17 August 2009

PROFESSOR LES FIELD

DEPUTY VICE-CHANCELLOR
(RESEARCH)

National Enabling Technologies Strategy – Submission
Secretariat to the Expert Panel
Enabling Technologies Policy Section
Pharmaceuticals, Health Industries and Enabling Technologies Branch
Department of Innovation, Industry, Science and Research
GPO Box 9839
CANBERRA ACT 2601

Email to: enablingtechnologies@innovation.gov.au

Dear Expert Panel,

UNSW SUBMISSION RE: THE NATIONAL ENABLING TECHNOLOGIES STRATEGY

1. DECLARATION OF INTERESTS

This submission is being made on behalf of The University of New South Wales (UNSW). UNSW is a member of the ***Group of Eight***[1] research intensive Universities, and a member of ***Universitas21***,[2] an international network of research intensive Universities. In 2007, UNSW received research funding of approximately $250M, from a range of sources including the ARC and NHMRC, and is a world leader in the areas of Biomedical Sciences, Water, Environment & Sustainability, Next Generation Materials & Technologies, Social Policy, Government & Health Policy, ICT, Informatics & Robotics, Business, Law & Economics. UNSW is also a core or supporting participant in 13 Cooperative Research Centres, and 8 National Centres of Excellence, 8 ARC Centres of Excellence, and more than 60 UNSW Research Centres representing areas of research critical mass.[3]

2. INTRODUCTION AND BACKGROUND

The University of New South Wales welcomes the opportunity to make a submission as part of the National Enabling Technologies Strategy consultation process. This is a response to the ***"National Enabling Technologies Strategy – Discussion Paper"*** and makes practical recommendations to address the discussion points from a University research perspective.

Our reading is that the National Enabling Technologies Strategy (NETS) effectively amalgamates and replaces the existing National Nanotechnology Strategy (NNS) and the National Biotechnology Strategy (NBS). Biotechnology and nanotechnology have been recognised as the most important new scientific frontiers worldwide. They have the potential to transform Australian industry and research, and to provide significant benefits for consumers. The scope involved in these "enabling technologies" is very extensive, including materials for energy storage, medical diagnostics and cellular imaging, bioengineering, drug and gene delivery, improved foods by molecular design, novel materials for electronics, improved techniques for particle processing, and molecular sieves for filtering/purifying water and gases.

UNSW notes that NETS is focussed on Biotechnology and on Nanotechnology but there are clearly other important enabling technologies. These include the fundamental enabling disciplines such as Physics, Mathematics, Chemistry, Computing and Information Technology all of which underpin Australia's technology-based industries as well as our drive to become a more scientifically/technologically literate nation. There is a strong argument to suggest that NETS should be one of a suite of strategic programs which support the essential "enabling sciences".

[1] See http://www.go8.edu.au/
[2] See http://www.universitas21.com/
[3] See http://www.gmo.unsw.edu.au/CentresSecretariat/ListOfUNSWCentres.html

UNSW also notes that NETS really does not address the issue of research infrastructure support. The NCRIS scheme has been valuable as a program that mapped and supported major research infrastructure needs across the nation but in particular in the enabling technologies. ***While Nanotechnology and Biotechnology were specifically identified as initiatives for infrastructure support under the "Super Science" scheme, we identify the absence of an ongoing NCRIS-type program to support major national research infrastructure as a gap in an area that underpins the fundamental and enabling technologies.***

UNSW supports the findings of the 2008 review of the National Innovation System which recommended that the Government facilitate favourable conditions for the development and use of new and emerging technologies by establishing appropriately funded enabling technology strategies that:

- adapt or build regulatory frameworks to support the responsible and safe use of innovative services and products;
- support the science and metrology required to underpin effective regulation and capitalise on opportunities;
- foster public awareness and community engagement; and
- collect data and develop metrics to support evidence based policy development, monitoring and evaluation.

3. UNSW CAPABILITIES AND NATIONAL RESEARCH INFRASTRUCTURE NETWORKS

As one of Australia's large research-intensive Universities, UNSW is strongly placed to make a significant contribution in the Nanotechnology and Biotechnology areas where we have strong programs in nanotechnology research and education and the ability to bring together multidisciplinary teams with expertise including nanomaterials design and synthesis, analysis and characterisation, metrology, toxicology and environmental science.

