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SME access to medical imaging infrastructure

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Small business access to medical imaging infrastructure

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Jerad Ford is the Ernst & Young / Australian Institute for Business and Economics Research Fellow in The University of Queensland Business School (UQBS). His PhD research focused on the development of novel product innovations in the oil and gas sector of Australia. His research interests include inter-organisational collaboration and open innovation and how these relate to novel product and service outcomes. Prior to joining UQBS, Jerad spent ten years at the world's largest independent research and development (R&D) firm, Battelle. While at Battelle, he served as a business developer and research manager supporting the sale and execution of a diverse set of applied R&D projects spanning defence, oil and gas, and renewable energy sectors. A major part of his role involved the development of R&D strategies for clients, including the articulation of technology platforms, and R&D plans and programs.

Contents

1. Executive summary

This report takes the national imaging facility (NIF) as a case study in how small and medium-sized enterprises (SMEs) gain access to national public research infrastructure. In May 2015, further funding for NIF was announced under the National Collaborative Research Infrastructure Strategy (NCRIS) with $2.93 million committed for 2015–2016. However, the Boosting Commercial Returns from Research discussion paper released in late 2014 identified industry collaboration as an important part of NCRIS and has resulted in member institutes and universities refocussing their strategies for SME engagement[1,2].

This paper identifies three key areas of concern that currently serve to limit the level of engagement by SMEs with NIF research nodes:

1. Building better and **stronger networks**
2. Lowering **barriers to engagement** at the NIF nodes, including reconciling competing motivations of SMEs and academic institutes
3. **Consistent funding** for early stage pre-clinical feasibility research.

First, there is a challenge of making new connections and building collaborative networks within the emerging innovation system. A major component of this is the lack of knowledge in industry about NIF node capabilities. SMEs are often unaware of the capabilities available in the NIF and do not have the resources (e.g. time, attention) to search for them.

Based on 36 interviews with researchers, SME managers and industry experts, this research suggests that NIF nodes must prove their relevance to the industrial base and this is the primary lever to increase SME engagement with public research infrastructure. Fruitful research collaborations will result from investing in outreach to build brand identity and establish critical inter-personal connections that will lead to new research ideas. This will require increasing the attendance levels at practitioner-focused symposia and direct investments in business development activities at NIF nodes.

A second set of problems is associated with engagement. Once potential SME partners are identified there are several barriers standing in the way, including the high cost of access, lack of incentives for engagement and inflexible IP strategies which serve to dissuade SME engagement. More flexible IP strategies, tiered cost structures, introductory rates, research open days and the use of spare capacity to facilitate small research projects are all ways that nodes can ‘shake up’ the current paradigm and inculcate a more collaborative and open environment that might lead to interesting technological development projects. A few of these points are worth elaborating here. Nodes need to be *particularly* careful not to dissuade SME engagement by taking overly aggressive IP stances.

In the early development stages of technology this means not demanding ownership of project or foreground IP when there is little actual knowledge of the commercial value of the research. Similarly, in later stages of development, institutes have opportunities to perform fee-for-service work which is not an opportunity to create IP. Pragmatic and reasonable approaches to IP are required to draw SMEs into collaborations. Approaches to IP should primarily be business rather than legal discussions. In terms of capabilities, there is a dearth of research staff working under the facility fellows (and, in some limited cases, inadequate equipment) which is a capacity issue that limits nodes' ability to engage in more industry projects. Another aspect of the engagement problem for academic researchers is incentives that are not aligned toward translational research. This, in turn, creates an inwardly-focused culture when an outward-facing culture is required to engage with industry partners in a timely manner. Changes are needed to make commercial engagement more rewarding in terms of career progression for academics. More fundamentally, in terms of their approach to engaging SMES, institutions need to recognise the potential for many different types of engagement—each requiring different business stances. For instance, early-stage and 'tangential research' (i.e. ARC linkage grants) opportunities with SMEs offer greater potential for discovery and high intellectual property (IP) generating potential for institutional players.

However, SMEs have the most trouble sourcing funding at this stage and the onus is on the institute to secure and manage such projects while, at the same time, ensuring that they are keeping SMEs well informed about progress and direction. Later stage commercialisation efforts offer opportunities for fee-for-service work which has low IP potential for the institutes but are something that SMEs favour (now at a later stage of development with a better funding profile) and for which they can pay commercial rates. These income streams could subsidise other early-stage and tangential research opportunities.

The third issue is funding and this transcends NIF and directly concerns the health of the bio-medical innovation system in Australia and the role of the Department. The SMEs we interviewed consistently pointed to the severe gap in funding for early pre-clinical technology feasibility. To remedy this problem we recommend more consistent government support in the form of small grant schemes in the order of $10,000–$100,000 that do not require matching funds. The ethos behind these grants should be short proposals, quick review cycles and quick awards. There is a successful model for this type of grant in the USA called the Small Business Innovation Research (SBIR) that has been independently verified by researchers as providing excellent returns for public investment[3–6]. Currently ARC linkage and NMHRC schemes operate on time frames that are much too long, with highly uncertain outcomes and low probabilities of success. Matching fund requirements are a deterrent. In combination, this serves to deter SMEs with limited resources

and great ideas. Smaller and more quickly awarded grants would allow SMEs to quickly work through new technology ideas and jumpstart commercialisation efforts. In this vein, small *block grants* that are tied to the use of NIF facilities would be one way of remedying the dearth in funding at critical early stages and to directly increase SME engagement with the nodes. Finally, the Department should aggregate the disparate funding schemes maintained at the state and federal level into an up-to-date web portal to help SMEs find current funding sources. This portal should also help connect SMEs to venture capital.

An important point to make about this research is that we did not limit our interviews to SMEs that currently use NIF resources. Instead, we targeted SMEs in the bio-medical industry that may or may not have direct need for imaging per se, but that do have a need to engage with research institutions to drive innovation activities by accessing equipment and capabilities.

From this approach we can see that the tendency to engage with institutional players like those represented by NIF nodes, and the barriers facing SMEs, are a more pervasive challenge than those facing just NIF. The findings from this report should have applicability across the broader investments made under NCRIS.

2. Background and scope

Access to government-funded advanced scientific infrastructure (e.g. equipment, facilities and staff) is a way that small and medium-sized enterprises (SMEs) and start-ups can jumpstart and extend their innovation activities. Since SMEs comprise most economic activity in Australia, connecting these businesses to government-funded advanced scientific infrastructure is important to the proper functioning of the Australian national innovation system as a whole.

This report sought to uncover the current state-of-play with regard to SME engagement with national imaging facility (NIF) research nodes. The report identifies hurdles preventing collaboration and suggests potential pathways for increasing collaboration levels. The report takes a broad-based perspective with regard to small business engagement with government- funded infrastructure. It is based on interviews with many entities, including those directly involved with NIF nodes.

We interviewed small-business executives, industry trade group leaders, as well as NIF node directors and facility fellows in order to paint a clearer picture of the status of SME engagement and the potential rewards and challenges.

The report is not intended to be a prescriptive document. It seeks to identify engagement successes / shortfalls that represent potential areas to leverage / improve. We do not aim to make prescriptive recommendations about how SME engagement should be 'fixed', but rather to provide material for subsequent policy discussions within the NIF administration, NIF nodes and the Department of Industry, Innovation and Science. SMEs may also find it useful to help them understand how other firms view engagement with research entities like those represented by the NIF nodes.

3. Approach and Research Method

The research is interview-based qualitative assessment. Consultations with the stewards inside institutions that house government-funded equipment were organised to gain an 'inside out' perspective on the issue of SME engagement. Significant research effort was dedicated to obtaining an 'outside in' perspective from various small businesses in the biotechnology and medical fields that are either directly involved with NIF facilities or that could potentially be. A list of the final set of interviews is shown in Table 3.1.

