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TE PŪNAHA HIRINGA WHAKAEA

MSI Briefing: Industry-facing models for High Value Manufacturing innovation support

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Action Sought

	Action sought	Deadline
Hon Steven Joyce Minister of Science and Innovation	Note the contents of this briefing as an input into the ATI design process.	

Contact for telephone discussion (if required)

Name	Position	Telephone		1st contact
Peter Crabtree	Deputy Chief Executive, Systems Strategy and Policy			✓
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The following departments/agencies have seen this report

☐ COMU	☐ MAF	☐ MFAT	☐ TPK	☐ DOC	☐ TEC	☐ MfE
☐ NZTE	☐ MED	☐ Treasury	☐ MoH	☐ MSD	☐ MoE	☐ Other

Please specify:

Minister's Office to Complete:

- ☐ Approved
- ☐ Declined
- ☐ Noted
- ☐ Needs change
- ☐ Seen
- ☐ Overtaken by Events
- ☐ See Minister's Notes
- ☐ Withdrawn

Comments:

Executive Summary

1. Collaboration is the active participation in joint innovation projects with other organisations. It is an important part of the innovation activities of many firms, improving outcomes and efficiency. Working together promotes exchange of skills and knowledge, including tacit knowledge, increasing firms' absorptive capacity and often leading to creation of new ideas (and ongoing joint work). It also enables fragmented specialist skills to be aggregated and focused on specific issues, creating critical mass – especially useful in a small country with dispersed capability.

2. Many countries have mechanisms to foster collaboration among research organisations, and between industry and research organisations. We have reviewed several overseas models in this paper, and a number in New Zealand.

3. Common features of international systems are:
   - a form of voucher to encourage SMEs to engage with research providers
   - support for graduate or other researchers to be placed in businesses to foster linkages
   - support for innovation-related networks and other linkage events/mechanisms
   - contestable funding rounds or competitions which seek to engage groups of businesses and research organisations to collectively address a specific issue.

4. The particular focus of this briefing is on mechanisms to foster science-industry collaboration, i.e. joint programmes of work where industry has active engagement in governance and/or through cash or in-kind contribution to the work. The specifics of these vary across the systems reviewed, and there is no one successful formula. However, key features of those which appear successful are:
   - the motivation, experience and personal relationships of individuals on both sides
   - a focus on minimising transactions costs/barriers to business participation – including understanding business needs and timeframes, and a sensible approach to IP ownership/management
   - specific measures that recognise the cost and resources required to operationalise collaboration (e.g. the ability to use research funds to pay for support for linkages across partners)
   - recognition of the time and effort required to build the trust and reputation of the collaborating research partners, which will seed ongoing industry interest and participation (i.e. patient funding).

5. Conclusions of the review and some implications for the ATI include:
   - A co-ordinated suite of mechanisms is required, to improve firm readiness and willingness to engage as well as foster collaborative R&D. This needs to include support for linkages and networking between firms, and between firms and research organisations, neither of which is currently well catered for in our HVMS innovation system.
   - Involving industry/end-users in programme design is important to improve effectiveness. Successful jurisdictions involve industry at several levels, in governance roles and in programme design as well as participation in specific projects.
   - A range of approaches may be required to meet different industry needs, including allowing for the geographic and size distribution of industrial subsectors. It is likely the ATI will need to form strong relationships with overseas partners (in industry and research) to create the scale required to address some business needs here.

- Specific parameters can be included in funding mechanisms and contracting approaches to support industry engagement, including improving business experience (e.g. minimising transactions costs and delays in processes and a business-friendly approach to IP management) and incentivising and focusing agents (e.g. making funding contingent on meeting specific targets, and a fast failure approach to ensuring a path to impact).
- A critical success factor is the calibre and motivation of individuals in leadership and business-facing roles. This has implications for the likely time and cost to establish these functions in the new ATI, if it is to carry out this role successfully.

Recommendations

It is recommended that you:

a.	**Note** that many countries have mechanisms – generally, a coordinated suite of programmes – to foster both linkage and collaboration among firms and between firms and research organisations.	
b.	**Note** that a key area under-represented in New Zealand appears to be actively promoting linkage across firms, as an important precursor to collaboration.	
c.	**Note** that while examining overseas models provides several insights into programme and funding arrangements to support collaboration, a critical success factor is the calibre and motivation of individuals in both leadership and business-facing roles.	

Peter Crabtree
Deputy Chief Executive
Systems Strategy and Policy

Date

Hon Steven Joyce
Minister of Science and Innovation

Date

Purpose

1. This paper responds to your request for more information on industry-led, market-focussed collaborative models for R&D and innovation support to HVMS firms.

Background

2. On 20 February we briefed you on the main research partnership and collaboration models currently in use in New Zealand's innovation sector, including MSI's Partnerships, MSI's Platforms, and the Centres of Research Excellence. We also separately briefed you on international models of technical institutes supporting HVMS firms.

3. You have asked for more information on some international models, in particular collaborative arrangements that have been successful in providing innovation support to HVMS businesses.

Potential benefits from improved linkage and collaboration

4. New Zealand has significant public research capability to support the HVMS sector, currently distributed across universities, polytechnics and the CRIs. However, many of these organisations are not engaged or specifically mandated to invest in developing relationships with smaller firms, and all have different approaches to industry engagement.

5. The fragmentation and geographic spread of capability makes it difficult for firms to identify the support available. Firms also find barriers to engagement quite high, particularly the timeframes involved in obtaining approval for funding and time to delivery of R&D; the proposed arrangements for managing IP; and cultural differences between science and business.

6. There is an opportunity to better integrate the capabilities of science, engineering, and design and to direct this towards finding commercially-feasible solutions to industry and market needs, with distinctive user-oriented functionality. There is also a need to better integrate R&D, education and training and commercial product and process development, enabling these domains to inform each other.

7. Private investment in R&D can be hindered by several factors, including the scale and cost of projects, lack of expertise, and technical and commercial risks. Collaboration, i.e. active participation in joint innovation projects with other organisations, is a powerful way of drawing heightened value out of disparate specialist skills. This can include either or both of:

   - composing teams with the relevant skills and motivation to attack an agreed opportunity
   - bringing together multiple sources of funding that may be driven by different (but mutually compatible) underpinning objectives.

