R.A.P.I.D. D.I.F.F.U.S.I.O.N. - Linking crown science agencies with users

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Government science agencies need collaborative arrangements for their science to be adopted. This paper has used the acronym R.A.P.I.D. D.I.F.F.U.S.I.O.N. to describe the key measures that can be taken by government and their science agencies to foster successful collaborative arrangements. These measures are:

Rapid results – early successes encourages further collaboration
Appropriate costs to benefactors – in particular jointly fund partly appropriable research
Passion – people passionate about the goal make collaboration work
Involve partner early – people build passion if involved early in the project
Demand led innovation – technology push just creates a shelf full of unused inventions

Drumbeat of industry – decisions on projects and funding needs to be speedy
Internal venture capital funds – will help link entrepreneur energy with resources
Funding decisions consistent with outcome sought – especially collaboration
Foster collaborative work – trust, candour and win:win strategies
Understand different cultures – share time and the ultimate goal
Success stories – Myths and legends like Black Magic raise a nation
Inspire innovation – at every level: the firm, industry, region and nation
Outwardly mobile staff – collaboration follows people
Networks – possibilities abound when people interact.

The conclusions in this paper are drawn from four separate research studies into raising the adoption of technology from government science agencies in New Zealand. The author also has experience in commercialising government science, developing science policy, support for companies adopting technology, board membership of a university company, directorship of innovation programmes, and management of a seed venture capital fund.

Rapid results – start small then move to larger and more complex projects

It is rare for companies to dive into large scale, long term, risky projects with a swarm of strange scientists unknown to the company. More likely is a long term, slow process that gradually builds up confidence and a relationship. Commonly these relationships start with testing work or minor jobs that do not require a crown science agency's intellectual powerhouse to solve. But they gradually grow into larger and more complex projects as trust and understanding grow.

Schill et al. (1994) observed that applying results speedily was necessary to maintain confidence in strategic alliances.

Appropriate costs to benefactors

Appropriability is the ability to capture the benefits.

The grid below shows examples of types of science and the appropriability of some public sector science activities.

An example of fully appropriable science is forensic investigations. The work is done solely for the Police who can be charged the full cost of the science. At the other end of the scale is non appropriable research, for example developing gene mapping techniques. The benefactors include the world scientific community, and there is no obvious client. Such research is typically fully funded by government.

Note the shift in kiwifruit classification from non appropriable to appropriable. In 1956, when the government first began research into kiwifruit, there was no industry to pay for it. There were a couple of interested growers but their ability to capture the full benefits of kiwifruit research was mimimal. Now, there is a large industry that can pay for and capture the benefits from kiwifruit research.