Table 3.1: Interviews conducted

	Name	*Role(s)*	*Organisation(s)*	*Type of org.*	*Service(s) / product(s) / Knowledge area(s)*
1	Peter Beven	Corporate Educator	QUT Business School	Research institute	Strategy, business planning, innovation and entrepreneurship
2	Helen Chenery	Executive Dean, Health, Science and Medicine	Bond University	Research institute	Language neuroscience, Research management
3	Steve Wesselingh	Executive Director	South Australian Health and Medical Research Institute (SAHMRI)	Research institute	Health and medical research imaging
4	Perry Bartlett	Director	Queensland Brain Institute	Research institute	Molecular neuroscience, research management
5	Annie Chen	Scientific & Engagement Manager	National Imaging Facility (NIF)	Research institute	Research infrastructure administration
6	Susan Porter	Manager	Preclinical, Imaging & Research Laboratories (PIRL) section of the South Australian Health and Medical Research Institute (SAHMRI)	Research institute	Research management, veterinary pre-clinical imaging
7	Anonymous	Facility Fellow	National Imaging Facility (NIF) Node Anonymous	Research institute	Imaging, radiology
8	Karine Mardon	Facility Fellow	National Imaging Facility (NIF), Centre for Advanced Imaging (CAI)	Research institute	Molecular Imaging
9	Anonymous	Facility Fellow	National Imaging Facility (NIF), Node Anonymous	Research institute	Cyclotron and radiochemistry
10	Rebecca Osborne	Deputy Director	National Imaging Facility (NIF) Centre for Advanced Imaging (CAI)	Research institute	Lead node in the NIF network
11	David Reutens	Centre Director	National Imaging Facility (NIF), Centre for Advanced Imaging (CAI)	Research institute	Major facility in the NIF network
12	Ian Brereton	Node Director	National Imaging Facility (NIF), Centre for Advanced Imaging	Research Institute	Research-funding, commercialisation, industry engagement strategy
13	Dr Tim Kuchel	Node Director	National Imaging Facility (NIF), Large Animal Research Imaging Facility (LARIF)	Research institute	Large animal imaging research
14	Anonymous	Area Director	South Australian Health and Medical Research Institute (SAHMRI)	Research institute	Small animal studies
15	Prab Takhar	Director	Molecular Imaging and Therapy Research Unit (MITRU) of SAHRMI	Research institute	Radio pharmaceuticals research and development and products
16	Lawrence Bremner	Deputy Director, business and partnering	Centre for Integrated Preclinical Drug Development (CIPDD) / TetraQ Pty Ltd	Research Institute	Therapeutic drug development and commercialisation, entrepreneurship, innovation, venture capital

	Name	*Role(s)*	*Organisation(s)*	*Type of org.*	*Service(s) / product(s) / Knowledge area(s)*
17	Amy Gathercole	Managing Director	COMPATH	SME	Health monitoring and disease surveillance programs in animal research laboratory facilities.
18	John Greenwood	CEO	Skin Pty Ltd (LARIF collaborator)	SME	Cultured composite skins (CCS) – CCS is designed to abolish the need for skin grafting by producing cultured layers of dermis-derived cells
19	Nicky Milsom	Independent consultant, Former CEO of medical device company	Anonymous	SME	Imaging technology, entrepreneurship, venture capital, funding
20	Nigel Greenwood	Managing Director	Evolving Machine Intelligence Pty Ltd	SME	Modelling, computation, data mining, systems biology
21	Alan Taylor	Executive Chairman	Clarity Pharmaceuticals (CAI collaborator)	SME	Radio pharmaceuticals
22	Anonymous	COO & Co-founder	Anonymous	SME	Pharmaceuticals
23	Garry Redlich	CEO	Implicit Bioscience Pty Ltd	SME	Clinical-stage immune-regulatory molecules for treating cancer and autoimmune diseases
24	Anonymous	Technical Manager	Anonymous	SME	Agricultural biotechnology products, university collaborations
25	Helen Roberts	CEO	Dendright	SME	Pharmaceutical drugs to fight autoimmune conditions, including rheumatoid arthritis, MS, diabetes
26	Neil Finlayson	CEO	Admedus Vaccines Pty Ltd	SME	Prophylactic and/or therapeutic DNA vaccines for infectious diseases and cancers in humans
27	Anonymous	CEO	Anonymous	SME	Aortic devices for heart failure and drug-resistant hypertension
28	Richard Aird	CEO	Magnetica Limited	SME	Magnetic resonance coils and radio frequency antennae for medical imaging equipment
29	Anthony Maloney	CEO	Melcare Biomedical Pty Ltd	SME	Honey-derived medical devices for treatment of chronic medical conditions
30	Barry Thomas	CEO	Cook Medical Australia	SME	Interventional technologies and therapies for treating and diagnosing cardiovascular disease and also reproductive health and urology
31	Angus Forster	CEO, COO	Vaxxas	SME	Nanopatch vaccine delivery system
32	Clarence N	CEO,	Bond Wireless Bond	SME	Entrepreneurship, venture

	Name	Role(s)	Organisation(s)	Type of org.	Service(s) / product(s) / Knowledge area(s)
	W Tan	Professor	University Singularity University (Singapore)		capital, university systems
33	Tim Cragg	CEO	Vascular Enhancement Technology	SME	Medical-device commercialisation
34	David Hughes	CEO	BioPharmaceuticals Australia (BPA)	Trade group	Grant-funding expertise, manufacturing facilities
35	Mario Pennisi	CEO	Life Sciences Queensland	Trade group	Funding, venture capital, networks
36	Greg Beaver	Founder	Health Tech Innovation Queensland	Trade group	Networking organisation to collaborate and inspire health tech entrepreneurship, commercialisation and investment.

Notes: Research Institutions: 16, Trade groups: 3, Small business: 17, Total interviews: 36

4. Findings

The interviews uncovered several potential problem areas that may currently undermine collaboration. These are grouped into two areas which are: (1) establishing new connections and better networks and (2) the mechanics of engagement. Each of these areas are discussed below.

4.1 Establishing new connections and better networks

There was a consistent recognition that, in order to facilitate collaborative innovation opportunities, SMEs and institutional players must first find each other—a problem of search. Second, making connections between SMEs and institutions is not as easy as one might think, particularly for 'outsider' firms that are not currently connected to the university locations which house NIF equipment. Third, the institutional players can do more in terms of attracting SMEs to their door by 'putting on a commercial face'. These three points are discussed below.

4.1.1 Search: connecting institutes with industry partners

An initial problem in terms of connecting institutes to potential industry partners is the lack of effective communication about NIF node capabilities to industry. Small business and trade group executives generally characterised this issue as a problem of institutional outreach. They viewed the efforts on the part of institutes as being inadequate in terms of making interesting connections that lead to novel research collaborations.

Many of these executives thought that institutional researchers should strive to spend more time outside the laboratory in order to cultivate relationships with industry. Several of them suggested that institutional attendance at translational and practitioner conferences that were more commercially focused was appropriate. Preeminent life sciences conferences like the Bio International

Convention and the DIA annual meeting were suggested as premier networking opportunities which the NIF should focus its attention on.

Another suggestion was to develop dedicated business development managers who could conduct more consistent outreach activities at the institutional level in an attempt to build bridges between academia and industry. According to one institutional executive, they need to spend lots of time and effort 'networking the networks'. Another executive challenged public research entities to 'make yourself relevant' by 'showing others what you've got'. They obviously consider the onus being on the NIF in terms of outreach.

The institutes are the interested party that must invest in outreach simply because SMEs are resource limited. SMEs are very focused on achieving commercial milestones related to their limited product/service set and do not have spare personnel, funds or time available to seek out potentially novel partnerships—particularly if they are tangential to their current product focus. Consequently, they may be completely unaware of institutional capabilities—even when those capabilities may directly support their efforts or help to short-circuit innovation activities by providing unique product development pathways or insights.

Node directors and research fellows can play significant direct roles in building networks. Characterising the inter-personal connections that underpin strong networks, one NIF facility director we interviewed is personally engaged in as many cross-institutional roles as possible, including serving on various boards and ethics committees in order to become very aware of the activities of others in the network. Consistent networking along these lines helps to elevate the node in the consciousness of network partners and improves the chances of being recommended in future interactions. However, these roles are a luxury when the operators of specialised equipment in the nodes are often on short-term contracts due to funding limitations. There is a role here for government to dedicate funding towards business development capabilities in NIF and within NCRIS more generally.

Another benefit of these networking activities is that, over time, it helps to position these institutes as knowledge brokers within the industry network. Such brokers are privy to more diverse sets of firms and information, and this increases the opportunity to play matchmaker to facilitate truly novel research partnerships in which they can play a key role. Some facility fellows were found to have deep connections with industry, often resulting from prior industry positions with key imaging technology businesses such as GE and Siemens.