8. Collaboration arrangements can be viewed as a joint venture, to share costs and risks, as a cost effective way for different participants to pursue their own objectives. They are useful to increase efficiency through reducing potential duplication, and (particularly in a small country) to build critical mass from distributed talent.

9. However, in addition to the benefits of aggregating resources, a less tangible but possibly the most significant outcome is the interchange of ideas and knowledge that occurs during collaboration, which both supports success in the immediate project, and also stimulates further ideas and creates relationships that can lead to on-going joint projects. The exchange of skills and knowledge permanently increases participants' absorptive capacity.

10. Collaborative R&D programmes reduce barriers to private R&D, by providing subsidies (usually indirect, via research organisations) to reduce risk and support working relations between firms and centres of technical expertise. They aim to help firms benefit from expertise and facilities in public sector research, while also orienting the latter towards more industry-relevant research goals. Benefits include identification of opportunities and needs; exchange of ideas and expertise; and development of networks. As well as direct knowledge dissemination and diffusion, such programmes can also support intersectoral mobility since they often involve secondments of researchers and doctoral candidates to industry.

11. A number of international models of collaborative arrangements have been reviewed to see what lessons can be drawn to inform the ATI work. Annex One includes details of the following:

- Denmark (Innovation Consortia and Networks)
- Finland (Strategic Centres for Science, Technology and Innovation)
- Norway (Centres of Expertise, Centres for Research-based Innovation)
- Belgium (IMEC centre)
- Canada (Business-Led Networks of Centres of Excellence; Waterloo ecosystem)
- United Kingdom (Catapult centres)
- Australia (CSIRO Flagships & Collaboration Fund; CRCs; IBES).

12. The systems include roles to foster both **linkage** (i.e. collective knowledge sharing and brokering connections and discussion) and **collaboration** (i.e. actively working jointly on programmes). All international systems examined for this briefing included at least one initiative designed to improve linkages among firms and between firms and knowledge institutions, with a view to increasing firms' absorptive capacity and preparing them for collaboration – i.e. making them "ready and willing". Annex Two outlines the Danish "pipeline" in this respect, and includes some other examples of activities designed to foster collaboration readiness through strengthening linkages. The remainder of the briefing focuses on mechanisms directly aimed at achieving collaboration.

Collaboration among New Zealand businesses

13. The 2009 Innovation Survey found that while 41% of New Zealand businesses had undertaken innovation activity in the past two years, only 10% had cooperative arrangements of any kind in place. The main reason cited by HVMS businesses[1] for collaboration was to access new markets (49%). Accessing R&D (46%) and accessing production processes (37%) were significantly more important reasons for HVMS firms than for other sectors, while sharing costs and access to other tacit knowledge (work practices, management skills) ranked lower. Spreading risk was a factor for only 22% of cooperative arrangements.

14. This pattern was mirrored by the activities undertaken when cooperating. The most common activities were joint:

- marketing or distribution (53%)
- training (36%)
- R&D (32%)
- prototype development (26%).

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1 The HVMS-specific figures were extracted from the Innovation Survey 2009 as part of the HVMS sector profile work currently being finalised.

15. Larger firms were much more likely to engage in collaboration in order to access R&D (50%), and to undertake joint R&D (44%) and prototyping activities (38%), than smaller firms who were more focused on new markets and distribution.

16. The most frequent collaboration partners were suppliers and customers (15% and 12% respectively). However, other businesses also featured strongly as partners, with 8% cooperating with businesses in their own industry and 7% with those from other industries. Only 4% of innovating businesses had partnered with each of CRIs/other research institutes, and universities/polytechnics. HVMS firms were slightly more likely to have partnered with CRIs, and with overseas customers. Most collaborative arrangements were with organisations located in New Zealand only.

New Zealand models of collaborative arrangements

17. An earlier briefing[2] outlined MSI models that incentivise science collaborations and linkages with users. Most relevant to this briefing are **Partnerships** (previously Research Consortia) that co-fund consortia of users and researchers to undertake user-led science programmes. These are MSI's main instrument for strong industry or user-led investments with a delivery/commercial focus.

18. Partnerships are an "on demand" instrument (projects which meet the criteria can apply and be approved throughout the year, provided there is sufficient funding remaining). They require at least two industry members and one knowledge institution, and must be at least 50% co-funded from the private sector. Most of the 13 current partnerships are in primary industries. Attempts to date to establish them in the HVMS sectors have not been successful, as it has proved difficult to achieve agreement across the diverse interests in the sector to a programme of pre-competitive (sector good) research to the extent required to make up the co-funding requirement.

19. Some collaborative models are emerging on an *ad hoc* basis that effectively join up and harness capability, and which are closely connected with industry. The **Materials Accelerator** centre is a firm-focused portal offering joint technology planning and access to expertise and facilities distributed across several research partners. The researcher alliance is funded by MSI[3], hosted by the University of Auckland and includes three CRI and five other university subcontractors[4], together creating a network of more than 100 leading materials researchers drawn from engineering and science disciplines. The four-year $8.5 million contract started on 1 April 2009, and the Accelerator is currently working with over 30 companies in four market sectors[5] across nine technology platforms – these include e.g. composite structures with roll-formed light gauge steel; enhanced functionalities in building materials; microprocessor controls – and has recently established a virtual prototyping hub.

20. The project is regarded as a successful model for company engagement and cooperative research. A number of features are thought to have contributed to this:

- it is led by high quality scientists supported by staff with extensive industry experience, which has helped build and maintain relationships with industry

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2 *B/12/040 Collaborative Partnership Models*, 20 February 2012.

3 MSI funding is through a High Tech TRST (Transformational Research, Science and Technology) contract, which was the precursor to the current Enabling Technologies mechanism.

4 The subcontractors are IRL, GNS and Scion; and AUT, Massey, VUW, Canterbury and Waikato (the last two have joined in the last 12 months).

