10th November 2020

The Australian Academy of Science (the Academy) welcomes the opportunity to comment on priorities for industry roadmaps under the Modern Manufacturing Strategy.

The Academy has a strong interest in increased collaboration between manufacturing and Australian scientists. As a nation, we must look to where we have comparative and strategic advantages, not just a competitive advantage. Central to meeting the ambitions of the strategy will be forging a strong relationship between Australia's scientists and industry. Science, its role, responsibilities, and possibilities should be considered from the ground up in developing industry roadmaps for the government national manufacturing priorities.

Science and priority roadmaps

The Modern Manufacturing Strategy identifies a central role for science and technology to support industry and sustainable manufacturing. Australian science is extensive and covers diverse disciplines. Based on investment in research and development (R&D), Research areas where Australia invests most heavily are the information and computer sciences, medical and health sciences, engineering, and agricultural and biological sciences. Australia is a world leader in space science, physics and computer science based on citations of research publications.

Research and development activities in Australia are divided into four broad categories:

- Fundamental research: experimental and theoretical work to acquire new knowledge. The ABS defines this as pure basic research.
- Directed fundamental research: similar to pure basic research but is directed into specific areas. ABS defines this as strategic basic research.
- Applied research: experimental work with a specific view to identify applications.
- Experimental development: experimental work that is directed to produce new or improved materials, products, processes or services.

Although Australian science covers the full spectrum of research activities, recent trends in government funding to support work with anticipated practical and commercial outcomes has meant that research has become less focused on knowledge for its own generation, i.e. pure fundamental research.

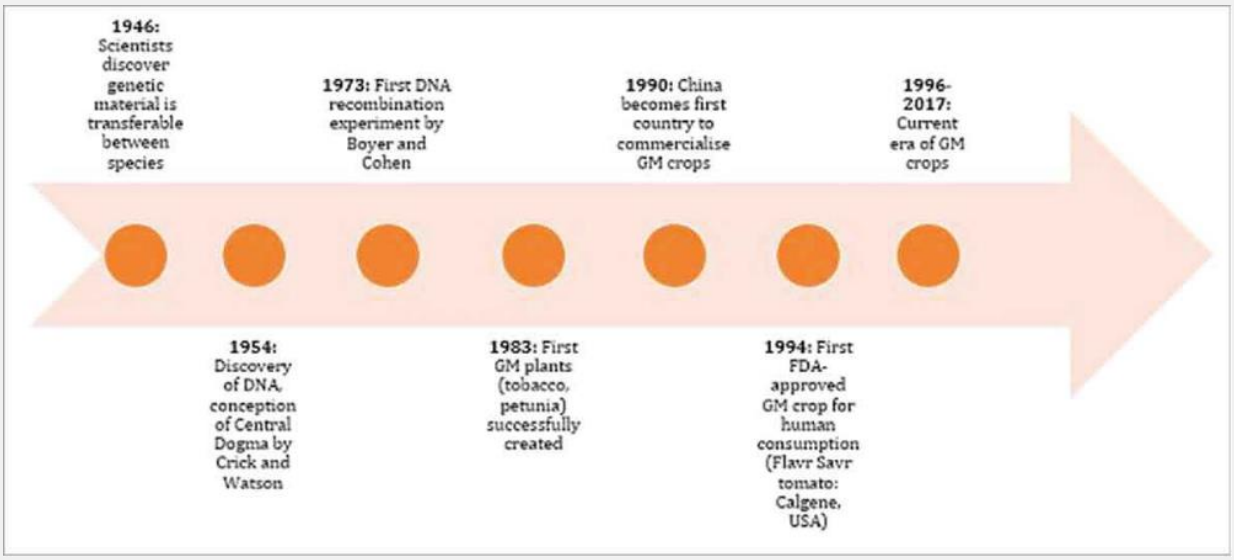
CASE STUDY

FUNDAMENTAL RESEARCH IN ESOTERIC BACTERIAL ENZYMES & GENE TECHNOLOGY

People have been modifying the genes of plants, animals and microbes for thousands of years, using traditional breeding and selection methods to produce desirable traits. Selective breeding methods have produced such things as higher yield and drought- and pest-resistant crops, docile livestock, and low-allergenic fur in dogs.

Through the study of esoteric bacterial enzymes used to cut up invading DNA – a fundamental science question that had no obvious industrial applications at the time – modern genetic engineering has emerged. These techniques have led to real world applications like GM products, the production of vaccines and other medicines, gene therapy and ultimately CRISPR.

GM crops, for example have had real world economic and social impacts. From 1996–2013, they generated $117.6 bn over 17 years in global farm income benefit alone. Furthermore, while increasing global yield by 22%, GM crops reduced pesticide usage by 37% and environmental impact (insecticide and herbicide use) by 18%. To achieve the same yield standards more than 300 million acres of conventional crops would have been needed, which would have further compounded current environmental and socioeconomic problems.



Source: Ruchir Raman (2017) The impact of Genetically Modified (GM) crops in modern agriculture: A review, GM Crops & Food, 8:4, 195-208 DOI: 10.1080/21645698.2017.1413522

There is risk in this shift in funding priorities. The fruits of fundamental research and knowledge generation are often not immediately realised but can become immensely important in the future. This is especially the case for strategic basic research. A healthy science system needs the support of the full spectrum of research activities.

