The Australian Institute of Physics Science Policy

Suggestions to policy@aip.org.au

Introduction

The Australian Institute of Physics (AIP) has developed its Science Policy as a platform to support the role of Australian Physics in industry, education, research and the community. The AIP and its members are often required to express opinions on a range of issues concerning Physics, its application and its consequences for Australia. This document provides a formal policy resource on a range of issues endorsed by the members of the AIP. The policies act as a guide to elected representatives of the AIP, or their nominees, to allow them to make comment on behalf of the membership. This document is not intended as a roadmap for change; separate AIP documentation will be produced on a "needs be" basis to forward the cause of Physics. This document only seeks to outline the broad policies of the AIP.

This document is a living document and will be updated at regular intervals. Input from the AIP membership and other interested persons is welcome and comments can be sent to aip@aip.org.au.

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1 Education

1.1 Primary Education

Introduction: Education is a life long process that begins at the earliest stages of development. A child's interest in science can begin at any age and should be nurtured within Australian school environments.

Policy: The AIP promotes the inclusion in primary school curricula units that explore simple scientific principles, including Physics, Mathematics and Chemistry (the enabling sciences).
Reason: The aim is to get children interested in understanding the world about them, to foster an interest in science.

Policy: Primary school curricula should include units that explore how science and engineering can solve their community's and the country's most pressing social and environmental problems.
Reason: The aim is to show the value of science and engineering to children in shaping their world and to show that they can have a role in this. This is empowering for children and may foster a general interest in science and a desire to study it further.

Policy: The AIP supports the training of primary school teachers in Physics and Maths.
Reason: To ensure that teachers have suitable training to educate children in these areas.

1.2 Secondary Education

Introduction: Secondary school education in Physics is vitally important for the discipline of Physics. It is from the interaction with Physics teachers and the material they present that students gain an understanding of the methods of Physics, the principles underlying the discipline and its value to the community. The public perception of Physics is likely to be set by their association with Physics at the secondary school level. This perception is then taken into the community with the students and ultimately has an impact in all areas, including business and government. The quality of secondary level Physics education will also influence the numbers of students taking a Physics subject at the tertiary level. The greater the collective experience with Physics that resides in the community, the greater the likelihood for support for the discipline, particularly at the level of government and business.

Science teachers with appropriate Physics training tend to be very dedicated teachers. The Australian Institute of Physics 2003 Physics Culture Report[(1)] has shown that 85 % of science teachers with qualifications that have allowed admittance into the Institute, work

more than a 40 hour week, while more than 60 % working greater than a 50 hour week.[1] It is also very important to note that 93.3 % of these well trained teachers - having chosen this very important role in our community - enjoy their work. They work such long hours because they want to. Enjoyment seems to be the major incentive for these dedicated individuals, since 84.6 % agreed that work place incentives were unimpressive.[1]

The ability to attract well qualified individuals to the teaching profession as Physics teachers is of course affected by the remuneration. In Western Australia 31 % of those now teaching Science had professions in other areas before becoming teachers.[2] In the past there appears to have been a strong tradition amongst science teachers in gathering other world experience before entering into teaching. However, the current HECS levels penalise people who study Physics and then move into teaching, this is a severe disincentive for those with Physics backgrounds who might consider a teaching option. Schools who have teachers with higher degrees should receive further government funding to increase the salaries of such teachers and to encourage their employment. In the 1970s teacher salaries were equivalent to that of engineers. Now the salaries are about half. To attract bright and talented people into teaching away from other professions teacher salaries should be suitably increased. The public perception of the value of a profession is related to the amount earned by them and the responsibility of the profession. Teachers are undervalued by the community because of the low rates of pay. Moreover, teaching is an unappealing mid-career change option for people with appropriate skills due to the lower levels of pay.

