Australia's Major National Research Facilities: Issues to consider for the next phase of Backing Australia's Ability

Australian Academy of Science

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Executive Summary

1.1 The purpose of this report from the Australian Academy of Science is to contribute to the process of shaping Australia's approach to the provision of Major National Research Facilities (MNRFs) and other large research facilities. The lead-up to the second phase of *Backing Australia's Ability* promises to be pivotal in setting the future shape of federal government policy towards research infrastructure, including the provision of MNRFs. A new initiative was announced in the May 2003 budget aimed at developing a *National Strategy on Research Infrastructure*.[1] In addition, research infrastructure is being considered as part of the study aimed at mapping Australia's science and innovation system.

1.2 Australian policy-makers have little information on the nature and extent of unmet demand for research infrastructure funding. In order to fill part of this gap the Australian Academy of Science has determined the current status of the full bids for support in the last Major National Research Facilities (MNRF) bidding round in 2001 that were *not* funded. The Academy has identified the sources, and levels, of funding obtained from other sources on a case-by-case basis. The data collected allows the magnitude of the shortfall in MNRF funding to be assessed and also allows areas of outstanding need to be identified.

1.3 There were 86 full bids for MNRF funding, 1 bid (the Victorian Synchrotron proposal) was subsequently withdrawn in order to be developed independently of the MNRF program and 15 were funded, leaving 70 bids un-funded. Of these 70 bids, 44 partnerships (63 percent) are understood still to be actively seeking funding for these proposals at the time of writing in 2003. Full financial details for 40 of these active bids and information on subsequent funding received have been provided to the Academy. Eight (18 percent) of the 44 bids that have actively sought support after MNRF funding was not provided have gone on to secure sufficient funding to allow the facility to develop significantly. 13 partnerships (30 percent) have managed to obtain lower levels of support that has allowed the proponents to keep the proposal alive or to develop some parts of the facility. 23 bids (52 percent) have received no subsequent infrastructure funding, although some have received small amounts of project-based support. On the basis of the information we have been able to obtain, 26 bids are no longer active.

[1] This will involve: (a) developing a coordinated approach to high end research instruments in priority areas of research; (b) targeting funds to ensure access to key overseas research instruments; ensuring that Australia has a world class high performance computing capacity; and (c) developing an integrated research telecommunications network.

1.4 A total of $113.8m has been raised by the 44 partnerships that are still actively seeking funding since MNRF program funding was turned down. For the 40 bids for which financial details were obtained, this amounts to 8 percent of the total funding originally requested (total funding requested by the sample of 40 was $1,422.8m) and 28 percent of the MNRF funding requested ($413.8m for the sample of 40). Over half of this subsequent funding ($60.24m or 53 percent) has been provided by the federal government, the bulk ($36.7m or 32 percent) coming from the *Systemic Infrastructure Initiative* (SII). ARC and NHMRC support accounts for another $20m, or 18 percent. State/territory government funding at $26m accounts for 23 percent of the total. To date, internal funding provided by partners to the bid, at $23.6m, or 21 percent is about the same as that provided by the states and territories. Unlike the MNRF program, the federal programs that have provided the bulk of the funding for these continued MNRF partnerships are only open to bids led by higher education institutions.

1.5 The fact that the partnerships still seeking funding have been so tenacious and have been successful in meeting part of their needs is compelling evidence that these are serious proposals of sufficient merit to secure funding from other sources. There remains a shortfall in government-sourced funding of around $300m (the $413.8m MNRF funding sought less the $113.8m raised subsequently from all sources). The report details the research areas that, on the basis of this stock-take of MNRF bids, remain as potentially significant areas of need.

1.6 The states and territories together with overseas agencies and international organisations are in a position to make substantial contributions to MNRF and larger-scale research facility funding. It is therefore in the national interest that there be no administrative impediments to this potentially important avenue for leveraging federal funding. At present, the uncertainty generated by the ad hoc nature of the MNRF program, the tight time frames for bidding, the lack of sychronisation between the federal and state/territory bidding processes and the limited potential to attract overseas funding in the MNRF bidding process restricts the potential for such leverage. The onus is therefore on the states/territories as well as the federal government to improve the scope for leverage. The states and territories that have yet to do so can help to improve the scope for leverage by creating programs designed to fund research infrastructure. The federal government can help to improve the scope for leverage by removing the uncertainty over future MNRF funding availability. The federal government can also act by designing MNRF funding mechanisms that provide greater opportunities for both international donors and the states and territories to commit to substantial funding contributions within the constraints of their own funding procedures. These moves would generate the opportunity for the substantial leverage of federal MNRF funding with both international and state/territory funding, in so doing significantly improving the capabilities in the Australian science and innovation system.

1.7 The 15 MNRFs funded under the 2001 MNRF bidding round are in the process of developing asset management strategies. These strategies are designed to maximise the efficiency with which their research assets are utilised by external researchers. This asset-based perspective seeks to demonstrate the overall national benefits that arise from the higher levels of capacity utilisation and the superior technical capabilities of the MNRFs when compared with 'fragmented' investments in research infrastructure.

1.8 Finally, workshops held with the Directors of the 15 MNRFs that did receive funding in the last round have highlighted another unmet need in the nation's science and innovation funding system. This is the lack of targeted funding for researchers to use Australia's MNRFs. If ARC and NHMRC research grants do not provide adequate project funding for using an MNRF's state-of-the-art facilities, backed up by specialist technical expertise, then the overall contribution of the MNRFs to the efficiency and effectiveness with which Australian research is conducted is reduced. It makes little sense to invest in creating or improving these major research assets unless we also provide adequate funding for the research community to *use* these assets. An MNRF use line-item in ARC and NHMRC research grants has been suggested as one means of ensuring that adequate funding is available for researchers to exploit Australia's MNRFs.

1.9 In the Academy's view there is a role for two types of funding arrangement for major research facilities. In situations in which it is attractive and feasible to attract international funding partners then a facility should be fully funded by these partners with access granted free of charge to users based upon scientific merit. A standard Protocol could be drawn up to cover these international partnership-funding arrangements. This Protocol should be based upon a contractual relationship between the percentage of full costs contributed by a donor and the percentage of facility capacity used by that donor. There are existing international models for this type of Protocol, such as that used by the European Synchrotron Radiation Facility. Relevant state/territory governments and the federal government could unite to provide the Australian funding contribution within such a Protocol.

1.10 The development of large fully-funded major research facilities in Australia based upon international partnerships would give Australia an enhanced capacity to create and exploit the reciprocal benefits from involvement in such international partnerships. These partnerships could provide substantial leverage of both federal and state/territory funding with consequent scientific, economic, environmental and social benefits for Australia. However, the model of fully funded major facilities based upon international partnerships is not appropriate to all types of major research facility. In many cases, the current MNRF funding model is both

attractive and feasible provided that MNRF use is funded adequately via a line item in ARC and NHMRC research grants.

1.11 Consequently, the most robust method of funding major research facilities in Australia, both under the MNRF Program and the larger-scale facilities that require direct Cabinet approval, is to adopt a dual approach. This provides the option to develop fully-funded facilities in which the public sector user does not pay based upon international consortia. The dualistic approach also provides the option to continue to develop smaller scale facilities in which public sector users do pay. An MNRF and other major facility use line item in research grants will guarantee that facility users have the means to fund the use of these national research assets. This in turn will avoid the diseconomies associated with a fragmented research infrastructure.

1.12 Although the Academy's preference would be for fully-funded major research facilities in all situations the Academy also recognises that this is not a preferred option from the federal government's perspective. The strength of the Academy's dualistic approach is that it is pragmatic. It would allow a non ad-hoc MNRF Program to move ahead quickly using a line-item in research grants to ensure that MNRFs are used effectively. It would also create the option to develop fully-funded, larger scale, facilities based around international partnerships. This option would be particularly useful in relation to proposed facilities that exploit unique or rare locational advantages possessed by Australia but that require substantial international funding.