In developing roadmaps for the six priority areas, consideration should be given to how to engage with all forms of research, and understanding the roles and responsibilities of all actors across the innovation value chain – from discovery research through to translation and commercialisation.

Australia's National Manufacturing Priorities

The Academy would be pleased to assist the Department in the development of industry roadmaps for the national manufacturing priorities. Through the Fellowship and 22 National Committees for Science, the Academy has access to scientific expertise that can be called on to inform the roadmap development.

The Academy is of the view that when considering developing and renewing Australia's manufacturing capabilities for the 21st century through the roadmaps, sufficient weight should be put in the role of digitalization across the manufacturing value chain. The Australian Government should continue its commitment to industry 4.0, as demonstrated by the work of the former Prime Minister's Industry 4.0 Taskforce, and the Digital Economy strategy, and continue to collaborate with science as a equal partner.

In particular, the Department may wish to consider consulting decadal plans for science and industry under a range of priorities. These may include:

Resources, Technology & Critical Minerals Processing: in 2017 the Academy worked with AMIRA International to develop a proposal for a fifteen-year industry roadmap for exploration of Australia's hidden mineral wealth, including rare earth or critical minerals. *UNCOVER: Unlocking Australia's Hidden Potential* calls for:

- developing the new technologies and understanding needed to increase our exploration success rate in our vast but under-explored covered areas.
- enabling better-informed decision making about our nation's resources, including groundwater and soils.
- driving innovation in knowledge analytics in other economic sectors that also deal with sparse data; and
- regaining and expanding Australia's share of international mineral exploration spending by reducing the technical risk of exploration investments.

Food & Beverage: The Academy's National Committee for Nutrition has developed, *Nourishing Australia: A Decadal Plan for the Science of Nutrition***.** The plan provides:

- recommendations for advancing nutrition science to provide drivers for growth and value in the agri-food and nutritech industry sectors
- nutrition credentials that will drive a premium agrifood sector, particularly for exports
- growth of a 'nutritech' sector that provides software, hardware, analysis and commercial services to support a healthy and sustainable food and health system
- a plan to focus investment in the scientific understanding to achieve the above

Additionally the Department should consult *Grow. Make. Prosper. The decadal plan for Australian Agricultural Sciences 2017-2026*. The plan outlines:

- strategies to improve the strength and efficiency of agricultural research in Australia
- plans to increase the ability of governments and producers to maintain productivity and efficiency in the face of evolving natural challenges.
- challenges in identifying, developing and deploying the next generation of game-changing scientific advances.
- strategies to capitalise on emerging technologies that will affect the agricultural sciences.

Recycling & Clean Energy: The Department may wish to consult a 2016 report, *Energy for Australia in the 21st Century*. Focusing on three key drivers—affordability, security and sustainability—the report examines the science and technology that will drive and enable a transformation in Australia's electricity system over the coming decades. The report calls for Australia to:

- diversify its range of electricity sources, lower their costs and limit their environmental consequences »
- secure the many benefits that flow from an enhanced capacity to store electricity »
- enable greater benefit from electricity use through implementation of smarter distribution grids and higher end-use efficiencies »
- provide a range of new and diverse energy industries and employment opportunities

Space: Working with the National Committee for Space and Radio Science, the Academy is consulting with the science community to develop a strategic plan for space science. This project will identify key scientific challenges, changes and trends, and associated applications, which provide new opportunities in space science research and can support the development of Australia's scientific capability and contribute to national priorities.

Cross-sectoral issues

The Department may also wish to consider additional plans that provide for across sectoral initiatives at this stage of developing the manufacturing priority roadmaps. These are:

Preparing for Australia's digital future: A strategic plan for information and communication science, engineering, and technology. This plan was a partnership between the Australian Academy of Science's National Committee for Information and Communication Sciences and the Australian Academy of Technology and Engineering. It identifies priorities and actions to:

- enable Australia's education, research, and industry sectors to increase national capacity and performance in all aspects of information and computer science (ICS)
- translate this enhanced capacity into improved hardware and software innovation and increased industry participation in the development of new information and communication technology products and services
- develop a shared, sector-wide understanding of the challenges and opportunities for ICS in Australia
- encourage greater collaboration in areas that are identified as priorities.

Chemistry for a better life: The decadal plan for Australian chemistry 2016–25. The plan identifies the key challenges, barriers and opportunities for Australia in the 21st century and proposes solutions that can help Australia reach its potential as a world class international manufacturing hub. In considering investment to re-invigorate strategic manufacturing, chemistry is one of the most promising areas. To continue to have impact and relevance over the next 10 years, Australia needs:

- enable Australia's education, research and industry sectors to increase chemistry knowledge and skills
- improve the scientific and technical capabilities of the research sector
- raise the level of innovation efficiency and enhance the capacity of industry to innovate; and
- improve the image of chemistry

If you would like to discuss any aspect of this submission, please contact Chris Anderson, Director Science Policy, Australian Academy of Science (chris.anderson@science.org.au).