The teaching of science in secondary schools is under excessive strain. It is known that there is a diminishing resource base of well trained teachers in the enabling sciences. However, Australian governments do not keep statistics related to the qualifications of secondary school teachers. The United Kingdom has relevant statistics.[3] In the U.K., during 2001, 66% of secondary school physics teachers did not have a related degree and 29% did not have physics training beyond their A levels i.e. were teaching students at a higher level than they themselves had been taught. Of greater concern was a severe downward trend of Physics graduates seeking teaching qualifications. These problems have not been quantified here in Australia, except in Western Australia where the Science Teachers' Association of Western Australia (STAWA) commissioned a report in 2000 on the subject.[2] The STAWA report states that in the year 2000, 16.7 % of secondary school physics teaching in Western Australia was carried out by unqualified teachers. The STAWA definition of 'qualified' was for teachers that had completed second year university units in the subject being taught. Whereas the the Federation of Australian Scientific and Technological Societies (FASTS) defines suitable qualifications for science teaching as a university major or higher degree in the relevant subject,[4] a larger percentage of unqualified teaching would therefore have occurred under the FASTS definition. Also according to the STAWA report, the projected student numbers for science subjects is set to remain constant for the next 20 years in Western Australia,

however Biology teachers were being appointed at twice the rate of Physics teachers, despite a decline in students studying the biological sciences.(2) More students are studying the Physical Sciences in Western Australia than the Biological Sciences. However, about half the number of teachers with a Physical Science background are being appointed compared to those with a Biological Science background.(2) This indicates that a severe shortfall of Physics trained teachers is now in progress in Western Australia.

It is believed by University academics in other states, based on contact with existing and past Physics students, that the problems of Physics teacher supply may be considerably worse than the W.A. or the United Kingdom experiences. A comprehensive review of needs and resources in the education and training of the enabling sciences is required for all states.

1.2.1 Physics teachers

1.2.1.1 Qualifications

Policy: The AIP promotes the BEng/BSc plus Dip Ed model as the preferred option for training teaching staff particularly those who are involved in teaching the senior years of secondary school.
Reason: It is important that Physics teachers have a strong understanding of Physics at levels significantly higher than the level they teach. This is necessary for a clear understanding of concepts, and to augment the teacher's ability to take more advanced students further.

Policy: The AIP is strongly opposed to overcoming shortages in Physics teacher numbers for senior levels by the retraining of non-science teachers unless this retraining involves a program recognized by a professional body.
Reason: There have been moves to cover the short-fall of Physics teachers teaching senior year students by the use of unqualified teachers,(2,3) or by the retraining of non-science teachers. The AIP is strongly opposed to band-aid approaches that may have a deleterious effect on student knowledge, understanding and appreciation. Furthermore there is anecdotal evidence that poor teaching of Physics at secondary school results in fewer students taking Physics at the tertiary level.

Policy: The AIP strongly supports the educating of secondary school administrations on the value of Physics.
Reason: It is recognized that a perception problem for Physics is evident even within the administration of secondary schools. This suggests a growing problem in that Physics trained teachers may be undervalued by their administration.

Policy. The AIP promotes the development of 2 to 3 year discipline based training as a national standard for science teachers.
Reason: This is to ensure uniform teaching standards across the nation.

Policy: The AIP promotes the concept of government maintaining statistics on the qualifications of secondary school teachers.
Reason: At present no Australian government statistics are maintained on the qualifications of secondary school science teachers. Though it is generally recognized that there is a shortfall of science teachers with graduate level science qualifications, it is not possible to say what those numbers are. Such statistics should be gathered for strategic planning purposes.

Policy: The AIP promotes the strengthening of the enabling science component of teacher training programs and supports initiatives to provide financial rewards for successful completion of programs to upgrade skills.
Reason: The maintenance and updating of science training skills is essential to maintaining a high standard of science education.

Policy: The AIP promotes the provision of financial support for extensive in-service training programs in the enabling science disciplines for secondary science teachers.
Reason: This is to improve the quality of Physics teaching at the secondary level.

1.2.1.2 Salaries

Policy: The AIP promotes a salary loading to teachers in the enabling sciences with honours or higher degree qualifications in the enabling science disciplines. However, so as not to disadvantage teachers trained in the enabling sciences (by representing them as a high cost option for local schools) it is important that extra funding be provided by government directly to those schools that hire such teachers. This will promote the hiring of Science trained teachers and represent them as a high prestige group within the teaching community.
Reason: There is a shortage of fully qualified Physics,[2,3] Chemistry and Mathematics teachers, which is strongly influenced by low levels of pay and lack of recognition.[2] The aim is to attract people with graduate degrees in Physics into the teaching profession.