1.13 The combined impact of these shifts in major facility funding policy would have a dramatic impact upon the sustainability and scope for growth in Australia's major research facilities. It would also facilitate the attraction of major international investment in Australia with associated spin-off benefits.

Based upon these key findings and points, the following recommendations are put forward**.**

Recommendation 1. The ad-hoc nature of MNRF funding should cease. The Federal Government should, as a matter of priority, announce that there will be future bidding rounds.

Recommendation 2. The federal government should take the lead in drawing up a Protocol for partnership-funding designed to create fully-funded major research facilities in which access for public interest research is granted free of charge to users. This Protocol should be based upon a contractual relationship between the percentage of full costs contributed by a donor and the percentage of facility capacity used by that

donor. Models of such a Protocol for multi-national facilities already exist overseas. These arrangements allow for periodic adjustments to donor contributions based upon actual levels of facility use. This Protocol could be used to facilitate stronger involvement of international funding sources in contributing to Australian facilities, thereby providing substantial leverage of federal and any state/territory funding.

Recommendation 3. The federal government should establish a new line-item for MNRF and other major facility use in ARC and NHMRC research grants applications. This line-item would be designed to divert resources away from duplicating infrastructure with low levels of capacity utilisation via uncoordinated purchases. It would direct more funding to facilities managed in order to maximise the benefits to the research community as a whole. At present, it is often easier to obtain funding to purchase a cheaper, less effective set of research instruments and equipment than it is to obtain funding to use a state-of-the-art MNRF.

Recommendation 4. Federal government - state/territory government partnerships should be developed with the aim of delivering an agreed level of state/territory government matching of federal funds for major research facilities. This combined national funding contribution would comprise the Australian element any multinational major research facility established using the Protocol for multipartite research facilities. These partnerships would be most easily achieved by providing the opportunity and the lead-time for state/territory governments to commit to making substantial cash contributions to MNRF and other major research facility bids as part of their own infrastructure funding programs.

Recommendation 5. An MNRF investment fund should be established. The Federal Government should commit to making annual injections into this investment fund in the region of $40m per annum via an MNRF line item in the Federal Budget. The disbursement of funding from this investment fund should be made according to long-term strategic requirements with flexibility over the levels and timing of these disbursements. Flexibility should also exist over the level of annual Federal support to be provided.

Recommendation 6. A more strategic internationally-oriented MNRF selection process should be instituted at three-yearly intervals. The first stage should consist of an Expression of Interest (EoI). Potential partnerships could be identified and some bids amalgamated. Bids would then be selected on the basis of scientific and technological merit and successful EoI's would be invited to submit fully developed proposals. An additional selection round would then select those proposals that should *in principle* be funded and these bids would enter a waiting list. Decisions would then take place over which bid should be funded in which year. The decision on the actual release of funding would constitute the final stage of the selection process.

Recommendation 7. The entire process from soliciting EoI's through to final funding awards should, where this is relevant, be conducted via substantial consultation with potential international donors.

Recommendation 8. An annual report on the MNRFs funded each year and the MNRFs waiting to be funded should be provided by the Office of the Chief Scientist.

Recommendation 9. Should the previous recommendations be adopted then special consideration should be given to re-negotiating the contracts for the 15 new MNRFs in order to align them with the new funding system should they wish to take-up this option. This would involve exploiting any opportunities for greater international and state/territory funding in the move to a fully-funded model, in so doing reducing the MNRFs reliance upon external revenue for their financial viability.

Recommendation 10. The Office of the Chief Scientist should be provided with appropriate support to permit it to co-ordinate long-term strategic planning for both future MNRF requirements and larger scale facilities that require direct Cabinet approval. Should an MNRF investment fund be created via a line item in the Federal Budget as part of the next phase of *Backing Australia's Ability* then funding for this co-ordination role could be provided from the MNRF investment fund/line item in the form of an administration charge. This co-ordination by the Office of the Chief Scientist would be necessary to ensure that sufficient international liaison with overseas governments, agencies and international organisations takes place as part of the MNRF and other major facility selection processes. It would also be necessary to improve liaison with Department of Foreign Affairs and Trade. This applies to situations in which access to major research facilities, and any associated science, technology and intellectual property access and transfer issues are addressed in trade negotiations and in multi-lateral and bi-lateral discussions between governments.

2 Introduction

The purpose of this paper

2.1 The purpose of this report from the Australian Academy of Science is to contribute to the process of shaping Australia's approach to the provision of Major National Research Facilities (MNRFs) and other large research facilities. The lead-up to the second phase of *Backing Australia's Ability* promises to be pivotal in setting the future shape of federal government policy towards research infrastructure, including the provision of MNRFs. A new initiative was announced in the May 2003 budget aimed at developing a *National Strategy on Research Infrastructure*.[2] In addition, research infrastructure is being considered as part of the study aimed at mapping Australia's science and innovation system.

2.2 The Academy has a long-standing interest in the adequacy of Australia's research infrastructure. Over the years the Academy has argued consistently for improvements to arrangements for funding research infrastructure. Seeking a line item for funding *Major National Research Facilities* in order to remove the uncertainties created by ad hoc funding rounds is a key element in the Academy's published policy statement (Australian Academy of Science, 2001).

2.3 This research and consultation process has included two workshops with the Directors of the 15 *Major National Research Facilities* funded in the last bidding round in 2001. It has also examined the arrangements for funding access to research infrastructure in the context of the approaches adopted overseas and has traced the current status of the bids for MNRF funding in the last round that did *not* receive MNRF program funding. The follow-up on unsuccessful bids for MNRF funding provides a useful snapshot of the nature and extent of the funding still being sought for MNRFs. In so doing, the study provides some insights into gaps in the nation's research infrastructure. These analyses and consultations provide the basis for putting forward a set of recommendations for funding MNRFs in the future. The work has been carried out using a grant from the Australian Research Council's *Learned Academies Special Projects Scheme*.

[2] This will involve: (a) developing a coordinated approach to high end research instruments in priority areas of research; (b) targeting funds to ensure access to key overseas research instruments; ensuring that Australia has a world class high performance computing capacity; and (c) developing an integrated research telecommunications network.

The new rules of the game

2.4 It is helpful to identify at the outset the key issues faced in making the case for a greater commitment to major research facilities funding by the federal government. The over-arching issue from government's perspective is clear. Government expects a return on its public investments. Government therefore seeks to weigh-up the returns it can expect from different uses of public funding and, consequently, any case for support is strengthened by clarity over the nature and extent of these returns – even if this is framed in qualitative terms.

2.5 In this respect, it is becoming easier to justify major research infrastructure investments over time. This is because major research infrastructure is becoming more and more critical not only to science but also to science-based innovation by high-technology companies. Major research infrastructure is also becoming more and more critical to our capacity for the rapid identification and response to the challenges posed by environmental degradation, climate change and other threats to national well-being such as terrorism, diseases and pests.

2.6 The capabilities of the scientific instruments used at the sub-atomic, atomic and molecular scales have evolved from a passive to an active role. We have moved from an era in which we were able to passively image and simulate behaviour at the molecular and sub-atomic and atomic scales to an era in which we can image, simulate and actively control these phenomena. What were previously solely tools for observation are now tools for manipulation (e.g. nanotechnology).

2.7 At his keynote address on '*Science and Technology in a Vulnerable World: rethinking our Roles*' at the 27th Annual AAAS Colloquium on Science and Technology Policy John Marburger, Director of the Office of Science and Technology Policy at the Whitehouse noted that:

> We are witnessing advances in the technical infrastructure of science that do justify large increases in certain fields, and large increases have been forthcoming. …. the revolutionary nature of these advances, which are occurring in instrumentation that permits us to image and control the properties of organic and inorganic materials at the atomic scale, and in powerful computational and information technology that enables us to manipulate atomic level information, and to simulate the functional properties of matter based on its atomic level description. The result is an unprecedented understanding of, and power to control, the functional properties of all matter composed of chemical atoms.

