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15 May 2008

Ms Cathryn Cummins
Council Officer - Committees
Legislative Council
NSW Parliament House
Macquarie Street
Sydney NSW 2000

Re: Nanotechnology in New South Wales

Dear Ms Cummins,

I enclose my amended transcript from my appearance before the Standing Committee on State Development on Monday 28 April 2008 and provide the following additional information in relation to the questions on notice.

Page 32/33 of the Transcript – Attached is a copy of two pages of further information on the activities and achievements of the UWS Nanotechnology Network.

Page 33/34 of the Transcript – The UWS Nanotechnology network had received funding from the Federal Department of Transport and Regional Services (DOTARS) now the Department of Infrastructure, Transport and Regional Development under the Sustainable Regions Program which concluded in June 2006.

Web link: <http://www.sustainableregions.gov.au/nsw/cam/projects.aspx>

While continuing funding for the Network activities has been discussed with staff at DOTARS, no formal application to a funding scheme has been made to date. There have been initial discussions with the NSW Department of State and Regional Development regarding possible funding however as there was no relevant schemes to lodge an application, so no formal process was undertaken.

Page 35 of the Transcript – My office undertook a web search looking at TAFE and the National Training Information Service and was unable to locate any current vocational level training courses available. The only mention we found was in online course, Laboratory Operations Training Package listed on the National Training Information Service web page the course was developed by the Manufacturing Industry Skills Council. Whilst searching for this information we note that in the Report to the Minister of Industry, Tourism and Resources entitled: *Options for a National Nanotechnology Strategy* June 2006, reference page 39 under Education/skills, it stated:

Can you describe to the Committee the work that UWS has undertaken through the Nanotechnology Network to promote knowledge of nanotechnology in Western Sydney?

1. Since 2003 UWS has offered an undergraduate course Bachelor of Science (Nanotechnology) at the UWS Campbelltown Campus.
2. UWS Nanotechnology Network has been conducting quarterly networking meetings with academics/researchers, UWS students, Business & Industry, Government (Federal & State), secondary school science teachers and students, and interested community members since 2003.
3. These meetings are regularly attended by over 50 people.
4. Meetings have been mainly conducted at UWS Campbelltown campus but have also been held at Blacktown City Council (in conjunction with Blacktown City Council) and Western Sydney Business Centre (in conjunction with NSW DSRD)
5. Held the UWS Nanotechnology Seminar in November 2004 attended by over 80 people.
6. Between 2004 -2005, in partnership with the Kirk Group, conducted an ARC Linkage Grant on the Development of a Cost-Effective Organic-Inorganic Nanocomposite for High Quality Gravure Printing
7. In March 2005 conducted a seminar for the Polymer Industry on nanotechnology in conjunction with NSW DSRD re possibility of forming a cluster.
8. Facilitated exploration of research and consultancy opportunities between UWS academics/ researchers and various Western Sydney industry partners.
9. Produced three 2C 10⁻⁹ Newsletters in 2004, 2005 and 2006 that have been widely distributed to business, industry, government, secondary schools in greater Western Sydney and beyond.
10. In May 2006 over 80 secondary school senior science students and their teachers participated in the UWS Nanotechnology Seminar for Macarthur High School students at UWS Campbelltown campus.
11. In September 2006 hosted a visit from USA of Mike Treder, Centre for Responsible Nanotechnology and conducted a public lecture on "Disruptive Abundance: Nanotechnology in Our Time" at UWS Campbelltown campus.
12. In 2006 developed the Special Agreement with Schools (SAWS) with a cluster of secondary schools in the Macarthur region to pilot better liaison between UWS and secondary schools.
13. In July 2006 published an article "One University, four Schools, and a pinch of Nanotechnology: a model for mutually beneficial linkages between science staff and students in high schools and universities" about SAWS in Science Matters, the newsletter of the NSW Science Teachers Association (STANSW)
14. Developed the Sci High DVD in conjunction with NSW DET and Campbelltown Performing Arts High School. This has been shown 4 times

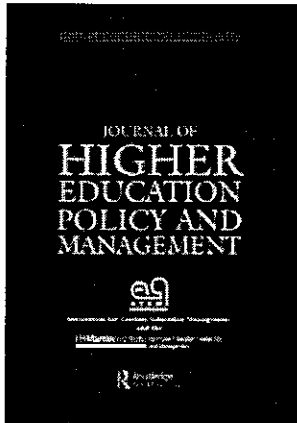
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on community television station TVS; has been distributed to over 250 secondary schools in greater Western Sydney and widely to other key influentials after being launched in August 2007.

