686	7843

OVERSEAS STUDENTS

STATE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NSW	367	409	502	488	584	685	793	1036	1157	1513
Victoria	331	374	393	515	515	603	777	891	911	1268
Queensland	110	128	203	303	387	322	341	526	604	626
WA	85	73	98	90	97	89	114	128	152	187
SA	49	64	72	82	89	210	199	182	222	434
Tasmania	32	55	27	31	47	37	40	70	89	53
NT	1	0	0	2	0	2	0	1	0	0
ACT	13	11	25	17	10	27	16	23	15	19
Australia	988	1114	1320	1528	1729	1975	2279	2857	3150	4100

ALL STUDENTS

STATE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
NSW	2390	2605	2732	2657	2711	2738	2728	3388	3323	3797
Victoria	2415	2392	2493	2970	2840	2740	2886	3484	3169	3601
Queensland	1370	1518	1533	1616	1771	1679	1643	1811	1896	1919
WA	581	639	690	654	715	655	709	816	901	985
SA	517	563	506	582	587	648	608	656	755	1012
Tasmania	100	198	169	167	154	175	166	282	537	368
NT	4	11	7	14	11	16	9	6	11	2
ACT	143	196	208	224	210	270	223	270	244	259
Australia	7520	8122	8338	8884	8999	8921	8972	10713	10836	11943

Source: DEST unpublished statistics supplied to Engineers Australia

Table 3.8 represents Table 3.7 by States and Territories. At this stage data that would enable analysis by State and by level of course was not obtained and so inference is necessary to extend the above discussion geographically. Inspection of the overseas student panel of the Table shows that there has been strong growth in graduations of overseas students in the 5 largest States but much less activity in Tasmania and the two Territories. Given that Bachelors and Coursework Masters graduation accounted for 86% of overseas student graduation, there are sound reasons to suggest the national pattern has been replicated in the States.

3.5 GRADUATION FROM ENGINEERING COURSES BY SPECIALISATION.

Reviews of Higher Education time series data, by course specialisation, is fraught with difficulty because of a change in the statistical classification system in 2001. The Department of Education, Science and Training (DEST) provided requested time series data in two parts, the first for the period up to 2000 and the second for the period since 2000 reflecting the discontinuity created by the change over. Very short time series are of limited value, and consequently, it was decided to attempt the construction of a link between the two parts of the data to provide a longer series.

Higher Education statistics for Australia are collected by DEST as part of its administration and oversight of Higher Education funding. Prior to 2000, Higher Education data were collected by DEST according to the Field of Education classification system. Throughout the 1990`s, the ABS had led a process aimed at the development of a more comprehensive education classification system, covering all levels of education. This new system, the Australian Standard Classification of Education (ASCED), was formally adopted in 2001 by the ABS and DEST.

The two systems are quite different and simultaneous use of them in a given tabulation is not possible. At the time this document was prepared, there were only three data years since the change and this is insufficient for useful work. As time elapses and data for more years becomes available, this limitation will be overcome. Until this occurs a decision was taken to present graduation data by specialisation according to both old and new classification systems.

To achieve this, a correspondence was constructed between the two classifications using information obtained from the ABS web-site.[14] Table 3.9 shows graduations for the main engineering specialisations, by citizenship, for the period 1994 to 2003 using the old classification. The Table shows that the strongest growth occurred in the graduation of Electronic and Computer Engineers, Civil and Structural Engineers and the Other Engineers category. Interest in Electronic and Computer Engineering was shared by domestic students and overseas students alike, with both groups recording strong growth. However, most of the growth in Civil and Structural Engineering graduation was by overseas students. There was also sound growth in overseas students graduating from Electrical, Industrial and Mechanical Engineering courses.

Comparatively few overseas students graduated from Mining and Minerals Engineering courses. Domestic student graduation from these courses fluctuated around a slight upward trend, with the overall numbers remaining relatively small. In this context, the skill shortages reported in the current mining and minerals boom is not difficult to understand.

There are significant numbers of graduates in the Other Engineering category. At any time there will be an “other” category in any statistical classification. However, the growth in this category demonstrates why the ASCED classification was adopted.

TABLE 3.9
ENGINEERING COURSE COMPLETIONS BY SPECIALISATION USING THE OLD CLASSIFICATION SYSTEM 1994 TO 2003

DOMESTIC STUDENTS

ENGINEERING SPECIALISATIO	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Aeronautical Engineer	146	167	133	166	181	197	180	256	217	243
Chemical Engineer	388	386	433	425	429	378	398	416	410	320
Civil and Structural Engineer	1212	1222	1118	1223	1228	1130	1022	1215	1109	1138
Electrical Engineer	933	803	794	850	639	632	631	773	593	621
Electronic and Computer Engin	908	889	875	956	993	1001	930	1438	1369	1605
Industrial Engineer	217	326	316	383	389	280	208	128	128	104
Marine Engineer	25	63	63	44	56	75	45	0	40	34
Mechanical Engineer	937	1010	897	969	917	845	792	831	809	793
Metallurgy	96	101	115	84	75	69	51	143	128	92
Mining and Minerals Engineer	170	175	217	218	223	212	205	214	199	250
Other Engineers	1187	1544	1784	1719	1877	1961	2125	2093	2279	2245
Surveying & Related	313	322	274	321	264	256	258	286	303	280
TOTAL	6532	7008	7018	7356	7270	6946	6693	7856	7686	7843

OVERSEAS STUDENTS

ENGINEERING SPECIALISATIO	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Aeronautical Engineer	19	30	21	16	29	22	36	33	41	22
Chemical Engineer	46	62	76	61	96	117	116	98	135	159
Civil and Structural Engineer	87	132	146	181	209	249	290	500	424	527
Electrical Engineer	202	201	214	233	304	279	315	330	377	492
Electronic and Computer Engin	193	175	209	238	261	273	351	544	644	1130
Industrial Engineer	46	47	64	40	39	214	255	230	313	359
Marine Engineer	1	7	3	4	9	13	13	0	7	12
Mechanical Engineer	123	118	174	236	266	215	292	412	483	492
Metallurgy	3	4	3	7	8	4	8	24	9	16
Mining and Minerals Engineer	21	13	14	27	9	23	18	9	5	16
Other Engineers	220	300	365	435	454	531	566	625	670	855
Surveying & Related	27	25	32	50	45	36	22	52	42	20
TOTAL	988	1114	1320	1528	1729	1975	2279	2857	3150	4100

ALL STUDENTS

ENGINEERING SPECIALISATIO	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Aeronautical Engineer	165	197	154	182	210	219	216	289	258	265
Chemical Engineer	434	448	509	486	525	495	514	514	545	479
Civil and Structural Engineer	1299	1354	1264	1404	1437	1379	1312	1715	1533	1665
Electrical Engineer	1135	1004	1008	1083	943	911	946	1103	970	1113
Electronic and Computer Engin	1101	1064	1084	1194	1254	1274	1281	1982	2013	2735
Industrial Engineer	263	373	380	423	428	494	463	358	441	463
Marine Engineer	26	70	66	48	65	88	58	0	47	46
Mechanical Engineer	1060	1128	1071	1205	1183	1060	1084	1243	1292	1285
Metallurgy	99	105	118	91	83	73	59	167	137	108
Mining and Minerals Engineer	191	188	231	245	232	235	223	223	204	266
Other Engineers	1407	1844	2149	2154	2331	2492	2691	2718	2949	3100
Surveying &Related	340	347	306	371	309	292	280	338	345	300
TOTAL	7520	8122	8338	8884	8999	8921	8972	10713	10836	11943

Source: DEST Statistics supplied to Engineers Australia

Tables 3.10A to 3.10C represent Table 3.8 using the ASCED classification. As indicated above, this classification will supersede the field of education classification in time. An unfortunate aspect of the data in these Tables is the relatively high proportion of data in “not elsewhere classified” categories. Correspondence with DEST indicates that this is due to the way Universities respond to DEST data returns.[15]