2.8 These advances mean that the rules of the game have changed. The technologies used in science and the science used in technologies are converging. In the new industrial activities

generated by these advances in converging science and technology not only is there no substitute for access to leading-edge tools in order to do leading-edge science, there is no substitute for access to these tools in order to achieve leading-edge innovation. The time and cost required to move from the laboratory to applications in some areas, such as nanotechnology and some areas of biotechnology, may be dramatically reduced provided that the appropriate major research facilities are available.

2.9 Similar challenges and opportunities exist at the macroscopic scale – in analysing the complex web of inter-dependencies that link phenomena in the atmosphere, on the surface of our landscape, and the processes that take place beneath this landscape. The capacity to image and simulate these complex multi-dimensional processes rests largely upon the sophistication of the analytical tools available and the depth and breadth of the data-sets we are able to build and maintain. Understanding salinity, soil acidification and other landscape-scale processes require sophisticated imaging technologies (such as air-born sensing of sub-surface structures and conditions) and sophisticated models and complex simulations. Aside from the major economic benefits generated by facilitating exploration for minerals, oil and gas by providing comprehensive data on geological structures, this landscape-scale aspect of our research infrastructure plays a key role in helping us to understand the risks we face due to environmental challenges.

2.10 Whatever the scale at which observations are carried out (sub-atomic/atomic/molecular, landscape-level, astronomical-level) complex-data sets, high-bandwidth communications to allow these data-sets and facilities to be used remotely and sophisticated simulation and analysis capabilities are required. This has been termed ‘e-science’. e-science involves common challenges and uses shared information and communication technology infrastructures. This is therefore another form of technological convergence, and an opportunity to pool resources for the benefit of many fields of research. E-science also benefits the community. Developments in information technology that have had major impacts on society have their origin in the needs of large scale international collaboration over major international facilities. The web was developed at CERN to serve the high-energy physics community. The grid, currently under development by the high-energy physics and astrophysics communities, has the potential to change the way major corporations handle their IT.

2.11 The combination of the capabilities to image, simulate and control complex phenomena at the sub-atomic, atomic and molecular levels and the capabilities to image and simulate complex phenomena at the landscape, planetary and astronomical levels are critical to the future of science and to national prosperity.

2.12 In the final analysis, Australia's future Net Worth (the nation's total tangible and intangible assets less our financial liabilities to the rest of the world) rests upon the adequacy of our investment in the research assets that will generate new industries, re-vitalise existing industries and which will help us to understand and respond to the economic and environmental risks we face (such as salinity, soil acidification and climate change). The consequences of under-investment in research infrastructure are likely to manifest themselves in a weaker national balance sheet.[3]

2.13 The geo-scientists are already able to demonstrate this hard-nosed R&D outcome. This is because they have made long-term strategic investments in collating data on the value of the nation's economically demonstrated resources (EDRs) of minerals, oil and gas. These economic assets have been generated by the reduced risks to exploration investment made possible by releasing basic geological data-sets. Because these data-sets have been assembled by geoscientists these asset values are now included in Australia's official *National Balance Sheet.* They are currently valued at $245.7bn, amounting to 8.4% of national Net Worth and 6.5% of total national assets.[4] This contribution to Australia's net worth represents a remarkable return on investment in geosciences R&D. This contribution is critically dependent upon the research infrastructure provided by large costly and complex datasets (Strategic Plan for Australian Earth Sciences, 2003).

2.14 Similarly, our 15 new Major National Research Facilities (MNRF) assets are likely to play a key role in strengthening the national balance sheet. The *Australian Computational Earth Systems Simulator* (ACESS) provides an advanced computational environment that will both facilitate minerals exploration and help to improve understanding of natural and human-induced geo-hazards that place some of Australia's tangible assets at risk (including advances in predicting earthquakes). The group of bio-science MNRFs collectively provide an integrated research infrastructure that will allow the chain of causality from the sequencing of genes (genomics), separating, identifying and characterising proteins (proteomics), understanding how genes regulate the behaviour of cells and tissues (phenomics), through to enhancing our capacity to carry out cell engineering to be carried out quickly and cost-effectively.

2.15 Other biologically-oriented MNRFs focus upon neurological research, on providing comprehensive data on the genetic material in Australia's livestock and on understanding the

[3] The growth in the value of national assets will be lower than could otherwise be the case and the risks to the value of these assets will be greater because we have an insufficient understanding of how to forecast what the future holds for us in terms of the impact of environmental degradation and climate change.

[4] ABS 1301.0 2002 National Balance Sheet.

factors that affect the quality of wine. The MNRF providing nanostructural analysis capabilities also supports this integrated set of bio-science facilities via advanced molecular imaging. This MNRF also assists Australia to generate high-value added activities based upon nanotechnology applications in the physical sciences. All these MNRFs, and particularly in combination, intend to open up new opportunities for developing products and services (particularly drugs and therapies) upon which new high-value added industrial activity can be based. Further infrastructural support for growing new high value added industries is also provided by the MNRF that provides a means of testing semiconductors remotely. This eliminates the risks in leakages of intellectual property associated with sending semiconductors to be tested overseas. Another MNRF provides the infrastructure for developing photonic chips. Astronomy's facility-development R&D has a recognised track record in stimulating spin-off benefits in optics, electronic imaging, signal processing and other areas of technology. The MNRFs therefore provide the set of complementary research facilities that are critical to both 21st Century science and creating the intangible assets (in the form of intellectual property) that are key to generating high-value added exports in the future.

2.16 As John Marburger (quoted above) went on to conclude, the new rules of the game mean that research instrumentation itself must be a national priority (in this case he was commenting upon the United States but the point has a more general currency):

> If we want to achieve balance in federal science funding, we are going to have to understand how the complicated funding process works, or fails to work, to sustain the essential tools upon which our most exciting and productive areas of science and technology depend.

3 Findings from the analysis of unsuccessful MNRF bids

A 'stock-take' of unmet MNRF funding requirements

3.1 Although the Department of Education, Science and Training (DEST) is unable to provide details of the bids for MNRF funding due to confidentiality constraints, it has been possible to make direct contact with the proponents of these bids in order to obtain details of the bid and of their subsequent experience in securing funding.[5] This is inevitably indicative information

[5] DEST officials have been extremely helpful in supporting this study by passing on the limited information that they are in a position to release. Officials have also been of great assistance in helping to track down the most appropriate contacts for unsuccessful 2001 MNRF bids where this proved difficult. On a few occasions DEST has been asked to release the full

because circumstances do change. Some MNRF proposals have been resurrected after they have been deemed to have been abandoned.

3.2 There were 86 full bids for MNRF funding in the last bidding round, 1 bid was subsequently withdrawn (the Victorian Synchrotron proposal) in order to be developed independently of the MNRF program and 15 were funded, leaving 70 bids un-funded. On the basis of the information we have been able to obtain, 26 partnerships are no longer seeking funding for their bid.

3.3 Forty-four of these MNRF partnerships are still actively seeking funding for the proposal put forward in the last bidding round, although in some cases the design of the proposed facility has evolved since MNRF funding was sought. For 40 of the 44 partnerships that are still actively seeking funding it was possible to obtain either the full MNRF bid or an extract from the bid in which commercial-in-confidence information on proposed partners and partner funding and in-kind contributions had been removed.[6] There were only four bids for which the full financial details of the MNRF bid were not provided to the Academy.[7]

3.4 Given that 40 out of 44 bids (i.e. 91 percent) that are still actively seeking funding had provided full financial details in order to assist the Academy in this study, the four bids for which full financial details were not provided have been treated as a special case in the following analysis. Indeed, the fact that full details were provided for most of the bids that still deem themselves to be actively seeking funding is one indication of the serious latent demand for MNRF funding.

3.5 The 40 bids for which full financial details are available sought total funding of $1,422.8m and a total MNRF programme contribution of $413.8m (i.e. 29.1% of total funding). Anticipated user fees totalled $153.52m (amounting to 10.8% of total funding required). Planning and construction costs totalled $473.66m (33.3%) and operating costs $535.32m (37.6%).