15. Sci Hi #2 is currently in production and further explores nanotechnology through the cochlear ear implant; the Nuclear Magnetic Resonance (NMR) facility at UWS Campbelltown campus, and the Freedom Wheelchair that has been developed through Network participants and connections.
16. Between March and June 2006 conducted site visits to over 240 businesses in greater Western Sydney to inform them of the opportunities that nanotechnology may provide to their industries.
17. Conducted Industry Surveys in 2003, 2005 and 2006 to research industry knowledge, understanding and application of nanotechnologies. These surveys were mainly of greater Western Sydney businesses.
18. Provided Reports back to industry, government and others based upon this research.
19. Identified from this research that industry generally is still looking to academia for knowledge of nanotechnology, and especially in its application to various industries.
20. Identified that there will be an increasing demand for a highly skilled nanoscience based workforce; and that it is imperative to begin by increasing participation in science, mathematics and technology in primary and secondary schools.
21. Published and presented results of research at a number of national and international conferences.
22. Supported UWS Professor of Nanotechnology, Bill Price's NMR Symposium on Imaging and Diffusion in 2005, 2006 and 2007.
23. Conducted a number of site visits by industry, government and international visitors to the NMR facility at UWS Campbelltown campus.
24. Made submissions to the Australian Government National Nanotechnology Taskforce Strategy based upon this research.
25. In November 2007 the Freedom Wheelchair, which incorporates the nanomaterials Nanoflex made by Sandvik Steel in Sweden was unveiled.
26. Through setting up an Interim Steering Committee and conducting a series of meetings for interested industry partners UWS was instrumental in forming the NSW Chapter of the Australian Nano Business Forum in 2006.
27. In 2007 partnered with several industry partners (Nanottra) to develop a Technology Roadmap for the Toolmaking Industry titled "Exploring Some Advanced Manufacturing Applications of Nanotechnology" funded through Ausindustry.
28. Participated in a number of Nanotechnology related seminars, meetings and workshops conducted by NSW DSRD, and other organisations such as OzNano2Life, ANBF, SPE.
29. In 2007 conducted the 'Diamond Anvil workshop' with UWS, industry and federal and state government representatives to determine ways and means to maintain and increase the relevance of the UWS Nanotechnology Network.

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Demographic Trends in Australia's Academic Workforce

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responding to the accelerated demand for academic staff in the 1960s and 1970s, Australia utilized immigration and the paper examines the role of immigration in addressing the impending increase in demand for academics. A final section discusses some of the implications of the demographic changes in academic staff for human resource planning in the Australian universities.

There are two main sources of data utilized in the present paper to analyse trends in academic staff in Australia. The first is the Australian census of population and housing. The Australian census recognizes universities as a separate *industry* (ANZSIC) class¹ and within its occupational (ASCO) classification (ABS, 1997). Australians who are employed in universities are divided according to the type of work² they do. In the analysis here the definitions that are used are as follows (ABS, 1997, p. 79):

Academics are members of staff at universities who undertake teaching, research, a combination of both functions, or who are responsible for staff undertaking such functions.

Academic workers are those who perform a teaching-only function or a combination of both teaching and research. For those who do both, the balance of teaching time to research time is not known.

Accordingly, the census data analysed here involve two groups:

- (a) all university academic staff, which includes researchers, teachers and other professionals responsible for them
- (b) university academics who are involved in teaching in universities either as teaching only or in combination with research.

The second source of data utilized here is the returns made by universities to the Commonwealth Department of Education, Science and Training (DEST). This has undergone change over time which does make comparability over time somewhat difficult. Until 1987, data are available on full-time and part-time academic staff but thereafter the information is for full-time equivalent staff. Moreover it has not been possible to make a clear separation between research, teaching/research and teaching staff in all the years for which information are available. The data are sent by each university to DEST for a particular reference date each year.

