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FAO: Committee Chair Ms Maria Vamvakinou

Fellow Australians and Members of the Commonwealth Parliament,

I welcome the foresight and sound judgment exhibited in calling this inquiry into what is essentially a key part of Australia's future economic well being. I write to you to express my personal opinions not as a career academic, but as a former high technology industry executive who recently moved to academia after 15 years in industry spanning three continents and large multinationals to Silicon Valley start-ups. My observations are therefore directly motivated by the desire to boost the nation's position in science and to help establish the bridges that lead to successful commercial exploitation of that leadership thereby directly benefiting the nation. The role played by universities in this when done correctly cannot be overstated as evidenced by the Silicon Valley model for example.

Taking this viewpoint I respectfully attach a response to the terms of reference and some recommendations based on the observations therein. I look forward to a robust debate and some outcomes that will steer the sector into a better position for the nation.

S.J. Madden

**Responses to the Terms of Reference**

**1. The contribution that Australian universities make to research in Australia, including:**

- **The contribution of research training programs to Australia's competitiveness in the areas of science, research and innovation;**

In the past 10 years, it is true to say that some of Australia's foremost non-university based science research establishments have either been closed or severely cut (e.g. Telstra Research, CSIRO, etc). This has made the role played by universities even more crucial than it used to be in maintaining Australia's position in the world of science and research. Naturally this cannot continue without training programs that bring bright new minds into the field and provide them with the specialised knowledge, understanding, and facilities to be able to make a genuine and important contribution. Despite the difficulties faced by the university sector over the past 10-15 years, it is clear that a number of Australian university groups are world leaders in their fields. To cite some concrete examples, then within the area of which I am part at the ANU, the Quantum Information Processing group and the Chalcogenide Waveguide and Ultra-fast Laser Process groups are acknowledged world leaders in their emerging fields. Importantly, for reasons addressed in some of the other terms of reference, we are unable to retain graduating PhD students and even lower level members of staff and so this leadership has been maintained through training new researchers to the level that they can contribute to world leading breakthroughs. Discussions with colleagues at conferences etc suggest that these examples generalise to other departments and universities throughout Australia thereby reinforcing the importance of training and the competitiveness of Australian research.

Despite clear success in establishing Australia's competitiveness in science and engineering at the academic level, it is however deeply troubling that this has not translated to competitiveness in the economic sphere where we do not see a large number of science and engineering based companies taking on the world. With the exception of a few potentially lucrative Intellectual Property examples (e.g. the CSIRO patent underlying the widely used WiFi networking system which is currently being fought out in the US courts), then academic success gives us only "bragging rights" and does not materially benefit the community. All too often the benefits have been derived overseas, which does not leave Australia looking like such a clever country. This is a clear area of deficit and one in which universities and government have a key role to play. In its own right this perhaps deserves its own senate inquiry to establish and execute a path to commercial success for Australia's future wellbeing.

- **The effectiveness of current Commonwealth research training schemes;**

The examples cited above suggest that the existing Commonwealth schemes succeed to a large degree when someone can be enticed into PhD study, though the "when" is an issue in its own right and related matters are discussed below. For post-doctoral training, the situation is approaching catastrophic for reasons covered below in section 2. Also many of the shortcomings of the existing system are masked because they are not measured. For example, budgetary cutbacks have led to the loss of many technical and administrative support staff, with the result that the workload has been transferred to academics. The number of academics has in some instances also shrunk further as a result of the same financial pressures, increasing workload on those remaining. Coupled with the constant need to apply for grants, this has had a direct effect on the quality and quantity of supervision and training provided and has unquestionably resulted in missed opportunities and incomplete capitalisation on areas of success, and sub-optimal development of those being trained.

- **The adequacy of current research training schemes to support Australia's anticipated future requirements for tertiary-qualified professionals in a wide range of disciplines.**

It is my understanding from reading the press that it is generally accepted that there are not enough people taking up science and engineering at even the undergraduate level to meet anticipated requirements, therefore the current research based schemes will do nothing to address the anticipated demand in this area. Ultimately this is a result of the science and engineering areas being seen as far more intellectually demanding and yet less financially rewarding than other areas. Until this situation is remedied, there will be no closing of the gap.