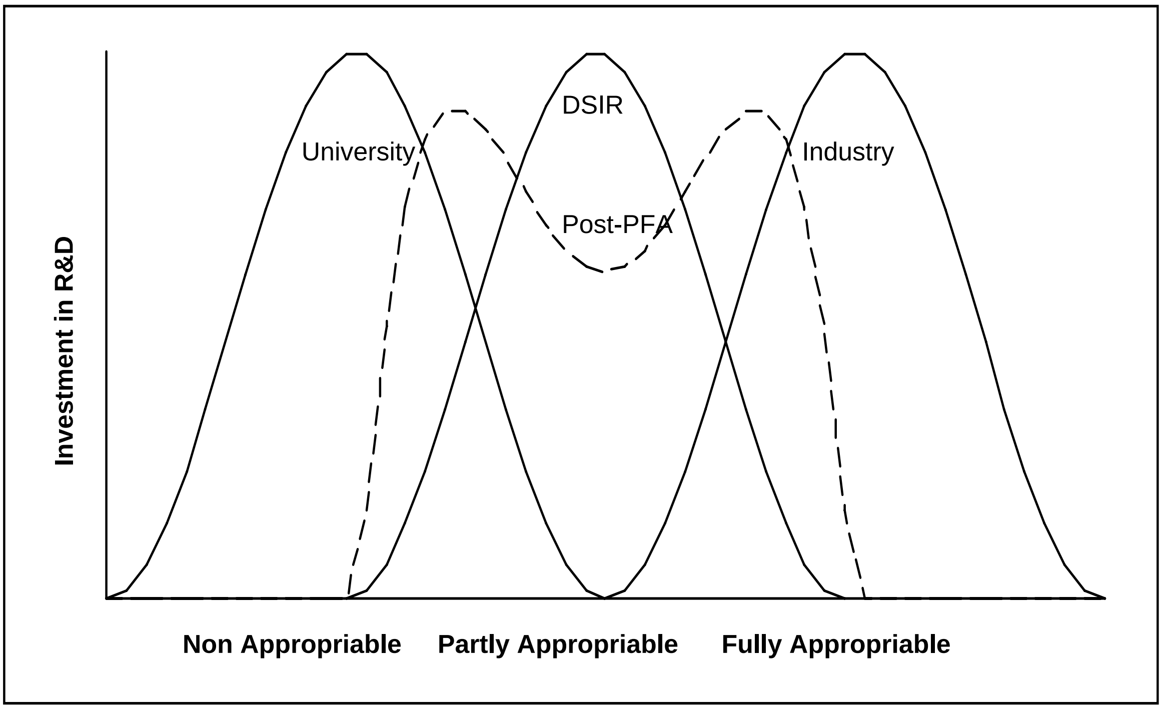
Most research fits into the diagonal set of shaded boxes. The original intention for the government science laboratory (the Department of Scientific and Industrial Research, DSIR) when established in 1926 was to provide the applied interface between university research and industry, which is the centre box in the diagram.

Under the 1987 Public Finance Act, science was classed as either a public good or a private good (ie. non appropriable or appropriable). No sensible mechanism was put in place for science at the interface of public and private good (partly appropriable). In the late 1980s New Zealand scientists shifted their efforts from the problematical applied science to science that had more secure funding prospects – services, strategic and basic science.

Work with the private sector shifted from industry creation to short term, fully funded contracts. The only rationale for a government science agency doing this work was that it had the economies of scale and association from its public goods science work.

	Non Appropriable	**Partly Appropriable**	**Fully Appropriable**
Services	Managing Antarctic research	Weights and measures standards	Forensic science
Applied	Plant breeding of kiwifruit in 1956	Machine vision for variable products	Plant breeding of kiwifruit now
Strategic	Gene mapping techniques	Mapping New Zealand's landforms	Properties of milk protein
Basic	Curiosity driven research		

Figure 1. Appropriability of types of research



------ Optimal range of research   - - - - Trend following the Public Finance Act

Figure 2. The problem of no funding mechanism for partly appropriable projects in the DSIR

A yawning gulf opened up. Strategic science could not find its way to commercialisation without crossing no-mans land of applied science. Yet dual involvement of researchers and users is essential for research uptake (Gronhaug & Haukedal, 1997). Although numerous publications resulted, there was no pathway to commercial uptake. As a result the public science effort became bi-modal

The difficult funding issue is with partly appropriable research. Industry development is often partly appropriable. The benefits accrue to the whole industry once it has developed but the industry does not exist until a few hardy innovators have paved the way. Industry development also has national spinoffs. Correctly the costs of this research should be split between the public and private purse (Hill, 1994).

Take the example of developing machine vision for variable products. Manufactured bolts can be easily judged as passing or failing quality standards – but what about a kiwifruit? At what point does a blemish, distortion or the size put it into a lower grade? Many of New Zealand's primary industries need an electronic grading technology that can cope with shades of variability. The New Zealand science industry was keen to develop machine vision for variable products. But the research was hampered because no industry could be found that, on its own, could capture sufficient benefits to fund the research.

The answer lay in developing collaborative relationships with at least one industry and sharing the cost with government. To Treasury this looked like cross subsidisation and the PGSF system was set up to stamp out this phantom danger.