UNSW is involved in research in areas of diagnostics and therapeutics (medical applications) toxicology (human and environmental) and the design and specification of reference materials. UNSW adheres to national and international standards and is involved with policy bodies such as International Union of Pure and Applied Chemistry (IUPAC).

As a result, UNSW is well placed to provide leadership, expertise and advice to the National Enabling Technologies Strategy on the key issues of policy advice and coordination, industry uptake, international engagement and public awareness and community engagement.

Specifically, UNSW has ***capabilities and major national facilities which underpin NETS and should be strongly supported through the National Enabling Technologies Strategy*** and these include:

(i) The UNSW Analytical Centre

The UNSW Analytical Centre[4] houses major equipment and facilities valued in excess of $35M including the most important major instruments used in the characterisation of biological, chemical and physical materials. The Analytical Centre also includes preparation laboratories, smaller instruments and computing facilities.

The Analytical Centre incorporates:

[4] See http://www.dvcresearch.unsw.edu.au/analytical.html for further information

- An Electron Microscope Unit which contributes to NCRIS as a major node of Australian Microscopy and Microanalysis Research Facility (AMMRF) under the Characterisation capability;
- The Bioanalytical Mass Spectrometry Facility which contributes to NCRIS through the Evolving Biomolecular Platforms capability;
- A Nuclear Magnetic Resonance Facility (NMR); and
- Solid State Facilities (including X-ray analysis, XRD, XRF, Raman Imaging *etc*).

The co-location of major research equipment permits the University to provide the appropriate infrastructure to support the instruments and provide a world-class research environment within which the instrumentation can be maintained and operate to specification. The UNSW Analytical Centre also provides the technical/professional support for the instruments and facilitates access by external researchers. The provision of major research infrastructure in a cross-disciplinary environment also has great potential to encourage collaboration and also provides an environment where a range of related techniques can be focused on any particular problem.

(ii) ARC Centre of Excellence for Quantum Computer Technology

UNSW is the headquarters of the ARC Centre of Excellence for Quantum Computing Technology (CQCT)[5] which is involved in developing revolutionary new single-atom nanotechnologies.

The Centre for Quantum Computer Technology is an Australian multi-university collaboration undertaking research on the fundamental physics and technology of building, at the atomic level, a solid state quantum computer in silicon together with other high potential implementations. The objective is underpinned by a vigorous semiconductor research program that includes a sophisticated quantum measurement capability at ultra-low temperatures.

Established in 2000 through funds from the Australian Research Council and participating institutions, the Centre has nodes at the University of New South Wales, the University of Queensland, the University of Melbourne, UNSW@ADFA, Griffith University, Macquarie University and the University of Sydney. CQCT encompasses major research infrastructure at each of the nodes, including an extensive semiconductor nanofabrication facility, crystal growth, ion implantation, surface analysis, laser physics, high magnetic fields/low temperatures, and has substantial theoretical support. The Centre has 2 Federation Fellows (Professor Michelle Simmons and Professor Gerard Milburn) leading strong programs and until 2009 had a 3rd Federation fellow (Professor Robert Clark) as is director.

(iii) ARC Centre of Excellence for Functional Nanomaterials

UNSW is a major participant in the ARC Centre of Excellence for Functional Nanomaterials.[6]

The Centre was established in 2003 with a $6.4M ARC grant over 5 years. Under the directorship of Professors Max Lu and Rose Amal, the centre was extended for 3 years with a further grant of $4.8M.

The Centre aims to:

- carry out world-class research at both fundamental and applied levels into the synthesis, characterisation and application of various nanomaterials;
- provide first class research training contributing to the growth of Australia's human capital; and

[5] See http://www.qcaustralia.org/home.htm
[6] See www.ceic.unsw.edu.au/centers/partcat

- establish close research linkages with leading international groups, positioning Australia as a world leader in this emerging field. The programs will lead to innovative techniques and technologies that will underpin new materials and products for applications in clean energy, environmental, and health care industries.

(iv) ARC Centre of Excellence in Photovoltaics and Photonics

The School of Photovoltaic and Renewable Energy Engineering at UNSW is internationally recognised for its research in the area of photovoltaics, most of which is now conducted under the ARC Centre of Excellence in Advanced Silicon Photovoltaics and Photonics[7] formed in 2003. This Centre of Excellence incorporates the Special Research Centre for Third-Generation Photovoltaics and the Key Centre of Teaching and Research for Photovoltaics Engineering. The Centre is headed by Federation Fellow Professor Martin Green.