TABLE 3.10A
ENGINEERING COMPLETIONS, BY ASCED SPECIALISATION, 2001 TO 2003

DOMESTIC STUDENTS

ENGINEERING SPECIALISATION	2001	2002	2003
MANUFACTURING ENGINEERING			
Manufacturing Engineer	67	69	70
nec	17	19	16
PROCESS AND RESOURSE ENGINEERING			
Chemical Engineer	415	403	318
Mining Engineer	214	199	250
Materials Engineer	143	128	92
nec	118	190	188
MECHANICAL AND INDUSTRIAL ENGINEERING			
Mechanical Engineer	810	799	780
Industrial Engineer	90	90	68
nec	122	112	110
CIVIL ENGINEERING			
Civil Engineer	837	741	756
Construction Engineer	41	55	62
Structural Engineer	33	78	71
Building Services Engineer	36	23	41
Water and Sanitory Engineer	3	2	6
Transport Engineer	3	2	2
Geotechnical Engineer	0	1	2
Ocean Engineer	3	7	9
nec	259	200	189
GEOMATIC ENGINEERING			
Geomatic Engineer	36	29	27
Surveying and Related	250	274	253
ELECTRICAL AND ELECTRONIC ENGINEERING			
Electrical Engineer	516	454	484
Electronic Engineer	306	205	339
Computer Engineer	741	738	816
Communications Technologies	171	200	218
nec	349	364	370
AEROSPACE ENGINEERING			
Aerospace Engineer	200	173	152
Aircraft Maintainence	0	0	43
Aircraft Operations	63	99	105
nec	75	59	50
MARITIME ENGINEERING			
Maritime Engineer	0	30	22
Marine Construction	0	10	12
Marine Craft Operations	0	321	203
nec	133	5	10
OTHER ENGINEERING			
Environmental Engineer	233	173	173
Biomedical Engineer	146	151	99
OTHER ENGINEERING NEC	1426	1283	1437
TOTAL	7856	7686	7843

Source: Unpublished DEST statistics supplied to Engineers Australia

TABLE 3.10B
ENGINEERING COMPLETIONS, BY ASCED SPECIALISATION, 2001 TO 2003

OVERSEAS STUDENTS

ENGINEERING SPECIALISATION	2001	2002	2003
MANUFACTURING ENGINEERING			
Manufacturing Engineer	210	303	351
nec	14	24	27
PROCESS AND RESOURCE ENGINEERING			
Chemical Engineer	98	125	159
Mining Engineer	9	5	16
Materials Engineer	24	9	16
nec	31	51	68
MECHANICAL AND INDUSTRIAL ENGINEERING			
Mechanical Engineer	341	366	370
Industrial Engineer	23	12	12
nec	80	138	186
CIVIL ENGINEERING			
Civil Engineer	240	239	265
Construction Engineer	29	23	16
Structural Engineer	2	20	18
Building Services Engineer	1	1	1
Water and Sanitory Engineer	2	1	3
Transport Engineer	42	1	66
Geotechnical Engineer	0	1	0
Ocean Engineer	0	1	2
nec	184	137	156
GEOMATIC ENGINEERING			
Geomatic Engineer	2	1	0
Surveying and Related	28	27	20
ELECTRICAL AND ELECTRONIC ENGINEERING			
Electrical Engineer	285	324	418
Electronic Engineer	88	90	171
Computer Engineer	243	299	417
Communications Technologies	127	158	341
nec	131	150	275
AEROSPACE ENGINEERING			
Aerospace Engineer	32	38	22
Aircraft Maintainence	0	0	0
Aircraft Operations	8	12	19
nec	8	40	2
MARITIME ENGINEERING			
Maritime Engineer	0	7	5
Marine Construction	0	0	7
Marine Craft Operation	0	33	14
nec	19	1	1
OTHER ENGINEERING			
Environmental Engineer	34	31	43
Biomedical Engineer	14	16	29
OTHER ENGINEERING NEC	508	456	584
TOTAL	2857	3150	4100

Source: Unpublished DEST statistics supplied to Engineers Australia

TABLE 3.10C
ENGINEERING COMPLETIONS, BY ASCED SPECIALISATION, 2001 TO 2003

ALL STUDENTS

ENGINEERING SPECIALISATION	2001	2002	2003
MANUFACTURING ENGINEERING			
Manufacturing Engineer	277	372	421
nec	28	41	41
PROCESS AND RESOURCE ENGINEERING			
Chemical Engineer	513	538	477
Mining Engineer	223	204	266
Materials Engineer	167	137	108
nec	152	243	258
MECHANICAL AND INDUSTRIAL ENGINEERING			
Mechanical Engineer	1151	1165	1150
Industrial Engineer	113	102	80
nec	202	250	296
CIVIL ENGINEERING			
Civil Engineer	1077	980	1021
Construction Engineer	70	78	78
Structural Engineer	35	98	89
Building Services Engineer	37	24	42
Water and Sanitory Engineer	5	3	9
Transport Engineering	45	3	68
Geotechnical Engineering	0	2	2
Ocean Engineering	3	8	11
nec	443	337	345
GEOMATIC ENGINEERING			
Geomatic Engineer	38	30	27
Surveying and Related	278	301	273
ELECTRICAL AND ELECTRONIC ENGINEERING			
Electrical Engineer	801	778	902
Electronic Engineer	394	295	510
Computer Engineer	984	1037	1233
Communications Technologies	298	358	559
nec	480	514	645
AEROSPACE ENGINEERING			
Aerospace Engineer	232	211	174
Aircraft Maintainence	0	0	43
Aircraft Operations	71	111	124
nec	83	99	52
MARITIME ENGINEERING			
Maritime Engineer	0	37	27
Marine Construction	0	10	19
Marine Craft Operations	0	354	217
nec	152	6	217
OTHER ENGINEERING			
Environmental Engineer	267	204	216
Biomedical Engineer	160	167	128
OTHER ENGINEERING NEC	1934	1739	2021
TOTAL	10713	10836	11943

Source: Unpublished DEST statistics supplied to Engineers Australia

3.6 SOME COMPARATIVE STATISTICS

Statistics relating to the proportion of Engineering and Science enrolments are often used as an indicator of growth in the Science and Technology workforce.[16]. Table 3.11 presents data on the share of domestic Engineering and Science enrolments in total domestic University enrolments for the period 1994 to 2004.

TABLE 3.11
DOMESTIC STUDENT ENROLMENT IN ENGINEERING AND SCIENCE RELATIVE TO ALL DOMESTIC ENROLMENTS, 1994 TO 2004

YEAR	ENGINEERING	SCIENCE	SET	ALL ENROLMENTS
1994	42644	79463	122107	544941
Prop %	7.8	14.6	22.4	100.0
1995	43084	81249	124333	557989
Prop %	7.7	14.6	22.3	100
1996	43068	85546	128614	580906
Prop %	7.4	14.7	22.1	100.0
1997	43772	95638	139410	595853
Prop %	7.3	16.1		100.0
1998	43399	96036	139435	599670
Prop %	7.2	16.0	23.3	100.0
1999	43370	99104	142474	603156
Prop %	7.2	16.4	23.6	100.0
2000	42785	99776	142561	599878
Prop %	7.1	16.6	23.8	100.0
2001	46917	105989	152906	599878
Prop %	7.8	17.7	25.5	100.0
2002	47599	108254	155853	711563
Prop %	6.7	15.2	21.9	100.0
2003	47810	106806	154616	719555
Prop %	6.6	14.8	21.5	100.0
2004	47325	103637	150962	716422
Prop %	6.6	14.5	21.1	100.0

Source: DEST Students 2004 (Full Year); Selected Higher Education Statistics, www.dest.gov.au

Note: From 2001 Educational Statistics changed classifications and Science includes Information Technology and Science

In 1997, domestic engineering enrolments were 7.8% of domestic University enrolments. Over the next 10 years this share saw-toothed downwards until in 2004 engineering enrolments were 6.6%. Domestic science enrolments were not quite twice that of engineering in 1994. Domestic science enrolments increased their share of enrolments until 2001, and then fell back to about its 1994 level in 2004. There was a change in classification for education statistics in 2001, and some portion of the changes in this Table can be attributed to this. However, this should not alter shares within a given year excessively.

Internationally, Australia is in the middle of the league table with 316 first degree graduates in engineering per million population. While this is higher in the USA, Germany, Sweden and India, it is less than in Japan, Singapore and the UK. Table 3.12 shows this information. In contrast, Australia has a very high proportion of first degree science graduates. Comparing Tables 3.11 and 3.12 shows why. Government policies of various types have encouraged the study of science. Typically science degrees are three years in duration compared to four years for engineering. Longer course duration is reinforced by higher HECS fees compared to arts and commerce courses. This important distinction between engineering and science is often glossed over by focusing on the so-called SET (science, engineering and technology) courses as a group. Table 3.11 shows that over the past decade the change in engineering enrolments was about 11% while the change in SET enrolments has been 23.6%. This lazy practice fails to recognize the different skills and roles of engineers compared to scientists. This is not an argument about one discipline being more important than another. Rather, it is an explanation as to why engineering skill shortages have developed at a time when the Commonwealth Government has significant policies and programs in place to encourage Australia's technical development.

