ministry of science + innovation
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MSI Briefing: International Models of Innovation Support for High Value Manufacturing

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ACTION SOUGHT		
	Action sought	**Deadline**
Hon Steven Joyce Minister of Science and Innovation	Information only	21 February

CONTACT FOR TELEPHONE DISCUSSION (IF REQUIRED)				
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Comments:

Executive Summary

1. Science and technology institutes designed to support innovation in advanced technology sectors, including high value manufacturing and services, exist in most developed countries. This briefing provides an overview of relevant institutes in Denmark, Sweden, Finland, the United Kingdom (UK), Taiwan, Korea, Singapore and Queensland (Australia). All the institutes examined carry out a range of functions. In most cases, applied R&D is the predominant function, but is also supported by a range of technical and business services and sometimes also explicit roles in coordination and capability building for industry. Denmark's Danish Technological Institute (DTI) is distinctive in its focus on technical services.

2. A number of observations can be drawn from these models that lead to some questions relevant to New Zealand's establishment of an Advanced Technology Institute (ATI) such as:

   - Should the ATI be established from a science or a business base?
   - What functions should be established in the ATI, and how do they relate to capabilities in the wider New Zealand innovation system?
   - What strategic roles of R&D may be important to the success of the ATI?
   - What profile should the ATI have in the Innovation Strategy?

Recommendations

It is recommended that you:

a.	**Note** the contents of this briefing on international models relevant to the establishment of the ATI.	Agree / Disagree
b.	**Note** that MSI can provide you with further information, including overviews of models in other countries such as Germany.	Agree / Disagree
c.	**Note** that you will receive further background material to inform discussions on the functions and form of the ATI.	Agree / Disagree

Peter Crabtree
Deputy Chief Executive
Systems Strategy and Policy

Date

Hon Steven Joyce
Minister of Science and Innovation

Date

Purpose

1. This paper provides you with information on the institutional approaches used by a selection of other countries to support their high tech manufacturing and services sector and the observations from these that can inform the development of New Zealand's Advanced Technology Institute (ATI).

2. It is relevant background for our meeting with you on the ATI on Tuesday, 21 February. It should also help put the discussion you have had this week with Danish DTI representative Knud Erik Hilding-Hamann into a wider international context.

Background

3. We will be working with you over the next few months to develop a set of options for the functions and form of the new ATI. While it is clear that the ATI will need to be closely engaged with industry and focused on their innovation needs, there are some choices to be made in relation to the functions it performs, in relation to other providers in the system. This relates particularly to the scale and nature of R&D it will perform, its networking and brokering roles, and its education and training functions.

4. Overseas, the provision of tailored support for advanced technology industries has been developing steadily over the past few decades and in some countries dates back 50-100 years. Many countries now have well established institutional models that are seeking to lift the value and productivity of the sector and drive overall economic gains.

5. This briefing describes the ATI-like models operating in Denmark, Sweden, Finland, the UK, Taiwan, Korea, Singapore and Queensland (Australia). These countries all have institutes that can provide us with lessons. Most are also small countries or regions, comparable in size to New Zealand. Within these countries we have focused this review on the institute (or network of institutes) that plays the most significant role in supporting high value manufacturing and service industries with advanced R&D and technical support.

6. An overview of the models in each country follows with more in depth information in Annex 1 on their size, government funding, sectoral focus, and technical capability. Implications for the development of New Zealand's ATI are also presented.

International Models

What do they do?

7. At a general level, the functions of the overseas institutes include:

   - **R&D**, both industry-led (e.g. contract research services), or collaborative projects with other public or private partners, typically with an applied focus, and supporting both technology development and technology adaptation and adoption
   - **Technical services**, such as product analysis, process testing, calibration, certification, access to equipment and facilities
   - **Business** services, for example the provision of technology management courses for industry, IP management advice, market analysis and technology foresight services
   - **Capability development** through student training (in-house or industry placements) and industry outreach and training

- **Facilitation** of innovation activities, for example brokering links with specialist external technology providers or R&D partners (like Global Expert), coordinating and promoting knowledge transfer in national R&D partnerships or innovation networks
- **Commercialisation,** of the institute's own IP for example through licensing of own technology and development of spin-offs.