**2. The challenges Australian universities face in training, recruiting and retaining high quality research graduates and staff, including, but not limited to:**

- **Adequacy of training and support (including income support) available to research graduates in Australia;**

There are considerable shortcomings in both the training and support of those who have completed their PhDs or who are in post-doctoral employment. These include:

- inadequate remuneration compared to competing positions within the public service and industry which also require less qualified people (no PhD required)
- the total lack of job security caused by short fixed term contract employment
- the funding uncertainties created by forced reliance on ARC competitive research funding which allows for no longer term planning or secure career development paths
- lack of access to expensive but basic facilities in science areas that are freely available overseas
- shortage of available training time from the most skilled individuals due to the constant need to find money and increased admin loads

Taking the first three of these, then the remuneration and contract employment issues have in my experience been a direct and significant cause of people either fleeing the country to better opportunities overseas or leaving research altogether, most often for the public service in a role totally unconnected with science, ie a total loss of skills to the research and wider community. The reasons why people do this are clear. Completing

a PhD entitles one to take up a research level A position at step 6 with a salary of $60k for typically 3 years contract period ***presuming*** such a position is available (related to competitive grant success). The scale tops out at $65k and gaining promotions beyond that (especially within 3 years) is difficult and essentially limited by lack of finance. An uncertain life of fixed term contract based employment then lies ahead where the next contract relies on the success of another person's ARC Discovery grant application (widely regarded as a lottery in the academic community where the level of effort is not commensurate with the returns but mandatory as it's the only game in town). At some undefined period likely 10-15 years ahead, a tenured position may arise when someone dies, leaves, or retires then offering some career stability. By comparison, the entry level for new PhD graduates in the public service has been reported to me by a number of people who have taken this route to often be at APS level 6 or above (salary range $65-73k for APS6), no fixed term contracts or concerns about availability of funds for future contract renewals, and better promotion prospects (one former young staff member who went to the APS recently reported he was told he could expect a promotion to EL-1 with a salary band up to $95k within 12months of commencing). The pre-tenure low level academic employment environment is just not a sensible way to treat some of the most educated and skilled people in our society and desperately needs fixing if we are to retain and grow the best people here in Australia and have some prospect of extracting an economic benefit.

Looking within the immediate vicinity of my group and considering the past ~10 years, there were approximately 23 people who either graduated with PhDs or left post doctoral employment at the lower levels, and of these 14 remained in Australia rather than moving overseas. Note that the vast majority of those who moved overseas were Australians and not overseas students returning home. Of this remaining group, 8 went to public service positions, and only 4 are now engaged in science based employment with only 2 of these in a university environment. The very low level of people going into industry (2) is also clearly concerning, but not entirely surprising when we consider the dearth of industry and the lack of support to spawn new high technology businesses. How much these results can be generalised to other departments or universities is uncertain, but it clearly indicates problems with support in the university research environment.

Three low to mid level positions were appointed over the period, but six people lost (and likely another three departing in the year ahead) which on the whole we cannot afford to replace due to shrinkage of the budget in real terms after pay rises and expiry of ARC based Discovery grant money. So when people graduate we cannot afford to employ them or in some cases even retain current staff. Again, a clear indication of support issues.

Access to equipment and facilities is also a problem in at least some research fields in Australia that encourages the best researchers to move elsewhere. In my field (Silicon wafer based processing of optical and nano-devices) there is no national facility available where all required processes can be undertaken. The NCRIS initiative will provide a small but welcome amount of assistance in a few areas, but has in my opinion already failed in terms of delivering a solution to national facility access. The reason behind this is that the NCRIS scheme, rather than addressing a community agreed unified country wide list of missing infrastructure, has resulted in research groups essentially buying the tools they need (often duplicating infrastructure already existing elsewhere in the country or being purchased under the NCRIS scheme) rather than those needed overall by the country or that are otherwise unavailable. Critical pieces of infrastructure standard to the industry continue to be unavailable in Australia (e.g. stepper-scanner based optical lithography, flip chip bonding, etc). Compare this to countries smaller than Australia (e.g. Denmark, Ireland) who have dedicated single building national facilities that do possess this infrastructure in an open access service scheme and will process wafers for users from start to finish. In the US for example there are more than 10 such "public access" facilities for wafer processing. Importantly these facilities are also essential to incubating and growing a sustainable industry in the Nanotechnology market, which at an estimated US$1-3 trillion per annum by 2015 (National Science Foundation and Lux Research), is too big to be ignored.

