

**Electron Microscope Unit**  
**Professor Simon Ringer**  
7th August 2009

**AMMRF Response to**  
**National Enabling Technology Strategy (NETS) Discussion Paper**  
***The Benefits of Online Collaborative Tools in Advanced Microscopy for NETS***

The Australian Microscopy and Microanalysis Research Facility (AMMRF) is Australia's peak facility for the characterisation of materials and biological systems from the macroscale to the nanoscale through state-of-the-art microscopes and advanced microanalysis platforms. Much of the core science that underpins enabling technologies such as nanotechnology and biotechnology in Australia has been, and continues to be, discovered and developed through the tools provided by the AMMRF. As products and processes from these technologies are adopted, the AMMRF will remain an important and integral part of the development and commercialisation of these technologies, through support of R&D activities and through support of nanometrology.

Bearing in mind the importance of advanced microscopy and microanalysis to enabling technologies, this document provides brief responses to the questions raised in the NETS Discussion Paper.

***Question 1: What are the key issues and challenges that need to be addressed by the National Enabling Technologies Strategy?***

Many of the issues and challenges have been highlighted, or touched on, in the NETS Discussion Paper. However, the overarching challenge, if we are to capture the benefits that will arise from enabling technologies, is to optimise the legislative and commercial environments to encourage and expedite technology transfer of enabling technology developments into consumer products, diagnostic tools, industrial processes and so on in a safe manner, but with the minimum of red tape. This, in turn, will require meeting the challenges of: continuing to lay the scientific groundwork for enabling technologies, by appropriately resourcing relevant research and making sure that pivotal research infrastructure, such as advanced microscopy, is provided and is openly accessible; increasing the engagement between researchers in enabling technologies and industries that would benefit from such technologies; providing better government support, directly or indirectly, to the process of capturing, protecting and further developing promising types of enabling technologies; providing emerging industries with access to appropriate expertise and facilities, such as in nanometrology, to meet future legislative requirements that will be unique to, for example, nanoparticle-containing products; and ensuring that members of the public better understand the benefits and the risks of enabling technologies, so that they can make informed product selection as consumers and have a sound grasp of relevant government policies as voters.

Advanced microscopy and microanalysis has important contributions to make in helping to meet these challenges. For example, it is key tool for research in enabling technologies; it will be an increasingly critical part of the nanometrology arsenal for future industries; it provides a training ground for future workers in emerging, knowledge-intensive industries; and it is an educational resource for higher education students and school students, thereby contributing to better public understanding of enabling technologies (see below).

***Question 2: How should these issues and challenges be addressed? What is your organisation doing to address those issues and challenges?***

These are complex issues that will benefit from multipronged approaches and willingness to try new ideas. Nevertheless, the AMMRF is already making contributions towards these challenges. In support of research in enabling technologies such as nanotechnology and biotechnology, for example, the nodes of the AMMRF are continually growing the scale and diversity of capabilities they offer. Moreover, the AMMRF nodes are establishing in-house research programs around these capabilities to provide world-leading capabilities, both in instruments and expertise, to Australian scientists and engineers.

This growth in capabilities, along with the rapid expansion of enabling technologies at the laboratory bench as well as increasingly at the industrial level, is resulting in greater demand for instrument training and use, which is stretching the AMMRF's available human resources. In order to continue to meet these demands and maintain the quality of the user experience, the AMMRF is working to develop a variety of online tools, which are beginning to have positive outcomes for enabling technologies and, with appropriate resourcing and partnerships (see Question 4), could be made to have far wider benefits. The online tools under development include:

- Online training in techniques and instrument operation for AMMRF users and for higher degree students.
- Outreach to and engagement with schools and the general public about microscopy and enabling technologies.
- Telemicroscopy, which allows remote operation instruments and long-distance
- collaboration in support of research.

These tools also compliment other national initiatives in eResearch, such as in collaborative research environments, data sharing and storage, publication management, and libraries.

As for the challenge of nanometrology, the AMMRF has developed a collaborative relationship with the National Measurement Institute (NMI). Through this, we have already provided training in advanced microscopy to NMI staff members, who are now accessing the facility regularly for their nanometrology-related projects. The AMMRF and NMI have also initiated a joint project on calibration of different forms

of advanced microscopes, which is aimed towards eventually metrology of nanoparticles and other nanotechnologies.