TABLE 3.12
FIRST DEGREES IN ENGINEERING AND SCIENCE
SELECTED INTERNATIONAL COMPARISONS
(Number per million population)

COUNTRY	ENGINEERING	SCIENCE
Japan	814	258
Singapore	419	526
UK	341	547
Australia	316	835
Canada	311	334
USA	211	296
Germany	160	134
Sweden	139	765
India	34	175

Source: Calculated from Table 2-33, Science and Engineering Indicators, 2004, National Science Board, www.nsb.gov and US Census Bureau, International Data Base, www.census.gov

4. EMPLOYMENT IN SPECIALIST ENGINEERING OCCUPATIONS

4.1 AUSTRALIAN EMPLOYMENT IN SPECIALIST ENGINEERING OCCUPATIONS

In Section 2 the difference between engineering occupations and the Engineering Profession were discussed. Reiterating, the key issue is that engineers will occupy a wide diversity of occupations as they progress through their career paths. The Engineering Profession is characterized by an emphasis on the attributes of its members which is in stark contrast to the ABS ASCO classification system in which the attributes of jobs and occupations are the focus. This distinction is of paramount importance when it comes to understanding the ABS Labour Force Survey. This survey collects data according to the ASCO classification system. The engineering occupations in ASCO are components of the Engineering Profession, but they are, however, not a full count of the Profession as some analysts appear to believe.[17]

This Section deals with data from the ABS Labour Force Survey. Originally intended to provide macro-economic data on employment and unemployment, the Labour Force Survey has developed over the years into a more diverse data source. Being a survey, this process has at times stretched the limits of survey methodology. Besides the definitional issues already mentioned, disaggregation of Labour Force Survey data will encounter difficulties with survey standard errors. This issue, which does not seem to trouble some analysts[18], can mean the difference between useful data and essentially meaningless data. In the material which follows, data which is too close to, or within survey standard errors are not reported. Unfortunately, this means that in some cases that data relating to some issues are patchy, but this is a better option than the risk of presenting misleading data.

TABLE 4.1
EMPLOYMENT IN SPECIALIST ENGINEERING OCCUPATION, AUSTRALIA, 1996-97 TO 2004-05

ENGINEERING SPECIALISATION	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
CIVIL	24200	28450	27525	26425	25450	30575	29025	25950	24075
ELECTRICAL & ELECTRONIC	23325	26950	26275	25225	25075	23675	26425	23675	25875
MECHANICAL, PROD. & PLANT	23150	22150	19325	18725	19350	18050	15200	18525	20575
MINING & MATERIALS	4625	5625	5825	4725	4200	3925	4650	3950	5150
ENGINEERING TECHNOLOGIST	425	450	1150	550	400	625	250	400	200
OTHER ENGINEERING	9325	11000	10725	11775	12125	9925	10625	13875	13575
TOTAL	85050	94625	90825	87425	86600	86775	86175	86375	89450

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery

Table 4.1 presents Labour Force Survey data for employment in specialist ASCO engineering occupations for Australia for the period 1996-97 to 2004-05. These are occupations at the 4-digit level. While the ASCO classification system conceptually disaggregates further to the 6-digit level, for example, to divide electrical and electronic engineering into separate electrical and electronics components, in practice the survey approach from which the data are obtained does not allow this.
Year to year fluctuations in employment levels are very common. Consider the category Civil Engineer. Employment levels moved from 24,200 in 1996-97 to a peak of 30,575 in 2001-02, not in increasing increments, but in a saw-tooth fashion. In the latest year for which data are available, 2004-05, there were 24,075 Civil Engineers employed. This is fewer than in 1996-97 and somewhat at odds with the inclusion of this occupation in the immigration skills in demand list.

The fluctuating year to year pattern is also evident in the employment of Electrical and Electronic Engineers where there was a small upward trend for the tabulated period. The data for Mining and Materials Engineer employment shows a pattern similar to Civil Engineer, but at a lower level. The employment of Mechanical, Production and Plant Engineers appears to be trending downwards. This is often associated with the decline of Australian manufacturing.

There is solid evidence of growth in employment in the Other Engineers category. This includes a range of engineering specialisations such as Aeronautical Engineer, Bio-medical Engineer, Chemical Engineer, Industrial Engineer and Agricultural Engineer.

The peak employment level occurred in 1997-98 at 94,625 and has since fallen away to 89,450, once again in contrast to the prevailing view that there are shortages of engineers. This result highlights the significance of the distinction made at the beginning of this sub-section between the Engineering Profession and ASCO engineering occupations.

Table 4.1 includes a classification called Engineering Technologist. It is difficult to understand why this category is used and how it is used. The key point, however is that the ABS`s Engineering Technologist does not mean the same as it does in the lexicon of *Engineers Australia*. While holding a Bachelor level degree is the relevant indicator of skill level for the ABS, no distinction is made between 3 and 4 year degrees. In other words, ABS data generally is unable to make the *Engineers Australia* distinction between professional engineers and engineering technologists.

4.2 STATE AND TERRITORY EMPLOYMENT IN SPECIALIST ENGINEERING OCCUPATIONS

Table 4.2 to Table 4.6 represents Table 4.1 by States and Territories for ASCO specialist engineering occupations

TABLE 4.2
EMPLOYMENT IN CIVIL ENGINEERING, AUSTRALIA, 1996-97 TO 2004-05

YEAR	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
NSW	8925	10500	10125	10450	10375	10575	10425	9250	7625
VICTORIA	4900	7525	5700	6100	5400	7325	5850	6650	5650
QUEENSLAND	4575	5000	5900	5025	4875	7350	6750	5575	5150
WA	3150	2900	3600	2675	2900	2725	3125	2400	3750
SA	1575	1150	1125	1225	1075	1325	1850	1325	925
TASMANIA	325	575	525	200	300	800	300	250	700
NT	175	450	350	525	225	150	150	150	175
ACT	525	300	250	225	300	325	525	375	100
AUSTRALIA	24200	28450	27525	26425	25450	30575	29025	25950	24075

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery

NOTE: Data for Tasmania, the NT and the ACT are unreliable because they may be within survey standard errors.

TABLE 4.3
EMPLOYMENT IN ELECTRICAL & ELECTRONIC ENGINEERING, AUSTRALIA, 1996-97 TO 2004-05

	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
NSW	9375	8750	9700	9275	8450	8175	9525	9250	8950
VICTORIA	6750	8675	6075	6750	8475	6625	7025	5300	8350
QUEENSLAND	2300	2800	3100	3600	3175	2975	3775	3950	3925
WA	3125	3050	3050	2825	2175	2600	2525	2500	2100
SA	975	2275	3175	1725	1525	1800	2200	1550	1600
TASMANIA	300	550	125	300	775	575	475	300	375
ACT	450	575	700	450	425	700	650	500	350
AUSTRALIA	23325	26950	26275	25225	25075	23675	26425	23675	25875

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery
NOTE: Data for the NT have been omitted due to excessive survey standard error issues. The data for Tasmania and the ACT may be unreliable because numerous quarters were close to survey standard errors.

TABLE 4.4
EMPLOYMENT IN MECHANICAL, PRODUCTION & PLANT ENGINEERING, AUSTRALIA, 1996-97 TO 2004-05

YEAR	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
NSW	7725	7575	5800	4725	5200	5275	4200	5050	5975
VICTORIA	7650	7100	6800	6300	6075	5900	5000	6000	6800
QUEENSLAND	2300	2075	1975	2375	2900	2025	5250	3000	2850
WA	3225	3225	2975	3225	3225	2700	2800	2375	3350
SA	1475	1725	1325	1475	1350	1325	1225	1525	1000
TASMANIA	425	325	225	300	325	525	175	300	350
AUSTRALIA	23150	22150	19325	18725	19350	18050	15200	18525	20575

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery
NOTE: Data fot the NT and the ACT have been omitted due to excessive survey standard error issues.
The data for Tasmania may be unreliable as numerous quarters were close to survey standard errors.

TABLE 4.5
EMPLOYMENT IN MINING & MATERIALS ENGINEERING, AUSTRALIA, 1996-97 TO 2004-05

YEAR	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
NSW	1175	1600	675	1300	1375	875	450	650	700
VICTORIA	800	775	875	550	300	300	775	675	475
QUEENSLAND	900	1575	1325	750	375	675	950	700	650
WA	1475	1625	2550	1675	1725	1425	1925	1175	2350
AUSTRALIA	4625	5625	5825	4725	4200	3925	4650	3950	5150

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery
NOTE: Data for WA and Australia are reliable. The balance of the data are unreliable in some years
NSW in 2001-02, 2002-03 and 2004-05, Victoria in 2000-01and 2001-02 and Queensland in 2004-05.