The Growth in the Academic Workforce

To understand the contemporary Australian academic workforce it is necessary to summarize its evolution over the last four decades. This is shown initially through examination of census information. Table 1 shows how the teaching staff in Australian universities experienced substantial growth in the 1970s and 1980s. This was a function of a massive expansion in the number of students in Australian universities as is evident in Figure 1. This was a function of two factors:

meet the shortfall of insufficient numbers of Australian graduates (Borrie, 1962) available to fill the new positions being created. The UK had also experienced a postwar baby boom but it was much less pronounced and shorter in time than was the case in Australia. These new staff were overwhelmingly recent graduates and aged in their twenties and thirties.

It will be noted in Table 1, however, that there was a slowing down in the growth of teaching staff between 1991 and 1996 when the increase was only half that of 1986–1991. Then in 1996–2001 there was no increase at all in the numbers of teaching academics. This of course was an era of substantial change in the way universities operated with the introduction of more managerial models, expansion of administrative staff and an emphasis on increasing the numbers of students taught per staff member. This is apparent in Table 2, which indicates that teaching loads increased by 46.5% over the last decade. This also was a period in which several universities initiated redundancy programmes and this also contributed to the leveling off in the number of teaching staff. It will be noted in Table 1, however, that while there was a net increase in teaching staff of only seven there was an overall increase in the number of university staff of 7227. This points to a significant increase in the number of administrative and research-only staff in universities over the period.

The census data are interesting in that they allow precise comparison with other occupation groups. While there was no net increase in university teaching staff there was a 16.1% overall increase in university staff, a 22.9% increase in the number of lawyers, an 8.4% increase in the number of doctors and an 8.7% increase in the number of school teachers. Census data rely on an individual's own definition of the type of job that they do and are collected only once every five years in Australia. DEST data rely on returns from individual universities reporting their staff situation and are available on an annual basis.

Figure 2 brings together annual count information on the number of academic staff in Australian tertiary education institutions over the last half century. Full-time equivalent (FTE) data are available from DEST only back to 1988. Prior to that date information was obtained from ABS Yearbooks and only allowed division into full-time and part-time components. Nevertheless, the trends evident in the annual data are interesting. It will be noted that in the 1950s, university staff doubled from 2388

Table 2. Australian universities: Student–teacher ratios, 1993–2003

Year	Ratio	Year	Ratio
1993	14.2	1999	18.3
1994	14.2	2000	18.5
1995	14.6	2001	19.1
1996	15.6	2002	20.2
1997	17.2	2003	20.8
1998	17.9		

Source: Australian Vice Chancellor Committee (AVCC).

each of the last two years has seen a net increment of around 1000 to the academic staff.

The Age Structure of the Academic Workforce

As a result of the rapid growth of the academic workforce in the 1960s and 1970s followed by a period of slow growth and stability, the age structure of the academic workforce is one characterized by a significant amount of "age heaping", that is, the concentration of the population into a normal range of age groups. The age structure of the Australian academic workforce in the 1970s was a quite young one, as is evident in Figure 3. However, the bulge evident in the 20–39 age groups has moved up the age pyramid and as a result of the slowdown in the increase of student numbers and the increasing staff-student ratios, the numbers recruited to the younger cohort following them have been relatively small in number. This is evident in Figure 4, which overlays the age–sex distribution of the Australian academic teaching workforce with firstly the total workforce and secondly with the total professional workforce at the 2001 population census. There are two things which immediately distinguish the academic teachers:

- they are disproportionately represented in the 40+ age groups and substantially under-represented in the 25–39 age group
- women are under-represented.