5 Construction, Agritech, Transportation and Consumer durables.

- there is industry engagement at a number of levels, including through the Manufacturing Materials Advisory Board (senior executives advising on research outcome uptake, capability development, industry collaborations and IP)[6]
- there is specific focus on increasing industry participation - a Business Development Manager is tasked with expanding industry relationships, including achieving the co-funding targets, and a range of incentives are provided to companies to engage in joint projects (including increased exclusivity in exchange for a higher level of co-funding)
- there was extensive initial market research, including talking with nearly 200 companies at the outset of the project to fully understand their "pain points" and industry needs. This has been followed by in-depth R&D and business case engagements with companies and groups of companies to explore opportunities for joint work
- some mechanisms in the MSI contract itself are believed to have contributed to this success: e.g. there are specific achievement measures related to end-user engagement and value generated by such engagement over time (including specified company co-funding targets and revenue streams from commercialised products); and the contract specifically allows for the expenditure of contract monies on facilitation and processes to achieve those goals (e.g. hiring expertise to assist in linking with end users).

21. The "pull and push" model for accelerating basic research by placing it into a company product context is challenging researchers. At the same time, the disciplined approach to project management and tightening timeframes for product development is changing perceptions and conventional practices of engaged businesses. The tightening of cycle time in particular requires a higher level of collaboration between company executive and researchers, and thus a new level of trust and commitment.

22. **MSI business investment programme.** No MSI business investment programmes specifically aim to foster collaboration between firms or between firms and providers of innovation services (although funding is made available to collaborative ventures, if they apply successfully). Two initiatives (Expert Funding and the new Technology Vouchers) are aimed at fostering linkages and encouraging firms to use such services, with the expectation that increased capability in businesses may lead to further collaborative engagement (similar to the Danish innovation agents and knowledge voucher schemes).

23. There are a number of programmes managed by other departments which are aimed at increasing collaboration among researchers and users, including:
    - **Centres of Research Excellence (CoREs)** - funded by TEC
    - **NZ Food Innovation Network** (formerly FINNZ) – funded by MED
    - **Health Innovation Hub** – funded by MED.

24. We understand you have received briefings on these models recently and will not cover them in detail in this briefing. We note, however, that the initiatives are largely aimed at improving aggregation of fragmented researcher capability and improving access to infrastructure, rather than fostering collaboration among firms. In respect of the CoREs, engagement with industry varies widely and is largely dependent on the personalities and relationships of the individuals involved. The MacDiarmid Institute in particular is an example where close and enduring relationships exist between lead researchers and clients (some of which are spin-out companies formed by previous students).

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6 There is also a Science Advisory Committee (advising on science quality and direction).

Potential implications for the ATI

25. As outlined in an earlier briefing[7], rather than building significantly greater scientific research and technological development capability within an ATI, there is significant scope to build industry-led, market driven platforms and partnerships between knowledge institutions and firms. An ATI could, for example:

- support firms to make connections to the knowledge institution(s) and people that are best placed to meet their needs, whether that expertise and capability is located in New Zealand or offshore. This could extend to providing leadership and project management services for joint programmes of work, or providing funding for such activities
- play a direct role in building innovation networks within industry and with knowledge institutions, e.g. providing management, communications and other support for such networks, and being an active knowledge partner
- broker collaborations between research organisations that best serve the needs of HVMS sectors, harnessing the best system-wide capabilities and providing joined-up advice to government on R&D
- broker collaborations between industry and research organisations, and engage in these to the extent it has relevant in-house capability.

26. A number of themes emerge from the review of collaborative mechanisms in practice.

Coordinated suite of instruments required

27. Most countries recognise the importance of fostering collaboration and employ a suite of mechanisms to increasingly draw firms into collaboration, including:

- vouchers and/or advisory services to encourage SMEs to engage
- fellowships and/or other mechanisms to place scientists or graduates in businesses, to foster closer linkages and greater awareness
- active support for networks and other linkage mechanisms (conferences/symposia, workshops, newsletters, online portals)
- collaborative arrangements themselves, usually a form of contestable or competitive funding to address issues of national priority.

28. Collaborative mechanisms are closely related to and need to be considered in the context of other core policy instruments. The mechanisms share certain features, and many countries have recently introduced reforms to make them more industry-responsive. There are no universally-accepted success factors for specific programmes, and each has been adapted to fit with other successful features of the system in which they sit (including venture capital, incubator and technology park approaches).

29. New Zealand generally has some form of most of the instruments or mechanisms in use overseas. It makes sense for the delivery of future programmes (including operational design) to be managed by an agency which is closely engaged with the target businesses, and accountable for outcomes. The criteria for moving management or administration of mechanisms to the ATI, and changes to funding levels for different approaches, should focus on whether the ATI will have the best incentives to actively engage with industry to achieve the Government's objectives, and sufficient flexibility to be responsive to industry needs (particularly timeframes).

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7 *B/12/115 Key ATI Design Questions - Current Thinking*, 16 March 2012.

There is a role for increasing linkage in New Zealand

30. A key element missing in the New Zealand system is responsibility for innovation-related linkages. Vouchers have only recently been introduced, with limited (but increasing) uptake to date, and there is no specific network-formation mechanism. Some have "sprung" from the research sector, e.g. NERI and the Lighthouse Platform, but these have been initiated and supported as one-off initiatives, rather than through a system-wide channel of support, and have struggled to gain traction.

31. The ATI could usefully play a role in forming (or helping sector organisations to form) knowledge networks such as in Denmark and the UK. This would involve identifying the firms within a sector – including suppliers and customers - determining their level of interest in innovation and R&D and working with them to develop an industry-led research agenda, as well as fostering knowledge exchange. This could include both individual projects, which develop skills, and a body of knowledge, which can be useful to others (such as is happening in the Materials Accelerator); and potentially some (sub)sector good areas of research which could be supported through other instruments (e.g. Partnerships).