8. Table 1 below shows the spread of functions across the institutes reviewed. All the institutes carry out a range of these functions (indicated by a tick) though differ in their dominant focus (indicated by shaded box).

Table 1: Functions of overseas institutes reviewed

(tick indicates function is present in the institution; shading indicates dominant focus)

Country (institute)	R&D	Technical services	Business services	Capability development	Facilitation	Commercialisation
Denmark (DTI)	✓	✓	✓	✓	✓	
Sweden (SP)	✓	✓	✓	✓	✓	
Finland (VTT)	✓	✓	✓	✓	✓	✓
UK (High Value Catapult)	✓	✓			✓	
Taiwan (ITRI)	✓	✓	✓	✓	✓	✓
Korea (KIST)	✓			✓		✓
Singapore (A*STAR/ SIMTech)	✓	✓	✓	✓	✓	✓
Queensland (QMI)			✓		✓	

9. An overview of the functions and origins of the institutes for the range of countries follows.

Denmark

10. Denmark has a network of nine government-approved technological institutes collectively known as the GTS System. The DTI is the largest of these and supports many technologically based sectors, not just manufacturing. Other members of the GTS network cover areas such as biotechnology, electronics, and metrology. The institutes are independent not for profit entities, legally constituted as either independent foundations (e.g.

DTI) or a limited company owned by industry and/or universities. The GTS has 3700 staff; DTI is one of the largest with 974 staff in 2010.

11. DTI originated in industry in the early 1900s and functions principally to support Denmark's large SME sector with technological know-how to increase the productivity of firms and the economic competitiveness of Denmark. DTI's emphasis is the provision of technical services, such as product and process testing and certification, and innovation checks for firms. It also provides industry training, and facilitation services to coordinate innovation networks.

12. DTI has not historically been as research-oriented as models in other countries but is now developing its capability in this area. R&D rose from 21% to 28% of revenue between 2009 and 2010. The development of research capability was prompted by a 2009 evaluation that recognised the growing research intensity of production globally and the imperative for firms to keep lifting their research effort. DTI's public funding currently makes up only 11-15% of total revenue, but the evaluation recommended this was increased to 20%.

Sweden

13. Similar to Denmark, Sweden has a network of advanced technology institutes. The Swedish model is called the RISE network (formerly IRECO) and is a fully government owned umbrella company consisting of four sub-group institutes, each of which has 3-8 of its own subsidiary companies. RISE was formed in 2008 to address what is known as the 'Swedish paradox': the country has high levels of expenditure on R&D (4%) relative to other countries yet only modest rates of economic growth. RISE was established to build and consolidate activity at technological institutes working at the intersection of academic research and industry and accelerate commercialisation. The network is business-facing and supports both SMEs and large companies. SP is the largest sub-group institute and similar in size to DTI with 940 staff. The other institutes are Swedish ICT, Swerea (materials and production), and Innventia (biorefining and packaging). RISE institutes receive government funds (19% of turnover) to support strategic competencies.

14. SP has six sector-aligned business areas: energy, ICT, life sciences, risks and security, built environment, and transport. It has a strong focus on R&D and in fact is Sweden's largest research institute. R&D makes up 70% of its activity, and 44% of R&D turnover is publicly funded (from core and competitive sources). It currently participates in around 60 EU research projects and has aspirations to double this. SP also has facilities for large scale testing prior to market introduction and provides a wide range of technical services, for example in calibration, testing, metrology and standards. Reflecting its strong R&D focus, SP participates in 12 different centres of excellence and coordinates three of them.

Finland

15. The VTT Technical Research Centre (VTT) is Finland's ATI-like institute and calls itself a multitechnological applied research organisation. Its competencies are broadranging and relate not only to high value manufacturing and services sector but also to energy, ICT, forestry and biotechnology. It is a state owned, not-for-profit entity that operates under the Finnish Ministry of Employment and the Economy. It has service centres across Finland and contact points in Europe, the USA, Russia, Korea and China. With 3,200 staff, VTT is one of the largest R&D organisations in Northern Europe.

