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for the **2005 Inquiry into Australian technological Innovation and pathways to commercialisation**

Australia's socio-economic growth will depend on its scientists receiving appropriate training in commercialisation during their tertiary education.

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Conclusion

DEST must update the current education of PhD science students to include formal training in the essential business skills required to recognise and drive commercial opportunities arising from scientific discovery. Without this training, Australia's scientists will continue to be inadequate in recognising and managing financial, technical and market risk, which will continue to inhibit Australia's ability to become a significant player in the emerging global high technology industry sectors. The preferred model would be a revised APA scholarship for PhD students that would fund a four year combined PhD/MBA (or similar, specifically designed for scientists).

Summary

Australia must be strategic in its efforts to develop sustainable high technology industry sectors based on Australian scientific discovery. High technology innovation involves high risk that is offset by the potential of high returns from targeted global markets. If the risk is not identified or managed adequately then large financial investments from the government, public and/or private sectors will be lost. The more failures, the more limited will become the resources and the confidence to invest in future innovative opportunities. Australia is a relatively small global economy and high technology industries compete in global markets. As such, Australia must be highly efficient in removing risk so that it does not waste its relatively limited resources. That is, Australia must adopt a strategy that will effectively increase its overall probability of picking winners in the high technology sectors.

Any future success in scientific innovation will be highly dependent on Australia having access to a critical mass of the best quality human capital to drive it forward. One aspect of generating this essential human capital, which has been continuously neglected by all governments, is how we educate our future scientists. Australia expects scientists to make the discoveries that will be converted into high technology businesses of tomorrow. Australia expects these businesses to be major exporters and that the resulting financial returns will enhance its socio-economic growth. Yet the formal education of our scientists has not changed to reflect these expectations. The majority of our future scientists are still solely taught scientific fundamentals at both undergraduate and postgraduate levels. If scientists are to be effectively innovative by identifying and targeting opportunities that arise from their research they must have the business, commercial and professional skills that are essential to evaluate and drive the technology forward. Without these skills, Australian scientists will continue to come up with ideas that are not effectively evaluated and not appropriately commercially focussed.

Many of these putative innovations will continue to be funded despite the fact that they are still full of technical, financial and market risk. If the majority of scientists had the appropriate business skills and an understanding of business imperatives much of this risk could potentially be recognised and if possible managed. Alternatively, if the risk is deemed too great they can be discarded before significant financial investment had been lost.

The Federal government needs to insist that universities revise their education programs for scientists and it must allocate sufficient funding to allow this revision to happen. Some universities are currently addressing this issue at an undergraduate level by offering students "innovation" degrees that include courses in business training, or combined programs in "innovation management". At the postgraduate (PhD, MSc) level no formal business training seems to be offered or required. Many universities (including technology transfer units), government departments (including state), professional associations, and industry sectors offer *ad hoc* seminar sessions that discuss at an introductory level some of the issues relating to scientific innovation and commercialisation. These are voluntary and the majority highlight what needs to be done but do not teach how to do it. Internationally, universities are beginning to recognise that the PhD experience and training needs to be updated to meet the changing demands of society's expectations of the scientific community. For example, some universities in the US now offer their science students the opportunity to undertake a combined PhD/MBA. This author is of the opinion that this is a similar road to what Australia should be taking. Australian PhD students should be offered, if not obliged, to undertake formal business training throughout their studies. The content of this business training should be focussed on the issues relating to scientific innovation and include topics such as creativity, project management, intellectual property management, finance and accounting, business principals and planning, marketing, and strategic communication. Issues relating to the potential for dilution of the scientific training can be dealt with in the design and funding of the program and should not be used as an argument to block its adoption. The government cannot expect universities to be individually responsible for the establishment and design of these program revisions. It must be a Federally (DEST) led initiative, which offers the appropriate workable guidelines and funding models.

Australian Dream – The Innovative Nation - but how?