Moreover, some fellows tended to have diverse and international connections that represented substantial and unique opportunities for collaboration.

4.1.2 Ease of making connections: insiders and outsiders

At this point, it is necessary to recognise that some SMEs that exist in the biotech / biomedical space do not have a problem locating and utilising institutional capabilities. During our interviews we discovered two basic types of SMEs. The first type is *insiders*. Insiders are spinout SMEs founded on IP that was originally created at certain universities. These firms have intimate knowledge of the university capabilities. They often have employees who hold dual appointments

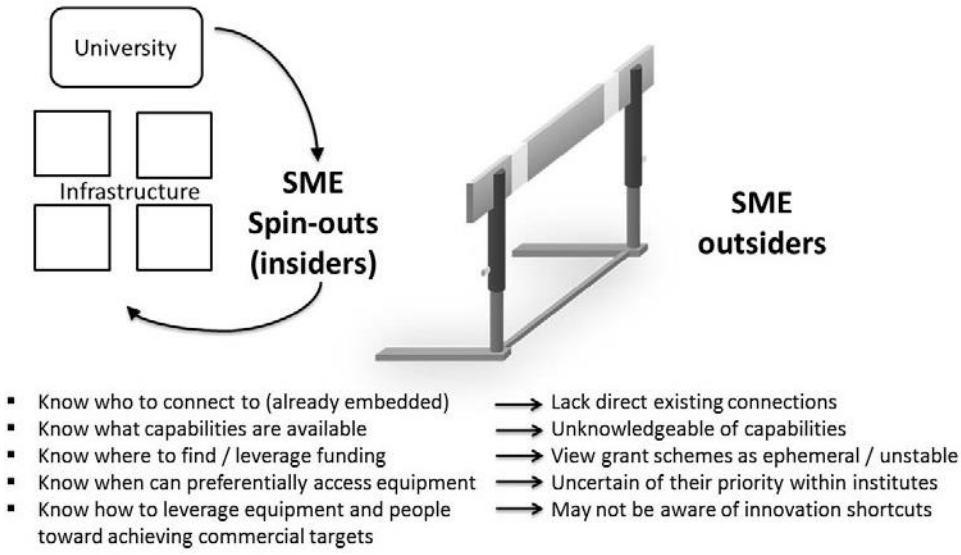
in the firm and the academic institution. Insiders were repeatedly observed as obtaining preferential access to equipment—often to the bemusement of delighted executives who reaped the benefits. One executive called this power: 'bypassing the bureaucracy'. Another executive said that spinouts get special treatment and even went as far as claiming that the institutional players are incentivised to 'bend the rules' for these spinouts.

Collectively this provides insiders with a tremendous advantage.

Some of the spinouts characterised themselves as 'virtual' firms. This type is even more embedded in the university infrastructure because they are often simply projects which are wholly conducted by institutional researchers. For virtual firms, 'external' involvement comes from funding (often by third parties including multinational drug firms) and senior management (themselves often former university employees). Consequently, this type of company is quite comfortable with access to university infrastructure and is aware of what is available in terms of research arrangements. See Figure 4.1.

A typical example of an insider SME is a company called Magnetica. This company spun out of the University of Queensland as a result of IP associated with the design of magnets for MRI machines. While the company has needed to navigate collaborative challenges within UQ, they are also very aware of the capabilities that exist within the university and how UQ can assist them with technological development. Most recently, Magnetica has used the UQ Centre for Advanced Imaging to calibrate their new generation of MRI machines.

Figure 4.1: Two types of SMEs



The second type of SMEs is *outsiders*. These are firms which do not have pre-existing ties with the institutes housing scientific infrastructure. They are often unaware of the institutional capabilities that can help to accelerate their innovation processes. This situation is best characterised by the example of a SME CEO near Brisbane who was unaware of any of the equipment available a NIF node just a few kilometres from his office. This is despite the fact that this

technology is directly applicable to his current commercialisation efforts and desire to conduct in vivo imaging of immune response to cancer therapeutic in a rat model—something well within the capabilities of the CAI Node.

Beyond the difficulties involved in locating relevant capabilities, engaging with institutes and universities was viewed as being a challenging process by many outsider SME executives. Although, in many cases, SMEs are interested in engaging with institutes, finding any spare financial resources available in order to engage is problematic. Grant schemes that support their involvement are seen as fleeting and ever-changing with a 'clock-speed' not appropriate for SMEs trying to commercialise technology. For example, the ARC linkage grant scheme can take over a year from initial discussions to finding out the result of a grant application, and then the probability of success is less than 30 per cent. Outsider SMEs crave better knowledge of the funding available and means by which to access it.

Also, not having the benefit of prior direct knowledge of capabilities and personnel makes it hard for outsider SMEs to know how the institution might help them with their particular technology development efforts. Weary of past intellectual property negotiations that went sour, these SMEs are also skittish about engaging because they do not want to lose control of their technologies.

Case study 4.1

One anonymous small business CEO typifies the challenges faced by outsider organisations. After finding the university environment in New South Wales too constraining to support development of a new cardiovascular device, the CEO moved to Queensland in order to seek (and ultimately win) a Queensland Government *innovation start-up grant.* This grant funded the development of a prototype, preliminary animal studies, market research and business planning efforts. However, according to this CEO, lack of a core life sciences and medical devices 'hub' within Brisbane made it hard for his company to get subsequent traction for the device. He is frustrated with existing trade groups which are either too focused on pharmaceuticals (rather than devices) or are highly institutionalised and cater to institutional players rather than small businesses. Over the past few years, a significant amount of time has been focused on chasing grant money while the development of the product languished. He is also frustrated with the current state of funding, stating that it is 'hard to get a finger what's going on…there are state schemes and federal schemes and they are changing quite a bit'.

Although he is aware of the Advance Queensland Grant scheme, he feels without an existing partnership or shared IP with an institutional player, he will be disqualified from the scheme, along with other firms in the same situation. He eagerly awaits more details on the small business portion of the Advance Queensland scheme and hopes that this will not be the case. At the same time, the CEO is very cautious about engaging with institutional players because of the high costs associated which can 'quickly eat through your funding', together with the danger of losing IP position.

Connecting with outsider organisations represents a unique opportunity for institutional SMEs, particularly in the facilitation of novel research. Outsiders—due to their inherent distance from core institutional activities and their different perspectives cultivated outside the (particular) institutional realm—represent opportunities to facilitate truly novel discoveries by bringing fresh perspective and information to the research efforts of the institution. This is the type of relationship that should be sought out by institutes to, as one particular centre director put it, 'facilitate unknown-unknowns'. These are the type of connections that can lead to projects where new uses for equipment are dreamt up and attempted. One approach to facilitating this sort of collaboration is to 'research open days' that allow access to equipment at little to no cost to interested SMEs. The Fraunhofer Institutes in Germany often use these open days to engage new business partners and find novel uses for their technology.

4.1.3 Putting on a commercial face

Another problem relates to the perceived seriousness of institutional players to engage in industry partnerships. SME executives were interested to discover how much industry work institutional researchers 'really want to do?' The answer to this question lies in the way in which the institutes present themselves; we were able to find examples of organisations that were investing in state-of-the-art equipment which offers a one-stop-shop for customers, procuring the international credentials that provide confidence in the facility's operations, and a significant web presence that signals to the business community a serious dedication to collaboration.

4.1.3.1 One-stop-shop

The Molecular Imaging and Therapy Research Unit (MITRU) at the South Australian Health and Medical Research Institute (SAHMRI) has invested heavily in establishing 'gold- standard' facilities to support the development and translation of radiobiological compounds. Housing SA's first cyclotron, they have been successful in obtaining Therapeutic Goods Administration (TGA) production licences and GLP certification in order to establish themselves as a premier production facility for radioactive tracer compounds. They have even invested in state-of-the-art positive air-control monitoring systems for their clean-lab production facilities that are above standard. Pre-clinical imaging equipment is within reach in the facility and further investments are slated for clinical imaging laboratories. The director of the facility argues these investments are of 'world-class standard' and are specifically designed to appeal to global industry players by providing the complete breadth of services required to develop and commercialise a new compound. This approach is strongly tied to attracting significant international project obligations at MITRU.