(v) Australian National Nanofabrication Facility (ANFF)

UNSW is a major participant in the Australian National Nanofabrication Facility (ANFF)[8], which links 7 university-based nodes to provide researchers and industry with access to state-of-the-art nano-fabrication facilities. ANFF was established under the National Collaborative Research Infrastructure Strategy (NCRIS) in 2007. In May 2009 the federal government announced an additional $50M investment in ANFF over 2009-13 through its "Super Science – Future Industries" scheme.[9]

(vi) Australian Microscopy & Microanalysis Research Facility (AMMRF)

UNSW is a major participant in national networks, notably the Australian Microscopy & Microanalysis Research Facility (AMMRF),[10] which provide the critical research infrastructure underpinning the nanotechnology strategy. AMMRF covers the microscopy and microanalysis capabilities needed to measure nanoparticles and understand their properties. These capabilities are available to government and industry as well as to university and research organisations.

In addition to electron and scanning probe microscopies, UNSW provides research infrastructure for a much wider range of research infrastructure ranging from surface analysis to NMR to spectroscopic imaging, offering specialist expertise in support of research in nanoscience and technology.

(vii) Links with the National Measurement Institute (NMI)

NMI[11] will need partners in fulfilling its goals to provide reference materials to Australian researchers and industry. For example, the first standard nanoparticle reference materials recently produced by NIST required 6 different measurement & analysis techniques just to define their diameters fully.[12]

UNSW already has strong links with NMI both through researchers in the Faculty of Science and through existing collaborations with the UNSW Analytical Centre. The Analytical Centre provides research capabilities to NMI (particularly in quantitative NMR spectroscopy) where we offer collaboration and specialist instrumentation complementing that available at NMI.

[7] See http://www.pv.unsw.edu.au/
[8] See http://www.anff.org.au/
[9] See http://www.innovation.gov.au/General/Corporate/Documents/supersciencefutureindustries_budgetfactsheet0910.pdf
[10] See http://www.ammrf.org.au/
[11] See http://www.measurement.gov.au/
[12] See http://www.nist.gov/msel/ceramics/gold-standard.cfm

(viii) Centre for Marine Bioinnovation[13] (CMB)

Research on marine chemical ecology and prokaryote/eukaryote interactions focuses on the identification of novel bioactive compounds. Natural antifoulants from seaweeds and other marine organisms, provide models for the development of novel antifouling technologies. Microbes evolve both defensive and antagonistic strategies, including the production of toxins and other biologically active secondary metabolites to evade predators and/or prevent the colonisation; this represents a unique reservoir for the discovery of new drugs and bioactive molecules with applications across medical, industrial and environmental settings.

(ix) Centre for Advanced Molecular Design (CAMD)

The Centre for Advanced Macromolecular Design (CAMD), [14] University of NSW is focused on the synthesis and application of novel macromolecules. To achieve this aim the Centre combines advanced polymerization techniques and biomolecular science to produce materials for high technology applications.

The Centre is oriented towards using polymers in biotechnology applications with the primary areas of research being:

- Enzymatic monomer synthesis to target biodegradable polymers for drug delivery and tissue engineering.
- Glycopolymers based on carbohydrate clusters and synthetic polymer hybrids.
- Biomaterials (contact lenses and prosthetics).
- Fast throughput synthesis techniques and micro-arrays.
- Solid phase synthesis - new solid phases and synthetic approaches.
- Bioprocessing of novel biopolymers and their natural-synthetic hybrids.

4. KEY ISSUES AND CHALLENGES FACING THE NATIONAL ENABLING TECHNOLOGIES STRATEGY AND HOW TO ADDRESS THEM

Policy advice and coordination

Coordinate policy advice across governments: UNSW agrees that it is important to coordinate policy advice across governments on issues related to the development of enabling technologies. We recognise that important issues that cross jurisdictional and portfolio boundaries require national coordination to be effective. Alongside working with relevant Commonwealth agencies and State and Territory governments, it is important to involve nongovernmental bodies and groups to ensure expert advice is on hand to develop best practice policies and regulation.

[13] See http://www.cmbb.unsw.edu.au/
[14] See http://www.ceic.unsw.edu.au/centers/camd/people_staff.html

Industry uptake

Facilitate uptake of enabling technologies: UNSW welcomes the establishment of the Enabling Technologies Policy Section which will establish partnerships with a range of stakeholders, both in industry and government, to develop and deliver activities and communication strategies that will help to overcome information gaps.