Australia wishes to become a major player in the emerging high technology industries and to enjoy the inherent resulting economic benefits. High technology industries grow and develop from the seeds of scientific discovery. This means that all scientists for the good of Australia are now charged with the somewhat alien responsibility of being commercially innovative. To be effectively commercially innovative requires a broad spectrum of business acumen, knowledge and drive. Most scientists are not innately commercially driven; otherwise they would have chosen business or finance as their career paths. Without a commercial mindset and the appropriate business training, it is unlikely that many scientists would be able to adequately identify and define any commercially viable opportunities that arise from their research efforts.

The traditional education of the average Australian research scientist involves the study of scientific fundamentals at undergraduate level and a more focused and specialised study of scientific fundamentals at postgraduate level. Most science based PhD graduates have undertaken formal tertiary study for a minimum of 7 years, yet during that period the majority will never have had exposure to any commercial aspects of science. Those graduates who are successful in creating science based businesses will have had to develop their business acumen and entrepreneurial mindset on the job.

In Australia, as is the case for most developed nations, a large proportion of new high technology based businesses are spawned from research activities conducted in government funded research agencies (GFRAs), such as universities, teaching hospitals, state departments and CSIRO. Most Australian universities have commercialisation or technology transfer administrative units, which are responsible for identifying any potential intellectual property and for the development and implementation of strategies to gain a financial return on its eventual commercial exploitation. Academics and other government funded researchers are being asked by their institutions to look for commercial opportunities in their research findings and report them to these units for review. This leads to a situation whereby the academic does not know how to adequately define the opportunity let alone the markets and the representative from the commercialisation unit, despite often being scientifically trained, does not adequately understand the technology. This mismatch will lead to good potential opportunities being missed and opportunities that in reality do not have sound potential being pursued for much longer than necessary. As a consequence, risk is not reduced, resources are wasted and true commercialisation opportunities are lost. A similar scenario exists for those seeking private equity investment. Again the business models are unlikely to be as sound as they might have been if the scientist was business savvy. The chances of unidentified or unmanaged technical, market and/or financial risk will be significantly higher. During the due diligence process, the investor will most likely lack the required specific technical ability to identify some of this risk and as a result make an unwise investment, which eventually leads to the loss of their own investors' capital. On going failure of the private equity funded Australian high technology sector to deliver on the promise of high returns will see institutional investors turn away from venture capital funds with the firm belief that high risk equals no returns. When a technology fails resources are lost, which means the next idea that comes along, even if it has true commercial potential, may not be resourced and will disappear. If we keep failing then we will never have a high technology industry.

High technology risk management – how can Australia do it better?

In the commercialisation of high technology, particularly in fields with long productisation lead times such as biotechnology, the identification and management of risk should be of the highest priority. These technologies can fail at any step of the commercialisation process and any expenditure up until that failure must be written off without any return. The failure may be at proof of concept or at clinical trials or at product launch. The longer the risk is not appropriately addressed the higher will be the cost of failure to the Australian economy. Categories of major risk for emerging high technology industries relate to the market, technology, finance, clinical trials and validation, intellectual property, competitors, management, timing, and government legislation.

Since Australia is not a global economic power, in order to become a substantial player in the high technology market sectors it must manage its relatively limited resources more efficiently than its many competitors that have much deeper pockets. More efficient management will result in picking more winners and identifying and discarding losers as early as theoretically possible. To perform better that our competitors, we must be better at identifying risks in proposed technologies, better at addressing them and more efficient at giving up the projects if the risks cannot be addressed.

The best way of discarding losers as early as possible is to have scientists trained in business skills. The only way for this to happen, at least for future generations of Australian scientists, is the mandatory inclusion of business training in the undergraduate and postgraduate science programs. For this to succeed the Federal government (with input from State governments) must be proactive by developing policies that will allow, if not enforce, the required uptake of change by universities. Simple rhetoric from the Federal government saying that universities should be doing so of their own accord without any government assistance, be it managerial, administrative or financial, will maintain the status quo for the foreseeable future by which time Australia will no doubt of missed the boat and be left to import (while it financially can) high technology rather than export it.