The differences are apparent in Table 3, which shows that only a third of lecturers and tutors were aged under 40 in 2001 compared to half of the total workforce and half of professionals. Even 40% of doctors were aged less than 40 years and doctors are the next oldest professional group to university lecturers among professionals. It will be noted in Table 3 that among Information Technology professionals, more

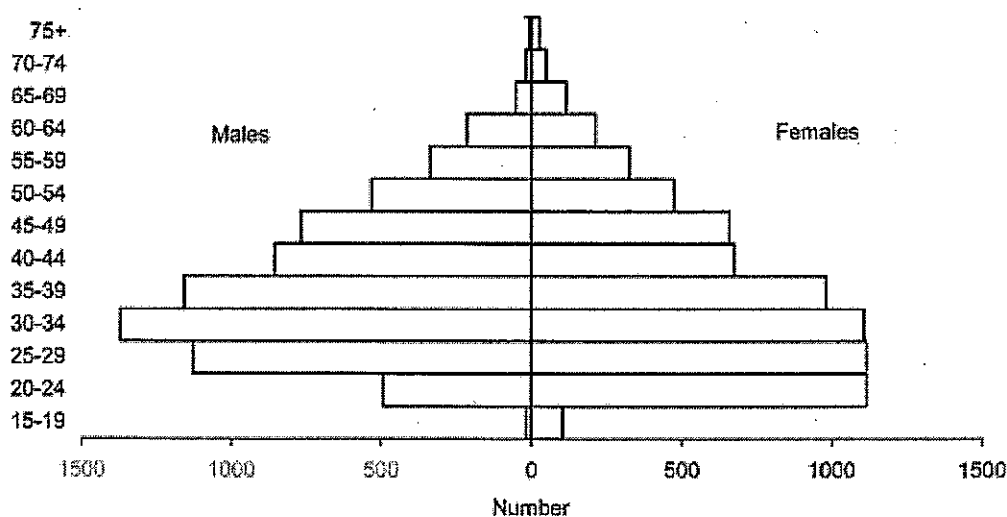


Figure 3. Australia: Age-sex structure of university lecturers and tutors, 1976
Source: ABS 1976 census.

Table 3. Australia: Percentage of the workforce by age groups, 2001

	All academics	Lecturers and tutors	All workforce	All professionals	Doctors	IT professionals
55 years and over	15.7	19.0	11.5	11.1	20.1	3.6
45 years and over	44.5	51.2	33.4	36.3	45.2	18.7
Under 40 years	40.8	33.8	53.8	49.3	39.5	67.7

Source: ABS 2001 census.

Table 4. Australia: Sex ratio of the workforce by age groups, 2001

	All academics	Lecturers and tutors	All workforce	All professionals	Doctors	IT professionals
55 years and over	229.2	259.2	169.5	140.3	566.1	559.6
45 years and over	156.7	175.7	133.7	104.3	350.0	447.7
Under 40 years	106.3	110.8	118.4	83.4	130.4	336.9

Source: ABS 2001 Census.

improvement in gender balance with age is evident in the fact that among lecturers aged under 40, the sex ratio (males per hundred females) was 110:8. The gender ratios are lower among the total academic workforce. The improving gender balance over time is evident in all professions so that there are more female professionals aged under 40 than males. Even among doctors and IT professionals, where the sex ratios are most imbalanced, there has been an improvement over time. Nevertheless, the proportion of academics who were female increased from 27% in 1988 to 33% in 1995, and 53% in 2004.

The DEST data too depict a shift in the age structure of the staff of Australian universities. The proportion aged over 45 has increased from 45% in 1998 to 49% in 2004 while that aged 55 and over increased from 13 to 18%. On the other hand, the proportion aged 35 or under has decreased from 25 to 23%. Table 5 confirms the increased ageing of the academic workforce. The last decade has seen an unprecedented effort by universities to offer redundancy packages to older academic staff in a push to increase student:staff ratios, reduce the number of higher level academic staff and to reduce the overall costs of the academic teaching workforce. Nevertheless, between the 1996 and 2001 censuses, there was an increase in the

Table 5. Ageing of the Australian Academic Population

	% aged 50+	Median Age
1991	26.0	43.4
1996	29.8	43.9
2000	34.0	45.1
2003	38.5	46.6

Source: Calculated from DEST data.