3.6 Of the 44 bids that are still seeking funding, eight (18 percent) have managed to obtain sufficient funding to allow significant progress to be made towards developing the facility, 13 bids (just under 30 percent) have managed to obtained smaller amounts of funding that allows

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MNRF bid document to the Academy with the permission of the bid's proponents. At the request of the proponents, an undertaking was given not to disclose details of any particular bid in this report or via any other means as these are deemed to be commercial-in-confidence (particularly with regard to details of partner contributions).

[6] There were only a handful of cases in which confidentiality was an issue and in which the full bid was edited down.

[7] Some of the MNRF bidders went to extensive efforts to track down and provide their MNRF bid document and additional information on the current status of the bid.

them to keep the proposal alive by funding discrete parts of it. Twenty-three bids (52 percent) have received no other funding at all.

3.7 To date, it has been possible to identify $113.8m of non-MNRF funding obtained by the 44 unsuccessful 2001 MNRF bids that are still actively seeking funding. This amounts to 8 percent of the total funding requested by these bids in the 2001 MNRF bidding round (total funding requested by the sample of 40 was $1,422.8m), and 27.5 percent of the MNRF funding requested ($413.8m for the sample of 40). Thus, just over one-quarter of the MNRF funds requested have subsequently been met from other sources, even though this may have entailed trimming-down aspects of the proposal.[8]

3.8 The following table provides a breakdown of these sources of alternative funding.

Table 1: Details of funding obtained since the 2001 MNRF bidding round

Subsequent non-MNRF funding	**$m**	**%**
CRC Program derived funding	-	-
ARC Centre of Excellence derived funding	5.0	4.39%
NH&MRC	10.0	8.79%
DEST: Systemic Infrastructure Initiative	36.7	32.22%
ARC: LEIF	0.5	0.44%
Federal agency and RDC funding	8.1	7.10%
sub-total federal funding	*60.24*	*52.94%*
State government program funding	26.0	22.81%
Internal funding by partners	23.6	20.73%
Domestic private sector funding	1.00	0.88%
Private non-profit funding	3.00	2.64%
International funding	-	-
sub-total non-federal funding	*53.6*	*47.06%*
TOTAL	**113.8**	**100.0%**

Source: survey work carried out by the Australian Academy of Science

3.9 Alternative funding sources are dominated by four major sources: the *Systemic Infrastructure Initiative* (SII) administered by DEST; *state/territory government* funding, ARC and NHMRC funding and internal funding by project partners. The latter is especially significant because it demonstrates a clear commitment to attempt to develop the facilities despite the unavailability of MNRF funding.[9] Overall, federal schemes account for 53% of all subsequent funding, well over twice that of state/territory government sources.

[8] These are only indicative estimates of the proportion of total and MNRF funding sought because: (a) it may be possible in some cases for the same research capability to be provided at a slightly lower budget due to the combination of technological change in instrumentation and a 'leaner' budget, and; (b) there is one case in which details of subsequent funding have been obtained but for which we do not have details of the original value of the bid and the value of the MNRF funds requested.

[9] Matched funding provided by universities accounts for a large element of this source.

3.10 These findings provide compelling evidence to support the following propositions:

- many of the unsuccessful applicants for MNRF funding are serious in their search to fund these proposals in the sense that they did not abandon the bid when MNRF funding was not awarded;
- the merit of the proposals that are still actively seeking funding is sufficiently high that many have managed to obtain funding from other sources, but only in a minority of cases (eight) is this funding sufficient to do anything more than keep the overall concept alive by funding discrete parts of the original proposal – often the current costs rather than the capital costs sought.

3.11 This evidence suggests that the last round of MNRF competitive funding left a substantial residual requirement for MNRF funding and that whilst other sources of funding have gone a little way to meeting this requirement (thus demonstrating the merit of these bids) there is still a large shortfall.

Implications for understanding the structure and performance of Australia's system of research infrastructure funding

3.12 Tracing what has happened to the unsuccessful bids for MNRF funding in 2001 provides some useful insights into the extent to which different funding sources substitute and complement each other.

3.13 State and territory governments are in a position to make substantial funding contributions to research infrastructure, particularly when it is physically located solely in that state or territory. The states and territories recognise that their capacity to attract inward investment in science-based industries is closely linked to the capabilities of the research infrastructure that they possess. The introduction of Goods and Services Tax (GST), the revenue from which is passed on to the states, is now a significant source of income for them. Indeed, the GST revenue passed on to the states amounts to $23.854 billion in FY2000-01 which is 11.16 per cent of total tax revenue from all levels of government.[10]

3.14 The Victorian Government has committed funds of $310m over five years in order to 'catalyse the development of world class science and technology infrastructure, skills and the commercialisation of innovation in Victoria.' To date $120m has been invested via a targeted scheme, *STI Infrastructure,* via two bidding rounds. Funding from the Victorian Government dominates subsequent state/territory sourced funding for the unsuccessful 2001 MNRF bids.

[10] ABS 5506.0 2000-01 'Taxation Revenue'.

3.15 The medical research institutes receive special funding from state governments in order to compensate them for their exclusion from the Commonwealth programs for funding research infrastructure (i.e. the indirect costs associated with research grants covered by formula-based grants in the higher education sector). In New South Wales, Victoria and Western Australia this funding is paid on the basis of the value of competitive research funding won (although details of the rate at which this is paid differ according to the type of institute and other factors).[11] In Queensland and South Australia lump sum payments are made on a more ad hoc basis.[12] The formula-based funding model used to fund research infrastructure in these medical research institutes provides one possible model for a wider-scope system for leveraging federal MNRF investments.

3.16 The recently announced South Australian Government Budget included a new $4m *Premier's Research and Innovation Fund* to support new bids for science projects and to leverage federal and industry funding. It also allocated $3.1m to support the development of high performance computing facilities, $7m for science, technology and innovation support programs and Bio Innovation SA; and $8.4 million for a *Broadband Telecommunications Task Force* and infrastructure fund. The Queensland Government's $270m 10-year strategy announced in the 1999 budget for positioning the state as a center of excellence in biotechnology and medical research also aims to leverage federal funding.

3.17 Whilst the potential exists for the state/territory governments to substitute for federal funding for MNRFs the evidence from this study indicates that this will tend to take place at a significant level (as in Victoria) when targeted funding for research infrastructure is provided. Should increased levels of targeted funding for research infrastructure become a general feature of state/territory support for science and innovation then the potential would also exist for state/territory funding to leverage federal funding. The capacity to exploit this potential would rest upon such practical matters as the degree of synchronisation between the federal and state/territory biding rounds. Alternatively, this scope for leverage could be provided by creating greater opportunities for the states and territories to commit funding as part of a more strategic investment planning process for MNRFs. Furthermore, should stronger international funding be obtained for major facilities in Australia the potential would exist for greater leverage from combined federal and state/territory funding.

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[11] This lies in the range of 57 to 50 cents per dollar of competitive research funding in New South Wales. The Victorian Government's 2002 budget announced an increased rate of 25 cents per dollar of competitive research funding, increasing to 40 cents in the dollar for 2005-06.

[12] The Northern Territory government also provides funds however details of the formula are not known.

3.18 This analysis of the extent to which other funding sources have been able to meet the outstanding MNRF funding requirements indicates that there is no overall national substitute for MNRF funding. Although the *Systemic Infrastructure Initiative* (SII) has accounted for nearly a third of the subsequent funding secured, this funding is only available to the higher education sector. Similarly, although other federal funding sources have been able to go some way to meeting the outstanding funding requirements they still leave a large funding shortfall. Consequently, there are currently no alternative program-based sources of funding than the MNRF program save for cases in which targeted state/territory funding is made available. This adds weight to the argument that more should be done in Australia to build international and federal-state/territory partnerships over funding for MNRFs.