The appropriately trained scientist will be able to identify potential commercial opportunity in their research. They will know how to benchmark their technology, define and describe the associated intellectual property, identify and value potential markets for their technology, identify competitors and potential partners, map the envisioned innovation and commercialisation process, address regulatory issues, prepare the initial business and project plans, budgets and timelines, strategically communicate and negotiate effectively the advantages of the technology and the business proposition to a range of audiences, etc. They will also have an enhanced capability of identifying and addressing if possible any potential risk, whether it is of technical, financial or market origin. As a result, when the scientist contacts their commercialisation unit, the opportunity will be well defined and the decision as to whether to proceed with the commercialisation to the next stage will be consequently of lower risk. Scientists will take on the initial task of screening and refining the opportunities and allow the limited resources of commercialisation units to actually focus on the commercialisation process rather than the screening and evaluation.

Restructuring of Australian tertiary science programs

A major difficulty that needs to be overcome is that the majority of science students (and academics) are studying science for interest sake only and not for the commercial opportunities. Science students do not queue up to study business! Their high school education has not reinforced the linkage between science and industry and many, if not the majority of, current science students will not realise the absolute importance and relevance of business skills until they get out into the real world and find a job, wherever it may be.

Undergraduate

At an undergraduate level, an obvious solution to the education problem would be to include appropriate business focused subjects in the course work and some universities are taking this approach. However, this strategy can potentially result in the technical course work being diluted to an extent that the students do not receive sufficient training in the actual science. Though the graduates may be business educated they may not have sufficient scientific grounding to become research scientists capable of making cutting edge discoveries. Another strategy adopted by some universities is to offer science undergraduate students the option of taking on additional study for separate awards relating to the business side of science. This option has several advantages in that it does not involve dilution of the science course work, can be offered to all science students and not just those studying in a particular discipline, and can be completed in the same time frame as the science degree providing most of the business courses are taken outside of main academic sessions.

Postgraduate

The commercialisation forums offered by universities, government departments, and professional bodies are usually structured as short seminar series and occasionally include workshops. These are only at best sufficient to introduce the student to the key sections of the innovation process. Students are not actually trained in the various phases of the process but do have the opportunity to get a reasonable picture of what is involved. However, postgraduate science students in general tend to not take advantage of these forums. This is because the majority of science students as stated previously are not business focussed and have yet to recognise the importance of business skills for their future careers. Secondly, most students are reluctant to take on extra studies if they do not receive any formal accreditation.

In this author's opinion, the ideal model for training postgraduate PhD science students would be to offer an alternative scholarship to the current Australian Postgraduate Award (APA). The scholarship would be for a combined qualification PhD/MBA (or the like e.g Masters in Research Management, Masters in Scientific Innovation, etc). The scholarship would be for 4 years (ie. a 1 year extension on the current APA). During their studies, the students would take formal courses (at the rate of one full course per session) that have been tailored for the science student, which cover all areas relating to the innovation process. An example of a possible program outline is given below;

Year 1: Project and risk management; Intellectual property
Year 2. Strategic communication; Accounting and economics;
Year 3. Marketing; Business management
Year 4. Finance; Business planning

All courses would be a combination of formal lectures, tutorials and workshops. Assignments would be designed to allow the students to use their own research interests and efforts as the basis of the tasks. The structure of the program would be designed to augment and improve each student's ability to efficiently conduct their PhD research projects. The program would also be available to external students (e.g. professional scientists) as a full time or part time study option. Each Australian university would not necessarily need to establish its own complete in-house program and complement of courses. A single metropolitan or regional university could take on the responsibility of administering the program and the delivery of the component courses. Alternatively, universities could work together to manage the program with each university delivering specific courses that are aligned with its interests and expertise. The mode of delivery could also be flexible ranging from on-line, during session, to intensive block structures.

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