16. VTT's emphasis is R&D. It undertakes both contract and strategic collaborative R&D activities with the latter including projects in the areas of e-engineering, industrial biomaterials, green waste solutions, intelligent energy grids and intelligent transport. VTT also provides technical services (through VTT Expert Services), but with less emphasis on this than the Danish GTS/DTI model. This probably reflects both VTT's origins in the science sector and also the structure of the Finnish industry which is characterised by large companies which have in-house technical expertise rather than the SMEs that dominate

Denmark. VTT is evolving its focus from being a 'technology developer' to an 'innovation developer'. As well as having an IP business group, VTT has also established a VTT Ventures group to develop spin-offs through pre-seed, seed and venture capital investments.

UK

17. In 2011 the UK Technology Strategy Board commenced the development of the new 'Catapult' network of technology and innovation centres. The first centre is in the area of high value manufacturing. Further centres have been agreed in the areas of cell therapy, offshore renewable energy, space applications, and connected digital economy. The Catapult centres are intended to be business-focused, providing firms with access to technical expertise, infrastructure, skills, and an environment for multi-disciplinary work including collaborative and contract R&D. They aim to bridge the gap between research and industry and accelerate the commercialisation process. They are intended to be an integral part of the wider innovation support system in the UK which also includes components such as knowledge transfer networks, and small business research initiatives.

18. The centres will be constituted as independent entities, with operational autonomy within a core framework provided by the Technology Strategy Board. Core public investment (£200m over four years committed) is expected to be matched (in a one-third, one-third, one-third model) with revenue from business contracts and competitive public funding.

19. The High Value Manufacturing Catapult was launched in October 2011. Hosted by the University of Sheffield's (pre-existing) Advanced Manufacturing Research Centre (180 staff), this Catapult includes six other partner organisations and provides a consolidated capability in all forms of manufacturing R&D, facilities and technical support involving metals, composites, as well as process manufacturing technologies and bio-processing. Training and knowledge transfer capabilities are being developed within the wider Advanced Manufacturing Institute at the University of Sheffield and funded through a government Regional Growth Fund, separately to the Catapult.

Taiwan

20. Taiwan's Institute of Technological Research (ITRI) is a large institute (5,800 staff) that supports Taiwan's high-tech (SME-dominated) manufacturing industry with technological expertise. It is recognised as the powerhouse behind Taiwan's economic success and has been instrumental in transforming Taiwan's manufacturing industry from light manufacturing (plastics and textiles) to high tech, high value products. For example, Taiwan's semi-conductor industry originated as an ITRI spin-off.

21. ITRI's core activity is R&D, with a focus on applied R&D and technology transfer in which technical and R&D capability are used principally to identify, acquire, adapt and adopt leading edge technologies from overseas. This reflects Taiwan's industry development strategy which, rather than the creation of new industries, is focused on technology upgrading of existing business. Government funds around half of ITRI's R&D and commissions them to undertake most of its National Science and Technology Projects (targeted technology development initiatives). ITRI also provides IP licensing and business development support and will enter into alliances for co-development. It will also support the development of spin-offs if there is no private company that would be able to benefit from technology transfer of a discovery, and progress in research is likely to stagnate otherwise.

22. As well as R&D, ITRI also provides technical services, and supports business development through their 'open labs'. Open labs are physical, incubator-like, facilities that provide firms and academics with technical assistance as well as marketing, managerial and legal advice. It also plays a key role in capability building for the private sector, operating as a stepping stone into industry for university graduates and other staff.

Korea

23. Korea's Institute of Industrial Technology (KIST) is one of 13 government research institutes. It was founded in 1966 by the Government as a research agency to promote the nation's economic growth and modernise the field of engineering. KIST is recognised as having played a major role in Korea's economic development. Recent S&T strategy has sought to further improve Korea's economic performance, addressing issues of excessive competition in the R&D system, poor coordination and staff mobility between university and industry. KIST and the other government research institutes are expected to play a role in addressing these issues.

24. KIST's core function is R&D and it maintains an emphasis on R&D at the frontier of technological developments and their convergence. This basic research capability provides some contrast to other models which have a stronger emphasis on applied R&D. KIST also provides tertiary education and training and confers degrees. It has around 700 staff but many hundreds more visiting researchers and students. Technical services do not feature as a function of KIST which may be characterised as a research and technology-led R&D organisation, rather than a business-responsive technology service provider.