At UNSW, the ARC Centre of Excellence for Functional Nanomaterials, under the co-directorship of UNSW Professor Rose Amal, focuses on the novel synthesis, characterisation and applications of functional nanomaterials such as nanoparticles, nanotubes, thin films, and nanoporous and nanocomposite materials. Such materials, constructed by self-assembly at the nanometer scale (1-100 nm), possess unique properties such as high surface area, nanosize and quantum confinement effects, ordered porosity, and high adsorbing and sensing abilities. They are ideal materials for adsorbents, catalysts, sensors, fuel cells, and battery systems and will form the basis of new materials into the future. Nanomaterials and nanotechnology will have a profound impact on many industries including microelectronics, manufacturing, medicine, and energy and environment, Australian R&D in this field has to target industries most relevant to the Australian economy, aiming at technologies for early entry into niche markets in order to reap maximum benefits.

The clean energy, environment and health care industries have been identified as application areas where nanostructured materials will have significant early impacts and so the Centre is specifically interested in the following technologies:

- Clean energy production and utilisation: gas to liquid conversion, hydrogen production and storage, fuel cells, and high energy density batteries;
- Environmental technologies: photocatalytic reduction of pollutants in water and air, economic removal and recovery of organic vapours, greenhouse gas reduction and utilisation;
- Health care: biomaterials for orthopaedic and cardiovascular applications and tissue repair;

Astute Nanotechnology[15] is the commercialisation arm of the ARC Centre of Excellence for Functional Nanomaterials. It is operated by UniQuest Pty Ltd, the main technology transfer organisation for The University of Queensland, recognised as an Australian leader in research commercialisation.

In addition to the technologies that are available for further development and/or commercialisation, a wide range of expertise, with over 100 researchers at the Centre for Functional Nanomaterials, is also available for contract research in such areas as:

- Designing novel inorganic nanoparticles for a wide range of biomedical and industrial applications;
- High performance hydrogen storage materials;
- Novel membranes for gas separation;
- Synthesis of non-UV (visible) light active surfaces with super hydrophilic, antifogging and/or bactericidal properties;
- Designing catalysts with high specificity and performance for a variety of chemical processes;
- Photocatalysis for a wide range of applications in environmental remediation;
- Preparation of thin films with tailored physiochemical properties;

[15] See http://www.arccfn.org.au/.

- New carbon and inorganic nanotubes;
- Encapsulated chemicals and biocides engineered for slow release;
- Novel nano-structured membranes for desalination and water recycling;
- Improved hydroxyapatite polymer nanocomposites;
- High level theoretical and computational chemistry underpinning our understanding of nano-materials and their properties

International Engagement

Participate in international forums addressing policy and regulatory challenges: The policy and regulatory challenges posed by enabling technologies are being faced by governments around the world and are being addressed in a number of international forums, such as the OECD and the International Organization for Standardization (ISO). The National Enabling Technologies Strategy aims to support participation in those forums both by the Enabling Technologies Policy and Public Awareness Sections and by engaging scientists and regulators.

Work with Australia's enabling technology sectors to support their efforts to engage globally: The National Enabling Technologies Strategy aims to work with industry to support efforts to engage internationally to develop partnerships and obtain new markets.

It is the nature of research intensive universities to seek collaboration both nationally and on the international stage. Collaboration with other world-class institutions is at the cornerstone of all successful research. The University of New South Wales is well placed to exploit already existing ties for the development of the National Enabling Technology Strategy.

As an example of the breadth of collaboration available, the ARC Centre of Excellence for Quantum Computer Technology, headquartered at the University of New South Wales and lead by Professor Andrew Shields, encompasses major research infrastructure at and collaboration with the University of Queensland, University of Melbourne, UNSW@ADFA, Griffith University, Macquarie University and University of Sydney as well as CSIRO, Defence Science and Technology Organisation (DSTO).

Public Awareness and Community Engagement

UNSW recognises the importance of the dissemination of correct and accessible information to counter negative perceptions amongst the public about Nanotechnolgy and Biotechnology as critical enabling technologies. UNSW welcomes the National Enabling Technologies Strategy's stated aim, through its Public Awareness and Community Engagement Program, to continue to ensure the community is kept aware of the real issues and kept informed by experts in these areas.