1.2.1.3 Professional development

Policy: The AIP promotes the establishment of a national triennial conference on Science curricula and implementation with an aim to bring together the schemes in different states where there is advantage in doing so for the rationalization of resource supply. As outlined in its constitution the AIP will provide advice on matters of curriculum for the development of Physics.

Reason: This has great benefits in the sharing of teaching resources and in the mobility of teaching staff within Australia. It also has the benefit of raising national issues of concern to Physics teachers. Australia is a large enough nation that the standardisation of science teaching within Australia would also allow a new industry to be built for the supply of national text books and other teaching resources. This has national and international implications.

1.2.1.4 HECS

Policy: There should be no differential HECS for science based degrees (see 1.3.3).
Reason: A student who obtains a science degree, and wishes to then gain teaching qualifications is disadvantaged by a much greater HECS burden than a student who studies to become a teacher at the outset. This is a disincentive for high quality Physics graduates to move into teaching.

Policy: There should be HECS bursaries provided to students undertaking teacher education programs in priority areas that involve enabling sciences (see 1.3.3).
Reason: There is a shortage of teachers in the enabling sciences (Chemistry, Mathematics and Physics). This policy provides some financial incentive for science students to take teacher training.

1.2.2 Laboratory resources

Policy: The AIP promotes a national program to improve teaching resources, support staff and additional scientific equipment to maintain modern laboratories in the enabling sciences. This does not equate to more computers!
Reason: Current trends in secondary schools see a lot of money spent on upgrading and maintaining computer resources while Physics laboratory equipment is in bad neglect. The AIP believes that the use of practical demonstrations as aids to teaching Physics is vital for a proper understanding and appreciation of the value of the discipline. The adoption of national standards for the teaching of science, facilitated through a national triennial conference (see1.2.1.3), would enable Australian based industries to support the supply of laboratory resources at lower cost.

1.2.3 Teaching resources

Policy: The AIP promotes the use of Physics teaching resources, including experimental apparatus, visual aids and text books, to aid Physics teachers.
Reason: This provides a means for transferring new ideas about ways of teaching and demonstrating Physics. This can help Physics teachers to promote understanding and enthusiasm for Physics.

1.2.4 Quality of teaching

Policy: The AIP promotes the differentiation of science teachers into discipline specialists at senior secondary school levels.
Reason: The term "science teacher" covers Physics, Chemistry and Biology, but not Mathematics. The short fall of fully qualified Physics teachers has led to the situation where teachers without proper Physics training have been required to teach Physics. The reason is related to their designation as a science teacher rather than as a Physics teacher.

Policy: The AIP promotes the development of national minimum standards for the matriculation of students that involves compulsory study in English, Mathematics and the Sciences to the end of secondary education.
Reason: A large number of students now progress to university from secondary school. Those students must be trained in the basic skills that will be required of them at the university level. Minimum matriculation standards will ensure that students are properly prepared before coming to university. It is of greater importance now to have an understanding of the sciences regardless of the area of study that one pursues at university. A solid scientific grounding in science among graduates in law, business studies and journalism, for example, is increasingly important as technological change plays a greater role in society and the economy. Moreover, people now entering the workforce are expected to make a number of career changes during their lifetime, and their ability to do so effectively will be influenced in part by the breadth of their education.

1.2.5 The use of the web and other automated teaching

Policy: Although the use of the web as a teaching tool is beneficial, the AIP is opposed to the use of web-based and other automated teaching at the expense of person-to-person teaching.
Reason: The use of automatic systems for teaching has many drawbacks. They limit the student from asking questions beyond the capability of the software; they cannot include a proper laboratory experiment - simulated experiments provide little appreciation of the issues required in the real world to make experiments work; there is only limited feedback available with such systems, and the lack of human interaction can have a negative effect in the development of a child's social skills.