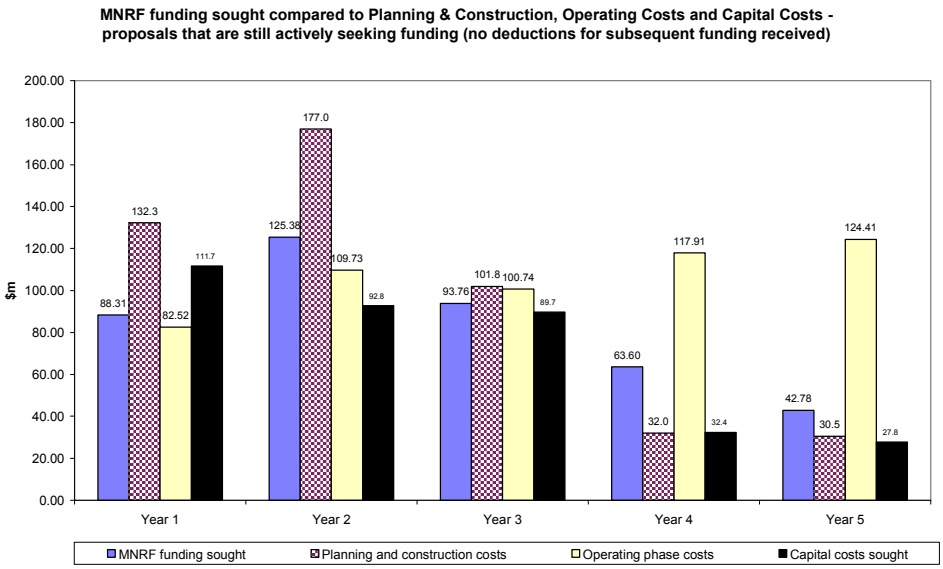
Indicative funding requirement for a non-ad hoc MNRF programme

3.19 The partnerships still seeking funding following the 2001 MNRF bidding round would constitute a major source for future MNRF bids. As such, the financial details collected via this study allow some indicative funding requirements for a non-ad hoc MNRF programme to be generated and it is to this issue that we now turn.

3.20 The funding sought in the last MNRF bidding round tended to be 'front loaded', a natural reflection of the infrastructure and capital expenditures involved. This is illustrated in the following graph of the time-profile of funds sought by the 40 bids that are still actively seeking funding and for which we have full financial data. There has been no deduction for funds received subsequently.

3.21 The first column indicates the MNRF funding sought, clearly showing a decline following the first two years of facility establishment activity. By the fifth year the MNRF funds sought by this sub-set of the bids only amounts to $42.78m (the five-year total MNRF funding requested of $413.83m averages $82.77m per year). The other columns put these funding levels into context by indicating the budgeted annual levels of planning and construction costs, operating costs and capital costs requested (note that these categories are not all additive as capital costs is a sub-set of both planning and construction costs and, to a lesser extent, operating costs).

Figure 1: Profile of unmet MNRF funding requirements[13]



3.22 This time-pattern of funding requirements highlights the fact that if future MNRF funding were to be staggered in a form of 'rolling start' via a coherent and sustainable program the levels of annual funding required would not be high. Even if subsequent funding is not deducted, funding in the region of $83m per year ($413.82 divided by 5 years) would suffice to fund all 40 of the bids analysed here. If there were to be a coherent and sustainable MNRF program it is likely that the total funding sought by bidders in the future would grow far above this level and that there would consequently be a high level of competition over seeking MNRF funds.

3.23 If stronger international and state/territory involvement in MNRF partnerships is to be encouraged, particularly with regard to substantial cash funding that leverages federal funding, then sufficient time must be made available for these partnership-based proposals to be developed and for agreement on international and state/territory cash contributions to be obtained. This, in turn, requires that the current high level of uncertainty over whether there will be MNRF bidding rounds in the future be eliminated. The current level of uncertainty is a major impediment to obtaining cash funding contributions from other governments. There is little incentive for other governments to plan to leverage MNRF funding in a strategic manner when the funding rounds are ad hoc. In addition, the current design of bidding rounds provides little scope for the proponents to secure funding commitments from other governments as part of their MNRF bid.

[13] Source: survey work carried out by the Australian Academy of Science

3.24 Bearing these funding levels and issues in mind it is now worth examining the question of the areas of particular need that remain in Australia's research infrastructure - as indicated by these unmet funding requests.

Areas of particular need in Australia's research infrastructure

3.25 One approach to identifying areas of particular need is to identify the sub-set of bids that have managed to secure some subsequent funding, including funding from internal resources of the partners. This as an indication of the merit of the proposal and of the commitment of the partnership to developing the project.

MNRF bids that have demonstrated continued need by securing low levels of subsequent funding

3.26 The 13 bids that fall into this category fall into the following research areas:

- The preservation of material and data on Australia's natural genetic endowment in plants, animals and fish on-shore and off shore (3 bids);
- Support for experimental activity on the exploitation of biomass resources (1 bid);
- Monitoring and prediction of ocean behaviour (1 bid).
- Integrated support for clinical trials (2 bids)[14];
- State-of-the-art electron beam instruments (1 bid);
- Ion beam experiments (1 bid);
- Dedicated supercomputers for use in fluid dynamics and lattice gauge theory (1 bid);
- Experimental production of silicon-based microelectronic devices (1 bid);
- Bulk solids handling technology (1 bid);
- Large-scale experimental fire test facility (1 bid)

MNRF bids that have not secured subsequent funding

3.27 There are 23 bids that are still actively seeking funding but which, as far as we are aware, have yet to secure subsequent funding. Of these:

[14] These bids have received significant funding, but this still falls below the overall requirements as stated in MNRF bids.

- 5 relate to the commercialisation of research in agriculture and aquaculture and to safeguarding stocks of plants, animals and fish;
- 2 to generic bio-informatic data-sets and their exploitation;
- 2 relate to oceanography;
- 4 relate to R&D, design and development in the ICT, energy, industrial and construction sectors;
- 4 relate to monitoring and modelling the processes involved in environmental degradation;
- 2 relate to the earth sciences (upgrading existing seismic imaging capabilities and improvements to analysing isotopes in minerals);
- 1 to astronomy;
- 1 to provide upgraded facilities for nuclear magnetic resonance (NMR) for use in medical research;
- 1 to drug and therapy development;
- 1 on plasma containment as part of fusion research.

3.28 It is evident that there are clusters of bids in some areas, with possible scope for combining or selecting between them.

4 The benefits gained from international science and technology collaboration

4.1 Australia participates in a wide range of international collaborative projects involving overseas research facilities. Examples are the Ocean Drilling Program, the Photon Factory, the Gemini telescope system, and the International Spillation Fusion Agreement. The *Access to Major Facilities Program* administered by ANSTO (current funding $621,500 per annum) and the MNRF program funding for the *Australian Synchrotron Research Program,* also administered by ANSTO ($14.8m over the next five years) are important sources of funding for using overseas research facilities.

4.2 The *Access to Major Facilities Program* provides merit-based funding for using international facilities in very high demand and for which access is often granted at short notice and requires a team of technicians and post-graduate students to conduct the experiment. A rapid

response to applications and the provision of funding for several personnel are therefore key features of this program.

4.3 The *Australian Synchrotron Research Program* operates two overseas facilities. One is based at the Photon Factory in the High Energy Accelerator Research Organisation (KEK) in Japan. The other is located at the Advanced Photon Source at the Argonne National Laboratory in the USA. These two facilities provide Australian researchers with access to synchrotron radiation for use in biotechnology, advanced materials, mineral processing, nanotechnology, and ICT research.

4.4 The benefits obtained by Australia from this international science and technology collaboration arise from the simple fact that their cost is often so high that international collaboration is the only feasible means for the research community to access such facilities. Even the United States recognises this cost-constraint means that international collaboration is essential.[15] As a result of this 'international trade' in collaborative facility use each nation is able to access a far wider range of research facilities than would be the case if each nation attempted to go it alone. Given the large differences in national science and innovation budgets, and particularly research infrastructure budgets, this means that a small economy such as Australia is able to gain access to incredibly expensive research facilities such as the Hubble Space Telescope by virtue of the international standing of our researchers. The cash cost to Australia are much less than the full cost time to the facility host of providing the observation time. In short, the benefits obtained by Australia are that the scale, scope and speed with which research takes place is far higher than would be the case if this international access were more restricted.