A key component of the National Nanotechnology Strategy was to fund the Australian Office of Nanotechnology (AON), which consisted of eight staff within DIISR, including "policy and public awareness officers".[16] While the AON and NNS helped collate useful information on nanotechnology and nanotechnology health-related issues, this group was more operational than strategic and did not have the depth of knowledge or sufficient "expert advice" from leading academics and industry experts involved in nanotechnology.

[16] See pages 20-22 http://www.innovation.gov.au/Section/Innovation/Documents/NNS%20Annual%20report.pdf

UNSW recommends that the new NETS establish "Advisory Boards" or "Reference Groups" comprised of "leading academics and industry experts involved in nanotechnology and biotechnology". Members for such groups could be nominated by universities and the national academies. Such groups would provide high-level advice to government in the formulation of policy and strategy.

5. SUMMARY RECOMMENDATIONS FOR THE NATIONAL ENBALING TECHNOLOGIES STRATEGY

- ***Capabilities and major national facilities which underpin NETS should be strongly supported through the National Enabling Technologies Strategy.***

- ***The National Enabling Technologies Strategy should take advantage of the expertise and existing industry links within the university sector to fully inform its policy advice and coordination, its plans for industry uptake, and to advise its Public Awareness and Community Engagement Program.***

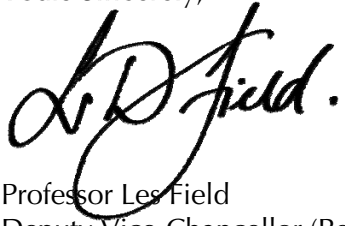
- ***UNSW notes that NETS is focussed on Biotechnology and on Nanotechnology but there are clearly other important enabling technologies. These include the fundamental enabling disciplines such as Physics, Mathematics, Chemistry, Computing and Information Technology all of which underpin Australia's technology-based industries as well as our drive to become a more scientifically/technologically literate nation.***

- ***While Nanotechnology and Biotechnology were specifically identified as initiatives for infrastructure support under the "Super Science" scheme, we identify the absence of an ongoing NCRIS-type program to support major national research infrastructure as a gap in an area that underpins the fundamental and enabling technologies.***

- ***UNSW recommends that the new NETS establish "Advisory Boards" or "Reference Groups" comprised of "leading academics and industry experts involved in nanotechnology and biotechnology".***

UNSW would welcome the opportunity to contribute further to the development of the National Enabling Technologies Strategy should the Review Panel have any questions.

Yours Sincerely,



Professor Les Field
Deputy Vice-Chancellor (Research)

Appendix 1

UNSW – KEY CONTACTS AND EXPERTISE IN ENABLING TECHNOLOGIES OF NANOTECHNOLOGY AND BIOTECHNOLOGY.

1. Nanotechnology

Professor Michelle Simmons – Fabrication of Atomic-scale devices in silicon; quantum electronic devices;

Professor Andrew Dzurak – Electron beam lithography, nanofabrication, Quantum computation, single electron transistors; quantum transport in low dimensional (1D and 0D) devices;

Professor Tom Davis – Polymers; applications of nanotechnology in medicine and drug delivery, free radical polymerisation kinetics; new synthetic routes to macromolecules; enzymatic synthesis; molecular modelling of polymerisation reactions; hydrogels, biomaterials & biocompatibility; membrane fabrication and degradation;

Professor Aibing Yu – Particulate science and technology; nanoparticles, mineral/metallurgical/chemical engineering;

Professor Rose Amal – Particle technology; fine particle aggregation, photocatalysis; nano-particle synthesis and their applications;

Professor Justin Gooding – Nanostructuring surfaces; development of biosensors; target applications are for environmental monitoring and biomedical diagnostics.

2. Biotechnology

Dr. Mike Manefield - Bacterial biofilms and cell-cell signalling; characterisation of solvent-tolerant microbes from bioremediation; electron shuttles for degradation of chlorinated pollutants;

Professor Brett Neilan – Algal toxins, pharmaceuticals from marine algae and bacteria;

Professor Staffan Kjelleberg - Environmental microbiology, water quality and re-use;

Professor Rick Cavicchioli - Biotechnology aimed at developing enzymes with industrial applications;

Professor Marc Wilkins – Proteomics and bioinformatics;

Professor Peter Rogers – Biofuels, bioethanol from cellulose.