32. A related issue is the relative importance of large anchor/key client firms around which successful collaborative arrangements can build. While this was not discussed directly in the evaluations we reviewed, a scan of memberships showed that although several programmes aim to include SMEs, in practice, longer term arrangements include at least one large firm (and usually several) able to contribute technological knowledge and competence at a high level and commit to co-funding arrangements. This has implications for New Zealand and the ATI's ability to foster collaborations in certain subsectors, given our industrial structure and the small number of firms who could play this role. It heightens the likely need for the ATI to look overseas in seeking to build collaborative innovation arrangements.

Industry/end-user engagement is important

33. Consulting industry on the coverage and design of programmes will increase the likelihood of business participation. The most successful models have industry and other stakeholders formally engaged in planning, implementing and monitoring progress.

34. There is a need to consider the role and engagement of end-users and, in particular, how "upstream" that involvement is to be – e.g. in ATI governance or advisory arrangements in general, as well as on developing programme parameters and then participation in the programmes themselves.

Programmes should recognise different needs of sector segments

35. Successful collaboration doesn't start from day one – there needs to be an initial investment in raising awareness of the benefits of collaboration and on developing a common language and trust between prospective participants. This process is time and resource-intensive, and requires high-calibre experienced individuals who are able to understand the needs of the particular business or group of businesses. The Materials Accelerator is believed to have benefited from the specific recognition of the need to fund active pursuit of business engagement.

36. The ATI will need to have sufficient funding to undertake this role (either through core funding or devolved funding e.g. from MSI current programmes). There also needs to be clarity about the role of the ATI in this space and its distinction from other programmes (while overseas jurisdictions often have similar issues with overlapping programmes, there are clear signs of "business development manager fatigue" among New Zealand firms).

37. There are no clear signals from overseas experience to inform the relative funding emphasis to be placed on different instruments. However, improving linkages and stimulating demand for collaborative engagements does successfully lead to the delivery of industry-relevant

innovation activity, in comparison with New Zealand's track record of "science-push" funding. This supports the argument for operational funding to support linkage activity, and increased emphasis on contestable or otherwise demand-led funding for collaborative R&D projects.

Funding mechanisms/contracting approaches supportive but not sufficient

38. Public funding alone tends to be insufficient incentive for firms to become involved in R&D collaboration with public sector research organisations. Firms will be deterred if administrative requirements are too burdensome and time-consuming. Arrangements for IP management need to be clear from the outset, and will improve the chances of high engagement if they are broadly favourable to firms.

39. Certain approaches to funding programmes appear to have improved the likelihood of success, including making continued funding contingent on demonstrating success in business engagement, and in some cases also commercial outcomes. Most programmes overseas are time-limited, with at least a mid-term review, although only one has a mandatory end date. The "fast failure" approach of CSIRO, where path to impact is regularly reviewed, is an interesting model.

40. Responsiveness is a key issue highlighted in discussions with New Zealand businesses. Some overseas institutions have the flexibility to make decisions on programme parameters and/or approve specific proposals, but not all. The level of flexibility – including rules around IP management - will need to be considered for the ATI in the context of its overall mandate and scope of operations.

Calibre and motivation of individuals is critical

41. Possibly the most important factor in achieving success is the motivation and personal relationships of individuals involved on both sides. The extent of business engagement realised in practice (demonstrated by the level of external contract revenue) has varied widely within the different programmes depending on personalities, the excellence of specific researchers, and relationships between individuals as well as the relevance of the research.

42. The success of the ATI in fostering both linkage and collaboration will therefore depend to a large degree on the calibre and experience of the people recruited to lead the organisation and to carry out the business-facing roles. There are some examples of performance measures and contractual obligations which can provide additional incentives at an organisational level.

43. While not directly related to collaborative arrangements, close and innovative arrangements with universities (particularly engineering schools, as in Waterloo, Canada) and international linkages would make the ATI more vibrant, up to date and relevant, enhancing its reputation and thus supporting its leadership role as well as contributing directly to its ability to provide services to its customers.

Next Steps

44. Work is currently under way to explore the potential demand of New Zealand's HVMS firms for a range of services that could be provided by the ATI, including demand for facilitation or leadership of collaborative arrangements. We will brief you when that work is complete (expected mid-April).

45. We are happy to discuss the contents of this briefing with you or provide further information if you wish.

Communications

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

Annexes

Annex One: International models of collaborative arrangements

Annex Two: International initiatives designed to prepare firms for collaboration

Annex One: International models of collaborative arrangements

47. There are a number of models in use overseas designed to promote and foster development of collaboration among firms, and between firms and knowledge institutions, which could provide insights into how an ATI might operate to achieve these goals. The examples below have been chosen to demonstrate a range of different approaches to achieving these goals[8].

48. A useful distinction can be drawn between "science-science" collaborations, where research organisations work together to address a common issue, and "science-business" collaborations (i.e. where businesses are participating in governance and/or through cash or in-kind contributions to a joint programme or project – not just direct contracting of R&D services). The distinction is becoming blurred as the first types of programme are increasingly required to involve or be driven by end-users. This review focuses primarily on science-business collaborations.

49. The international examples included are:

- Denmark (Innovation Consortia and Networks)
- Finland (Strategic Centres for Science, Technology and Innovation)
- Norway (Centres of Expertise, Centres for Research-based Innovation)
- Belgium (IMEC centre)
- Canada (Business-Led Networks of Centres of Excellence; Waterloo ecosystem)
- United Kingdom (Catapult centres)
- Australia (CSIRO Flagships & Collaboration Fund; CRCs; IBES).

Denmark

50. The Danish Council for Technology and Innovation (DCTI, an independent council reporting to the Minister of Science, Technology and Innovation) administers two main programmes to support collaboration.

51. **Innovation Consortia**. Begun in 1995, this co-funded scheme supports joint projects aimed at completing high-quality industry-relevant research that will be subsequently spread widely to the Danish business community, particularly SMEs. Each consortium must include at least two businesses which participate throughout the entire project, a research institution and an advisory and knowledge dissemination party. The role of the participating enterprises is to ensure the project is relevant to Danish business needs and the project is informed by business knowledge and competences; projects cannot be aimed at product development for individual businesses. Businesses must contribute a minimum 50% of total project costs. About half of participating businesses to date have been in manufacturing, with 25% in financial or business services and 15% in trade and retail.