4.5 This international engagement is not just a matter of obtaining adequate access to overseas research facilities. Australia should not simply plan to be a travelling partner in these international collaborations. Our capacity for global engagement in science and innovation would be enhanced if we were better positioned to host a small number of major international facilities. These assets, and the enhanced international engagement that they represent, can be used when negotiating access to overseas facilities and in other aspects of international affairs (Matthews, 2002).

[15] The response to this reality in the US has been to start to develop a whole-of-government strategy towards international collaboration. The first comprehensive profile of the nature and scope of U.S. government spending on international cooperation in R&D was produced by the RAND Science & Technology Policy Institute in 1997 (Wagner, 1997) and was updated in 2000 (Wagner et al 2000).

5 Current developments

Australia's Major National Research Facilities

5.1 The most notable feature of the ways in which the 15 MNRFs that were funded in the 2001 bidding round are organising themselves is the strong emphasis placed upon providing state-of-the art research facilities for general use by the Australian research and industrial communities. The choices of organisational and operational structures, user fees and strategies for marketing the facilities are based upon the premise that they exist to enhance Australia's overall science and innovation capabilities rather than the capabilities of the specific partnership operating the facility.

5.2 The long-term sustainability of these MNRFs is viewed by facility Directors as resting upon their ability to generate a strong user-base that is able and willing to pay for the services offered by the MNRF. The MNRFs are acting to support this strategy of active engagement with their potential user-base by coordinating their marketing and facility development activities and by seeking to raise the profile of MNRFs in Australia's science and innovation system.

5.3 In line with this perspective, many of the MNRFs are in the process of developing asset management strategies designed to maximise the efficiency with which their non-financial assets are utilised. For incorporated MNRFs this can involve capitalising research equipment on the balance sheet rather than treating the investment as a research expense. It can also involve attempts to value these non-financial assets on the basis of the increased output of research papers per dollar of asset value that the higher levels of capacity utilisation and superior technical capability of the MNRF generates when compared with more 'fragmented' investments in research infrastructure.

5.4 As Hoj, Oemcke and Wall (2003) point out, a far greater level of overall investment is required to generate high-quality research papers and other outputs from the 'fragmented' system of infrastructure provision associated with support for discrete research projects than with coordinated national provision. This is simply by virtue of the different levels of capacity utilisation obtained.[16] An MNRF investment allows economies of scale, scope and speed in research to be generated and it therefore makes sense to attempt to capture the value of these benefits on the balance sheet (Hoj, Oemcke, Wall op cit). In this respect the MNRFs lie near

[16] Non-centralised research equipment acquired for particular research projects by individual departments or research teams that is characteristically not used at a high rate of capacity utilisation and which can become obsolete relatively quickly because funding is not readily available to cover its economic depreciation (and hence allow it to be upgraded).

the cutting-edge of innovation in the management of research assets in Australia. The benefits that arise from a more formalised approach to managing non-financial assets and measuring the efficiency with which they are used may be an important advantage from forming incorporated joint ventures as a vehicle for cooperative research and infrastructure provision.

5.5 Since the announcement of the results of the 2001 bidding round the Australian Academy of Science has organised two workshops for MNRF Directors aimed at promoting the MNRF program as a whole. These workshops have resulted in several initiatives designed to strengthen the MNRF's capacity to support Australian science and innovation in general. These include:

- Exploiting the potential to link the services offered by the *Australian Proteome Analysis Facility*, the *National Centre for Advanced Cell Engineering*, the *National Neurosciences Facility*, and the *Australian Genome Research Facility* into an integrated set of services. This integrated set of MNRF services will allow users to move through the various stages in bio-medical and biological research, from being alerted to the existence of a potentially interesting genetic models in the mouse library through to understanding how these genes operate and the wider consequences. The active support for this integrated set of services by the 'bio-MNRF cluster' promises to create a 'whole' that is more valuable that the sum of the parts.
- Many of the MNRFs face challenges in handling large and very complex datasets (from data on mouse models through to astronomical data), achieving high-bandwidth communication and the remote use of facilities. Given the potential to pool ideas and resources in this area the MNRFs have decided to launch an 'e-science' working group in order to take the lead in developing these synergies. Given that there is currently no e-science initiative operating in Australia the MNRFs aim to extend the scope of their efforts to foster these synergies and cooperative activities to include other research teams. This effort by the new MNRFs would complement related initiatives being taken in the science base.[17]
- The MNRFs are also acting to share knowledge on growing and educating their user bases via such mechanisms are short courses on how best to use each MNRF. Additional cooperation is starting to take place over intellectual property management strategies, business strategies and different means of achieving financial sustainability.
- Finally, efforts are underway to establish a web portal as a gateway to information on all MNRFs and to establish an MNRF Association.

[17] For example, efforts to build-up grid computing capabilities in Australia.

5.6 The new MNRFs are therefore taking significant steps to build cohesion between themselves and to exploit the potential for sharing resources and ideas. The wider ramifications of these MNRF-led initiatives, in for example extending technical cooperation in the *e-science* and IP management area to encompass relevant Cooperative Research Centres (CRCs), may turn out to be important 'focusing devices' for cooperation in the overall science and innovation system.

5.7 The MNRFs also identify a major impediment to providing a national service for the research and industrial communities. This impediment is created by the difficulties faced by their potential client base in obtaining funding to use the MNRFs. There is a mismatch between the MNRF's business model of providing a state-of-the-art service for the Australian (and international) scientific communities and the capacity of potential users to obtain funding in research grant applications to use the services offered by the MNRFs. This impediment relates mainly to ARC and NHMRC grants in which requests for such funding may not be provided as part of the final grant award. The preferred solution advocated by the MNRF Directors is to introduce an MNRF use line item in ARC and NHMRC grant applications. This MNRF use line-item would ideally be re-enforced by guidelines that require a statement as to why the proposed research does not intend to use an MNRF if that MNRF is the most suitable method of carrying out that part of the research.

5.8 The current funding system is viewed by the MNRFs as being unaligned with the over-arching principle for funding major national research facilities: namely the provision of core multi-user research facilities for wide-spread use by the research and innovation community. The MNRFs point out that it is often easier to obtain funding to purchase a cheaper, less effective set of research instruments and equipment than it is to obtain funding to use a state-of-the-art MNRF. Such piece-meal development of the stock of research facilities and equipment means that instruments may be used relatively infrequently by the research team that owns them. In addition to providing a high level of asset utilisation, an MNRF also provides technical staff with a high level of expertise in how best to use and improve the facility and the major advantages of greater scale, scope and speed of research facility capability.

6 Recommended changes to the system of major national research facility funding

6.1 There is a growing recognition of the strategic importance of public sector investment in research infrastructure in the advanced industrial economies. Many countries have already, or are planning to, put in place mechanisms for increasing investment. Whilst there are distinctive differences in how these countries approach the issue some common themes can be observed. These are:

- a trend to increase real investment levels in the public sector, sometimes (as in the US) associated with concerns that the waiting list for major research infrastructure investments has been growing and that this 'pipeline' of unmet funding requirements needs to be reduced;
- a move to set priorities for key national infrastructure requirements, particularly on the 'e-science' area;
- an emphasis upon collaboration and partnership-building both domestically and internationally;
- wide-spread concerns that existing arrangements for dealing with operating and maintenance costs are not ideal and that it is proving difficult to define a way forward in this area.

6.2 The key differences lie in how major research facility use is funded.[18] Broadly speaking, in the fully-funded model, the facility calculates the cost of using a facility for experiments, multiplies this by the estimated time per year spent running experiments and arrives at the estimated quantum required to support this experimentation. This quantum is then paid to the facility by the government department that funds it as part of the overall budget. The facility allocates experimental time on the basis of scientific merit (usually via peer review), in so doing allocating this quantum (in effect) to the various research teams that win time on the facility. The alternative grant-based model involves researchers quoting for the costs of major research facility use as part of their research grant applications. Competitive, peer-reviewed processes for awarding these research grants then consider the merits of the proposal (including the capabilities of the facilities to be used) and awards the use fee by this route. The problem faced by researchers in Australia is that the current process falls between the fully-funded and the grant-based systems. There is no guarantee that a research grant award will actually fund major facility use within Australia, yet user fees do need to be paid because

[18] This paragraph draws upon material provided by Simon Ringer, Director of the *Nanostructural Analysis Network* MNRF.

major research facilities are not fully funded. The main exception to this in Australia is astronomy, which for historical reasons adopts the fully-funded approach.