Lastly is the issue of how much time those most skilled in the art have to actually train and develop junior staff. So much time is now occupied by fund raising, administration, and keeping the facilities running that real training is not occurring. As a supervisor I find myself having 5 concurrent PhD students as this is now the only way to get manpower to actually carry out the research, and getting sufficient quality time to train each of them is clearly problematic.

- **Factors for graduates that determine pursuit of a career in research;**

The main motivating factors that bring people into scientific research are the intellectual challenge, the excitement of making new discoveries, and working with leading edge technology/areas. Research freedom and workplace flexibility used to be important factors, but both of these are vastly diminished attributes of employment in academia today to the extent that I would no longer see them as major attractors. The combination of these three factors has to be sufficient to overcome all the negatives discussed elsewhere and the real word needs of the individual (such as the continuity of employment required to gain a mortgage) before they pursue a research career.

- **Opportunities for career advancement for research graduates and staff;**

For most staff, advancement opportunities are very limited due mostly to financial constraints caused by grant based funding and not competitive with public service or industry as discussed above. Beyond the straight financial issues there are also organisational barriers. ARC fellowships are one of the primary vehicles for promotion as they pay the researchers salary for typically 5 years. Attaining one of these is usually based on measurement criteria such as the number of publications or the H factor which do not take into account many of the realities or difficulties inherent in of certain types of research work (e.g. the need to build significant infrastructure) and are not actually measures of the quality of the research or the individual researcher in themselves. Also they do not encourage established industry based researchers to come into academia or academics to leave temporarily for an industry placement as they will be detrimentally affected upon coming back as they will not have published for several years. The measurement criteria are arguably ineffective in assessing the real quality of an individual's research or their personal capability, rather in some ways looking at the popularity of the research fields (ie a field with many research groups will likely yield more citations, and certain fields have many high impact factor journals whilst others have none), the cohort of people the individual has worked with in any capacity (e.g. a relatively minor contribution to a major work may result in many citations), and to some level the seniority of the individual (e.g. heads of department have traditionally had their name on every research publication even if they contributed nothing at all to the actual research work). I concede that assessing the actual quality of research or researchers is a very difficult task and wonder if in fact it is worth the effort. Given that the current system does not actually do this and the sector continues on I wonder if an alternative approach would not be more effective, more productive, and less time consuming for both researchers and government.

As concerns ARC fellowships as tool for advancement, then I think there are a number of issues with these. At the immediate post graduate point I think they are operating reasonably well, but become steadily less useful up the seniority scale. To give some specific examples, Australian Professorial Fellowships are universally acknowledged to be very hard to get (essentially impossible for those who have come from industry based on accounts related to me) and those in research only positions such as myself are in fact ineligible for them under the current rules. The proposed future fellowships also have some significant shortcomings unless the criteria are revised. For example the definition of mid-career as including someone five years out from a PhD is "creative" whilst the idea of excluding those 15+ years out (potentially at age ~40) seems equally strange.

- **Factors determining pursuit of research opportunities overseas;**

The factors affecting a decision to undertake research overseas are numerous and varied but include the following important points:

Remuneration:
Whist working in the US for example, I employed 3 fresh Australian PhD graduates and one post Doctoral fellow. The lowest cash component of salary paid to any of these 4 people was US$100,000 per annum. Research in an Australian university just cannot compete with this and needs to provide some other key inducements that are not currently present.