TABLE 4.6
EMPLOYMENT IN OTHER ENGINEERING OCCUPATIONS, AUSTRALIA, 1996-97 TO 2004-05

YEAR	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
NSW	2900	2975	5400	4575	3950	2875	1875	4225	4250
VICTORIA	3425	3600	2525	3200	3925	3250	4400	3825	3750
QUEENSLAND	825	1125	700	975	2000	1425	1925	2150	1975
WA	1175	2075	1350	825	1375	1550	1425	2225	1975
SA	875	575	275	600	600	675	500	1075	1350
AUSTRALIA	9325	11000	10725	11775	12125	9925	10625	13875	13575

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery

NOTES: 1; Other Engineering includes Aeronautical, Agricultural, Biomedical, Chemical and Industrial Engineering.

2; Queensland data in 1998-99 and 1999-00 and SA data in 2002-03 are unreliable as some quarters were within survey standard errors. Data for the NT and the ACT have been omitted due to excessive survey standard error issues.

4.3 WOMEN IN SPECIALIST ENGINEERING OCCUPATIONS

Table 4.7 presents data for the number of women employed in specialist ASCO engineering occupations. The Table shows that the proportion of women employed has increased from 3.5% of ASCO engineering employment in 1996-97 to 7.3% in 2004-05. These shares are somewhat lower than were evident in Census data (about 8%).

TABLE 4.7
EMPLOYMENT OF WOMEN IN SPECIALIST ENGINEERING OCCUPATIONS, AUSTRALIA, 1996-97 TO 2004-05

SPECIALISATION	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
CIVIL	900	1250	1225	1400	1550	1725	2375	2125	2475
ELECTRICAL & ELECTRONICS	200	975	1325	1300	1125	775	1150	550	1300
MECHANICAL, PROD. & PLANT	725	525	150	250	725	175	450	700	875
OTHER ENGINEERING	825	950	1775	1000	1150	1025	1925	1825	1700
TOTAL WOMEN	2975	4300	4950	4150	4750	4075	6325	5675	6525
% OF TOTAL ASCO ENGINEERS	3.5	4.5	5.5	4.7	5.5	4.7	7.3	6.6	7.3

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery

NOTE: Data for Mining and Materials Engineering occupations are unreliable because they were within survey standard errors. Data for Mechanical, Production & Plant Engineering occupations are unreliable in 1997-99 1998-99, 1999-00 and 2001-02 because some quarters were within survey standard errors.

4.4 STATUS IN EMPLOYMENT IN SPECIALIST ENGINEERING OCCUPATIONS

Table 4.8 sets out data for the employment status of specialist engineers. The proportion of engineers employed in these occupations who were employees has been relatively constant at about 94%. However, the proportion of employers fell from 1.9% in 1996-97 to 0.6% in 2004-05. While the proportion of engineers who worked on their own behalf fluctuated somewhat over the period tabulated, it remained relatively constant.

TABLE 4.8
STATUS IN EMPLOYMENT, SPECIALIST ENGINEERING OCCUPATIONS, 1996-97 TO 2004-05

YEAR	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
EMPLOYEE	80200	87800	86725	80850	81750	82375	81275	80125	84800
EMPLOYER	1575	1375	850	1425	925	1475	900	725	500
OWN ACCOUNT WORKER	3250	5075	3200	4950	3950	2250	3925	5350	4025
TOTAL	85050	94625	90825	87425	86600	86775	86175	86375	89450

Source: Australian Bureau of Statistics, Labour Force Australia, 6291.0.55.001, Electronic Delivery
NOTE: Data for Contributing Family Workers and Unpaid Voluntary Workers have not been included because they are within survey standard errors in numerous quarters.

5. THE CONSULTING ENGINEERING SERVICES INDUSTRY

5.1 AN INDUSTRY OVERVIEW

Table 5.1 provides an overview of this industry. In 1992-93 the Consulting Engineering Services Industry numbered 5454 businesses which employed 28,208 people, earned $2,358 million in income yielding a profit margin of 6.7%.

TABLE 5.1
CONSULTING ENGINEERING SERVICES INDUSTRY: OVERVIEW

	1992-93	1995-96	2001-02
Number of Businesses	5454	5514	10984
Employment	28208	30736	64495
Total income ($m)	2358	3233	9342
Operating profit margin (%)	6.7	11	12.5

Source: ABS, Consulting Engineering Services, Cat. No. 8693.0, various issues

Over the next 3 years the number of businesses grew marginally, employment rose with a significant increase in income earned and profit margins increased to 11%. The profitability of the industry attracted new entrants and by 2001-02 the number of businesses had grown to 10,984 and employment had grown to 64,495. Income earned was nearly 4 times the level of 1992-93 and profit margins continued to rise to 12.5%.

5.2 SOURCES OF INCOME IN THE CONSULTING ENGINEERING SERVICES INDUSTRY

Table 5.2 shows the range of activities from which the Consulting Engineering Services Industry derived income in 2001-02. It is not possible to establish the number of businesses which operated in multiple activities. The income earned was broadly shared across activities, except for the other category.

TABLE 5.2
CONSULTING ENGINEERING SERVICES, SOURCES OF INCOME 2001-02

Activity	Businesses (no.)	Income ($m)	Income Share (%)
Building/structural	1831	886.8	9.5
Building services	804	574.3	6.1
Roads & bridges	483	505.9	5.4
Urban development	427	554.9	5.9
Communications & technology	586	239.4	2.6
Electronic/power	1328	728.1	7.8
Industrial & process engineering	2657	1863.8	20
Materials handling	1362	441.3	4.7
Mining	820	557.1	6
Oil &gas	1278	656.7	7
Other engineering	3801	1923	20.6
Total engineering services	10590	8931.3	95.6
Other income	-	410.7	4.4
Total engineering services	10984	9342	100

Source: ABS, Consulting Engineering Services, Cat. No. 8693.0, 2001-2002, July 2003

5.3 CHARACTERISTICS OF EMPLOYMENT IN THE CONSULTING ENGINEERING SERVICES INDUSTRY

Table 5.3 shows the characteristics of employment in the Consulting Engineering Services Industry in 2001-02. Full-time and part-time employees comprised the majority of the workforce and casual employees comprised about 8.7% of employees. Working proprietors and partners numbered 1356 to complete the workforce. About one quarter of the workforce was women.

TABLE 5.3
CONSULTING ENGINEERING SERVICES, CHARACTERISTICS OF EMPLOYMENT, 2001-2002

CHARACTERISTICS	Male	Females	Total
Working proprietors & partners	858	498	1356
Permanent FT employees	41399	10033	51431
Pemanent PT employees	2207	4031	6238
Casuals	3568	1902	5470
TOTAL employees	47174	15965	63139
TOTAL EMPLOYMENT	48031	16463	64495

Source: ABS, Consulting Engineering services, Cat. No. 8693.0, 2001-2002, July 2003

5.4 MAIN ACTIVITIES OF CONSULTING ENGINEERING SERVICES BUSINESSES

About 61%, or 47,810, of people working in the Consulting Engineering Services Industry are engaged directly in main stream engineering activities. Table 5.4 shows that 6992 people provided project management services, 26,680 on-going staff provided engineering services and these were supplemented by 14,138 contractors. About 8.1% of the first two groups combined were women as were about 11.1% of the contractors.

TABLE 5.4
CONSULTING ENGINEERING SERVICES, MAIN ACTIVITIES OF PERSONS WORKING, 2001-2002

ACTIVITY	Males	Females	Total
Project management	6488	504	6992
Engineering	24442	2239	26680
Quantity surveying	2148	310	2458
Drafting	4802	764	5565
Administrative/clerical	2848	11050	13898
Other	7303	1597	8901
TOTAL	48031	16463	64495
Contractors providing engineering services	12572	1566	14138
TOTAL PERSONS WORKING	60604	18029	78633

Source: ABS, Consulting Engineering Services, Cat. No. 8693.0, 2001-2002. July, 2003

Around 8023 people were engaged in provide engineering related services, including quantity surveying and drafting. Women were 13.4% of this group. Administrative support and other activities occupied 22,799, or 29% of Consulting Engineering Services Businesses. The majority of this group (55.5%) were women.

5.5 THE SIZE OF CONSULTING ENGINEERING SERVICES INDUSTRY BUSINESSES

Table 5.5 shows that 92% of Consulting Engineering Services Businesses, or 10,104 businesses were very small businesses and employed fewer than 10 people. Although the majority of businesses (92%), this group accounted for a minority of employment (36%). The largest businesses, that is, those which employed more than 100 staff, accounted for a third of all employment.