With regard to the NIF nodes, LARIF has a rather unique capability of having an operating theatre collocated with imaging equipment and this is something that should be further leveraged through additional investment in equipment. The facility desires a dedicated cardiac catheterization (cath) lab that would provide unique research opportunities to implant, test and monitor cardiac products in the pre-clinical environment in one single location. The LARIF facility manager

noted the ‘peace of mind’ and ‘ease of use’ that this ‘one-stop-shop approach’ would provide to industrial collaborators.

4.1.3.2 Certifications and accreditations

Another important element of projecting a commercially-friendly front to industry involves international certification. Accreditations like Therapeutic Goods Administration (TGA) licences, Good Laboratory Practice (GLP) certification, Good Manufacturing Practices (GMP), ISO standards such as 9001 (management) and 1705 (testing) and Association for the Assessment and Accreditation of Laboratory Animal Care International (AAALAC) demonstrate to industry players that research, testing and production activities (where applicable) are up to international standards. This, in turn, leaves no room for doubt as to the quality of work that may be conducted at the facility.

4.1.3.3 Web presence

Another recognised area for improvement by SMEs and industry players alike is how institutes present themselves on the web. This criteria has less to do with having an exhaustive content listing than it has to do with presenting a webpage that ‘looks like’ one a well-respected professional firm would have. The internet is often the first port of call for curious SMEs and could be a singular failure point in establishing new collaborative relationships. A poorly designed website could be the first and last point of contact a potential research partner has with a research institute.

4.2 Mechanics of engagement

Several specific problems were uncovered which govern the mechanics of engagement.

These include: high costs and difficulty finding financial support to engage in collaborative research; the sometimes excessive and severe approaches to intellectual property; capacity issues (e.g. scientific staff and equipment); incentives for institutional researchers that do not align with commercial collaboration; misalignment of timing and urgency between institutes and small business; and an overall need to acknowledge that different business stances are required in different collaborative situations. Each of these areas is covered below.

4.2.1 Costs and finance

Cost of access and funding to support research were themes that were repeatedly described by SMEs as being problematic. The costs of accessing institutional capabilities was characterised by many executives as being high; a few thought costs were exorbitant and admitted that it was a reason steering their collaborative activities away from institutional players in Australia. Costs appear to drive some SMEs toward overseas universities and industry (instead of Australian academic) collaborators. These moves were characterised by SME executives as being both financially and temporally motivated. The costs of conducting similar work scope with these other entities was characterised as being affordable in comparison to university rates in Australia—even taking into

account the federal R&D tax credit. Some SMEs chose to collaborate with industrial partners because they exhibit qualities of expediency and efficiency. Industrial collaborators were considered to be much more responsive and more likely to achieve the desired results within the limited funding available, as well as the pre-determined schedule. SMEs also highlighted the cost disadvantage of accessing Australian researchers.

Overhead levies on contract research can be as high as 60 per cent when pricing labour and SMEs were of the opinion that universities used the commercial rates charged as an opportunity to cross-subsidise other research activities. One node director specifically acknowledged this practice and identified university overhead structures as the major culprit behind missed business opportunities with SMEs, saying: 'We've lost business because of it....they stop talking to us.'

Another finding was the demand for tiered or flexible rate structures for SMEs to access institutional capabilities. Some executives considered the practice of charging SMEs the same rate as multinational corporations as very unfair. They stated that this practice has a high likelihood of dissuading SMEs from engaging with certain institutes. Among the executives, there is a desire for conciliatory and flexible rates. A repeated request we heard was for structured (and transparent) tiered rate structures that would give some preferential treatment to SMEs and take into account their lack of resources and largesse in comparison with larger, established firms. To support this idea, we found evidence that supported the fact that institutional players who seemed to have developed the most robust industrial partnerships did so by initially offering concessions on costs. One node director discussed introductory rates or 'mates rates'. These were described by one facility manager as a way of getting over the first contact hurdle. According to one manager, the basis of fruitful long-term relationships was getting SMEs in the door and exploring the particular problem they are trying to solve—even if this first interaction involved some large cost concessions. The manager described their careful consideration of project scope in terms of the budget available to the SME; working closely with the SME to achieve results with the available budget. After securing an initial project in this way, the manager argued that additional collaborative work 'always followed' such good faith efforts on the part of the institute.

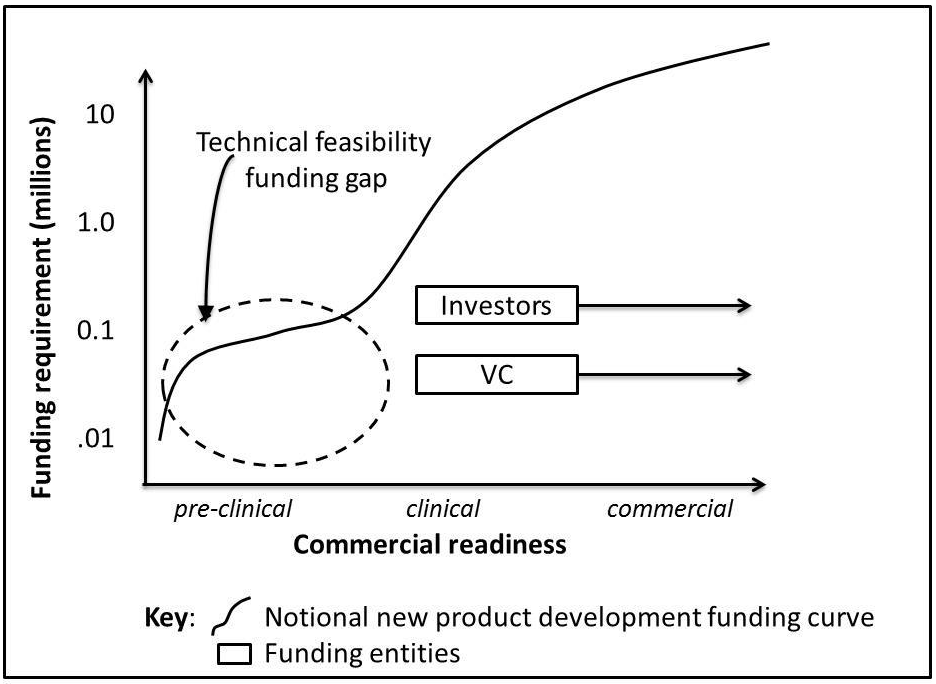
A repeated problem cited by most SME executives (and also astute institutional executives) was the poor state of funding for start-ups in Australia. The comments about this ranged from the lack of appropriate venture capital (VC) funding in Australia to frustration about the ephemeral grant schemes at the state and federal level that were viewed as being highly politicised and often too slow to be of value in the commercialisation process.Regarding VC (and as recently reported in *The Australian Financial Review*), Australia as a whole spends less on R&D than some individual corporations and the level of commitment to Australia VC funds dropped to $120m—down 20 per cent from last year[7]. Investments into life science businesses were worse with an estimated $60m invested by VC funds in 2013–14. One SME executive we interviewed characterised Australian technology VC as almost 'non- existent' and that any that is available is 'extraordinarily unimaginative' because investors

exhibit a long history of risk aversion and investing only in the later stages of product development where risks of loss are minimised.

In light of the limits of VC, many called for more federal and state grant schemes as solutions to fill the gap in funding. In Queensland, many executives lamented the demise of the *Innovation Start-up Grants* scheme. Grants like this provide funding in the order of $10,000–$100,000 in investments—a crucial amount of funding to support proof-of-concept studies. This level of funding was argued by several executives as being a crucial stepping stone that is desperately needed to progress nascent product ideas into the pre-clinical efficacy stages of development. In this way, they are then attractive enough to draw the high levels of funding required to move through from pre-clinical and clinical trials, and into product production. As one executive put it, funding helps 'develop the technology up to a point that it is able to draw between $5m and $10m of outside investment'. The recently announced Startup Queensland funding—part of a broader $180 Advance Queensland grant program—will no doubt help to fill this gap. The program will provide $52 million to start-ups: $12 million to create a Queensland Commercialisation Program that will support proof-of-concept projects and $40 million devoted to business development[8].

However, according to small business executives, the problem with many of the grant schemes was the requirement for matching funds. The Startup Queensland fund will require 50 per cent of matching funds[9] which is a major problem for firms with early-stage technology that lacks established feasibility. There is a desire for funding that either has no matching cost requirement—like that of the US SIBR program which even provides for a small profit margin for the firm over the life of the grant—or manageable cost-sharing splits that appropriately consider the value of in-kind contributions (i.e. labour and expertise—not just cash).