Singapore

25. To a large extent, Singapore's entire S&T system provides a model for support for high value manufacturing. From the 1980s, Singapore has pursued a strategy of development of science and technology capability to spur growth in high technology and knowledge intensive industries. Engineers and technologists now make up 63% of their research and student workforce, and this emphasis on technological disciplines is reflected also in Singapore's key industry clusters of Electronics and IT, Engineering, Chemicals and Biomedical Sciences.

26. With respect to R&D institutions, Singapore's public system is coordinated by the Agency for Science, Technology and Research (A*STAR) and comprises:

- the Fusionopolis cluster of seven research institutes which focuses on information communication technologies and includes the Singapore Institute of Manufacturing Technology (SIMTech)

- the Biopolis cluster of five research institutions centred on biomedical and genomic sciences which includes the Institute of Bioengineering and Nanotechnology which has relevance to high value manufacturing.

27. SIMTech has 250 staff with competencies in manufacturing processes and systems, and automation. It also offers industry-wide technical and technology business services to firms such as testing and metrology, training courses and technology roadmapping. SIMTech also hosts the Precision Engineering Centre of Innovation that undertakes product and process development projects for and with firms operating in sectors such as oil and gas, aerospace, medtech, and also supports SMEs with knowledge services.

28. Support for firms is coordinated by Singapore's Economic Development Board (EDB). They have a range of financial and tax incentives for firms (particularly those in manufacturing) seeking to innovate or lift their technological capability. EDB also make equity investments to support the growth and capability of strategically important businesses.

Queensland, Australia

29. QMI Solutions operates as a one stop shop for business advice for the Queensland manufacturing sector, with the aim of improving its skills, performance, innovation and capability. It has a strong brokering role, for example supporting the selection and adoption of practical solutions and sustainable business models for SMEs. Their network of Third Party Providers (TPP) means that QMI Solutions has access to a much broader capacity and

capability than it maintains itself. QMI Solutions does not undertake research but does broker links between industry and the R&D sector. QMI Solutions also provides business development, benchmarking, and commercialisation training programmes.

30. QMI Solutions is constituted as a company with an executive board that includes senior government officials. It is largely government funded ($3.6 million in 2009; 80% of revenue) and delivers its services for free or at highly subsidised prices. It is a small company of around 50 staff.

Significant themes and implications for New Zealand

31. Looking across the models in these countries there are a number of observations or themes that have implications for the establishment of New Zealand's ATI.

Origins influence functions

32. As highlighted in Table 1 the institutes vary in the types of function they perform and their emphasis. This appears to be related to both the origins of the institute and the structure and nature of the industry they are serving. For example, institutes that have their origins in industry and serve a strong SME industry structure (or are specifically focused on manufacturing) tend to be focused on technical services and facilitation (e.g. Denmark, Queensland). Institutes that have their origins in the science sector and/or serve large companies tend to have much stronger R&D and commercialisation emphasis (e.g. Finland, UK, Singapore, Taiwan).

33. This observation leads to questions about the starting base for the ATI. For example, it could be developed from the science sector and reach out to business. Alternatively, it could be initiated with a more industry oriented starting point, and reach out to science.

Integrated approach

34. Most of the countries examined have taken an integrated approach and configure their institutes to not only perform R&D and provide technical services, but also carry out other functions in the wider innovation value chain, for example the development of skills in and for industry, facilitation of partnerships between science and industry, and in some cases also commercialisation support. Even though most of the institutes are multi-functional, in no country is the full network of support, recognised as necessary for the advanced technology sector, located in a single institute.

35. For New Zealand, this implies a need to think carefully about what capabilities are established in an ATI and how they relate to capabilities distributed in the wider New Zealand innovation system. It also raises questions about what other changes may be needed to support the ATI, for example, in education and training for science and engineering, incentives for university research, the role of incubators and regional development initiatives. Your responsibilities across the science, economic development and tertiary education portfolios will facilitate this broader view.