***Question 3: What would you like to see as the main outcomes for the National Enabling Technologies Strategy?***

Clearly we would like to see outcomes that help address the kinds of challenges listed in response to Question 1. Specific examples would include:

- Accredited microscopy facilities for nanometrology (or at least moves towards them), made available to Australian industry. Whatever the mechanism, this naturally should be done in partnership with, or under the auspices of, NMI.
- Increasing amounts of local R&D in enabling technologies in order to locally commercialise more Australian science, especially in areas of national strength (or potential strength) or where our country has unique opportunities or challenges. Obvious examples are sustainable, drought-resistant, low-emissions agriculture, based on a variety of biotechnologies; and large-scale, cost-effective solar power, based on nanostructured photovoltaics.
- Greater public awareness of the benefits and risks of enabling technologies, leading to greater public interest in science and technology, and greater appreciation of the role of modern science in everyday life and the underpinning role played by microscopy.
- More students moving into education, training and careers in nanotechnology, biotechnology and allied industries.
- Far greater engagement, understanding and mutual respect among scientists, politicians, bureaucrats and industry leaders.
- Development of an appropriate legislative environment to support and manage enabling technologies.
- Governments, from local to federal levels, making sound policy decisions on issues related to enabling technologies, decisions made on the basis of our best current scientific understanding, rather than uninformed scare mongering ('grey goo' scenarios), commercial interests or pressure from lobby groups.

***Question 4: How do you think your organisation could work with the Enabling Technologies Policy and Public Awareness Sections and others to address those issues and challenges?***

The most obvious example would be further development and expansion of the kinds of online collaborative tools mentioned above, which could be achieved through an appropriately resourced partnership between AMMRF and the Enabling Technologies Public Awareness Section.

To illustrate the point, let's consider the modules that the AMMRF has begun to develop for online training of researchers, students and facility users. These systems include the creating virtual microscopes of different kinds as well as online instruction materials, and learning and assessment tools. These will have a variety of

benefits. The AMMRF will be able to fast-track the training of new users, enabling fundamental principles and theory to be taught and understood in an applied way prior to hand-on training on instruments. The concept of virtual microscopes will also allow students to explore the full range of controls on the microscopes in an intuitive way to achieve better understanding, but with no risk of damaging multi-million-dollar research instruments.

Moreover, tutorial and assessment activities can be offered continuously throughout the year rather than at specific times and dates, providing flexible training and learning solutions and allowing a larger market to access courses. Another appeal of this approach is that it offers a contemporary learning paradigm that appeals to the technologically savvy generations of current and forthcoming students, undergraduates and postgraduates alike.

These online tools will have flow on effects for enabling technologies. For example, the engaging and attractive nature of these online tools, along with the potential to train students and researchers in larger volumes, will help increase the cohort of researchers and technologists to meet the growing demand that is emerging from industries underpinned by enabling technologies.

Beyond these immediate impacts, however, the AMMRF could partner with the Public Awareness Section to develop and tailor these kinds of online tools a far wider audience. The result could be a core stream of school resources, pro-active media and general interest information to engage teachers, young students and the general public. These could be used to educate widely about enabling technologies and to raise social acceptance, through hands on demonstrations of the science as 'seen' via AMMRF microscopes—the 'eyes' of biotechnology and nanotechnology. A specific example is allowing students to remain in their classroom and yet see different types of nanoparticles and understand how and where they are used. Virtual microscopes and related concepts seem particularly promising in this respect. Alternatively, dedicated web-accessible microscopes (i.e., telemicroscopy) could be made available for educational purposes, allowing even more dynamic outreach experiences in the classroom, as per the 'web-SEM' model at the University of Oxford. Another part of the development work could entail developing these various online education resources to align with school curricula, so that these various resources can fit, in a modular way, directly into day-to-day teaching.

In conclusion, I hope these responses will make a useful contribution to your deliberations about how best to implement the National Enabling Technologies Strategy. Do not hesitate to contact me if you require further information about any of these ideas.

Yours sincerely,

Professor Simon Ringer Executive Director & CEO, AMMRF