Figure 4.2: Early stage funding gap



The Australian funding environment is particularly challenging which has resulted in some SMEs seeking finance from international sources. For instance, one executive stated that they are seriously considering relocating to Belgium as the government there has recently made hundreds of millions of dollars available to bridge the pre-clinical to clinical funding gap. According to the interviewee, this incentive has enticed large firms like GlaxoSmithKline to situate a 400-person facility in this country.

4.2.2 Intellectual Property

The treatment of intellectual property was a foremost concern for SMEs. Many executives interviewed for this report said that university IP-management strategies were antiquated and misdirected. One executive argued that the days where universities generated all the IP are long gone, citing rapidly improving (and affordable) computing capacity in the order of teraflops being available to 'garage inventors'. Indeed, the landscape is shifting rapidly so that SMEs with no strong prior relationship to universities are cropping up with their own IP which is completely unaffiliated with a university. The innovation literature has long considered the linear model of research commercialisation to be an incorrect representation of innovation and this is certainly the case for the examples of innovation we identified in this report. Valuable IP does not get produced exclusively in research institutions so that it can be developed in collaboration with industry partners.

Although SMEs are interested in accessing institutional equipment and capabilities, they are not willing to give away their IP position to access university technology. SMEs—and any other firms which owns their IP outright—are highly suspicious of starting to negotiate their position with universities if they own any foreground / project IP. In such cases, many executives cited instances where they felt it was preferable to 'walk' away from the table and seek alternative collaborations. Mostly this sentiment was expressed by outsider organsiations that are not already ingrained in the university system (refer to Figure 4.1). Outsiders are unlikely to enter into a collaborative project if there is a chance that it will erode their IP position. If a project IP ownership stance is adopted by the institutional player, it seems that it will almost always dissuade SMEs from engaging in a collaborative project. While some firms seemingly did not have issues with IP in terms of their institutional collaborations, it appeared that only the insider organisations espoused this view. Insiders were more likely to take a less proactive stance on IP because they have faith (based on the inter-personal trust established as a result of being highly embedded in the institute) that a reasonable IP negotiation process could take place at a later date. Consequently, these firms were more comfortable letting the institute claim ownership of the project IP because they knew that they would receive 'sweetheart deals' (as one CEO put it) in the licencing fee negotiation if the product has commercial viability.

SME executives cited the need for institutes to practice a more flexible approach to IP. One current NIF-node collaborator SME said institutional players need to 'let the IP breathe' referring to the fact that most IP will not translate into commercial success and therefore should not be locked up prior to determining its commercial potential. Another executive argued in favour of leaving the lawyers out of the discussion until the commercial potential of the IP can be truly

determined, and only at that point enter into negotiations regarding what to do with it. This interviewee said: 'IP management is not a legal issue; it is a management issue' and went on to cite several examples of how more relaxed IP strategies are becoming the norm at the institutional level—referring to the 'Stanford model' and the 'Singapore model' where the ethos is 'to give the IP away' and see which aspect of it is commercially viable. Australian universities that interviewees mentioned as 'getting it right' and 'moving in the right direction' in the IP space were Macquarie University and University of Western Sydney. While initiatives like the new DIS IP toolkit can help to better inform researchers and SMEs about IP management, they are of little value if the universities themselves are very traditional and encourage risk averse polices on IP, which researchers must comply with.

4.2.3 Capacity: people and equipment

One critical issue is the capacity of NIF nodes to engage with industry collaborators, with a primary problem being staff. One facility fellow noted the challenges associated with obtaining and training staff to the capability level expected by outside firms. This stems from lack of foresight in terms of the operational budget in order to support long-term contract hires. Instead, at some nodes at least, one-year contracts are being offered. The inability to offer employment security via multi-year employment contracts ('5 year plus 5' were mentioned as a useful heuristic) dissuades internationally-qualified professional staff from applying for staff positions at Australian NIF nodes. Often the best-suited candidates are living overseas and will not consider moving their families under such insecure employment terms. Consequently, although the facility fellow positions are securely funded positions paid by NIF, these fellows are hamstrung to hire and develop the people necessary to create a truly robust capability to handle internal research agendas, let alone have the capacity to support additional industrial collaborations with SMEs.

Another facility fellow discussed how one current collaborative project is completely monopolising the capacity in their research area. They said, in no uncertain terms, that there is no capacity to support more industry collaborations. According to this fellow: 'There are barely enough resources available to digest what happens on a weekly basis with the client and to undertake any self-directed basic research.' The failure of nodes to attract capable and talented staff because they are only being offered short-term contracts is potentially a serious issue that will undermine their ability to conduct basic science, as well as support industry collaborations. While the basic science problem has been highlighted elsewhere, we draw attention to the additional problems of creating and sustaining industry collaborations unless better job security is written into the funding of NCRIS centres in general. There is a clear role for government funding here.

In other cases it is equipment, not staffing, that is hindering SME engagement. The LARIF facility in SA has a long history of successful industry engagement but is currently turning away work because of antiquated equipment and equipment needs that have not been fulfilled. Outdated magnetic resonance (MR) equipment cannot run the latest imaging sequences and those sequences it can actually run take four times longer than new equipment. A new 3 Tesla (3T) MR system is needed and could support neurobiological imaging that

represents a unique growth area for the facility. Furthermore, this facility is one of the few that has operating theatres and imaging equipment housed within the same facility—a unique capability which they want to expand upon by installing a cardiac catheterisation (cath) lab. Investments like these will enable existing partnerships to be expanded and new partnerships to be formed.

4.2.4 Incentives

Another major issue related to building robust networks is the misalignment of logics between institutions and commercially-focused SMEs. Both business executives and institutional members recognised this as being a problem. A particular challenge occurs when infrastructure is collocated at purely academic institutions; the researchers (who are stewards of the equipment and the research conducted on it) operate under career progression paradigms that reward journal publication outputs. For them, commercial outcomes are considerably less important. Many academics who were interviewed (including their executives) consider short- term commercial work as a distraction from discovery and publication. Commercial work is considered to be at odds with their dominant logic. This focus on journal articles and competitive grant success is deeply ingrained in the university system. As an example, one interviewee mentioned the University of Queensland Q-index which is a dashboard of individual academic performance over a 7-year period. It measures an academic's career in terms of journal articles, books and book chapters, research student supervisions and grants, and calculates a single number that can then be compared with other faculty members. While industry research contracts can be included as a grant, other forms of collaboration and engagement are not covered by the Q-index. For example, industry reports—regardless of how influential they were—are given a score of 0.

Some executives argued that a broader set of measures are required to potentially reward academics for patenting and translational research—a similar problem noted in the UK as highlighted in the recent Dowling Report[10]. Interviewees argued that introducing incentives for academic researchers to engage in industrial work, and somehow valuing the outputs of such collaborations on an equal footing as publication, would be one way to increase levels of collaboration between nodes and industry. Shifting the way that university performance is measured in the research assessment exercise is probably the only long-term solution to changing internal performance incentives.

4.2.5 Timing and urgency

Another criticism of academic logic vis-à-vis accommodating industrial collaborations is the general lack of expediency exhibited by researchers and the tendency to stray far from the original research question(s). Although these are valuable attributes to support basic science, these same attributes actually dissuade SMEs from engaging academic researchers in their commercialisation activities. Many executives expressed how they kept anything that was on the scheduled 'critical path' away from academic intuitional influence. This is because the impetus for SMEs to engage is driven most often by commercial motivations: a 'technical problem', an 'immediate problem' or to 'get a leg up on a new market'—all of which are time- critical activities.

Time criticality is particularly important as SMEs are often in the latter stages of commercialisation when time-based milestones related to product efficacy become vitally important. During this time, SMEs are highly reticent to relinquish any control to others. Therefore, SMEs often want to involve institutes during these latter stages, but only to conduct fee-for-service work that supports the evaluation of the clinical efficacy of their products.

Reflecting this sentiment, one interviewee stated the role of institutions at this point was that: 'You are a supplier and that's not a [collaborative] relationship'.