52. The scheme costs around EUR 16 million annually. The budget of an average consortium is around EUR 3-7.5 million, of which the DCTI funds 40 percent on average, and projects last between 2-4 years. Application and reporting processes are kept deliberately light-handed,

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8 Please note the examples are not intended to provide a comprehensive picture of the systems in place to support HVMS innovation in the selected countries, but focus on specific mechanisms to foster collaborative innovation. *B/12/051 International Models of Innovation Support for High Value Manufacturing,* 20 February 2012, provided fuller information on institutional approaches used by a selection of other countries including Denmark, Sweden, Finland, UK, Korea, Taiwan, Singapore and Queensland, Australia. With the exception of Korea, all these models included facilitation and coordination of knowledge transfer as one of their functions.

with the university or GTS-institute dealing with application, annual reporting on an exceptions basis and a mid-term stop-go evaluation of each project. A recent DASTI[9] analysis of the scheme found that small business consortia participants experienced significant growth in profits and employment.

53. **Innovation networks**. This national programme (22 networks as at July 2010, annual budget EUR 10 million) is intended to foster collaboration between enterprises, research institutions and non-profit advisory/knowledge dissemination parties. Networks are nationwide in coverage, focusing on a particular subject area (there are networks for a number of industries including transport, food, production and materials, services, and there can be more than one within an industry - e.g. there are separate networks for aluminium, plastics and polymers, and robotics). The programme funds up to 40% of a network's annual costs, with at least 40% financed by enterprises and the remainder by regional sources, universities, technological/research institutes and the EU. Networks are funded for 4 years, with the potential to add additional 4-year periods in a contestable process.

54. The networks are largely a linkage mechanism, but some funds are used for specific projects. They facilitate a range of partnership projects including pre-projects (collaborative work to e.g. map market potential, or small-scale trials); R&D projects; and business partnerships (businesses working together on specific challenges or opportunities – no knowledge institutions participate). An impact study in 2011 found that network participation increased the likelihood of R&D collaboration by 4 times, and the probability to innovate by more than 4.5 times, after one year of participation.

55. A key role of the networks is to ensure smaller enterprises both participate in the networks, but also that they are aware of and make use of other innovation policy initiatives (including consortia and vouchers). A 2011 report found the use of such other programmes was three times higher among network participants than among similar enterprises not participating.

Finland

56. Over 2007-09 the Government set up six **Strategic Centres of Science, Technology and Innovation** (SHOK), where companies and research units work closely on jointly defined research. The focus areas are forestry, metal products/mechanical engineering, build environment, ICT, energy and environment, and health and well-being. Each centre is co-ordinated by a not-for-profit company, jointly owned by the shareholders (generally around 30-60 shareholders including companies, research organisations, funding agencies and different interest groups), and a virtual research organisation whose activities are based on a mission and strategic research plan drawn up by the partners.

57. As an example, the metals and engineering SHOK (FIMECC) has 32 shareholders; 11 "class A" shareholders own 5.2% each, including VTT (the Finnish technical institute) and corporates including ABB, Kone and Cargotec. Other shareholders include universities and research institutes as well as corporates. FIMECC's five research themes are service business, user experience, global networks, intelligent solutions and breakthrough materials. At the end of 2011 it was running eight research programmes under these, involving more than 110 companies (of which about half were SMEs).

58. Research carried out by the SHOKs is strategic, pre-commercial, and as a rule not associated with short-term market goals. As the time span of research usually is five - ten years at minimum, competitors may take part in the same programmes. SHOKs are open innovation environments, where controlled sharing of IP is managed. However, cluster projects that draw on research programme outcomes are confidential.

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9 Danish Agency of Science, Technology and Innovation (part of the Ministry of Science, Innovation and Higher Education).

59. Companies are expected to fund around 40% of the research costs; public funding organisations have committed to funding set up and research costs over the long term. Tekes (Finland's research funder) contributes to the research programme and projects and participates in the coordination of the centres as a whole and in the cooperation forum between the centres, but is not a shareholder or a contracting party. Some EUR 40-60 million is invested in research annually in each centre.

Norway

60. In the last decade Norway has seen an extensive effort to establish different arrangements specifically in order to strengthen the links between industry and the knowledge infrastructure. Two key measures are the Centres for Research based Innovation (CRI) and the Centres of Expertise programme.

61. **Centres of Expertise (NCE)** were established in 2005 to boost support to existing industrial clusters seen to have the capability and ambition to become leading international players. The programme is jointly funded by the three innovation agencies and administered by Innovation Norway. There are currently 12 NCEs across a range of areas including aquaculture, maritime, subsea, micro and nanotechnology, systems engineering and energy and emissions trading. As an example, the Maritime cluster includes 12 design companies, 17 ship owners, 13 ship yards and 161 equipment suppliers employing 21,000 dedicated employees based in the west coast region of Møre. Each cluster is funded for ten years to give companies the opportunity to initiate targeted, long-term development processes.

62. A 2009 evaluation of the first six projects in the programme found there had been benefits in increased competence through networking, but that more could be done to support innovation. In particular the report found a need to ensure demonstrable short term gains from collaboration as well as longer term competence building, and to introduce structured, robust indicators and reporting to balance clusters' flexibility in determining their work programmes.

63. **Centres for Research-based Innovation** are intended to enhance innovative capability by forging alliances between research-intensive enterprises and prominent research groups for long-term research projects, in areas where there is potential to develop cutting-edge research. A particular goal is to increase the attractiveness of Norway as a R&D location for international companies. The host institution may be a research organisation or an enterprise with a strong research capability, and must be a leader in the discipline or industrial area that is the subject of research. Each centre must have at least three user partners (companies), which must take active part in the centres' management, financing and research.

64. As an example, the centres hosted by SINTEF (Norway's technology institute) include concrete, aquaculture technology and future manufacturing; those hosted by other organisations cover a range of medical discovery and device areas, and diverse other areas including integrated oil drilling processes, sustainable fish capture and processing technologies and natural gas processes and products. The future manufacturing centre hosted by SINTEF has NTNU as its research partner and will undertake continuous product development in areas including the vehicle, aviation and engineering industries, the food industry, electronics, defence (munitions), furniture manufacture, and textiles. Among the 12 company partners are two large firms (turnover EUR 173 and 367 million[10]) and one very small (EUR 6 million); most are between EUR 30-70 million.

