

2016 National Research Infrastructure Roadmap

Capability Issues Paper

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Questions

- Question 1: Are there other capability areas that should be considered?
- Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure.
- Question 3: Should national research infrastructure investment assist with access to international facilities?
- Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?
- Question 5: Should research workforce skills be considered a research infrastructure issue?
- Question 6: How can national research infrastructure assist in training and skills development?**

Launched in May 2016 MATRIX (www.matrix-inst.org.au) is Australia's first international research institute for the mathematical sciences. MATRIX is focussed on extending high quality mathematics training by providing intensive **residential** research programs, and encouraging collaborations between groups of mathematicians leading to transformative ideas and discoveries. These informal collaborations, in the past, have led and contributed to important industrial applications such as the Internet, WI-FI, GPS and online-banking.

MATRIX is start up national research infrastructure for the benefit of, and endorsed by, the national research community in the mathematical sciences. While established through a joint partnership between the University of Melbourne and Monash University, with seed funding from the ARC Centre of Excellence for Mathematical and Statistical Frontiers (ACEMS), it needs sustained government funding to be scaled up to deliver on its potential as a national facility.

MATRIX provides intensive residential mathematical programs at the MATRIX House, a residential location in Creswick, Victoria.

Mathematics and statistics are inherently international disciplines, and international exposure of students and early career researchers is essential to prepare them for the global market in the growth demand area of science and technology. Through many international examples it is proven that a reputable Australian residential

research institute in the mathematical sciences is a very attractive proposition for leading overseas researchers to spend significant time in Australia. Such longer term visits during interactive research programs are essential for early career researchers to build new international collaborations and through face-to-face interactions quickly get to the forefront of international research leading to the identification and development of new areas within mathematical sciences.

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

Question 11: When should capabilities be expected to address standard and accreditation requirements?

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

Almost every OECD country has one or more research institutes in the mathematical sciences. Well known examples include the

- [Mathematical Sciences Research Institute](#) (MSRI) in Berkeley
- [The Simons Center for Geometry and Physics](#) in Stony Brook
- [The Banff International Research Station](#) in Canada
- ["Oberwolfach" and the Hausdorff Institute](#) in Germany
- [L'Institut Henri Poincare](#) in France
- [Mittag-Leffler](#) in Sweden
- [The Lorentz Center](#) in Leiden
- ["Bedlewo"](#) in Poland
- [The National Institute of Pure and Applied Mathematics](#) (IMPA) in Brazil
- [The Isaac Newton Institute for Mathematical Sciences](#) in Cambridge

It is MATRIX's vision to ensure that intensive residential research programs enhance Australia's international reputation as a leader in mathematical sciences, contribute to national and state science and innovation policies and provide the opportunity to explore collaborations with industry.

With time and upgraded facilities, longer programs can be offered by MATRIX which will contain embedded short conferences or lecturer series with the aim of enticing key academic and industry leaders in the mathematical sciences field as keynote speakers. This will also aid in the promotion of the mathematical sciences through the development of continuing to establish an 'inspiring women in mathematics network'.

Question 13: In considering whole of life investment including decommissioning or defunding for national research infrastructure are there examples domestic or international that should be examined?

Question 14: Are there alternative financing options, including international models that the Government could consider to support investment in national research infrastructure?

MATRIX believes Government should explore philanthropy as well as partnerships with industry and universities to jointly fund a venue and operational budget for a residential research institute in the mathematical sciences. Such funding models occur in the US and would be supported by the Australian mathematical sciences research community.

Health and Medical Sciences

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

Question 16: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 17: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Health and Medical Sciences capability area?

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

MATRIX believes that research in the mathematical sciences is a creative enterprise and real breakthroughs require new ways of thinking at highly abstract levels.

Intensive research programs lasting several weeks or months at **residential** research stations constitute one of the most successful pieces of infrastructure for fostering innovative and internationally competitive research in the mathematical sciences. As evidenced by well established overseas examples, such as those listed under Question 12, institutes offering dedicated collaborative and office spaces and are necessary infrastructure for transformative research in the mathematical sciences.