6.3 Save for the difference in how facility use is funded, the policy challenges for Australia are in line with this international pattern. However, Australian policy-makers have less information than some of their counter-parts on the list of unmet infrastructure investment requirements and on the overall state of the nation's public sector research infrastructure. For example, policy-makers in the US have access to data on both the projects waiting in the pipeline and the current state of the nation's infrastructure. Policy makers in the UK have access to a comprehensive assessment of the state of the physical infrastructure in UK universities (J M Consulting, 2001). The recently announced *National Strategy on Research Infrastructure* may provide an opportunity to provide some of this missing information. This study by the Academy will contribute to the development of this strategy.

Major National Research Facilities

6.4 The nation's stock of research facilities and equipment (our tangible research assets) together with the intangible assets associated with the technical skills required in order to use these facilities effectively is a key national asset. At present, the policy-framework that dictates how resources are allocated to the maintenance and upgrade of Australia's critical research assets does not take a long-term strategic view. The funding process is dominated by a focus upon annual flows of public investment and pays little regard to the stocks of research assets created by these annual flows of investment. In accounting terms the dominant emphasis is upon the financial flows rather than upon the health of the 'balance sheet'.

6.5 As the Expert Group tasked with examining 'funding, expenditure and infrastructure' as part of the current study aimed at mapping Australia's science and innovation system suggested, a balance sheet perspective could involve detailing the assets that Australia has, the risks to the value of these assets and the options that we have to add to and improve these assets.[19] Un-funded or partially funded bids that are still actively seeking funding can be thought of as options to add to Australia's stock of research assets. In this sense, Australia has a portfolio of 15 MNRF assets and options to invest in at least another 44 MNRF assets. This study demonstrates that a substantial investment has already gone into generating these options and in maintaining their currency.

[19] Provisor Pty Ltd (one of the new MNRFs) been developing a balance sheet-based approach to managing the efficiency of its non-financial assets, see Hoj, Oemcke and Wall (2003.)

6.6 Given the clear synergies that are emerging (and now being exploited) between the 15 MNRFS that have recently been funded, and the need to co-ordinate future government investment in a more strategic manner, it makes considerable sense to treat the MNRF program as an investment portfolio. These are not discrete investments with no relationship to each other. These are inter-dependent investments in which strong benefits are also to be gained from a forward-looking investment planning process. This forward-looking planning process needs to balance the different levels of funding required against the years in which this funding will need to be provided. As with all portfolios, scope exists to sequence the different investments provided that a strategic planning process exists to relate requirements to available funding. At present there is no such strategic planning process in Australia and there is no portfolio-based funding mechanism.

6.7 The core of the Academy's recommendations is that a strategic, internationally-focused investment portfolio based funding mechanism should be established. The recent announcement of the development of a *National Strategy on Research Infrastructure* indicates that there may now be a degree of receptiveness to such a notion.

6.8 In the Academy's view there is a role for two types of funding arrangement for major research facilities. In situations in which it is attractive and feasible to attract international funding partners then a facility should be fully funded by these partners with access granted free of charge to users based upon scientific merit. A standard Protocol could be drawn up to cover these international partnership-funding arrangements. This Protocol should be based upon a contractual relationship between the percentage of full costs contributed by a donor and the percentage of facility capacity used by that donor. There are existing international models for this type of Protocol, such as that used by the *European Synchrotron Radiation Facility*. Relevant state/territory governments and the federal government could unite to provide the Australian funding contribution within such a Protocol.

6.9 The development of large fully-funded major research facilities in Australia based upon international partnerships would give Australia an enhanced capacity to create and exploit the reciprocal benefits from involvement in such international partnerships. These partnerships could provide substantial leverage of both federal and state/territory funding with consequent scientific, economic, environmental and social benefits for Australia. However, the model of fully funded major facilities based upon international partnerships is not appropriate to all types of major research facility. In many cases the current MNRF funding model is both attractive and feasible provided that MNRF use is funded adequately via a line item in ARC and NHMRC research grants.

6.10 Consequently, the most robust method of funding major research facilities in Australia, both under the MNRF Program and the larger-scale facilities that require direct Cabinet approval, is to adopt a dual approach. This provides the option to develop fully-funded facilities in which the public sector user does not pay based upon international consortia. The dualistic approach also provides the option to continue to develop smaller scale facilities in which public sector users do pay. An MNRF and other major facility use line item in research grants will guarantee that facility users have the means to fund the use of these national research assets. This in turn will avoid the diseconomies associated with a fragmented research infrastructure.

6.11 Although the Academy's preference would be for fully-funded major research facilities in all situations the Academy also recognises that this is not a preferred option from the federal government's perspective. The strength of the Academy's dualistic approach is that it is pragmatic. It would allow a non ad-hoc MNRF Program to move ahead quickly using a line-item in research grants to ensure that MNRFs are used effectively. It would also create the option to develop fully-funded, larger scale, facilities based around international partnerships. This option would be particularly useful in relation to proposed facilities that exploit unique or rare locational advantages possessed by Australia but that require substantial international funding.

6.12 The Academy therefore recommends that:

Recommendation 1. The ad-hoc nature of MNRF funding should cease. The Federal Government should, as a matter of priority, announce that there will be future bidding rounds.

6.13 This would remove the high-level of uncertainty faced by researchers over funding for MNRFs which would in turn stimulate the careful preparation and updating of proposals for MNRF funding rather than the rushes to develop proposals caused by the current ad hoc arrangements. It would also facilitate more substantial cash funding contributions from state/territory governments and from international donors.

Recommendation 2. The federal government should take the lead in drawing up a Protocol for partnership-funding designed to create fully-funded major research facilities in which access for public interest research is granted free of charge to users. This Protocol should be based upon a contractual relationship between the percentage of full costs contributed by a donor and the percentage of facility capacity used by that donor. Models of such a Protocol for multi-national facilities already exist overseas. These arrangements allow for periodic adjustments to donor contributions based upon actual levels of facility use. This Protocol could be used to facilitate stronger

involvement of international funding sources in contributing to Australian facilities, thereby providing substantial leverage of federal and any state/territory funding.

6.14 A Protocol for funding multipartite facilities would provide both international donors and state/territory governments with the opportunity to commit substantial funds to MNRFs and other major research facilities.

Recommendation 3. The federal government should establish a new line-item for MNRF and other major facility use in ARC and NHMRC research grants applications. This line-item would be designed to divert resources away from duplicating infrastructure with low levels of capacity utilisation via uncoordinated purchases. It would direct more funding to facilities managed in order to maximise the benefits to the research community as a whole. At present, it is often easier to obtain funding to purchase a cheaper, less effective set of research instruments and equipment than it is to obtain funding to use a state-of-the-art MNRF.

6.15 The purpose of this line item is to provide ready access to funding for exploiting existing research facilities and equipment rather than encouraging the acquisition of technically inferior equipment that is likely to be used less intensively and less effectively in comparison with the services offered by an MNRF. Additional funding for this line item in project grants should be provided to the ARC and the NHMRC as part of the next phase of *Backing Australia's Ability*. This could be one outcome of a process of shifting Research Infrastructure Block Grant (RIBG) funding to the ARC and NHMRC should this option be taken up in the forthcoming review of the *Knowledge and Innovation* funding reforms. The creation of this new channel of funding would allow existing MNRFs to generate stronger client and user-fee revenue bases. This, in turn, will allow the MNRFs to increase their reliance upon user fee-based revenue as a means of attaining long-term financial sustainability. The fact that this funding is allocated by merit-based criteria as an integral part of the research grant selection process will ensure that the MNRFs support research excellence.