Strategic capabilities

36. The functions carried out by the institutes are underpinned by a range of capabilities and capital, notably skilled personnel and scientific facilities and equipment. It is important to recognise the ways in which these capabilities are used strategically by the institutes (and their government sponsors) to achieve not only immediate outputs (e.g. research outputs) but also broader national aims. For example:

- In Taiwan, applied technical and R&D capability enables them to access leading edge international value chains and identify, acquire, adopt new knowledge for technology upgrading of Taiwanese firms.

- In the UK purposeful investment in technical facilities coupled with access to excellent basic research capability is used to attract large multinational partners and helps lift local industry capability. An example of this is the Factory of the Future led by the University of Sheffield's Advanced Manufacturing Research Centre and its partnerships with Rolls Royce and Boeing.

37. In establishing an ATI, the needs for science and equipment capabilities (existing or new) should be considered in light of both their functional and strategic roles. For example,

    - What critical strategic role should R&D play in an ATI environment? To help access and partner with overseas world expertise? To help firms pursue transformative business opportunities? To attract and retain world-class capability?

    - What role could the development of technical plants and facilities have in, not only carrying out technical services for firms, but also serving as a locus for partnerships across universities, ATI and firms?

    - What is the appropriate balance of effort between R&D and technical services? What is the role of non-technological services, such as IP management advice or business model development?

Government commitment and targeting

38. All the countries examined have strong government commitment to advanced technology. This typically includes a clearly articulated vision or strategy for economic growth through advanced science and innovation, commitment at the highest political level, and guidance through a national-level Science Council. In a number of countries (for example in the cases of Korea and Finland) this commitment appears to have its origins decades ago, in times of crisis, and was instrumental in putting them on a pathway to national and economic security. It is likely that explicit government commitment to advanced technology seen in these countries has played a critical role in creating the alignment necessary across the system, and in wider society.

39. Targeted funding support accompanies this commitment though across the countries there is no common pattern to the nature of the targeting. Singapore's public support clearly targets particular sectors and their underpinning technologies and skills. European countries tend to provide some institutional funding for capability development and then allow competitive processes to select on scientific and or business merit.

40. The observation about government commitments implies the need to consider the positioning of the ATI as it is established. For example, what profile should it have in the forthcoming Innovation Strategy?

Technological culture

41. In most of the countries examined there is a business and wider societal culture that is committed to and capable of wealth generation through technological change and willing to take direction from government. This collectivist culture is most notable in the technologically capable, consensus-driven cultures in Scandinavia, and also in the Asian countries in their embrace of new technology and disciplined systems of top-down government direction.

42. This contrasts with that typically described for New Zealand where an individualist approach is more typical. It will be important that the design of the ATI 'fits' New Zealand's culture and taps into the main drivers for innovation in firms.

Communications

43. There are no media implications or communications requirements associated with this briefing.

Next Steps

44. The information in this briefing will inform our discussion with you on Tuesday, 21 February and the development of 'strawman' models for a New Zealand ATI.

Annexes

Annex One: Overview of International Models of Innovation Support for High Value Manufacturing

Annex One: Overview of International Models of Innovation Support for High Value Manufacturing