These perverse incentives were slowly realised and the criteria for funding has sought to foster more collaborative work between the public and private sectors. Over the subsequent decade, criteria for PGSF funding were cautiously relaxed to allow more interaction with industry. But there has never been wholehearted encouragement for government funding going to collaborative work between the government and industry. There has been some rhetoric, but if genuine collaborative arrangements are sought then many aspects of government science funding and attitudes will need to change. This paper outlines some of the required changes.

Passion

Science policy is based on the premise that government funding is best spent on the best projects done by the best scientists. This will probably lead to the best science output, but it will not lead to the best innovation outcome.

The Foundation for Research, Science and Technology has moved to building portfolios of technologies that link into a coherent strategy. This sounds laudable but it is largely based on the premise that innovation comes from good technologies not passionate people.

The science is but a small, front end to a lengthy and expensive process of making new ideas happen. If "making science *work* for New Zealand" is the desired outcome, then it must be a passion driven process, not a science driven process. It must have people in the science agency who believe their work is complete when it is in use. And to achieve this there must be equally passionate science users who will shepherd the project the entire path to success.

Allen (1977) first cited the term champion that is now widely used in innovation literature. Bidault and Cummings (1994) say champions, with faith and energy for the project, are essential for innovating through alliances. Ohmae (1989) goes further in describing business alliances as needing the same interpersonal elements as marriage.

Involve partner early

Innovation alliances are like a zip – the two partners need to be put together at the start. With government funded science, the technology is often near completion before a commercial partner is sought. But passion and commitment are forged at the early stage of the project.

Moreover the commercial partner's contribution at the early stages could be a little seed funding, access to plant and equipment, or just their market insights. This level of commitment is much easier to gain than substantial funds required for commercialisation.

In 1984 I undertook 23 experiments of strategies that could be used to get the private sector to adopt DSIR technologies. This was in the days before user pays. Bizarrely none of the strategies where the technology was offered for free were adopted. Success came when four factors were present. Firstly an analysis that talked in language that industry understood, including a little market analysis and a net present value. Secondly, there was a partner who was interested in working with the DSIR. Thirdly, the project was at an embryonic stage. And fourthly, the partner had to make some financial or other contribution. It seemed if we could open their pockets, their hearts would follow.

De Meyer (1991) makes a similar recommendation to companies. He urges companies to actively invite partners to solve problems for them, rather than limiting themselves to a passive search for ideas and information. Hill (1994) gives an excellent metaphor for the innovation process, "It is not a relay race but a basketball game."

Demand led innovation

"We will have a man on the moon by the end of the decade!" This public pronouncement by President Kennedy sparked a decade of intense research that led to Apollo 11 triumphantly landing on the moon in 1969. The problems faced by applied researchers drew forth a demand for basic research. Like aerospace, the United States Government defence, environment and health industries have funded scientists to solve their real problems.

In New Zealand, we have followed a research/technology push strategy, as described by Rothwell (1992) as the first generation model of innovation. Government science agencies have produced the science in the belief that users would follow. The Foundation for Research, Science and Technology (FRST) was set up as a quasi customer offering contracts for research deemed useful for the nation. On paper this may look like demand led science, but it has none of the real qualities of a customer – a pressing need, a relationship with the science provider, knowledge of the marketplace, or the ability to put the technology to work.

Von Hippel (1988) studied the contribution of users in the innovation process. He found that in most cases the original idea for the new product came from the potential user of the new product. Kline and Rosenberg (1986) found that important scientific achievements began with dealing with specific technical problems faced by firms.

The task for New Zealand Government policy makers is to find ways that arms of central and local government can be used as customers for research. For example the New Zealand Defence Department is keen to work with entrepreneurs to prototype industrial designs that might be useful in their operation, and to use their 21 defence attaches around the world to open the doors to buyers from other countries' defence departments. Designs range from sanitary towel dispensers to ways to land supplies into areas that don't have port facilities.