4.2.6 Recognizing the different types of SME engagement opportunities

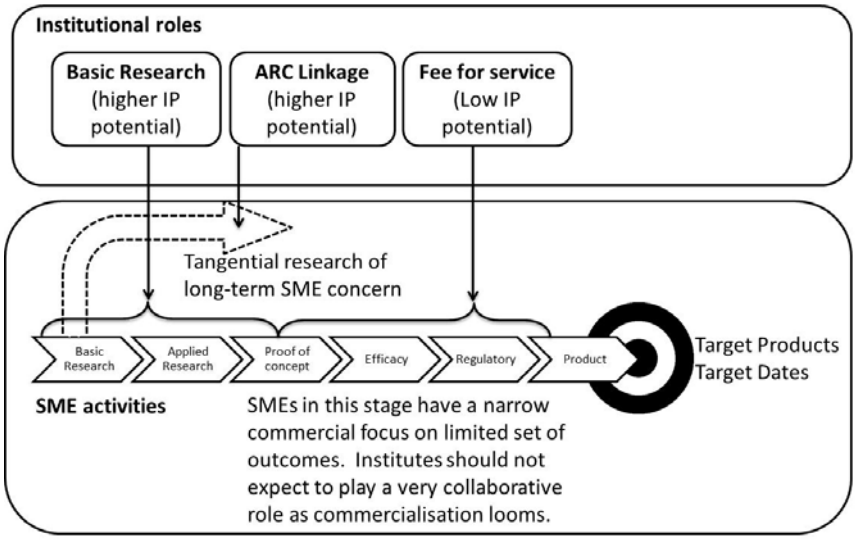
Various opportunities for SME engagement exist depending on the stage of development of the product or device and thus have different funding profiles, IP opportunities and timelines. First, the primary logic of the institutional players is to participate in the discovery process related to basic research, proof of concept and, in some cases, applied research. Such research has the highest potential for institutional IP development. After this point, if the technology is then housed in an SME (as a spinout, for instance), the institutional role morphs to providing fee-for-service support to the SME's translational efforts which is an extremely commercially-minded endeavour. That is, the SME is focused on quickly exploring the commercial space and translating successful products into commercially viable products for pre-clinical and clinical trials. One executive very clearly discussed the need to separate the discovery and translation phases, and made a point of arguing that the spinout is the best place to house the commercialisation effort because academic researchers are not equipped to support commercial efforts. The executive characterised these commercial efforts as moving '1,000 miles per hour' with an ethos of 'fail smart, fail fast' in order to quickly cull ideas that are not working and greatly increase the probability of finding a commercially viable product quickly. This logic differs greatly from the discovery-based logic of the researchers.

In later stages of development, institutional players are best positioned to provide fee- for-service work. SME executives do not view these as collaborative efforts and therefore there is little (if any) opportunity for creating joint project IP. Instead, the institute is executing the scope of work articulated by a commercial client. While this offers the university no potential for project IP development, it does offer a source of revenue that can subsidise other basic research endeavours. This approach to fee-for-service work is exemplified by LARIF. They provide very basic imaging services to professional clinics when the equipment would otherwise be idle, thus providing a valuable service to local practitioners. This is truly a marginal-cost activity for the node and helps to cover the operational budget without draining node resources. By getting practitioners in the door, it provides the potential for future collaborations.

Many SME executives expressed genuine interest in tangential research opportunities that are only loosely aligned with current commercialisation efforts. These represent opportunities for institutional IP development. Many SME executives discussed ARC linkage and NHMRC grant bids / wins focused on developing these tangential opportunities. Several expressed the desire to understand more fundamental mechanics of pharmaceutical molecules in vivo

or other 'interesting' pursuits that help to enhance the understanding of the product space while not directly supporting the commercialisation effort. Therefore, this type of collaboration is well-suited to the institutional players, and is where an iterative and non-linear approach to basic research can thrive. However, it is the long timelines associated with the funding schemes that support this research that perpetuate this tangential research focus. SME executives recognise the one or two-year time frames necessarily mean that the projects will not help their commercial endeavours any time soon. However, despite the longer-term focus it does not mean that executives are willing to let these projects operate in complete isolation from commercial reality. A complaint made by SME executives with regard to ARC linkage and NHMRC grants is the opaque nature of project management and reporting at the university level. Consequently, institutions must make an effort to draw the links between the basic science and the commercial outcome space, and ensure that the SME sponsor is included (or perhaps leading) this mapping exercise. Figure 4.3 summarises these different types of SME engagement opportunities (including the differing logics surrounding each) with a particular emphasis on opportunities for IP development and relationship to SME commercialisation efforts.

Figure 4.3: Aligning institutional roles and IP opportunities with SME efforts



5. Recommendations

This section summarises the recommendations relating to the NIF nodes—entitled *institutional*—and those directed toward the Department of Industry and Science—entitled *policy*. This section focuses on recommendations and readers should refer to the prior section for a nuanced discussion of the barriers.

5.1 Institutional

The institutional recommendations centre on investing in network building and improvements to the engagement strategies.

5.1.1 Investments in networks

The onus is on the institutional players to build awareness of their capabilities and expertise. SMEs are time poor, resource constrained, and highly focused on particular commercial pathways. Finding these SMEs and bringing them to the table will require consistent effort on the part of the institutes to convey their capabilities and 'make themselves relevant' as one CEO succinctly described the situation. SMEs will not just turn up at the door. Opportunities for NIF node directors include:

- investing in business development and marketing managers
- investing in a website presence that exhibits 'world-class' status
- investing in certifications and accreditations that portray competency to industry

  players
- supporting attendance and presentations at practitioner and translational conferences and symposia.

5.1.2 Engagement strategies

There are several issues with regard to improving engagement with SMEs. Five main themes are: creative treatment of intellectual property, flexible costing strategies, engagement in marginal-cost activities to generate revenues, investing in capabilities, and changing incentive structures. Each of these engagement strategies are suggested because they may help to support the development of new partnerships.

5.1.2.1 Intellectual property

There is considerable room for improvement in terms of the treatment of intellectual property. When institutes take full ownership stances for project IP, SMEs will be dissuaded from engaging with them. More flexible 'business first, lawyers last' strategies may be a better approach to enticing SMEs to engage. IP that is generated in the university environment may or may not have much commercial value. A favourite quote of many interviewees was 'not everything is Gardasil'—referring to the highly successful Human Papilloma Virus (HPV) vaccine developed invented by Dr. Ian Fraser and spun out of UQ. Another executive noted that '99.9 per cent' of IP has no commercial value—referring to the relatively small number of research ideas that reach commercial markets. Consequently, institutions should approach IP more openly in order to first determine if the idea is even feasible, and then decide what sort of commercial value it has. At this point, they can then negotiate proper terms for reaping the future rewards of the IP with the spinout or SME that is developing it for commercial markets.

Nodes should recognise that the various types of engagement opportunities differ in terms of IP development potential, depending on the current stage of commercial development (refer to Figure 4.3). In early stages, there is a potential for IP development–or at least negotiation–in the early collaborative

stages where feasibility is established. As projects move into later commercial stages, nodes may be most useful to SMEs as fee-for-service providers where there is lower potential for IP development. In later stages of development, SMEs have a stronger financial position (having been funded by venture capital, for instance) and can afford commercial rates on quick turn-around. As a result, institutes should use these opportunities to capture revenue streams that can be redirected to basic research. Tangential projects (e.g.NHMRC, ARC linkage) are good opportunities to engage in more basic research; as long as the node invests the time in developing the proposal and managing the work. SMEs are time poor and disinclined to spend large amounts of time pursing grant schemes on long timelines with low probabilities of success. Consequently, institutes must put forth most—if not all—of the effort in developing, securing and managing these projects.

In summary, NIF nodes should:

- make efforts to engage SMEs with a business / commercial mindset: IP negotiations should not be the first port of call for new industry engagement. This also means that NIF must employ business savvy, commercially-minded business development people (refer to Section 5.1.1 as well on this point).
- work with legal advisory departments to develop more pragmatic approaches to foreground IP that allow SMEs to retain ownership of inventions. Focus on developing strategies that firstly establishes the viability of the technology and, secondly focuses on sharing potential revenue streams resulting from commercialisation.
- open up and share existing university IP that is currently dormant to interested small businesses to spur additional collaboration activities. Remember that 'not everything is Gardasil' and that universities need to 'let the IP breathe' to understand its true commercial potential.
- When conducting fee-for-service activities—those where the industry partner is wholly directing the activities—eliminate discussions about foreground IP.