Country (institute)	Main function	Staff number Turnover (NZ$/y)	Government funding (% turnover)	Sectoral alignment / Business Areas	Science and technology capabilities and facilities
Denmark (DTI) DTI is part of a wider GTS network of technical institutes)	Technical services	974 $226m	15%	Building and construction Energy, transport and logistics Environment, work and health Food and packaging Meat industry Danish Meat Research institute Life sciences Materials and production Productivity and logistics	Technical capabilities: Industrial measurements and control, materials, surfaces, microtechnologies, engineering, robotics, sensor development, sensory analysis, microbiology chemistry, industrial production and development, business and innovation, productivity and management Research Institutes and Facilities: Danish Meat Research Institute, Energy FlexHouse
Sweden (SP) SP is the largest research group under the RISE network of industry research organisations.	R&D	936 $183m	19%	Energy ICT Life sciences Risks and security Built environment Transport	Technical capabilities: Calibration, verification, certification, metrology, chemistry and materials, electronics, mechanics, engineering and energy technology, fire technology, wood technology Research Platforms: biofuels, heat pumping, cleantech, pipes, maritime designs, systems analysis, wood measurements, tunnels, smart grids, zero emission buildings Research Institutes: Cement and Concrete Research Institute, Glass Research Institute, Swedish Institute of Agricultural and Environmental Engineering, Swedish Institute for Food and Biotechnology, Institute for Surface Chemistry
Finland **(VTT)**	R&D	3167 $457m	32%	Biotechnology, pharmaceutical, food industries Electronics, ICT Energy Real estate and construction Machines and vehicles Services and logistics Forest industry Process industry and environment	Technical capabilities: applied materials, bio- and chemical processes, energy, industrial systems management, information and communication technologies, microtechnologies and electronics, services and built environment, business and innovation
UK (High Value Manufacturing Catapult) One of five innovation support centres under establishment	R&D	Approx 500 Turnover not available	33%	Automotive and Aerospace Chemical, Food Energy Biotechnology and Pharmaceuticals ICT Materials Consumer Products Waste	Technical capabilities: manufacturing technologies, materials testing, metals, composites, machining, forging, hybrid and metallic composites, assembly, printable electronics, chemical processing, biotechnology, bio-processing, automation, fabrication, process modelling, civil nuclear component manufacture, product system optimisation, energy storage, digital verification Facilities include: Factory of the Future, Manufacturing Technology Centre, Printable Electronics Technology Centre, Anaerobic Digestion Development centre

Country (institute)	Main function	Staff number Turnover (NZ$/y)	Government funding (% turnover)	Sectoral alignment or Business Areas	Examples of science / tech capabilities and facilities
Taiwan (ITRI)	R&D	4700 (5800 including students) $615m	50%	Information and Communication Electronics and Optoelectronics Material, Chemical and Nanotechnologies Biomedical Technologies and Device Advanced Manufacturing and Systems Green Energy and Environment	Technical capabilities: smart endpoints, mobile-enabled cloud services, intelligent vehicles and transportation systems, green energy and healthcare, nanotechnology, and materials/chemical technologies, nano-electronics, flexible electronics, micro-opto-mechanical electronics, 3-D image processing, semiconductor optoelectronic, 3-D IC packaging, and advanced display technologyenergy, energy efficiency, alternative energy, energy management and policy, clean environments, and natural resources, in-vitro diagnostics, orthopaedic devices, tissue regeneration products, biomarkers, small molecule pharmaceuticals and herbal medicinal products, intelligent automation, green manufacturing, and intelligent inspection technologies Systems and solutions: flexible display technology, LED, smart green buildings, intelligent robots, electric cars, green car electronics, high performance cooling system for green cloud computing, advanced green house Facilities: Open Lab, Incubation Centre
Korea (KIST)	R&D	700 (2200 total including students) No data on turnover available	Approx 40%	Emphasis on technologies rather than sectors, but some emphasis on Biomedicine High tech manufacturing Green industries	Technical capabilities: nano-technology, bio-technology, and informational technology, technology convergence, high temperature energy materials, nanohybrids, nanophotonics, computational science, spin devices, electronics, imaging, biomolecular, fuel cells, solar cells, energy storage, clean energy, water research, environmental sensor system, energy mechanics, and human-centered interaction & robotics Research Institutes: Institute for Multi-discipliinary convergence of materials, Green City Techology Institute, Brain Science Institute, Biomedical Research Institute
Singapore (SIMTech)	R&D	250 No data on turnover available	Not available	Manufacturing ICT Electronics and semiconductor Precision engineering Oil and gas Medical technology Aerospace and automotive Marine Logistics	Technical capabilties: manufacturing processes and systems, automation, microfluidics, productivity technology, precision engineering, sustainable manufacture, re-manufacturing, innovation and technology assessment Facilities: Precision Engineering Centre
Queensland (QMI Solutions)	Business services	48 $20m	Approx 20%	Manufacturing firms (who work in sectors such as agribusiness, aviation, energy, marine, metals and minerals processing)	Technical capabilties: business, innovation and technology management, technology scanning and foresight, industry strategy, supply chain analysis, benchmarking, communications, training, project management