Drumbeat of industry in funding projects

The FRST funding system is like forcing a rabbit through a snake. All of the decisions for investment in science programmes are made just once a year. When the science agencies receive their funding in June they begin the process for the next year's round of bids. FRST has sought to reduce the pressure on the funding system by funding large programmes rather than projects and making allocations for longer time periods. However our experience of working with Industry New Zealand clients who are keen to invest in research and technology shows that it is impractical in most circumstances for industry to collaborate with science agencies to bid for FRST funds.

A project conceived of in December would wait 16 months before receiving an indication of whether their bid was successful, and 18 months before receiving any funds.

Internal venture capital funds

Ninety-two percent of New Zealand firms employ fewer than 10 staff. These firms have the ideas and entrepreneurial energy for innovation but lack the financial and other resources necessary to bring the product to market. By contrast, large firms in New Zealand appear moribund. Industry New Zealand sources estimate that large organisations in New Zealand have lost $15 billion in market capitalisation over the last 10 years.

Collaboration between entrepreneurial small firms and large companies with access to markets and resources could achieve mutual benefits.

I urge government to have an incentive scheme that encourages New Zealand companies to establish their own internal venture capital fund. Proposals for the funds can come from inside or outside the firm. Government support is only needed for around two years until the fund is established, operating and accepted.

Carter Holt Harvey and Fletcher Challenge have already developed internal venture capital funds. These funds have been useful in influencing the attitude of senior managers toward investing in innovation. They have provided an avenue for intrapreneurs in these organisations to advance their projects, and for entrepreneurs with synergistic projects to work in partnership. Some excellent projects have received investment.

New Zealand Post developed a creativity and innovation programme that encouraged staff to generate ideas for business ventures. These were then analysed and the best ones given to a manager to pursue. The programme died. It was based on a belief that innovation could be driven from finding the best ideas. Instead the programme should have focussed on supporting the people with the ideas – whether they are intrapreneurs or entrepreneurs.

Funding decisions consistent with outcome sought

Our interviews of 91 providers and users of government science highlighted their frustration with the FRST funding criteria. They believe that each year FRST would state its criteria but the decisions implied other criteria were used. In particular they argued that collaboration was encouraged but not supported.

The FRST contract bids require a statement on how the technology will be transferred, however published academic papers are generally regarded as an acceptable form of technology transfer. Marquis (1972) noted that in 567 successful innovations that less than 1% of the ideas originated from an academic paper. Most ideas came from an individual’s mix of experience or two individuals with different experiences and training. Even the terminology ‘technology transfer’ implies a baton passing rather than collaborative process.

FRST funding decisions would be more effective in fostering innovation if they favoured collaborative work, decisions were made more frequently to meet the needs of science users, and the outputs required from scientists focussed on real outcomes not just written papers.

Foster collaborative work

Collaborative work practices require a different kind of organisation than one aimed at operating competitively or as a loner. A study of Australian universities and public research institutes by Turpin and Dreville (1995) found that relationships were mainly at the interpersonal level with industry, but were often in conflict with the formal structures that were set up to manage the collaborative arrangements. Fostering collaboration is the process of fostering the relationships and networks, as well as formalising the agreements. Conway (1997) studied collaboration and communication in the development of 35 successful technological innovations. He observed liaison, bridging and link-pin roles but noted they were the property of individuals rather than organisational positions.

Lendrum (1997) demonstrates that organisations that form successful strategic partnerships have a quantum difference in their approach to those who have customer-supplier relationships. “These cooperative and trusting relationships are based on competence, character, honesty and personal friendship in working together, in good faith, as individuals and teams, to achieve common goals for mutual benefit. I would estimate that only 20 percent of firms today are capable of genuine partnering. Many know the words to the song, but few can hold the tune.”

Harari (1994) accuses organisations of posturing about partnerships but empty of the real meaning of building trust, sharing a vision and goals, being candid or genuinely seeking win:win solutions.