1.3 Tertiary Education

Introduction: Physics training at the tertiary level is fundamental to the support of high technology industry and Physics based research in Australia. It is also an increasingly important aspect for the support of traditional industries, where scientific advance has increased reliance on technology. Without healthy Physics and other science and

engineering programs, Australia must return to a 19th century agricultural economy supplementing its national income from mining and tourism without recourse to local technological support. This is a poor option for the nation. The AIP therefore supports the development of industry and technology in Australia and the training of qualified people to support the development of industry. The AIP also recognises the wider experience gained by university graduates in obtaining an education. The personal ties forged in the universities, the broader skills learned, the development of problem solving abilities and the social interaction that occurs, help to create whole people, educated in life skills as well as a science discipline. These aspects of a Physics education are also to be encouraged.

The AIP recognises that there is a general decline in support for the discipline of Physics and for all the enabling sciences. We therefore support the maintenance and strengthening of Physics as a discipline within the University environment.

1.3.1 Government funding

Policy: The AIP promotes an increase of core funding for Physics education.
Reason: The amount of money available for the operation of Physics departments has declined over the last decade which impacts on the ability of Physics departments to operate properly. Academic staff numbers in Australian Physics Departments have consequently declined from > 350 staff in 1994 to < 250 staff in 2002.(5) This is despite an increase in year 12 secondary school enrolments in Physics over much the same period to 1999,(6) and a recent, 2002, increase in University third year Physics enrolments, which has brought the number of these students back up to 1994 levels.(7) University student numbers for commercial and economic courses have grown to the point where there is an oversupply of these graduates. Yet those areas continue to receive high university funding under the present funding schemes. Strategic planning for the needs of Australia, such as that recommended by the STAWA report,(2) shows that there is a great need for science graduates. Hi-tech industries require people with physics qualifications, for instance, personnel for the opto-electronics industry are currently being provided by Physics departments in Australia. Medical physics personnel are also being trained by Physics departments. The AIP supports the concept of university funding that reflects the strategic needs of Australia for the future.

1.3.2 Employment and training

Policy: The AIP supports the provision of targeted research training places and scholarships in the enabling sciences.

Reason This policy will help to improve student numbers in areas that are strategically important to Australia's development as an industrial nation.

1.3.3 HECS

Policy: There should be no differential HECS for science based degrees (see 1.2.1.4)
Reason: A student who obtains a science degree, taking 3 to 4 years, and then a diploma of education will have a much greater HECS burden than a student who undertakes a Bachelor of Education to become a teacher at the outset. This is a disincentive for high quality Physics graduates to move into teaching. This is also a recommendation of a recent report by the Science Teachers' Association of Western Australia.[2]

Policy: There should be HECS bursaries provided to students undertaking teacher education programs in priority areas that involve enabling sciences (see 1.2.1.4).
Reason: There is a shortage of teachers in the enabling sciences (chemistry, mathematics and Physics).[2,3] This policy provides some financial incentive for science students to take teacher training.

1.3.4 Laboratory Resources

Policy: The AIP supports the renewal of laboratory infrastructure for tertiary Physics teaching.
Reason: The maintenance of Physics teaching laboratories is a high cost for Physics departments but is an essential part of maintaining a healthy Physics program. Students are provided with real world training through their experience with Physics training labs.

2 Research

2.1 Government Research Laboratories

Introduction: In the past Australians have been highly successful in their research efforts so that traditionally our research has been of highest standard. Unfortunately it has also been an Australian tradition that, for various reasons, development has been poorly undertaken. There has been a gap between good research that may be developed towards commercialisation, and its adoption for commercial purposes. Some recent attempts in government research bodies (CSIRO, DSTO, ANSTO, etc) to reverse this trend have had a negative effect in terms of the Australian research effort, with declining resources being directed towards the expensive commercial development of an increasingly narrower science research base. Basic research in some of the larger government research bodies has all but ceased in recent years, and even commercial research is undertaken on a much smaller scale. Similar overseas trends, most notably in the United Kingdom, have resulted in a research decline that has ultimately impacted on commercial development. Since 1998-1999 the United Kingdom government has increased its total R&D funding by over 1100 million pound sterling in an effort to address the results of science research neglect and decay that occurred in the 12 years prior to that.(8) The United Kingdom government R&D funding now matches 1986-1987 funding levels.(8)

The AIP recognises that the Australian research effort in our government run science organisations has been compromised by efforts to improve the development component of R&D. This has impacted on Physics job prospects, over 1000 jobs were lost in the CSIRO between 1990 and 2000.(9) This has caused the extinction of broad areas of research effort, ensuring that Australia's government research bodies are under resourced for future and present challenges in new technology development. For instance, there are at present no semiconductor based research efforts in the CSIRO so that that institute is incapable of initiating or contributing to the development of this industry in Australia.