65. Following a competitive process, 14 centres were set up in 2006 and a further seven appointed in 2010. A centre is financed for five years, with the possibility of one extension for a further three years (after which the centre is to be disbanded). Each centre receives an

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[10] From completely different sectors, i.e. ammunition and furniture manufacture.

allocation from the Research Council of around US$1.5 million per year, which must be at least matched by the host institution and partners together (companies must contribute at least 25% of total costs).

66. The mid-term evaluation conducted in 2010 (which extended funding for all 14 initial centres) found them overall to be well supported by all participants and engaging in application-oriented research that has demonstrably benefitted supporting industries and organisations.

Belgium

67. The **Interuniversity Microelectronics Centre (IMEC)** was set up in 1984 to link the developing microelectronics capabilities in Flemish universities and do more application-oriented research than was possible in the universities themselves, given the high cost of the research infrastructure required. Flemish industry at that time included a strong presence by Philips as well as a number of companies using micro-electronics. Nonetheless IMEC recognised the need to operate at an international level to build enough critical mass and resources to be world-leading, and to offer solutions that were relevant for industry.

68. To start this process, IMEC organised collaborative, precompetitive innovation with companies, sharing the risks and rewards. It developed a business model that brought together multiple industrial partners on a one-to-one bilateral contract basis, to explore and develop the knowledge and capabilities needed for next generation design and process technologies. In 2004/05, IMEC established a state of the art pilot line costing some EUR 400 million, co-financed by its industrial partners and the regional government. IMEC is now one of the few independent microelectronics research laboratories worldwide to possess such a facility, providing it and its partners a unique advantage.

69. IMEC's customers range from top-ranking microelectronic chip manufacturers and other major international companies, to suppliers of equipment, and a number of higher education institutions and other companies to whom it provides education, training and prototyping services. Working closely with universities is a key component of IMEC's success; over 200 PhD students work at IMEC premises and around 30 IMEC staff members teach part-time at partner universities. In 2005 it founded an open innovation centre in the Netherlands (with support from the Dutch Government, now with 20 research partners and a research staff of 185 people from 25 countries), and in 2008 a further centre was opened in Taiwan.

70. IMEC receives a yearly "grant" from the Flemish Government, for which it is expected to provide a number of benefits to the regional economy. In 2009 it received EUR 53 million in subsidies from the regional and national government, and earned EUR 212 million in contract revenues and a further EUR 10 million through conference income, in-kind contributions and other miscellaneous sources. It works with over 600 businesses and 175 universities worldwide.

71. A recent study[11] concluded that the IMEC example illustrates that:
    - internationalisation of the customer base brings learning advantages and can help an institute build world class capabilities, despite having a small geographic home market
    - it is possible to build to high levels of foreign income, bringing a high leverage effect for taxpayers
    - as a result, a small country can benefit from knowledge services of a size and quality well beyond what it could finance domestically.

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11 *A Step Beyond: International Evaluation of the GTS Institute System in Denmark*, S. Sörlin (Panel Chair), 18 March 2009.

Canada

72. In 2007/08, the Canadian Government invested CAD 46 million over four years in co-funding Business-Led Networks of Centres of Excellence (building on a successful existing academic-led programme). The BL-NCEs are headed by industrial consortia, and focus on increasing private sector investment in Canadian research and optimising the timeline between research and commercialisation stages. They must be partly co-funded by business, must complete their proposed activities within four years and are not eligible for a second term of funding.

73. A very successful **regional programme** is run in **Waterloo**, Ontario, a small region (population 500,000) which in 20 years has become the second-largest generator of start-up companies in North America (behind only Silicon Valley). At the heart of the system is a co-operative arrangement whereby students at the university undertake alternate semesters in academic programmes and the private sector (being paid as interns). This extends to all faculties, and although it means students take an extra year to complete their degrees the courses are oversubscribed fourfold because the employment outcomes are very good. Other key features include:

    - the university actively promotes student entrepreneurship at every level, making no claim on IP generated by staff or students other than providing protocols of how it should be managed
    - in engineering, multi-year teams of students are made up to encourage mentoring and collaboration supported by faculty to engage in various competitions (e.g. building a solar-powered car). The resulting enormous entrepreneurial thinking in students is then supported through various incubator/accelerator facilities on and off campus; the university-owned science park now has some of the most research intensive companies located in it, as well as national and private research laboratories.

United Kingdom

74. The Technology Strategy Board (TSB) was established in 2007 to drive innovation in the UK. It funds a number of programmes designed to promote collaboration, including a collaborative R&D annual contestable funding round, and very recently has begun to establish a network of technology and innovation centres (Catapults).

75. The **Collaborative research and development** programme is designed to assist the industrial and research communities to work together on R&D projects in strategically important areas of science, engineering and technology. Annual competitions have been held for funding collaborative R&D projects since 2004 (similar to MSI's investment rounds), and by June 2007 a portfolio of over 600 projects was being supported with a combined business and government investment in excess of £1 billion.

76. The programme is of interest because its scope has recently been expanded to include **Demonstrators**: business-led projects to demonstrate new products or services in the real world and at scale, such as in low carbon vehicles and social housing retrofits. The most recent programme is a four-year, £23 million programme aimed at delivering assisted living, with a target of establishing five communities of at least 10,000 people each for the demonstrator work.

77. **Catapults** are a new initiative, designed to transform the UK's capability for innovation in specific technology areas. The UK Government has committed £200 million over the next four years to establishing the network, which is to provide access for business to the best technical expertise, infrastructure, skills and equipment, which businesses cannot afford to invest in on their own. The intention is to provide significant, coordinated, long-term public investment and a competitive element to ensure the centres remain relevant and valued by

business; in a steady-state, the centres are expected to be funded one-third core funding, one-third from competitive grants and one-third from business contracts.