University of Adelaide are briefly discussed (Hugo & Rudd, 2004; Hugo, Daysh, Morris, & Rudd, 2004). In 2000, the University of Adelaide had one of the oldest age structures among Australian universities as is evident from Table 6. It has subsequently had some substantial rounds of voluntary redundancies targeting older academics, as has been the case in several Australian universities. This is evident in Figure 6, which indicates relatively small numbers in the 50–54 age group. Nevertheless it remains an old workforce age structure. The study is ongoing and involves a number of phases:

- analysis of the age structure of the various units of the university;

Table 6. Selected Australian universities: Age distribution, 2000

	Percent Aged Less Than 40	Percent Aged 50 and Over	Median Age
Curtin University of Technology	27.2	38.9	46.7
Edith Cowan University	17.8	45.1	48.7
Monash University	38.3	30.5	43.8
Murdoch University	30.3	34.4	45.6
Australian National University	31.4	35.6	45.6
University of Adelaide	29.7	38.2	47.1
University of Melbourne	38.1	29.5	43.7
University of NSW	30.8	35.7	48.7
University of Queensland	39.8	29.7	43.4
University of Sydney	31.1	38.0	46.1
University of WA	35.9	30.2	44.2

Source: Hugo, 2002.

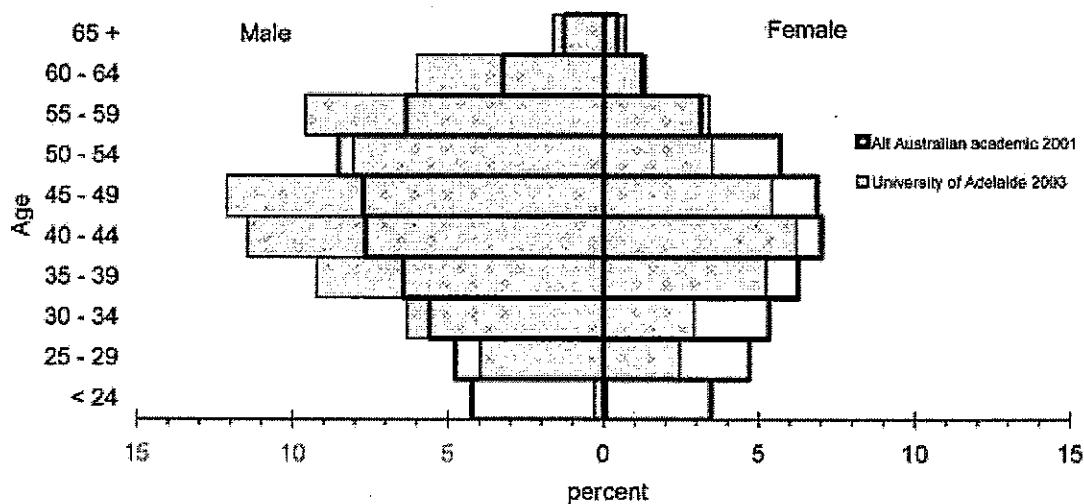


Figure 6. Composition of age-sex structure of academic staff of The University of Adelaide, 2003 and all Australian academic staff, 2001

Source: The University of Adelaide and ABS 2001 census.