These values for working collaboratively are built into the organisation culture. It includes how resources are allocated, what managers notice and reward, and how managers role model collaborative behaviour and values. The role given to lawyers in forming agreements is instructive. Like a marriage, agreement needs to be reached and a clear contract signed, but if you ever have to refer to the contract again the marriage is in trouble.

MacAvoy (1997) recommends careful selection and training of alliance managers. He describes them as, "diplomats – socially adept and flexible, yes, but also persistent, determined and results-oriented".

Understand and support different cultures

Research by Trompetter (1998) of New Zealand scientists and science managers shows there are distinct differences in personality types and aspirations. For example scientists tend to be introvert, value science thinking and peer recognition, whereas science managers tend to be extrovert, value intuition and are driven by the success of the project.

Scott (1997) notes that organisations seek to maintain their autonomy and resent putting scarce resources into building collaborative relationships. Inter-organisational conflict is therefore normal rather than being caused by a clash of different professions or personalities.

The understanding and support for different groups comes from working together on solving problems towards a shared goal. Senge's principles for building a learning organisation also hold true for building a collaborative relationship across organisations.

Different professions working in a group increases the opportunity to challenge mental models of how things are done, enhance personal learning and enhance group learning. However achieving this can be stressful and may require finding systemic solutions to problems facing the group.

Success stories

Economists have long known that business confidence is a major predictor of future economic performance. Politicians chase good photo opportunities. Organisations build myths and legends about their company to build their company culture. These are examples of the power of success stories in transforming people's behaviour.

New Zealand has lived on the myth of the do-it-yourself hero with the number 8 wire. New stories need to be told of heroes who have built world class businesses through ingenuity, technology and team building.

Black Magic, the name of the New Zealand yacht that took on the world and won the America's Cup, began to be used to describe a nation's view of its talents.

How can the government and politicians build the legend to excite confidence and trust by kiwis in their ability to be world class, successful business heroes?

Inspire innovation

Government science agencies need innovative, growing companies with whom to collaborate. Geoff Page, CEO of Industrial Research Ltd, stated that they are only willing to work with small to medium sized enterprises that had a mindset to foster innovation.

In the 1990s innovation was the key to competitive advantage. Now organisations need to be innovative just to compete.

Literature abounds on the requirements to make organisations innovative. It includes the need for an organisation culture that supports continuous improvement, fosters excellence, accepts some risk and errors, has a flat structure, a shared vision and so on. Innovation is not restricted to technologically based organisations – it includes government departments, local councils, small and large firms.

Innovation is inspired inside organisations, in industries, regions and nations. Firms that locate in Silicon Valley expect to be leading edge innovators. What does it take for New Zealand firms to feel inspired to be innovative? This week a world leading boat manufacturer located in New Zealand because the Government and the local authority demonstrated an attitude that made it easier for the company to set up business here. Government's new organisation, Industry New Zealand, is touching entrepreneurs' lives in ways that are helping them to achieve quantum leaps in their performance. These strategies and more like them help to inspire innovation in New Zealand firms.

Outwardly mobile staff

Collaboration follows people. Our interviews of 91 examples of government science agency and user collaboration highlighted the importance of pre-existing relationships. In particular, collaboration often occurred with former employees.

This suggests that secondment, staff divestment, and spinning off ventures with employees can foster collaboration.

Networks

MacAvoy (1997) notes that one of the key competencies of an alliance manager is the ability to build strong networks. Networks spawn the opportunities and relationships for collaborative agreements.

Government science agencies can be a hub for business networks through offering seminars, workshops, portals, feedback loops, business alliances, incubators, trade missions and so on. The more activities that are offered, the stronger the network. As the network grows, the number of relationships grows exponentially. It's like a magnet that becomes increasingly powerful and effective.

Conclusion

Government science agencies need collaborative arrangements for their science to be adopted. This paper has used the acronym R.A.P.I.D. D.I.F.F.U.S.I.O.N. to describe the key measures that can be taken by government and their science agencies to foster successful collaborative arrangements. These measures are:

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