Policy: The AIP supports calls for increased research based funding for our government science organisations. Separate and distinct funding for research and development is also called for on behalf of these organizations.
Reason: The level of funding for the CSIRO, as a function of C.P.I., decreased significantly through much of the 1990s.(10) The notable and much needed increase in funding received by the CSIRO from the Government in 2000 was encouraging, however since 2000 funding has again slipped below the increase in the C.P.I. Physics related disciplines have been hit heavily by these shortfalls in funding. In this environment of reduced government funding the CSIRO and other bodies have had to concur with a political push towards increased product development. This has left many government research laboratories bankrupt of new research, with only older research being developed

at a high cost of personnel and resource deployment. Though the year 2000 increase in C.P.I. adjusted funding was encouraging, it was not sustained. Unprecedented asset sales of $85,895,000 by the CSIRO occurred in 2002.(10) Greater funding is still required for both research and development if our government research laboratories are to be effective in their duty.

Policy: The AIP supports greater fundamental research within government research bodies and greater participation in this research by government scientists.
Reason: Fundamental research is required to maintain the research skills base of our government laboratories; to help attract quality researchers into government laboratories and to ensure that there is future research available for development within these laboratories. The AIP 2003 science culture report indicates that university based Physics researcher only staff are spending almost 80% more time doing research than the average government based Physics researcher.(1)

Policy: The AIP encourages the development of research principles for project management that take into account local management cultures. It also supports the development of management cultures that induce enthusiasm, professionalism, determination and creativity.
Reason: In recent years there has been a push towards the use of engineering based project management principles in Australian science organisations. Engineering operates from sets of highly developed material, operating and equipment standards. When undertaking an engineering project there are relatively few unknowns and project management can be undertaken in a usually predictable manner. For research projects, where there are many unknowns, a great deal of flexibility is required to meet the unknown. If overly conservative management styles are applied research projects may be doomed to failure at their onset. It is noted that many successful research groups are characterised by having self-driven, enthusiastic, hard working individuals who have sufficient freedom and resources to successfully carry out their activities. The AIP 2003 science culture report indicates that Physics based researchers have these qualities.(1)

Policy: The AIP endorses the establishment of studies on the impact of the management structures and cultures of the CSIRO, ANSTO the DSTO and other government laboratories. This review should include significant input from research scientists (as opposed to science managers) with a scope towards improving the management of research in Australia.
Reason: The AIP membership has become aware of a growing trend towards over-management in some of our government laboratories. The trend seems already to have tipped the scale towards research institutes with no research, and is not in Australia's interest. As mentioned above non-teaching research staff at Universities are currently spending almost 80 % more of their time on research than researchers based in government establishments. This is largely the result of the high

managerial/administrative load of the government researchers compared to their University equivalents.(1)

Policy: The AIP promotes the funding of large numbers of small research projects within our national science organisations.
Reason: It is recognised that only a very small number of research initiatives have a large impact on the Australian community. Attempts to "hand-pick" successful research projects by the bureaucracies of government organizations have proven to be largely unsuccessful. It is only through experimentation, by letting our brightest and best have a go, that research can be brought back into these organizations. The funding of small research projects is an effective way to rekindle research within our government based research laboratories. It should also be noted that small research projects are the fore runners of larger projects. Without the pilot studies which small projects allow research eventually stops.

Policy: The AIP supports the concept of a "period of stability" for the CSIRO and other government based research bodies. The CSIRO in particular appears to be in a continuous cycle of major restructuring. This restructuring occurs almost yearly for some divisions and is not part of a greater plan for the improvement of the CSIRO. It appears to be a heavily deleterious situation that occurs because of the short term appointment of managers.
Reason: Small improvements in an existing system of management when well implemented are to be hailed as exemplary. Continuous overalls of existing systems, that have not been given the opportunity to settle before they are again overhauled is simply time wasting and disruptive. When change is initiated a period of stability is required for staff to adapt to changes and for a new system to be properly assessed for its merits. Continuous re-structuring is not in the interest of the smooth running of our government laboratories.