TABLE 5.5
CONSULTING ENGINEERING SERVICES, BUSINESS SIZE BY EMPLOYMENT 2001-2002

	0 to 4	5 to 9	10 to 19	20 to 49	50 to 99	100+	Total
Businesses	9183	921	493	272	68	47	10984
Share (%)	83.6	8.4	4.5	2.5	0.6	0.4	100
Employment	16905	6320	6827	7952	4791	21699	64495
Share (%)	26.2	9.8	10.6	12.3	7.4	33.6	100

Source: ABS, Consulting Engineering Services, Cat. No.8693.0, 2001-2002, July 2003

5.6 CONSULTING ENGINEERING SERVICES IN THE STATES & TERRITORIES

The distribution of the Consulting Engineering Services Industry across the States and Territories broadly mirror the distribution of the Engineering Profession. The relative shares of businesses in the various jurisdictions are much the same as the employment shares, except in Queensland where the employment share is significantly higher than the share of businesses. This suggests that the relative size of businesses in Queensland is larger than elsewhere.

For Australia as a whole, the average income per businesses was $0.85 million and the average income per employee was $0.14 million. Businesses in NSW, Victoria, South Australia and Tasmania had average incomes per business and per employee below this and the remaining jurisdictions had averages significantly above Australian levels. The highest incomes were earned in the Northern Territory at $2.01 million per business and $0.28 million per employee.

TABLE 5.6
CONSULTING ENGINEERING SERVICES, BY STATE 2001-2002

	Businesses		Employment		Income	
	Number	Share	Persons	Share	$m	Share
NSW	4030	36.7	20891	32.4	2517.4	26.9
Victoria	3089	28.1	15021	23.3	2169.9	23.2
Queensland	1828	16.6	13787	21.4	2342.1	25.1
SA	604	5.5	3289	5.1	388.5	4.2
WA	1454	13.2	8305	12.9	1450.2	15.5
Tasmania	156	1.4	1045	1.6	105.5	1.1
NT	78	0.7	552	0.9	156.9	1.7
ACT	175	1.6	1605	2.5	211.5	2.3
TOTAL	10984	100	64495	100	9342	100

Source: ABS, Consulting Engineering Services, Cat. No. 8693.0, 2001-2002.
3 July 2003

6. ENGINEERS AND MIGRATION

6.1 AN OVERVIEW OF ENGINEER MIGRATION FLOWS

Recent skill shortages have highlighted Government policies to attract skilled immigrants to Australia. Skilled migration has been a feature of migration programs for some time, as shown in Table 6.1.

TABLE 6.1
CHANGES TO THE STOCK OF ENGINEERS FROM TEMPORARY AND PERMANENT MIGRATION, AUSTRALIA 1995-96 TO 2003-04

YEAR	ENGINEER SETTLER ARRIVALS (1)	NET FLOW OF ENGINEER RESIDENTS (2)	NET FLOW OF ENGINEER VISITORS (3)	NET MOVEMENT OF ENGINEERS (1+2+3)
1995-96	1333	-135	237	1435
1996-97	1144	-236	270	1177
1997-98	1190	-422	620	1388
1998-99	1221	-354	611	1478
1999-00	1327	-168	525	1684
2000-02	1365	-194	582	1753
2001-02	1055	-41	574	1588
2002-03	1079	100	530	1709
2003-04	2707	-666	946	2987

Source: Bob Birrell, Virginia Rapson and T Fred Smith, Immigration at a Time of Domestic Skill Shortages, Centre for Population and Urban Research, Monash University

Table 6.1 was constructed from data published by Birrell, Rapson and Smith in May 2005. The first column of the Table shows permanent settler professional engineer arrivals. Although there were a few year on year fluctuations to 2002-03, there was no strong trend. In 2003-04, the immigration of the previous year more than doubled.

Australian engineers have shown a modest interest in overseas employment for many years. This is shown in the second column of Table 6.1. While some expatriates return to Australia, during the years shown in the Table, there typically were more departures than returns with the exception of 2002-03

Short term movements to and from Australia are also common and the third column of Table 6.1 shows that over time Australia is increasingly benefiting from this exchange. This flow of visiting engineers to date has offset the loss of Australian engineers to other parts of the world.

The net movement of engineers is the sum of these separate changes and are shown in the last column of Table 6.1. There are increasing numbers of engineers from overseas in the Australian workforce. The trend is an irregular increase, being quite pronounced in the three years to 2003-04.

6.2 SKILLED MIGRATION AND ON-SHORE VISAS

In 2001, the Commonwealth Government made a significant change to migration regulations. In the past, overseas students studying in Australia who wished to migrate to Australia were obliged to return to their home country before applying for a permanent visa to migrate. Under the new rules, overseas students completing their studies could apply for a permanent visa to remain in Australia without first returning home. This has led to significant changes to the dynamics of the immigration intake as shown in Table 6.2.

TABLE 6.2
IMMIGRATION OF SPECIALIST ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	964	33	0	15	1012
2001-02	858	37	162	17	1074
2002-03	1068	44	299	11	1422
2003-04	1068	43	655	22	1798
2004-05	1345	147	1101	43	2636

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

This data once again is the result of research by Bob Birrell, but this time assisted by John Sheridan and Virginia Rapson. The data in Table 6.2 focuses on permanent migration to Australia only and up-dates the information in Table 6.1 and so the aggregates may differ slightly. The principal avenue for skilled migration for many years has been the various skilled migration programs and employer nomination schemes administered by the Department of Immigration and Indigenous Affairs (DIMIA). The first two columns of Table 6.2 show the impact of these arrangements from 2000 onwards. Both show upward trends, although in the case of employer nominations activity was slow until skill shortages began to bite in recent times. The impact of student on-shore visa applications is shown in the third column of the Table.

From a base of zero in 2000-01, overseas student on-shore visa applications for engineers increased to 1101 in 2004-05. In their first year, these new visas comprised about 15% of immigrant engineers and swamped immigration from employer nominations. By 2004-05 the on-shore visa share had increased to 42% of migrant engineers at a time when the overall intake itself had increased by 160%. On-shore visa entrant numbers now almost rival those from traditional skilled migration programs.

The latest DIMIA Migrant Occupations in Demand List[19] (MODL) includes Civil Engineers, Mining Engineers, Chemical Engineers and Petroleum Engineers. Tables 6.3 to Table 6.9 represent Table 6.2 by engineering specialisation classified according to ASCO to reflect on these areas of skill shortage.

TABLE 6.3
IMMIGRATION OF CIVIL ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	230	8	0	2	240
2001-02	217	3	43	1	264
2002-03	255	9	65	4	333
2003-04	219	8	123	5	355
2004-05	257	17	168	6	448

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

TABLE 6.4
IMMIGRATION OF ELECTRICAL & ELECTRONIC ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	231	3	0	4	238
2001-02	182	20	26	4	236
2002-03	204	13	62	1	280
2003-04	239	8	160	4	411
2004-05	302	37	273	9	621

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

For 2003, Tables 3.10A and 10B show that there were 949 domestic student course completions and 371 overseas student course completions in the various specialisations of Civil Engineering. Table 6.3 shows that 123 former overseas students who held Civil Engineering Degrees were admitted under the on-shore visa process that financial year. These statistics suggest that up to one third of the overseas graduates stayed in Australia as a result of the on-shore visa process. Care must be taken with comparisons like this because those admitted may not be from the same graduation year. Other reasons for caution are the large “not elsewhere classified” component of Table 3.10A and 10B and the inclusion of undergraduate completions.