78. The objectives and intended functions of the Catapult centres sound very similar to that intended for the ATI (although in structure they are similar to our CoREs). Each centre will focus on a specific technology with substantial global market potential and where the UK has significant capability. They are intended to:

- create a critical mass for research and business innovation and help commercialise the outputs of Britain's research base
- allow businesses to access equipment and expertise, as well as conducting their own in-house R&D
- help businesses access new funding streams and point them towards the potential of emerging technologies.

79. The first Catapult, in high value manufacturing, opened for business in October 2011[12]. Seven research institute partners are bringing together complementary expertise to provide an integrated capability embracing all forms of manufacture using metals and composites, in addition to process manufacturing technologies and bio-processing. In November a new National Composites Centre was opened as part of the Catapult, a £25 million investment shared by the Government, local EDA and the European Regional Development Fund.

80. The NCC is hosted and owned by the University of Bristol, and located on the Bristol and Bath Science Park. Its Steering Board comprises the university and six Tier 1 members (AgustaWestland, Air-bus, Rolls-Royce, GKN, Umeco and Vestas). The Tier 1 members have committed to almost £5½ million of work over three years, with further funding commitments from SMEs. (It is not clear to what extent these commitments were in train with the individual research organisations prior to this initiative.)

Australia

81. An earlier briefing[13] outlined a range of government mechanisms designed to incentivise collaborations and linkages with users, including:

- CSIRO's **National Research Flagships** were introduced in 2003 to address complex challenges by forming large-scale multidisciplinary research partnerships with Australian universities and publicly funded research institutions, the private sector and selected international organisations. Areas covered include climate adaptation, sustainable agriculture, future manufacturing, light metals and minerals exploration. Companies can participate in several programmes, across flagships – e.g. in 2009 CSIRO entered a four-year, $25 million alliance with Orica Ltd. which will cover research in three flagships, including future manufacturing. Projects appear to be largely one-on-one with major commercial partners (e.g. within the future manufacturing flagship, CSIRO is working with Boeing on paint, Olex on fire resistant cables, and Biofiba on biodegradable shipping pallets).

  Engagement with industry is reinforced by each Flagship's Advisory Committee, comprising a range of stakeholders and ensuring the research programme is responsive to industry strategic research needs. In 2005, a separate Collaboration Fund was added to the programme, specifically to draw in university expertise. In 2010/11, the Flagships

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12 Four more Catapults, in cell therapy, offshore renewable energy, space applications and connected digital economy, are due to open during 2012.

13 An earlier briefing, *B/12/028 Overview of Australia's Science System,* 13 February 2012, provided an overview of the Australian science system.

programme earned revenue of A$201.7 million from external partners (38% of total investment).

Shortly after the Flagships were established CSIRO radically changed its mode of operation from a previously siloed structure, to a coordinated matrix leadership and management structure capable of supporting the thematic research programmes and cross-organisational management structures of the Flagships. It also introduced a "fast failure" research management process focused on achieving impact (whereby projects are regularly reviewed against both science quality and path to impact, and can be stopped and resources redirected if the path to impact is compromised).

- **Cooperative Research Centres (CRCs)** are organisations formed through collaborative partnerships between publicly funded researchers and end users. CRCs must comprise at least one Australian end-user (either from the private, public or community sector) and one Australian higher education institution (or research institute affiliated with a university), and can be incorporated or unincorporated. Funded by the Department of Innovation, Industry, Science and Research, the CRC model is similar to MSI's Partnerships, but includes a formal teaching component.

  Applications are called every 2 years, and there are no restrictions on the number of seven-year funding terms a CRC can seek. Participants in the CRC must provide cash and in-kind contributions that at least match the funding from the programme over the period (although the timing of contributions can vary)[14]. Applications are assessed by the CRC Committee (drawn from industry, research providers and government agencies), with final decisions made by the Minister for Innovation, Industry, Science and Research. Sector participation has been dominated by primary industries, particularly in agriculture and mining.

  A 2008 review noted considerable change in the focus of CRC research activity over time, with the initial focus on national research objectives and capability being replaced by end use driven research, and particularly research with commercial potential. Industry submissions noted duplication, fragmentation and administrative complexity, and in particular major contention over IP protection and ownership as CRCs sought to generate commercial income (thus potentially competing with their own members). The review highlighted that the emphasis of CRCs should be on end user uptake rather than commercialisation by the CRC itself.

82. A state initiative of interest is the **Institute for a Broadband-Enabled Society (IBES),** a CoRE-like, university-hosted interdisciplinary research institute dedicated to innovations in broadband technologies, applications and end user experiences. Its primary focus is to seek out and develop opportunities for collaborations between members of the University of Melbourne's research community and researchers in other universities, other research organisations, and industry. Founded in July 2009, IBES currently supports 53 research projects and is becoming a focal point for research and innovation across the full spectrum of social, business and technological activities associated with and influenced by the Australian National Broadband Network.

83. IBES is jointly funded by the University of Melbourne and the Victorian State Government, through the Department of Innovation, Industry and Regional Development (funding has recently been renewed for a further three years). It receives cash and in-kind support from industry partners (around $2.2 million in 2010/11, from a diverse range of organisations including equipment vendors, service providers, ICT companies and local SMEs), and additional funding from external sources and consultancies. The Industry Partner Program has generated research that has resulted in collaborations as well as internationally awarded

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14 CSIRO has been the largest single participant in the CRC programme, although its focus has now moved its own Flagships. The CSIRO submission to the 2008 Review said "our collaborations are becoming much more top-down, purposeful ones… rather than the bottom-up, self-assembling that characterises most CRC bids."

work; the development, testing and showcasing of new applications and technologies in the Broadband Applications Laboratory (see below); the sharing of expertise between industry and academia; research outputs including publications of white papers; as well as driving broadband debates.