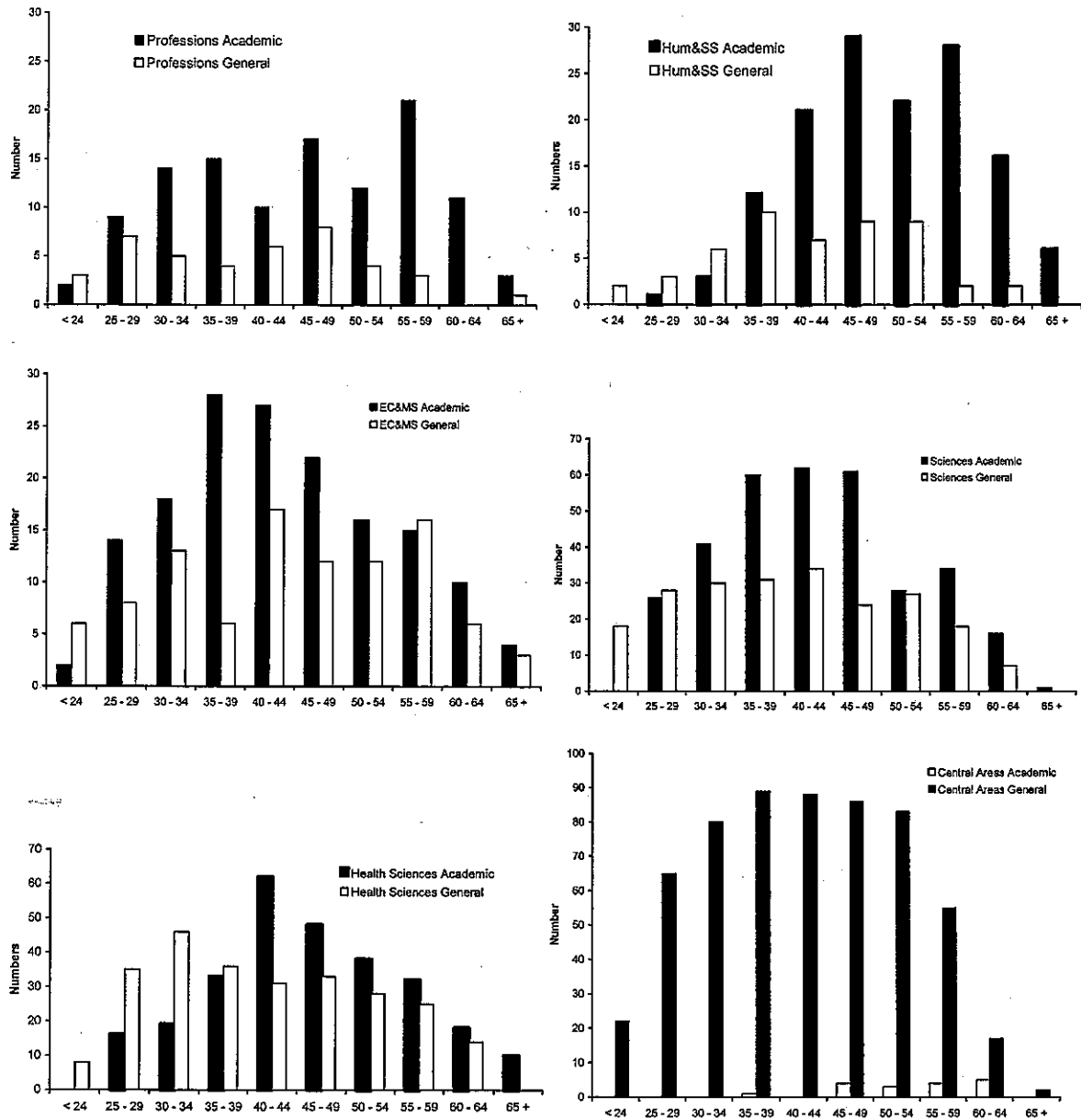


Figure 8. Age structure of academic and general staff by faculty 2003
Source: Hugo and Rudd 2004.

age at which a commonwealth pension can be claimed is 65 years, the former mandatory retirement age.

One of the most striking findings of the study is illustrated in Table 7. This was the high anticipated loss of staff over the next five years. At The University of Adelaide they range between 50.8% in Sciences (where there is a high turnover of research only staff, especially those on postdoctoral appointments) to 27% in Humanities and Social Sciences. In all areas there will be a significant attrition of long-term as well as contract staff. Indeed the demography of Australian universities, like The University of Adelaide, is such that they will face their greatest recruitment task for more than three decades. The previous period of high demand for staff however, was due to a

to large numbers of redundancies. On the other hand, there are real challenges to attract high quality staff members to replace those being lost. It would seem from the analysis presented here that the death of academics aged below 40 may indicate that a significant proportion of the so-called "Generation X" (born 1967 to 1981) have been lost to academia. They are a lost generation as far as universities are concerned. It may be that the lack of opportunities in the Australian universities over the last two decades and/or a decrease in the attractiveness of academic jobs has resulted in those aged in their 40s and 50s outnumbering those in their 20s and 30s by 31.1%. The question has to be asked as to whether it will be enough simply for academic jobs to become available in Australia to attract high quality recent graduates to those positions. Moreover, the international context needs to be borne in mind. The international competition for the highly skilled has never been more competitive. The academic labour market is increasingly internationalized. Australia must compete not only for potential academic staff from other countries but also for Australian graduates who are increasingly examining options in foreign universities. It has never been easier for highly skilled Australians to move to positions in foreign countries, especially other OECD nations. Countries have modified immigration regulations to facilitate the recruiting of the highly skilled researchers, scientists, and technologists. The labour markets in these areas are truly internationalized and Australia is becoming increasingly peripheralized.