2.2 University Based Research

Introduction: In Australia the universities carry out the three roles of research, teaching and community service. University research supports the nation but also provides facilities and opportunities for the training of post-graduate students. In recent years there has been a significant shift in the research emphasis within Australia. Almost all basic research is now carried out in the university sector. In this environment there has been increased teaching loads and severe reductions in the strength of many Physics departments.(5,7) With the reduced opportunities for researchers in this environment postgraduate numbers have fallen(7) and the number of high quality researchers within Australia appears also to have declined.(9) Jobs advertised in Australia, offering Physics based employment, were noted to have fallen off in the 1990's by an approximate

average of 200 jobs per year compared to the 1980's. It appears that within some Physics based disciplines the number of researchers may already be below a critical limit.

Policy: The AIP supports the funding of a larger number of Australian Professorial Fellowships and the continued funding of other Research Fellowships.
Reasons: With the high teaching loads being placed on lecturing staff (the average Physics lecturer now spends 39.4% of their time lecturing, with teaching administration added to this more than 45% of staff are working greater than a 50 hour week[(1)]). Dedicated research staff are required to maintain research programs and facilities and to aid in the training of postgraduate students. The average academic worker is now able to spend only 25.7 % of their time doing research.[(1)] With the decline in research opportunities in the CSIRO and other government laboratories the research options made available by university fellowships provide a small reservoir of high quality research staff that may meet some of Australia's future needs. Senior research fellowships are also needed to ensure that our best researchers are not lost from the system. At present career paths for senior researchers lead to management based duties that take our best researchers away from their areas of expertise. This trend should not be allowed to continue.

Policy: The AIP recognises a need to increase the number of tenured/tenurable positions at Universities.
Reasons: Only with permanent employment opportunity can viable career paths be maintained for researchers in the university system.

Policy: The AIP supports the continued freedom of academic staff (both research and lecturing staff) to carry out their research.
Reasons: Research in the Universities is generally the result of highly motivated hard working individuals.[(1)] Low pay and long work hours are compensated for by research freedom and by a high level of work satisfaction. Attempting to regulate or manage this process in government research laboratories has resulted in the loss of hard working individuals from that system,[(9)] either by movement out of the system entirely (by retirement, removal overseas or by escape to the university system) or by those individuals giving in to cultures that discourage individual achievement and an ethic of enthusiastic scientific inquiry. If the compensations of research freedom and work satisfaction do not remain in the universities, the universities will simply be unable to maintain their research portfolios. If this occurs we will once again be reliant on overseas nations to educate our postgraduate students, a situation that has not existed in Australia for over forty years.

Another quite separate reason for supporting research freedom in the universities is the rapid response to new areas of research that individuals can carry out in comparison to organisations. Funding bodies and government research laboratories are generally quite slow at providing resources, often taking many months or even years to support new

areas of research. Individual researchers can respond almost immediately, though perhaps with limited resources, by enacting an immediate change in research direction. Without this rapid response to a rapidly changing world Australia stands to fall well behind the "state of the art" in many areas.

2.3 The Australian Research Council

Introduction: The Australian Research Council (ARC) is the premier source of government funding for grant based research projects in Australia. Applications for ARC funding can be highly competitive with a yearly success rate of 20-31% for research based proposals.

Policy: The AIP encourages greater funding for the ARC, and is encouraged by recent government funding increases.
Reason: ARC grants, particularly Discovery grants are amongst the most highly competed for grants in the world with the quality of applicants being very high. ARC assessors have been of the opinion that 80-90% of applications are excellent and should be funded, yet in 2004 only 30.8% of applications were successful for 2005 funding.[(12)] Even those applications that are successful often receive only a fraction of the funding requested. This situation can only be addressed by increased funding.

Policy: The AIP promotes mechanisms for obtaining ongoing or renewable staff support for large equipment items.
Reason: There has been money available for purchasing large items of equipment but there is no money available for hiring technical staff to operate and maintain the equipment.