5.1.2.2 Flexible costing

There was general acknowledgment amongst the interviewees of the high fee structures governing infrastructure access. Several potential opportunities that are governed by specific policies of the universities and institutes include:

- Creating flexible rates for new partnerships, including cost concessions which can help to get SMEs in the door and facilitate future activities.
- Negotiating within the limited budgets of SMEs and trying to develop a mutually appropriate scope, with a focus on quickly overcoming the first engagement hurdle to establish the feasibility of early-stage ideas that can blossom into more fruitful long-term partnerships and revenue for the node.
- Considering tiered rate structures for both small and large businesses (particularly multinational drug firms) since the former are likely to balk at commercial rates which may deter engagement.
- Addressing high overhead mark-ups on university labour which have the effect of dissuading cash-strapped SMEs from engaging.

5.1.2.3 Marginal cost activities

In situations where there is spare capacity in node facilities to support additional activities, these may represent additional sources of revenue and may also help to transform first-time users into longer-term collaborators.

- A potential source of revenues can be obtained from fee-for-service activities that are conducted on spare equipment capacity. LARIF does this well by offering equipment time to local clinicians during slack research periods. While this is not a high IP value activity, it does represent a revenue stream that can subsidise more basic research endeavours.
- Conduct 'research open days' as suggested by several interviewees. The Fraunhofer Institute is an example of how open days can be used effectively to generate interest in the science activities at the institutes[11,12], as is the Australian Institute of Marine Science[13].
- Use spare capacity to facilitate small / basic research projects following a similar approach as the US Department of Energy's user facilities. These facilities are open to all interested parties regardless of nationality or institutional affiliation. The prioritisation of work and allocation of equipment time and staff resources to the projects is wholly determined on the merit of the proposals. No fees are
- charged for non-proprietary work if the user intends to publish their results in open literature[14].

5.1.2.4 Invest in capabilities

A major limitation to expanded engagement with industry is sufficiently trained and dedicated staff working under each facility fellow. Although this is arguably a funding issue,[1] the inability to offer research staff multi-year contracts is a major hindrance to building sufficient capability at the node level to support serious levels of industry engagement and this needs to be addressed at the NCRIS level. It is particularly obstructive in terms of the ability of research institutes to attract international staff to Australia. Therefore, the recommendations are:

- Find ways to fund longer-term positions that can work with a technical area for multiple years. One node collaborator is funding half of a post-doc position to support the current collaborative projects. In another example outside the biomedical space, Boeing is funding post-doc positions at UQ on the premise that Boeing will own all the IP that is generated. Cost-sharing strategies like these are one potential source of funding for additional research staff that should be heavily pursued.
- As mentioned in the section about investing in networks (5.1.1), having dedicated business development and marketing managers is another capability investment that should be considered.

[1] There is insufficient clarity on the node operating budgets year on year to anticipate the available resources for hiring staff.

5.1.2.5 Incentives

Node researchers' career progression rules and incentives are strongly tied to discovery and publication, and much less aligned with commercialisation. Researchers need to be incentivised and rewarded for industry engagement as a potential alternative pathway in order to increase collaboration levels with industry. Changes to the Research Assessment Exercise (RAE) may be the best way to influence university recognition of successful activities beyond publications and grants.

5.2 Policy

There are several recommendations that are outside the NIF purview, mostly associated with the need for funding grants at both the state and federal level to facilitate early-stage commercialisation to compensate for the lack of VC in Australia[7]. In the life sciences sector, funding gaps exists along the development pathway; however, they are especially acute in the critical early stages of development in the order of $10,000 to $100,000 to prove technological efficacy.

- Policy makers should strive to provide some consistency in terms of funding schemes and levels of funding available to support innovation in the biomedical space. The instability and highly politicised nature of funding schemes gives SMEs little leeway to test fundamental feasibility of their ideas. Schemes such as innovation start-up grants which have lower shared-cost requirements are in demand for serial entrepreneurs and are a source of ongoing frustration for them. New schemes such as the Startup Queensland fund which provide up to $300,000 in grants blocks will require 50 per cent matching funds[9]—an untenable proposition for many small business firms since they lack the fundamental proof of concept to attract outside investment to make up this funding gap shortfall. In this way, a financial gap still remains for early-stage research (refer to Figure 4.2). Dedicated (read: consistent) grant schemes that cater to SMEs with early-stage technology ideas that also have links to national innovation priorities, such as the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs in the USA, can provide useful lessons for developing a robust Australian SME grant scheme. Since the SBIR program's inception in 1982 through to 2009, nearly $27 billion dollars across 112,500 awarded projects was funnelled into innovation in small businesses[15]. Awardees have higher rates of commercialisation activity[4], more readily attract venture capital[6], have better survival rates, and higher and faster growth rates[3]. On the macro level, the SBIR program provides net positive benefits to the economy[4]. Sustained investment in small business like that demonstrated by the SBIR would stimulate additional technological innovation and commercialisation activity, and translate into positive economic outcomes in Australia as well. Interested readers should review the compelling argument made by David Connell from the Centre for Business Research at Cambridge University about the steps the UK should follow to implement a SBIR-like program there[5].

- The Department should consider maintaining an up-to-date centralised repository of grant and funding schemes to address the criticism, expressed by most SME executives, that these type of schemes seem ephemeral. A web portal could consolidate grants and funding programs at the state and federal levels, and could also provide a listing of active venture capital firms and other investment sources SMEs could pursue.
- One facility director suggested the idea of block grant 'credits' that could be cashed in to access NIF facilities. This approach has three benefits. First, if instituted for some length of time (i.e. over several years) these type of schemes e would provide stable funding that SMEs desire. Second, because the grants serve as credits for NIF facilities, the money will be spent at NIF nodes and will directly increase industry collaboration levels. Third, and following on from the second point, the funding would not leak to international universities or service providers because it will be spent on buying and building Australian research capabilities.
- Grant proposal processes like ARC linkage have very long lead items and are only appealing to SMEs with other (funded) commercialisation activities who want to explore tangential research. For SMEs that want to prove the conceptual feasibility of a new product idea, these aid packages are not beneficial because of the extremely long time frames and low chance of grant award success. A more appealing concept to SMEs would be smaller block grants with short proposal requirements and funding that can be released in a timelier manner in order to test new innovations quickly—an essential approach to innovation in the rapidly changing and competitive biomedical field.

6. Limitations of the report and future directions

To promote a more directed strategy for SME engagement with NIF facilities, a market segmentation analysis is likely required. This would involve a detailed mapping of capabilities (equipment, facilities, people) across NIF nodes to the existing industrial base in Australia. The need to understand what areas of biomedical research each facility can participate in is an important first step in developing a targeted SME engagement strategy, and further, the development of a healthy biomedical industrial base in Australia. Moreover, this effort could be the starting point for finding alternative uses for imaging equipment that transcends biomedical applications. This is because imaging, along with other similar modelling and rapid prototyping equipment and techniques, are considered innovation technologies (IvTs) which are capable of supporting multiple sectors of the economy by enabling rapid testing and evaluation of new ideas[16]. IvTs enable firms to more rapidly, efficiently and accurately move their ideas from the lab or the desktop into the market. Mapping the capabilities of NIF nodes in terms of potential alternative uses in other sectors outside the biomedical field is another way to establish new and exciting collaborations. Already CAI equipment has been utilised to investigate plant and animal materials products—efforts which are tangential to the pre-clinical focus of the facility.

This strategy mapping effort would take between 6 and 12 months (depending on resourcing and funding levels) to conduct and require market analysis and in-depth interviews with each node facility and research staff. It would result in targeted strategies for nodes to pursue in terms of building new relationships with the industrial base. This, in turn, would help nodes to make the most effective use of their limited funds to invest in outreach, cost concessions, new rate structures, etc., that are only recommended at a notional level in this report. In addition, this effort would more specifically justify the additional investments that are needed in capabilities at each of the NIF nodes to fully exploit the industrial engagement opportunities available to them—a criteria which also highlights the importance of an industry strategy at the node level as well as the NIF. We believe that an industry strategy at the level of NCRIS will be of limited value because of the differences across the technological bases represented within NCRIS.