84. The IBES Broadband Applications Laboratory includes equipment donated by Industry Partners, and provides a "sandpit" environment for the development of new broadband ideas and service offerings. The laboratory includes a state-of-the-art broadband network that supports the development and testing of new ideas in a real-life environment, ranging from configuring applications vertically through the technology stack through to assessing end user reactions to new services and applications. The laboratory provides:

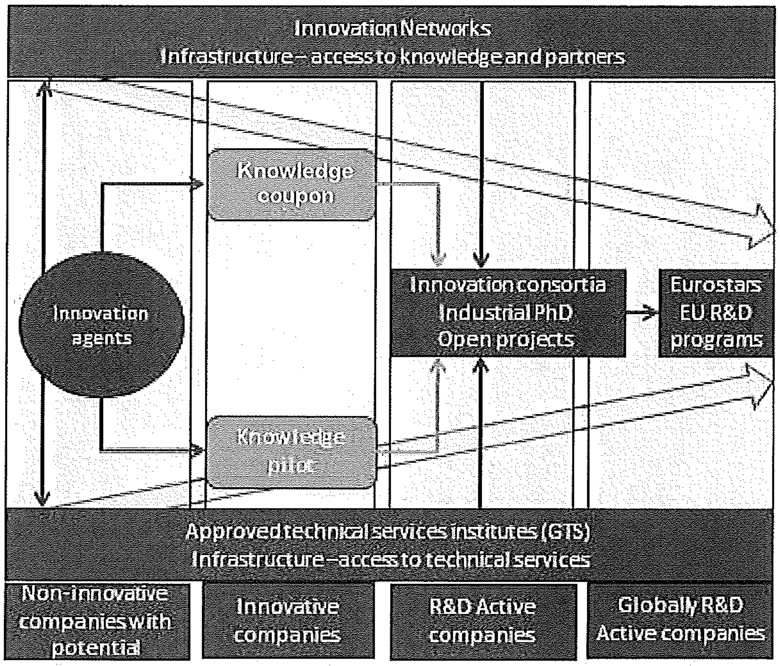
- access to the test facility and its equipment, including end user devices and test gear
- advice on the best use of technology for different applications
- hosting of applications
- limited software resources to assist with application development.

Annex Two: International initiatives designed to prepare firms for collaboration

85. As outlined in the paper, many innovation systems include mechanisms designed to prepare and interest firms in undertaking collaborative R&D. A number are included here to illustrate how the instruments work together.

Denmark

86. The Danish innovation system includes a number of programmes to support collaboration, including innovation agents and vouchers in addition to the networks and consortia discussed in Annex One. Other than the innovation agents, these programmes are administered by the Danish Council for Technology and Innovation (an independent council reporting to the Minister of Science, Technology and Innovation). The programmes work together to support businesses at different levels of innovation preparedness and capability, as shown in the following diagram:



87. **Innovation agents** and **knowledge vouchers** are both aimed at stimulating SMEs to innovate and work with knowledge institutions, as a precursor to more formal collaborative arrangements – i.e. they generally serve to make SMEs "collaboration-ready".

- The **Agents** programme has been running since 2010, and now includes 35 agents representing all nine GTS institutes (of which DTI is one, and also manages the programme). Agents target primarily innovation inactive or irregularly active SMEs, spending up to 20 hours on an innovation audit and follow up (including referral to the most appropriate knowledge institution).

  The programme is resource intensive to establish and maintain, requiring joint infrastructure (e.g. CRM) among the institutes involved, close working with all universities, networks and EDAs to ensure appropriate referrals, and highly skilled individuals to act as agents. However, DTI reports a reasonable success rate, with around 75-80% of SMEs subsequently being more engaged, and believes the programme is effective in creating opportunities for project partnerships across the institutions with groups of companies.

- **Vouchers** were established in 2008, and are based on (and similar to) the Netherlands Vouchers Scheme, and served as the model for MSI's own technology voucher scheme. Over the two years 2008-2010, 700 basic vouchers (subsidy EUR 9.6 million) and 35 extended vouchers (subsidy EUR 3.25 million) were approved.

  There are two types of voucher. A basic voucher provides state co-funding of 40% (to a maximum of around EUR 14,000), to enable the successful transfer of research knowledge to a SME. An extended voucher provides state co-funding of 25%, to a maximum of around EUR 67,000[15], to find a new solution to current problems. For the extended voucher, the knowledge institution must carry out the research on the field in question. A mid-term evaluation of basic vouchers in 2009 found that half of participants (on both sides) had increased their motivation to establish long-term cooperation relations, and the majority of businesses intended to enter into future collaboration projects with research and technological institutions.

United Kingdom

88. **Knowledge Transfer Networks (KTN)** are overarching national networks in a specific field of technology or businesses, bringing together experts from business, universities, finance and technology organisations. Funded by government, industry and academia, they provide activities and initiatives that promote the exchange of knowledge and the stimulation of innovation in these communities. There are currently 15 KTNs in operation, sharing an online portal funded by the Technology Strategy Board.

89. A comprehensive review in 2008 reported that 75% of businesses rated KTN services as effective/highly effective. Over half had developed or are developing new R&D or commercial relationships with people met through a KTN. The most highly rated functions of KTNs are monitoring and reporting on technologies, technology applications and markets, networking opportunities, and identifying and prioritising key innovation-related issues and challenges.

Australia

90. In 2008 DIISR established **Enterprise Connect**, an A$250 million investment in 12 centres across the country to provide business improvement advice and support to SMEs. Eligible businesses can request a comprehensive Business Review free of charge. Following a review, firms can access the Technology and Knowledge Connect service (also free), which is similar to the innovation audit offered in Denmark. The TKC will:

    - diagnose firms' technology and technical knowledge related issues/opportunities (i.e. processes, plant and equipment)
    - connect firms to the most appropriate domestic and international sources of expertise, suppliers of technology and technical knowledge advice
    - assist businesses to access prototyping and testing facilities
    - provide advice about other relevant innovation grant programmes.

91. EC also offers a *Researchers in Business* grant, whereby it funds up to 50% of the cost of placing researchers from universities or public research agencies into businesses for 2-12 months, to help develop and implement a new idea with commercial potential.

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15 Following a review in 2010 and discussion with key actors, the basic voucher co-funding was reduced to 40% from 50%, and the maximum co-funding for extended vouchers was reduced from around EUR 200,000 to EUR 67,000. Similar changes were recently made to New Zealand's scheme, to increase accessibility and uptake.