In recent years there has been an increased awareness in Australia of the importance of mathematical sciences to our economy. A previous report from the Chief Scientist identified that lag in mathematical research is detrimental to the country's prosperity, and Australian researchers must be internationally engaged and have strong international networks.

While major research and educational programs in mathematics and related disciplines have recently been funded, a gap for an internationally prominent residential mathematical research institute with sustained funding still remains.

In its 25th year of economic growthⁱ, Australia faces new challenges as the mining investment boom winds down. The Australian Government needs to look towards new and emerging areas of innovation across all sectors and fields to ensure we remain competitive in an economy that is increasingly lacking in momentum. New and long-term growth areas need to be developed and nurtured now to secure Australia's economic prosperity.

Australia needs to build its capability in the mathematical sciences arena. The continued evolution of the 'digital age' on the international stage, our students need to be made competent in analytical, statistical and computational skills and stay on top of international developments in this area. Produced by the Department of Employment, the *Employment Outlook to November 2020*ⁱⁱ report cites Scientific and Technical Services as the second largest area where employment is projected to increase by 151,200 (or 14.8 per cent) (to 2020).

For MATRIX to be internationally competitive research infrastructure, and build long term relationships with industry, a modern, dedicated building with sufficient capacity and increased operational funding needs to be guaranteed over a longer term. A dedicated incubator space will be made available within the building to support collaborations that will ideally lead to the start-up of potential new business ventures and/or with industry.

The long-term aim of MATRIX is to organise a variety of research programs, from one-week workshops to larger programs that could last several weeks. Emphasis will be placed on creating ample free time for research collaboration. Longer programs contain embedded short conferences or lecture series.

MATRIX has already run four successful programs: *Higher structures in geometry and physics*; *Locally disconnected groups*; *Approximation and optimisation* and *C*-algebraic invariants for dynamics*. An program on *Topological recursion and quantum invariants* will be held in December.

The benefits of MATRIX to STEM in Australia include:

- i. A vibrant, **dedicated** location for research and collaboration in the mathematical sciences;
- ii. Enhance Australia's international reputation as a leader in mathematical sciences worldwide;
- iii. The opportunity to engage more closely and regularly with top international researchers;
- iv. The opportunity to explore industry collaborations;
- v. Increase opportunities for women and students, especially from disadvantaged backgrounds.
- vi. A concrete contribution to the national and state science and innovation policies;
- vii. A magnet to attract outstanding young mathematicians with Australian ties for extended periods;

The MATRIX programs have already attracted participants from world-class institutes such as Nanchang Institute of Technology, Nanchang, Jiangxi Province (China); Massachusetts Institute of Technology (USA) and the École Polytechnique Fédérale de Lausanne (Switzerland).

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

It is important for Australia to liaise and collaborate with overseas residential mathematical research institutes such as listed under Question 12 to set coordinated research agendas. Such a network already exists in Europe and MATRIX believes this is an emerging trend in the mathematical sciences as they are inherently international.

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Understanding Cultures and Communities

Question 24: Are the identified emerging directions and research infrastructure capabilities for Understanding Cultures and Communities right? Are there any missing or additional needed?

Question 25: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 26: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Understanding Cultures and Communities capability area?

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

Question 28: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 29: Is there anything else that needs to be included or considered in the 2016 Roadmap for the National Security capability area?

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

Question 31: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 32: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Underpinning Research Infrastructure capability area?

Data for Research and Discoverability

Question 33: Are the identified emerging directions and research infrastructure capabilities for Data for Research and Discoverability right? Are there any missing or additional needed?

Question 34: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 35: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Data for Research and Discoverability capability area?

Other comments

If you believe that there are issues not addressed in this Issues Paper or the associated questions, please provide your comments under this heading noting the overall 20 page limit of submissions.

We would like to see a research active mathematician included in the Expert Working Group and in the group of Capability Experts.

ⁱ Commonwealth of Australia, National Innovation and Science Agenda Report (2016), viewed 7th September 2016. <http://www.innovation.gov.au/page/national-innovation-and-science-agenda-report>

ⁱⁱ Labour Market Research and Analysis Branch (2016, pg 4), *Employment Outlook to November 2020*, The Department of Employment.