This report points out the challenge of matching publicly funded infrastructure / capabilities to a burgeoning biomedical sector which is fast-paced and dynamic. The innovation policy and management literature currently recognises 'open innovation' as becoming the dominant pattern for the development of new goods and services in such settings. Open innovation can be defined as the purposeful flow of information across firm boundaries in order to jumpstart and extend commercialisation activities. Open innovation therefore is characterised by multi-directional flow of knowledge and technology between different players in the industrial ecosystem. A useful and influential typology of open innovation forms as proposed by Dahlander and Gann[17] is shown in Table 6.1. In the context of SME engagement with NIF nodes, this framework recognises that innovation processes can be outbound or inbound, and furthermore, these can be monetary transactions (pecuniary) or not. Examples of pecuniary transactions include: IP licensing (in and out) and spinout new ventures with equity investment. Examples of non-pecuniary openness include: publications and free revealing of innovation information to customers, collaborators and the like.

Table 6.1: Different forms of open innovation

	Inbound innovation	*Outbound innovation*
Pecuniary	Acquiring In-licensing, adopting or buying expertise or technology from external sources	Selling How firms protect, appropriate value from, and commercialise their intellectual property and technological artefacts
Non-pecuniary	Sourcing Leveraging existing external sources of information for innovation purposes	Revealing Sending information to the external environment selectively, in order to spur problem solving or aid in the diffusion of innovations

Source: Adapted from Dahlander and Gann (2010)

Emerging industries from unconventional gas production[18], electric and fuel cell cars[19], computing and biotech[20,21] all demonstrate the importance of non-pecuniary openness in terms of the development of novel innovations in new industries. This is because different players in the innovation ecosystem try to stimulate interest from commercialisation partners and customers, recognise what complementary technologies are available, and are aware of interesting applications that these innovations might have in different markets. In the NIF case, adopting such a stance with regard to imaging technology will help researchers discover information and expertise from the industry sector and encourage new relationships to be built to take advantage of innovative technology and source commercial opportunities. Similarly, non-pecuniary open innovation will help SMEs more easily find university skills and expertise to develop new products and services. While pecuniary forms of openness also have a place, in the early stage of industry development firms and institutes will benefit from policies and initiatives that support non-pecuniary forms of openness. These include employment stability for the researchers so they can maintain the external networks they build, and incentives for researchers to make contact with industry and build collaborative networks. Making it easier for SMEs to find information about research and expertise through websites and open days will also help with developing this form of openness.

The IP management regime can either help support or detract from an open innovation stance. The new toolkit developed by the Department of Industry, Innovation and Science may support open innovation if it promotes a flexible approach to IP management rather than a 'patent everything' outlook with lawyers dominating IP management processes. However, this may still be insufficient to overcome deeply embedded IP management policies within universities. While researchers may want to be more flexible, institutional processes need to also support this flexibility — particularly with regard to IP.

7. Conclusions

In summary, there is great opportunity for SME engagement with NIF infrastructure; however, there are currently several hurdles to overcome. Potential hurdles to facilitating this engagement include: establishing interesting connections with industrial players, and dealing with the mechanics of engagement and use of the facilities and funding. On the first point, the value of networking cannot be understated. This requires investment on the part of NIF nodes to incorporate (but not limit to) investing in outreach which includes: developing business development and marketing managers, gaining appropriate certifications and accreditations to exhibit quality, building web presence and investing in 'one-stop-shop' services.

On the second point regarding mechanics of engagement, hurdles include high costs, inflexible IP strategies, low capacity (people and equipment—the latter in limited cases), and misalignment of incentives, timing and urgency. As a result, recommendations were made for pragmatic IP approaches; tiered cost structures and concessions for first-time users; engaging in marginal cost activities like fee-for-service business as a revenue-generating endeavour and 'research open days' to spur interest; investing in capabilities (research and business development); and changing incentives to increase rewards for researchers engaging in commercial collaborations. In total, these recommendations provide nodes with the tools to engage in a diverse set of collaborations (refer to Figure 4.3).

On the third point, we made recommendations for funding early-stage research as a policy suggestion for state and federal level consideration. SMEs are idea rich and cash poor. Fleeting grant schemes and fund-matching schemes all serve to make it hard for SMEs with big ideas to access the exquisite infrastructure represented by NIF nodes. Hence, recommendations were made for faster-paced small grant blocks, and research credits only redeemable at NIF nodes, as ways to entice SMEs with interesting technology ideas to 'come out of the woodwork' to join in collaborative research and development with NIF nodes. We recommend that the department help to consolidate disparate research grant schemes and venture capital into a single portal. Fundamentally, a stronger and more robust commitment to funding technology investments by small business is needed on the state and national levels.

Bibliography

1. National Imaging Facility. Industry Engagement Plan 2015–2016.

2. Department of Education and Training. *Boosting the commercial returns from research*. Canberra, Australia, 2014.

3. Audretsch DB. Standing on the shoulders of midgets: The US Small Business Innovation Research Program (SBIR). *Small Business Economics*. 2003;20(2):129–135.

4. Audretsch DB, Link AN, Scott JT. Public/private technology partnerships: evaluating SBIR-supported research. *Research Policy*. 2002;31(1):145–158. doi:10.1016/S0048- 7333(00)00158-X.

5. Connell D. *'SECRETS' of the world's largest seed caputal fund: How the United States Government uses its small business innovation research (SBIR) programme and procurement budgets to support small technology firms*. 2015.

6. Lerner J. *The Goverment as a venture capitalist: The long-run impact of the SBIR program*. 1996. Available at: http://www.nber.org/papers/w5753.pdf.

7. Shulter S. Australia spends less on R & D than some companies. *Australian Financial Review*. 2015.

8. Redrup Y. Queensland's $76 million startup pitch impresses tech entrepreneurs. *Australian Financial Review*. 2015. Available at: http://www.afr.com/technology/queenslands-76-million-startup-pitch-impresses-tech- entrepreneurs-20150714-gichgj. Accessed September 21, 2015.

9. Queensland Goverment. Startup Queensland Fund. *Startup Queensland guidelines*. 2016,(June). Available at: https://publications.qld.gov.au/dataset/startup-qld-fund/resource/4839a37a-e817-4667-9561-e6f068be57a3.

10. Dowling PDA. *The Dowling Review of Business-University Research Collaborations*. London, 2015. Available at: https://www.gov.uk/government/publications/business- university-research-collaborations-dowling-review-final-report.

11. Fraunhofer-Gesellschaft. Wood Research Days 2014 – Fraunhofer WKI. Available at: http://www.wki.fraunhofer.de/en/events/taho2014_emissions.html. Accessed September 21, 2015.

12. Fraunhofer-Gesellschaft. Open Day at the Fraunhofer Institutes in Braunschweig. Available at: http://www.wki.fraunhofer.de/en/extras/open-day-2015.html. Accessed September 21, 2015.

13. Australian Institute of Marine Science. Open Day 2015. Available at: http://www.aims.gov.au/openday2015. Accessed September 21, 2015.

14. U.S. DOE Office of Science. User Facilities. Available at: http://science.energy.gov/user-facilities/. Accessed September 21, 2015.

15. U.S. Small Business Administration. About SBIR. Available at: https://www.sbir.gov/about. Accessed September 21, 2015.

16. Gann D, Dodgson M. *Innovation Technology: How new technologies are changing the way we innovate*. London, 2005.

17. Dahlander L, Gann DM. How open is innovation? *Research Policy*. 2010;39(6):699– 709. doi:10.1016/j.respol.2010.01.013.

18. Ford JA, Steen J, Verreynne M-L. The ins and outs of open innovation in networked environments. In: *Academy of Management Annual conference proceedings*. Vancouver; 2015:1–40.

19. 2015 MDJ 6, 8 9:02 Am. Like Tesla, Toyota is now giving away its patents. Available at: http://www.businessinsider.com.au/like-tesla-toyota-is-now-giving-away-its-patents- 2015-1. Accessed September 20, 2015.

20. Henkel J, Schöberl S, Alexy O. The emergence of openness: How and why firms adopt selective revealing in open innovation. *Research Policy*. 2013;43(5):879–890. doi:10.1016/j.respol.2013.08.014.

21. Henkel J, Maurer SM. Parts, property and sharing. *Nature Biotechnology*. 2009;27(12):1095–1098. doi:10.1038/nbt1209-1095.