Policy: The AIP promotes the development of a strategic plan to enhance the development aspect of Australian R&D. The formation process for this plan should be inclusive of both state and federal governments.
Reason: Although traditionally a nation with a strong track record in research, development in Australia has been poorly undertaken. With limited resources available for funding research it is important that funds be directed where they will have the most benefit. For this to occur Australia needs a strategic plan.

Policy: The AIP calls for a review of the application process for ARC grant proposals.
Reason: Over the years, partly as a means of culling applicants, the complexity and length required for ARC applications has slowly increased. A typical application is now 30-50 pages in length and may take 40 to 200 hours to prepare. In 2004 3,441 Discovery applications were received with only a 30.9% success rate.[(12)] Taking an average preparation time of roughly 120 hours, this represents approximately 412,920 hours of

effort. This represents a research time loss to the nation of approximately 245 working years. Taking this at the value of the salaries of the applicants, which would average at approximately the middle of level B (~$65,000 per year) this comes to a loss of about $15.9 million dollars in 2004, or the funding for an additional 56 Discovery projects. In addition, only a fraction of the 1051 projects funded by the ARC in 2004 for 2005 were provided to the nation's 40,000 scientists,[13] since engineering, humanities and the creative arts also receive ARC Discovery project funding.

2.4 National Research Centres

Introduction: The national research centres, although varying in relative degrees of success, have proven in the large to be an effective means of promoting areas of excellence in Australian science. In some cases the centres have also been successful as incubators of fundamental research, new technology and businesses. Though such success has been sporadic, overall the national research centres may represent Australia's best attempt to date at the commercialisation and development of science research.

Policy: The AIP supports the funding of centres of national excellence.
Reason: The centres maintain expertise and facilities that are important for the development of strategic areas of research. They also contain the resources necessary to develop research and to interact with business. The centres remain the most useful means of directing strategic research in Australia.

2.5 National Facilities

Introduction: National facilities, include expensive pieces of research equipment and infrastructure with dedicated support staff. Such facilities are generally accessible to researchers from all over Australia. These facilities may also have a role in drawing international researchers to Australia, and furthering international research relationships.

Policy: The AIP supports the funding of national research facilities with the facilities available to a wide range of industries and researchers.
Reason: Some research facilities are very expensive and can only be supported at the national level. These facilities are vital for ongoing research of national importance.

3 Industry

Introduction : "Much is made of the alacrity with which Australia adopts new technology particularly in IT and communications. According to the Year 2000 World Competitiveness Report produced by IMD Lausanne, Australia is among the world leaders in these areas, for example coming 6th in the world rankings in terms of computer power per capita and 8th in new information technology implementation. However this preparedness to take up IT is in stark contrast to recently published figures that highlight a negativity in Australia toward R&D in science and technology in general. In the 2000-2001 period the ratio of Australia's total expenditure on research and development to GDP was only 1.68%, well below the OECD average of 2.2%. Whilst Australian business is adept at taking up and applying new IT developed elsewhere, we are reluctant to innovate and take the risks involved in developing technology ourselves. Business investment in R&D in 2000-2001 was only 0.72% of GDP well below the OECD average of about 2%. There is an abundance of scientific, technological and engineering creativity in this country, our shortcoming is an inability to develop and market commercial products based upon this innovation."(14)

Policy: The AIP encourages the government to develop methods of inducing greater expenditure by the business sector on research in the enabling sciences.
Reason: Business expenditure on R&D in Australia is significantly below the OECD average.

Policy : The AIP seeks to expand the involvement of Physics research in industry and to expand the participation of Physics graduates in industrially based R&D.
Reason: Investment in R&D by Australian business has been viewed in the past as an expense. Investment is important for companies to maintain technological advantage over others in the "global economy".

Policy: The AIP supports the inclusion of a greater number of representatives from the enabling sciences onto the boards of Australian companies.
Reason: The boards of companies determine strategic directions which are increasingly determined by scientific, technological and engineering factors, requiring much greater scientific and technical awareness on the part of directors and top management.

Policy: The AIP urges government, and is much encouraged by the recent expansion of its policies and the mechanisms that facilitate and encourage the transfer of Physics technology from research laboratories into the industrial or manufacturing sectors.
***Reason*:** This provides a means for the community to realise the value of research, much of which has been paid for by the community through taxes.