TABLE 6.5

IMMIGRATION OF MECHANICAL, PRODUCTION & PLANT ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	216	7	0	3	226
2001-02	159	8	26	0	193
2002-03	251	8	72	0	331
2003-04	266	18	132	7	423
2004-05	339	31	196	16	582

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

TABLE 6.6

IMMIGRATION OF MINING & MATERIALS ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	42	3	0	0	45
2001-02	46	4	2	0	52
2002-03	36	1	4	0	41
2003-04	43	1	12	3	59
2004-05	45	23	13	5	86

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

TABLE 6.7

IMMIGRATION OF ENGINEERING TECHNOLOGISTS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	114	5	0	2	121
2001-02	152	2	35	4	193
2002-03	182	7	34	3	226
2003-04	181	1	139	0	321
2004-05	251	27	237	5	520

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

TABLE 6.8
IMMIGRATION OF CHEMICAL ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	82	3	0	3	88
2001-02	67	0	22	0	89
2002-03	85	5	48	1	148
2003-04	70	3	56	2	131
2004-05	74	7	147	1	229

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

TABLE 6.9
IMMIGRATION OF THE BALANCE OF OTHER ENGINEERS TO AUSTRALIA, 2000-01 TO 2004-05

YEAR	SKILLED MIGRATION PROGRAMS	EMPLOYER NOMINATION	ON-SHORE VISA OVERSEAS STUDENTS	OTHER	TOTAL
2000-01	49	4	0	1	54
2001-02	35	0	8	4	47
2002-03	46	1	14	2	63
2003-04	50	4	43	1	98
2004-05	77	5	67	1	150

Source: Bob Birrell, John Sheridan and Virginia Rapson, Why No Action on Engineering Training?, People and Place, vol. 13, no. 4, 2005, p44

Similar comparisons can be made for other engineering specialisations. There is a problem associated with the occupation “Engineering Technologists” which was covered earlier in this Handbook. These figures are set out in Table 6.10 for professional engineers arriving in Australia from all other immigration programs. Engineering Technologists are included with “other” engineers in this comparison, as are the “not classified elsewhere” course completions in Table 3.10. This comparison is fraught with difficulties, but none-the-less provides an order of magnitude to the relationship between Australian engineering education and skilled migration. The skilled migration data, including on-shore visa approvals, increased sharply in 2004-05. Unfortunately at this stage the 2004 University completions data are not available but the trend is fairly evident.

TABLE 6.10
AUSTRALIAN ENGINEERING COURSE COMPLETIONS COMPARED TO ON-SHORE VISA APPLICATIONS APPROVED, 2003

COURSE	DOMESTIC COMPLETIONS	OVERSEAS COMPLETIONS	SKILLED MIGRATION	ON-SHORE VISAS
CIVIL	949	371	232	123
ELECTRICAL & ELECTRONIC	1639	1006	251	160
MECHANICAL, PROD. & PLANT	850	721	291	132
MINING & MATERIALS	342	32	47	12
CHEMICAL	318	159	75	56
OTHER ENGINEERS	3745	1811	237	182
TOTAL	7843	4100	1133	665

Source: Tables 3.9A and 9B and Tables 6.3 to 6.9

7. ENGINEERING SKILL SHORTAGES

7.1 MEASURING SKILL SHORTAGES OR SURPLUSES

Each year the Graduate Career Council of Australia releases information on the proportions of new graduates in full time work and looking for full time work. This data enables a comparison to be made of the proportion of unemployed engineers to the proportion of unemployed graduates across all disciplines. The latter will move up and down annually according to the circumstances of the economy as a whole, and how this impacts on the labour market. However, the relationship between the unemployment rates of different disciplines reflects changes arising from changes in industry mix, as well as within industry structural changes, and so lends itself to the construction of a relative skill shortage index.

The relationship between the proportion of unemployed engineers and all unemployed graduates indicates whether engineers are finding it harder or easier to find jobs compared to graduates at large. Thus, when the unemployment rate for engineers is lower than the average for all graduates, engineers are finding full time jobs more readily than other graduates. Conversely, when the unemployment rate for engineers is higher than the average for all graduates, engineers are finding it harder to obtain full time employment than other graduates.

When the two unemployment rates are equal, the prospects of full time employment for the two groups is equal and depends on overall economic circumstances. These relativities can be expressed as an index number. When the employment prospects of engineers and other graduates are equal, the “skill shortage” index would equal 100. A relative over-supply of engineers would be indicated by an index number greater than 100, because the unemployment rate for engineers exceeds the average for other graduates. Similarly, a relative under-supply, or shortage of engineers, would be indicated by an index number less than 100 because the unemployment rate for engineers is less than the average for other graduates. The necessary data is available from the GCCA for a number of years making it possible to establish whether the present situation has just arisen, or has developed over time.

Table 7.1 reports GCA data for graduate engineers from 1999 to 2005. The last column of the Table reports a "Shortage Index" for graduate engineers relative to graduates as a whole. This data shows that for all years reported there has been a relative shortage of graduate engineers and that in recent years this relative shortage has become more acute. The GCA statistics are based on a survey of graduates rather than a census. Comparing the numbers included in the GCA work to the graduation of domestic students at the Bachelors level as reported in Table 7.1 provides more than adequate assurance that the GCA survey is representative.

TABLE 7.1
EMPLOYMENT OF GRADUATE ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	NUMBER	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	85.6	14.4	100	2681	19.2	75.0
2000	87.4	12.6	100	2341	16.4	76.8
2001	87.4	12.6	100	2350	17	74.1
2002	84.1	15.9	100	2584	18.7	85.0
2003	85.4	14.6	100	2584	19.9	73.4
2004	85.4	14.6	100	2495	20.3	71.9
2005	87.7	12.3	100	3030	19.1	64.4

Source: Graduate Careers Australia, GradStats, various issues

7.2 ENGINEERING SKILL SHORTAGES BY SPECIALISATION

The GCA data are available for different engineering specialisations. Although the definitions used are not consistent with ABS classifications, the data are sufficiently descriptive of engineering specialisations to be relevant, and, show that the relative shortages of engineers reported in Table 7.1 are even more acute in particular engineering specialisations.

TABLE 7.2
EMPLOYMENT OF GRADUATE MINING ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	NUMBER	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	89	11	100	73	19.2	57.3
2000	84.9	15.1	100	73	16.4	92.1
2001	85.9	14.1	100	85	17	82.9
2002	90.9	9.1	100	77	18.7	48.7
2003	94.1	5.9	100	85	19.9	29.6
2004	96.6	3.4	100	59	20.3	16.7
2005	98.8	1.2	100	82	19.1	6.3

Source;Graduate Careers Australia, GradStats, various issues

Table 7.2 shows that the relative shortage of mining engineers has been particularly acute, and the shortage index is consistent with industry advice to this effect. In the case of Aeronautical Engineers, Table 7.3 shows a more mixed picture with relative surpluses in 2001 and 2004, but with relative shortages in other years. Table 7.4 shows that Chemical Engineers have been in relative shortage for some time.

TABLE 7.3
EMPLOYMENT OF GRADUATE AERONAUTICAL ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	NUMBER	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	91.3	8.7	100	104	19.2	45.3
2000	95	5	100	119	16.4	30.5
2001	77.3	22.7	100	88	17	133.5
2002	82.9	17.1	100	123	18.7	91.4
2003	83.9	16.1	100	124	19.9	80.9
2004	76.3	23.7	100	118	20.3	116.7
2005	89.1	10.9	100	156	19.1	57.1

Source: Graduate Careers Australia, GradStats, various issues

TABLE 7.4
EMPLOYMENT OF GRADUATE CHEMICAL ENGI INEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	NUMBER	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	82.4	17.6	100	204	19.2	91.7
2000	88.5	11.5	100	156	16.4	70.1
2001	84.3	15.7	100	178	17	92.4
2002	89.2	10.8	100	166	18.7	57.8
2003	87.6	12.4	100	177	19.9	62.3
2004	84.2	15.8	100	120	20.3	77.8
2005	83.1	16.9	100	178	19.1	88.5

Source: Graduate Careers Australia, GradStats, various issues

TABLE 7.5
EMPLOYMENT OF GRADUATE CIVIL ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	NUMBER	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	90.6	9.4	100	630	19.2	49.0
2000	92.9	7.1	100	519	16.4	43.3
2001	92.4	7.6	100	512	17	44.7
2002	91.1	8.9	100	553	18.7	47.6
2003	94.3	5.7	100	542	19.9	28.6
2004	96.5	3.5	100	515	20.3	17.2
2005	95.7	4.3	100	537	19.1	22.5

Source: Graduate Careers Australia, GradStats, various issues

TABLE 7.6
EMPLOYMENT OF GRADUATE ELECTRICAL ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	SAMPLE (no)	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	90.2	9.8	100	306	19.2	51.0
2000	93.9	6.1	100	293	16.4	37.2
2001	91.4	8.6	100	301	17	50.6
2002	83.3	16.7	100	372	18.7	89.3
2003	82.1	17.9	100	358	19.9	89.9
2004	80.7	19.3	100	362	20.3	95.1
2005	87.3	12.7	100	371	19.1	66.5

Source: Graduate Careers Australia, GradStats, various issues

TABLE 7.7
EMPLOYMENT OF GRADUATE ELECTRONIC AND COMPUTER ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	SAMPLE (no)	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	84.8	15.2	100	422	19.2	79.2
2000	91.9	8.1	100	384	16.4	49.4
2001	89.1	10.9	100	403	17	64.1
2002	74.7	25.3	100	379	18.7	135.3
2003	73.5	26.5	100	483	19.9	133.2
2004	77.7	22.3	100	471	20.3	109.9
2005	78.3	21.7	100	631	19.1	113.6