Another implication of the trends examined here is that Australian universities need to look at ways to retain high quality staff. This applies across the board but one group undoubtedly is productive older staff in their 50s. Most universities know little about the retirement intentions of this group. It is clearly in the interest of universities to extend the age at retirement of many of its staff, in particular, those who continue to achieve at a high level. In universities as in many areas there is often a prevailing view that younger staff purely by virtue of the age are more productive, innovative, and more up to date with current developments in their disciplines. However, it is clear that while it is highly desirable in any academic group to have a balance between staff with respect to age it could prove just as problematical to have age heaping in younger groups as in older age groups. This is true in both the teaching and research endeavors of universities. One feature of Australian universities in recent years has been the substantial increase in average teaching loads. It may well be that this has been possible in part because of the highly experienced teaching workforce in Australian universities over this period. It could also be that replacing the teaching contribution of a retiree with decades of experience with a recent graduate may present difficulties. In short, a great deal of care needs to be taken with respect to developing policies in relation to the retirement of older staff. In Australia there has in the past been a focus on moving older staff out of the mainstream of universities although mentoring and emeritus positions are certainly increasing. Universities should be identifying their older staff who are high performers in research and/or teaching and ensuring that they do not leave the workforce prematurely.

of the university, developing joint international exchanges in teaching and research, incentives to keep “high fliers” in the university, gradual retirement programmes for selected staff and accelerated promotion for key staff.

With respect to their academic staff, Australian universities will need to address a new version of “The Three Rs”. *Recruitment* will be significant and this could involve innovative policies of attracting and retaining high quality post-graduates, effective development of new markets for staff especially in Asia and, to a lesser extent, Eastern Europe and Africa and more targeting of key individuals and groups. Secondly, we must be better at *retention* of high quality staff. Here women are an important group and universities must embrace their family-friendly work practices and policies. If more flexible staffing policies cannot be developed in the university work place there is little hope for improvement in other areas. The federal government is currently examining ways in which the average retirement age can be lifted in the face of a shrinking gap between the working age and older-dependent population (Costello, 2002, 2004). Universities should be leaders in development of innovative policies and programmes to ensure that high quality staff are not lost through retirement prematurely. Again, if universities cannot arrange a more extended transition between full time work and retirement, who can? The third “R” is *return*. There is a diaspora of tens of thousands of Australian Scientists, technologists, researchers, and university teachers in other nations, many of whom are favorably disposed to developing strong linkages with Australian-based universities and many of whom are interested in returning with their families. In the last decade in many Australian universities the other two “Rs” of *retirement* and *redundancy* have been widely practiced. The three “Rs” not only offer universities the opportunities to restructure and realign the programmes of the university which were facilitated by the two “Rs” but will be critical to Australia retaining and enhancing its global position in research and innovation.

Notes

1. Industry (ANZSIC – Australia and New Zealand Standard Industry Classification) Class – 8431 Higher Education (this class consists of establishments engaged in providing university undergraduate or postgraduate teaching or research). Selected occupations – those listed were selected as (in totality) they would generally represent “academic staff”. Occupations such as clerks, tradespersons, technical assistants, librarians, general administrative and managerial staff are specifically excluded.
2. Selected occupations (ASCO2):
 - 1293 Education managers (including Faculty Heads)
 - 1299 Other Specialist Managers (e.g. R&D Managers)
 - 2000 Professionals, not further defined
 - 211 Natural and Physical Science Professionals
 - 212 Building and Engineering Professionals
 - 223 Computing Professionals
 - 2293 Mathematics, Statisticians, and Actuaries
 - 2322 Nurse Educators and Researchers