Recommendation 4. Federal government - state/territory government partnerships should be developed with the aim of delivering an agreed level of state/territory government matching of federal funds for major research facilities. This combined national funding contribution would comprise the Australian element any multinational major research facility established using the Protocol for multipartite research facilities. These partnerships would be most easily achieved by providing the opportunity and the lead-time for state/territory governments to commit to making substantial cash contributions to MNRF and other major research facility bids as part of their own infrastructure funding programs.

6.16 The states and territories are developing funding schemes designed to leverage federal R&D funding. When state/territory government programs are created with the explicit objective of funding research infrastructure (as in the case of Victoria) the result can be significant injections of funding to fill unmet requirements. Dedicated programs of this type provide the potential to leverage federal funding to a far greater extent than at present.

6.17 The mechanisms used to leverage state/territory funding against federal funding must take into account Australia's 'loosely federal' system of government in which the states/territories tend to compete with each other over the location of large research facilities and over attracting associated foreign direct investment.[20] Given the difficulties in co-ordinating MNRF and other large research facility investments between the federal and state/territory levels of government the most attractive leverage mechanism would be for state/territory governments to be provided with an opportunity to back MNRF bids with substantial cash contributions as part of their own infrastructure provision strategies.

6.18 Substantial state/territory government cash contributions would provide a means of significantly reducing, or in some cases eliminating, the necessity to secure matching funding from non-government sources. At present, the need to obtain 50 percent of funding from non-federal sources poses risks to the economic sustainability of MNRFs if business plans for revenue generation cannot be met in practice. This is a risky approach because it may pose a threat to the sustainability of scientific activity in the areas that require MNRFs. The move towards coherent and sustained MNRF funding would allow the long-term planning process in developing MNRF bids to provide the necessary lead time and the opportunity for state/territory governments to consider making substantial cash contributions to MNRF bids. The current ad hoc and non-strategic nature of the MNRF bidding process limits the scope for obtaining substantial state/territory government cash contributions. Substantial cash contributions from the states and territories would increase the viability of these bids from the federal government's perspective – thus increasing the chance that the bid will be funded and will be located in that state or territory.

6.19 The limitations of this approach to leveraging federal funds using state/territory funds are that: (a) the territories, and the ACT in particular will be at a disadvantage given their low levels of GST and other tax revenue, and; (b) this approach may tend to favour single site facilities over multi-site or networked facilities covering more than one state or territory. It would therefore be useful if the federal government gave special consideration to the

[20] Although moves to increase inter-state cooperation are welcome, such as the announcement on 13th June 2003 of an alliance between New South Wales, Queensland and Victoria in order to coordinate the development of a sustainable biotechnology industry, inter-state competition is a structural feature in Australia (as is regional competition within any country when it comes to investment attraction).

constraints faced by bids from the ACT and the Northern Territory in relation to the availability of territory government funding. As regards multi-site and network MNRF proposals, the scope does exist for the proponents to persuade two or more state/territory governments to make substantial cash contributions. The onus is on the proponents to make a clear case for the benefits to the states/territories likely to arise from their funding of a multi-site or networked facility.

6.20 The main challenge would be to find a means of coordinating the federal and state/territory bidding processes. This coordination would need to allow a state/territory commitment to make a substantial cash contribution to an MNRF bid to be accommodated within their own infrastructure funding mechanisms whilst waiting for a final decision over MNRF program funding at the federal level. Whilst this is a substantial challenge, the fact that there is not necessarily a need to coordinate research infrastructure strategies and priorities between the two tiers of government in the context of strong inter-state competition increases the viability of this approach to leveraging federal MNRF funding.

Recommendation 5. An MNRF investment fund should be established. The Federal Government should commit to making annual injections into this investment fund in the region of $40m per annum via an MNRF line item in the Federal Budget. The disbursement of funding from this investment fund should be made according to long-term strategic requirements with flexibility over the levels and timing of these disbursements. Flexibility should also exist over the level of annual Federal support to be provided.

6.21 If it is necessary to accumulate funds in order to make larger funding disbursements in future years then the build-up of funding should be viewed as advantageous rather than as a failure to perform adequately. As such, this investment fund would, in line with the approach adopted overseas (such as in the Canada Foundation for Innovation), be operated at arms length from government in the sense that once handed over funding cannot be recovered.[21] A base-line annual commitment of $40m per annum in real terms is small, however it would have a tremendous impact upon Australia's capacity to build and maintain an effective stock of MNRFs.

Recommendation 6. A more strategic internationally-oriented MNRF selection process should be instituted at three-yearly intervals. The first stage should consist of an Expression of Interest (EoI). Potential partnerships could be identified and some bids amalgamated. Bids would then be selected on the basis of scientific and technological merit and successful EoI's would be invited to submit fully developed proposals. An

[21] The *Federation of Australian Scientific and Technological Societies* (FASTS), as part of its 2002 policy statement, also advocates that a rolling fund for financing MNRFs should be established.

additional selection round would then select those proposals that should *in principle* be funded and these bids would enter a waiting list. Decisions would then take place over which bid should be funded in which year. The decision on the actual release of funding would constitute the final stage of the selection process.

6.22 This approach would allow the timing of investments to be balanced against the funds required, providing the necessary flexibility to plan-ahead in a strategic manner. Where necessary small grants should be awarded by the MNRF investment fund in order to allow these bids to be kept up to update. This strategic investment process would provide bidders with a clear timetable over how their new or upgraded facility will be funded. This investment planning process would facilitate the process of leveraging the MNRF funding with state/territory funding sources.

Recommendation 7. The entire process from soliciting EoI's through to final funding awards should, where this is relevant, be conducted via substantial consultation with potential international donors.

Recommendation 8. An annual report on the MNRFs funded each year and the MNRFs waiting to be funded should be provided by the Office of the Chief Scientist.

Recommendation 9. Should the previous recommendations be adopted then special consideration should be given to re-negotiating the contracts for the 15 new MNRFs in order to align them with the new funding system should they wish to take-up this option. This would involve exploiting any opportunities for greater international and state/territory funding in the move to a fully-funded model, in so doing reducing the MNRFs reliance upon external revenue for their financial viability.

Recommendation 10. The Office of the Chief Scientist should be provided with appropriate support to permit it to co-ordinate long-term strategic planning for both future MNRF requirements and larger scale facilities that require direct Cabinet approval. Should an MNRF investment fund be created via a line item in the Federal Budget as part of the next phase of *Backing Australia's Ability* then funding for this co-ordination role could be provided from the MNRF investment fund/line item in the form of an administration charge. This co-ordination by the Office of the Chief Scientist would be necessary to ensure that sufficient international liaison with overseas governments, agencies and international organisations takes place as part of the MNRF and other major facility selection processes. It would also be necessary to improve liaison with Department of Foreign Affairs and Trade. This applies to situations in which access to major research facilities, and any associated science, technology and intellectual property access and transfer issues are addressed in trade negotiations and in multi-lateral and bi-lateral discussions between governments.

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Appendix A: Terms of Reference

1. Describe existing programs that support research infrastructure for Australian science, in particular:
    - The major National Research Facilities (MNRF) program;
    - Systemic Infrastructure Initiative (SII);
    - ARC's Linkage Infrastructure Equipment & Facilities (LIEF) program;
    - CSIRO, AIMS, ANSTO, Geoscience Australian etc;
    - Institute of Advanced Studies; and
    - State Government initiatives.

2. Examine applications to last year's MNRF program to identify areas of particular need that remain in Australia's research infrastructure.

3. How does Australia benefit from international science and technology collaboration through membership of international projects, such as the Ocean Drilling Program, the Photon Factory, Gemini, International Spillation Fusion Agreement and the International EPSI agreement; and
    - access to major facilities overseas.

4. Recommend changes to Australia's research infrastructure programs that would advantage the development and maintenance of Australia's research infrastructure; and
    i take account of the findings of this study,
    ii take account of examples of good practice from overseas,
    iii give consideration to recent developments in Commonwealth/State relations in Australia.

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