4 Community

Introduction: The AIP is the leading advocacy group for Physics in Australia, with a vital interest in promoting Physics in the general community, and providing expertise to guide national policy.

4.1 Perceptions of Science

4.1.1 ***Policy***: The AIP supports initiatives to enhance interest and excitement in Science, and to demonstrate that there are rewarding, challenging and creative careers for scientists.
Reason: There is a growing gap between the supply of scientists and mathematicians in essential areas and the demand.

4.1.2 ***Policy***: The AIP supports the idea of a national campaign (similar to advertising for the armed forces) showing the many varied and interesting careers available in Science and Mathematics.
Reason: There is a serious disparity between the public reliance on science and technology and community perceptions of employment prospects in this area. A national campaign will produce additional material for careers advisers.

4.1.3 ***Policy***: The AIP promotes a strong Physics, Chemistry and Mathematics culture in Australia with support from Government and Industry, to promote the image of enabling sciences nationally.
Reason: The aim is to highlight the role of the enabling sciences.

4.2 The Environment

Introduction: Protection of the environment is of utmost importance for the wellbeing of all forms of life on Earth, not least in Australia with its unique flora and fauna. The Physics Community is in a strong position to have a positive impact on these issues. Physicists have the skills to understand complex systems, and already make significant contributions in the fields of climate modelling, biospheric modelling, ground water modelling and ocean modelling. These skills are also contributing to the understanding of the functioning of complex biophysical systems that form the foundation of changes to the planet.

4.2.1 ***Policy:*** The AIP supports scientifically sound discussion leading to the development of environmental strategies based on sound scientific principles and evidence.
Reason: Policy decisions should be informed by scientific evidence. The AIP has the authority to contribute to public education in many aspects of environmental science.

4.2.2 ***Policy***: The AIP promotes the development and implementation of technologies that preserve the environment.

Reason: There is growing awareness of the risk of long-term degradation of the environment. Physicists are in a position to make a significant contribution to methods and technologies that help preserve or remediate the environment.

4.2.3 ***Policy***: The AIP promotes research into the effects of greenhouse gas emissions on the environment, and their relationship to regional and global climate change.
Reason: There is growing awareness of the potential for rapid large-scale climate changes, some of which are already evident. These changes include: rises in sea levels associated with melting of the polar ice caps and thermal expansion; acidification of the oceans due to increased gas concentrations; and increased rates of extreme weather events. Scientific research into these changes is vital for the formulation of appropriate policy.

4.3 Energy and Power

Introduction: Maintenance and improvement of the living conditions of the world's population depends on the availability of sufficient power, when and where it is required. The Physics community is strongly placed to contribute to the development of energy policy based on the relevant physics principles and numerical parameters.

4.3.1 ***Policy***: The AIP supports the development of a range of power sources which have low emissions and low cost when considered over the entire life of the source.
Reason: New sources of energy and methods of transportation involving greatly reduced emission of greenhouse gases are vital to Australia and the world. The Physics Community is in a strong position to contribute to the development of these technologies.

4.3.2 ***Policy***: The AIP supports the development of a range of energy storage systems.
Reason: Improved energy storage systems will allow more effective use of renewable but non-continuous energy sources.

4.3.3 ***Policy***: The AIP supports the development of policies and practices which improve energy efficiency.
Reason: Generation and use of energy depletes the Earth's resources. This effect can be reduced by improving energy efficiency.

4,3.4 ***Policy***: The AIP supports the development of a public education campaign to promote the efficient use of energy in everyday life.
Reason: Demand for additional power sources will be reduced if more people implement simple and inexpensive changes to improve the efficiency of energy use in the home and private transport.

4.4 Equal opportunity

4.4.1 ***Policy***: The AIP advocates an inclusive equal opportunity policy for all, and encourages such policy in the Physics employment, education and social communities.
Reason: Successful science requires input and participation from as broad a cross-section of the population as possible (regardless of gender, age, race and

ethnoreligious affiliation, marital status, disability, political or religious belief, sexual orientation, transgender, family or carer's responsibility) so that it can address a range of problems that affect all people.

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Revision History

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