Better facility access:
As noted above, there are some things that just cannot be done in Australia that are trivial to do in other countries. Do not underestimate the delays/competitive costs and frustration this can cause to high calibre researchers who then have to waste huge amounts of time circumventing these (arbitrary and non research based) limitations!

Better research funding (quantity, application processes, and transparency of allocation)
I know of people who have left the university system here for overseas opportunities in protest at the huge effort required to apply for only modest funding through the ARC with its often "quirky" outcomes. The competitive research funding program is a subject guaranteed to raise the ire of most academic researchers who almost universally agree that the system is fundamentally and seriously flawed. Again this is a topic that almost warrants an inquiry all of its own. However for many it is the only option and they are forced year after year to spend typically a month or more on each application. The reliance on this system needs to be reduced and the application process streamlined.

Wider industry support and opportunities to move technology to industry:
In Australia we have failed to grow and maintain a wide science and high technology based industry sector. This does not apply in many US, Asian, or European countries, and opportunities for industry collaboration, spinout of technology, and potential future employment are powerful motivators for many researchers. In many cases industry also drives the field adding to the excitement factor (believe me working in Silicon Valley has an excitement all of its own compared to anything I have experienced in Australia, even in industry). The almost total lack of incubation facilities for technology startups and the very high initial financial barriers to entry into some areas (eg nanotechnology) also discourages direct application of the technology (which is attractive to many researchers and available elsewhere).

Future career opportunities:
Dichotomy of tenure/permanent vs contract employment and how hard it is to make the jump to tenure in Australia.

- **Australia's ability to compete internationally for high quality researchers;**

Pretty much limited to non Japan parts of Asia as factors discussed above prevail and limit attractiveness.

- **Whether Australia's academic workforce is ageing, and the impact this may have on Australia's research capacity**

I think it is unquestionable that the academic workforce is ageing, as on the whole the conditions are not sufficiently inducive to bring the best young people back into academia for all the reasons outlined above. I think it is well understood in all employment sectors that there is a "talent war" raging, and the university sector is seriously lacking in firepower. Looking at the research group of which I am a part, there is only one academic without grey hairs, and I believe the dynamism of youth and the questioning of accepted "truths" is a key part of research advancement that will be detrimentally affected.

## Some recommendations:

1. PhD scholarships should be raised to $35k per annum or above and indexed to inflation to provide more pull and get people into PhDs. Even if this reduces the number of scholarships it might help to bring in the best people and enable them to concentrate on research rather than how to survive in an increasingly expensive society on inadequate funding. Overseas candidates also need to be better catered for as many of them choose to remain and enhance Australia's capabilities.

Having trained PhD students we need to be able to retain and develop them in science and engineering roles that will result ultimately in economic benefit. There are a number of requirements to accomplish this:

2. Need to make academic salaries competitive with at least the public service
3. Must provide better employment stability and a realistic career progression, starting at the minimum at the 5+ years out from PhD timeframe. My feeling is that fresh postdoctoral researchers will tolerate a few years of fixed term contract employment if there is some realistic prospect of permanency in the 5 year timeframe. To accomplish the employment stability it is necessary to hugely reduce reliance on competitive funding for paying salaries. I see little option other than increased government funding to accomplish this.
4. Must stimulate development of a sustainable industry base. This requires full service open access national facilities that do not currently exist and incubator facilities also. Perhaps target the nanotech and bio-medical areas where there is still a lot of room for growth?
5. Need to make it a rewarding proposition for academics to move research into commercialisation and move back and forth to industry by giving them a safe haven option without career development penalty.
6. Rework the ARC DP program totally to make it less burdensome, more transparent, and provide money for research costs rather than salaries (as the typical low grant amounts are easily eaten up in employing even a single researcher). Perhaps a two-stage application process as used in the US where a short 2-3 page outline is used to select the most promising projects for a full application. It may also make sense to have a structure to spread the research projects in an managed fashion from application oriented to blue sky with some weighting on money in each category ?
7. Review the concept of tenure – anachronistic today and imposes significant restrictions and inflexibilities on the university system.