Source: Graduate Careers Australia, GradStats, various issues

TABLE 7.8
EMPLOYMENT OF GRADUATE MECHANICAL ENGINEERS, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	SAMPLE (no)	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	78.4	21.6	100	514	19.2	112.5
2000	86	14	100	437	16.4	85.4
2001	85.9	14.1	100	467	17	82.9
2002	81.5	18.5	100	466	18.7	98.9
2003	87.2	12.8	100	476	19.9	64.3
2004	85.4	14.6	100	520	20.3	71.9
2005	89.5	10.5	100	504	19.1	55.0

Source: Graduate Careers Australia, GradStats, various issues

The acute relative shortage of Civil Engineers, which resulted in their inclusion in the DIMIA list of occupations in national shortage, is clearly evident in Table 7.5. Electrical Engineers are also in chronic shortage as shown in Table 7.6. In contrast, a closely allied field, Electronic and Computer Engineers was in relative shortage up until 2001, but since then has been in relative surplus. Mechanical Engineers were in relative surplus in 1999, but since then have been in relative shortage and there are signs that this shortage is intensifying.

TABLE 7.9
EMPLOYMENT OF OTHER ENGINEERING GRADUATES, 1999 TO 2005

YEAR	EMPLOYED FULL TIME (%)	SEEKING FT WORK (%)	TOTAL (%)	SAMPLE (no)	ALL GRADS SEEKING FT WORK (%)	SHORTAGE INDEX
1999	84.6	15.4	100	428	19.2	80.2
2000	83.1	16.9	100	360	16.4	103.0
2001	80.4	19.6	100	316	17	115.3
2002	83.5	16.5	100	448	18.7	88.2
2003	86.4	13.6	100	339	19.9	68.3
2004	85.8	14.2	100	330	20.3	70.0
2005	86.9	13.1	100	571	19.1	68.6

Source: Graduate Careers Australia, GradStats, various issues

Finally, the “Other” group which includes Environmental and Biomedical Engineers was in relative surplus in 2001 and 2002, but have since been in relative shortage.

8. ENGINEERING SALARIES

8.1 GRADUATE ENGINEER SALARIES

The Graduate Careers Council of Australia annually publishes data for the median starting salaries of Bachelor Degree graduates, aged less than 25 years, starting their first full-time jobs. Table 8.1 uses this data to compare the starting salaries of Engineers to all fields of graduates and to movements in average weekly earnings. Starting salaries for Engineers rose by 25% between 1999 and 2005 which was a little less than the 29% increase for all graduates. Even so Engineers retained their ranking as the fourth highest paid starting graduates and only Dentistry, Medicine and Optometry graduates earned higher starting salaries. The relative stability of this situation is shown by the ESS Index which is the ratio of Engineers starting salaries to the starting salaries of all graduates expressed as an index number.

TABLE 8.1
MEDIAN STARTING SALARIES FOR ENGINEERS, 1999 TO 2005 ($`000)

YEAR	ENGINEERS	ALL FIELDS	AWE	ESS (%)	GSS (%)	ESS Index	RANK
1999	35.1	31.0	38.0	92.4	81.6	113.2	4
2000	37.0	33.0	39.2	94.4	84.2	112.1	4
2001	40.0	35.0	40.8	98.0	85.8	114.3	4
2002	40.0	35.5	42.9	93.2	82.7	112.7	4
2003	40.0	37.0	45.1	88.7	82.0	108.2	4
2004	41.0	38.0	46.6	88.0	81.6	107.8	3
2005	44.0	40.0	48.9	90.0	81.8	110.0	4

Source: Graduate Careers Australia, GradStats, various issues

TABLE 8.2
MEDIAN STARTING SALARIES FOR ENGINEERS COMPARED TO OTHER FIELDS ($`000)

YEAR	ENGINEERS			ALL FIELDS		
	MALES	FEMALES	TOTAL	MALES	FEMALES	ALL
1999	35	36	35.1	32.5	30	31
2000	37	38	37	34.5	32	33
2001	39.5	40	40	36	34	35
2002	40	40	40	37	35	35.5
2003	40	40	40	38	36.3	37
2004	41	41	41	39	38	38
2005	44	44	44	40	39	40

Source:Graduate Careers Australia, GradStats, various issues

In contrast to other fields of endeavour, women Engineers attracted equality in starting salaries and indeed in some years had starting salaries higher than their male counterparts. This is shown in Table 8.2.

TABLE 8.3
MEDIAN STARTING SALARIES FOR ENGINEERS IN GOVERNMENT EMPLOYMENT, 1999 TO 2005 ($`OOO)

	ENGINEERS IN GOVERNMENT			ALL FIELDS IN GOVERNMENT		
YEAR	FEDERAL	STATE	ALL	FEDERAL	STATE	ALL
1999	38.5	35.0	36.0	32.0	32.0	32.0
2000	41.0	36.0	36.5	33.6	33.0	33.0
2001	42.5	37.0	38.0	35.0	34.6	34.7
2002	41.2	38.0	39.9	37.0	36.0	36.0
2003	42.7	40.3	41.0	38.0	37.0	37.2
2004	43.4	42.0	42.0	40.0	39.0	39.0
2005	47.0	43.0	44.0	42.0	40.0	40.0

Source: Graduate Careers Australia, GradStats, various issues

TABLE 8.4
MEDIAN STARTING SALARIES FOR ENGINEERS IN THE PRIVATE SECTOR, 1999 TO 2005 ($`000)

	ENGINEERS		ALL FIELDS	
YEAR	PRACTICE	INDUSTRY & COMMERCE	PRACTICE	INDUSTRY & COMMERCE
1999	34.0	36.5	30.0	30.0
2000	35.3	38.0	30.5	32.0
2001	37.0	41.0	34.0	33.5
2002	38.0	41.0	35.0	34.9
2003	40.0	40.0	35.0	35.0
2004	40.0	42.0	36.0	35.0
2005	43.0	45.0	38.0	37.0

Source: Graduate Careers Australia, GradStats, various issues

Tables 8.3 and 8.4 compare the starting salaries for Engineers and graduates in all fields in Federal and State Government employment and in engineering practice and industry and commerce in the private sectors. In all cases Engineers attract higher starting salaries. The highest starting salaries are for Engineers engaged by the Federal Government and by enterprises in the private sectors.

Economics suggests that skill shortages lead to higher salaries as supply is pressured by demand. The data in this sub-section show that while starting engineering salaries have risen over time and engineering starting salaries have maintained a high ranking against other disciplines, there is little evidence of unusual movements triggered by supply shortages.

8.2 TRENDS IN ENGINEERING SALARIES

The Association of Professional Engineers, Scientists and Managers, Australia in conjunction with Engineers Australia has been conducting remuneration surveys for Engineers every 6 months since 1974. This survey classifies Engineers according to career progression in the manner shown in Table 8.5.

TABLE 8.5
CLASSIFICATION OF ENGINEERS IN THE APESMA REMUNERATION SURVEY

CLASSIFICATION	DEFINITION	TYPICAL TITLE
LEVEL 1	Commencement level.	Graduate Engineer
LEVEL 2	Conducts professional engineering without detailed supervision on more responsible assignments.	Structural Engineer Design Engineer Technical Specialist Specialist Engineer Project Engineer
LEVEL 3	Requires application of mature professional knowledge. Deals with problems where modification to established guides needed.	Operations Manager Works Engineer Project Engineer Operational Planner Consulting Engineer Engineering Systems Manager
LEVEL 4	Work involves considerable independence Demands originality, ingenuity & judgement	Project Manager Regional Manager Senior Engineer Quality Manager Production Manager Manager Technical Specialist
LEVEL 5	Responsible for directing several professional & other groups in inter-related engineering Authority of major importance to an organisation	Associate Director Executive Engineer Group Manager Manager Project Manager Principal

Source: APESMA, Professional Engineer Remuneration Survey Report, December 2005

Table 8.6 shows the trends in Engineers salary packages, for the grades outlined in Table 8.5, from December 1995 to December 2005.

TABLE 8.6
MEDIAN ENGINEERING SALARIES PACKAGES, BY EXPERIENCE LEVEL, JUNE 1996 TO DECEMBER 2005 ($`000)

PERIOD	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL4	LEVEL 5	ABOVE 5
Jun-96	35.3	46.1	57.6	68.6	76.5	108.4
Jun-97	39.1	49.4	61.2	73.1	87.2	121.3
Dec-97	38.9	52.2	62.7	73.4	94.7	134.4
Jun-98	40.2	51.9	63.8	76.8	93.7	125.6
Dec-98	41.0	53.2	66.1	79.4	99.8	137.0
Jun-99	42.3	54.2	68.3	82.1	100.2	131.6
Dec-99	43.4	55.4	68.2	81.6	99.5	139.3
Jun-00	45.4	59.0	71.1	86.4	106.3	142.1
Dec-00	45.7	59.7	73.7	89.6	106.7	147.9
Jun-01	47.4	60.8	73.4	89.4	107.8	144.0
Dec-01	48.9	60.3	73.8	91.1	108.4	151.5
Jun-02	49.2	62.7	75.6	92.4	109.2	156.6
Dec-02	49.6	65.4	76.7	96.3	109.5	156.4
Jun-03	52.2	67.5	78.7	99.6	114.4	156.5
Dec-03	51.2	66.3	79.5	99.1	114.5	149.1
Jun-04	52.3	69.0	80.5	100.2	115.4	152.7
Dec-04	51.3	67.4	80.3	101.8	113.9	161.1
Jun-05	53.4	69.8	83.1	103.2	118.3	162.4
Dec-05	54.5	72.4	83.3	107.1	121.0	185.3

Source: APESMA, Professional Engineer Remuneration Survey Report, December 2005

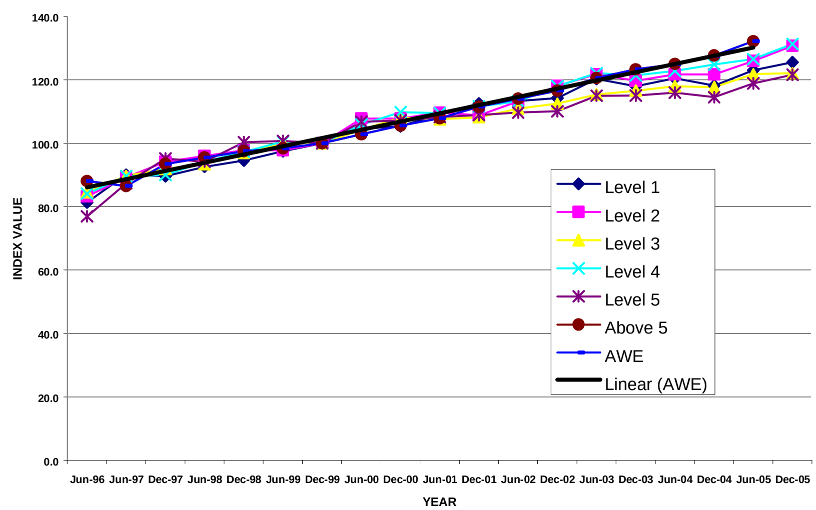


FIGURE 8.1: MEDIAN SALARY PACKAGES FOR ENGINEERS

Figure 8.1 represents the salary packages data of Table 8.6 as index numbers with December 1999 as base (that is set to 100) and compares the movements in salary packages to the linear time trend of average weekly earnings. Since about 2001, the trends in Engineers salary packages have fallen below the trends in average weekly earnings for all grades.

Figure 8.2 shows trends in the median salary packages for Chemical, Civil and Structural, Electronics and Communications, Mechanical and Mining Engineers. These data are averages across the grades of Engineers. These specialisations were selected because they are included in the DIMIA lists of occupations in National shortage (Chemical, Mining and Civil and Structural) and because the remaining two specialisations exhibited similar trends. Figure 8.2 also shows a linear trend line for average weekly earnings.

Average Engineer salary packages are clearly well above average weekly earnings. In the 5 specialisations illustrated the trends show that Engineer salary packages are increasing faster than average weekly earnings. Taken in combination with Figure 8.1, the trends in Engineers salaries depend on specialisation and the fortunes of the industries in which different specialisations are employed. The specialisations in Figure 8.2 are associated with major growth industries such as mining and construction. Anecdotal information has indicated skill shortages in these areas and the data here lend support to these views. There are signs that other specialisations (Mechanical and Electronics and Communications) are experiencing salary pressures similar to the specialisations believed to be in shortage.

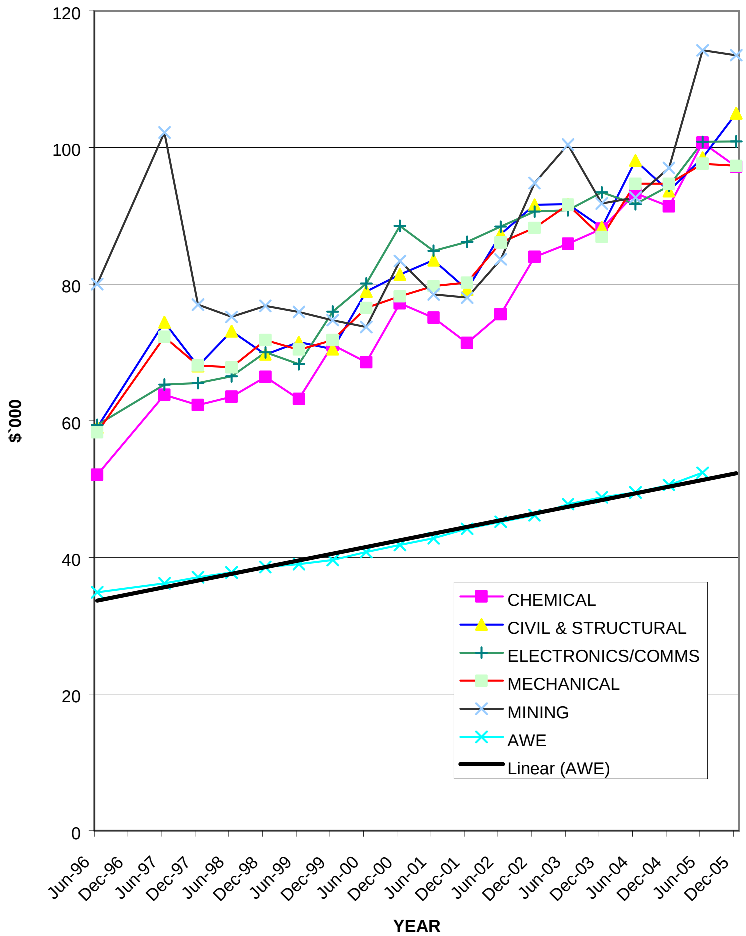


FIGURE 8.2: MEDIAN SALARY PACKAGES, SELECTED ENGINEERING SPECIALISATIONS IN THE PRIVATE SECTOR

9. ENDNOTES

[1] In a 2004 paper the Department of Employment and Workplace Relations (Australia's Future Professional Skill Needs) reported that 49.6% of all professional employed were aged 55years or over in 2003. Engineers Australia statistics are collected a little differently, but show that 39.1% of members were aged 50years or over in December 2005.
[2] www.en.wikipedia.org, Engineering
[3] Op cit, p2
[4] Sunny Y Auyang, Engineering-An Endless Frontier, Harvard University Press, 2004, also see extract in www.creatingtechnology.org,
[5] Op cit
[6] Engineers Australia, Chartered Status, Applicant`s Handbook for Chartered Professional Engineer (CPEng), Chartered Engineering Technologist (CEngT) and Chartered Engineering Associate Officer (CEngO), 2004, p5
[7] Australian Bureau of Statistics, Australian Standard Classification of Occupations (ASCO), Second Edition, July 1997, Ch 2 The Conceptual Basis of ASCO, P2
[8] Engineers Australia, The Engineering Profession and Official Statistics, November 2005.
[9] An example of how the US data can be used to analyse the variety of occupations held by engineers can be found in Abt Associates Inc, The Education and Employment of Engineering Graduates, 2004, Engineering Workforce Report Number 1, funded by the Division of Engineering Education and Centers, National Science Foundation.
[10] Op cit, p40
[11] APESMA, Professional Engineer Remuneration Survey, various issues.
[12] Op cit, 7 above, p13
[13] APESMA, op cit
[14] www.abs.gov.au/Ausstats/abs@nsf/66f306f503e529a5ca25697e0017661f/70c9
[15] Private correspondence with DEST officers.
[16] OECD, Education at a Glance: OECD Indicators 2005
[17] See for example the forth coming skills audit of Science, Engineering and Technology professionals being undertaken by DEST.
[18] For example, most of the general equilibrium macroeconomic model based around input-output model disaggregation seem to be able to overcome this problem with ease.
[19] www.immi.gov.au/migration/skilled/advice