# FACILITATING AND FUNDING THE PRODUCTIVE INTERACTION OF TRANS-TASMAN RESEARCH CAPABILITY TO ADDRESS INDUSTRY-IDENTIFIED RESEARCH PRIORITIES

Geoff Downes
Company and R&D Director
Forest Quality Pty. Ltd.
P.O. Box 293, Huonville, Franklin, Tasmania

## *Authors statement*

This paper is an attempt to explore mechanisms by which commercially-useful R&D capability within Australia and New Zealand might be better resourced and supported over time. Brief discussions were held with a wide range of both suppliers and consumers of R&D to better capture perspectives on past and present experiences. While I have endeavoured to be faithful to the views expressed, the responsibility for this paper remains mine. The intention here is primarily to offer a perspective(s) that will stimulate discussion, and hopefully assist in the process at arriving at a viable mechanism to maintain an optimally sized and sufficiently diverse R&D capability supporting commercial forest industries.

## Contents

# Executive summary

R&D capability within Australia specifically supporting the forest industries has declined over the past 5 years with a consequent loss of corporate knowledge. At the same time the face of the industry has gone through major changes over recent decades as a function of changes in tax law and socio-political attitudes. New opportunities are arising that potentially expand the range of products from our forests, and include a range of bio-fuels, plastics, and engineered products that will require extensive R&D support. Various initiatives are being developed to support these, however the recent decline in R&D knowledge is concerning. In addition the more traditional forestry operations and products also require R&D support, particularly as new technology and knowledge changes the way traditional tasks are performed.

Past experiences in trans-Tasman R&D has demonstrated at the scientific level that effective teams and partnerships can be formed, and produce commercially-useful outcomes. Management, administrative systems and personal attitudes have provided obstacles, as has the lack of clear statements of intent. The cost of government funded research has proved too expensive for private firms to consistently access. This limits the long-term funding security for the R&D provider, reduces the investment of public funds and affects long-term R&D capability planning. The extent to whether the "too expensive" claim is valid deserves a more considered assessment of the costs of providing R&D in terms of staff and facilities over time.

This is compounded by the different performance indicators required from research capability by public funded employers on the one hand and private firm customers on the other. Increasingly R&D capability in institutions such as CSIRO have been directed to see employers as stakeholders to be "clients" to whom you need to sell your "products" internally to maintain their investment. Wares consist of publications, media releases and other "public good" activity. This is often at odds to the performance indicators required by other funding sources. To attract the best young intellects, career opportunities need to be competitive.

The length and diversity of the forest value chain is too large to expect a local R&D capability to support each area; the question is which portions and types warrant local support.

- Expertise in forest inventory (remote sensing, forest health and biosecurity) warrant support to develop a combined capability, as do forest operations / harvesting.
- Processing applications for forest resources are diverse. However mechanisms that can support development capability to support incremental improvements into existing processes are needed. This will allow technology developed elsewhere to be adapted and implemented in local situations.
- Building systems R&D that underpins the role that timber can play in new design and construction applications.

# Introduction

*"R&D enjoyed strong support when integrated companies managed the value chain from tree to end-user. Today, however, because of tax law changes and the globalization of markets, manufacturing is typically separate from landownership. Divesture of timberlands by fully integrated forest products companies has brought fundamental changes. The new owners of large private forests are timber investment management organizations (TIMOs) and real estate investment trusts (REITs). Their obligations to shareholders, combined with the consolidation of forest products companies through mergers and acquisitions, have meant the dismantling of research budgets and greatly reduced investment in forestry and forest products development. (Kellison 2014)"*

Over the past 5 years there have been radical changes and general reductions in the research and development capability supporting the forest and forest products industry in Australia. This has accompanied a major change in the way the industry sector has been structured over the past two decades, against a backdrop of major changes in the way the global economy operates.

New Zealand has a strong forestry sector that employs around 20,000 people and represents 3%[1] of gross domestic product (GDP), produced from a predominantly exotic softwood plantation estate of 1.75 million hectares or 7% of the NZ land area. Australia has approximately 2.02[2] million hectares of plantations evenly spread between native hardwood and exotic softwoods, and a trade deficit in forest products of approximately $2 billion. It employs around 66,000 people [3], and represents 0.5 % of national GDP.

In a free-market system there are three main reasons for investing in research and development. The first is to boost profits. The second, to reduce costs. A third might be to protect profits by maintaining market share. The community is served, in a strict business sense, by producing goods that people want to buy, generating employment, and returning profits to those who take the risk of running a business. But business doesn't currently operate in a true free market, and market forces are significantly affected by social and political influences. This consequently affects research and development capability.

The above quotation from a recent report by Prof. Kellison addresses the US Forestry sector, and the report includes an assessment of the reasons for the decline in R&D expenditure in the US since the early 1980's. The similarities with the Australian situation are self-evident. The socio-politically mediated changes to the forest industry have naturally affected the R&D capability supporting it.

There is a growing body of literature that endeavours to understand and describe the role of R&D in global innovation. Much of this addresses R&D within large multi-national organisations rather than a single industry sector. von Zedtwitz, Gassmann et al. (2004) list six dilemmas of global innovation which provide a useful context for exploring R&D management. There is no identifiable preferred or "right" approach; most situations are consequent on a multi-variate suite of causes.

1. Local versus global

Too much freedom may lead to reinventing the wheel. Too much control may stifle creativity and innovation. Access to global R&D is much easier now, but know-how cannot be downloaded in publications. Local markets can differ from global ones and R&D needs adapting to local context.

2. Processes versus hierarchy

---

[1]http://www.mpi.govt.nz/forestry
2http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Forestry~181
3
http://www.daff.gov.au/ABARES/pages/publications/display.aspx?url=http://143.188.17.20/anrdl/DAFFService/display.php?fid=pb_afwpsd9able20131120_11a.xml

Hierarchical concentration of resources into technical and product competencies minimises duplication of effort, enabling critical mass to be achieved. However, this may stifle innovation and the interaction of groups must be facilitated to develop process-related capability. *"R&D processes cannot be managed and measured like repetitive routine processes in production. Deterministic models of managing innovation processes have given way to models incorporating chaos theory and randomness."*

3. Creativity versus discipline

It is difficult to find an effective balance between discipline and creativity, standardization and variety, organizational slack and cost cutting. Management focus on planning and standardization may generate greater efficiency and shorter cycle times, but at the cost of reduced freedom for creative chaos.

4. Control versus open source

Companies need to discriminate between ''must have'' (technologies that must be owned) and ''nice to have'' technologies. R&D organizations fear to lose ownership over future key technologies. Own only what you must, influence all you can.

5. Face-to-face versus ICT

Business and R&D is dependent on good, trustworthy communication. Information and Communication Technology (ICT) is a must in business. However it is yet to replace personal contact in building good relationships *"The challenge will not only be to manage face-to-face communication, but also how to manage and make sense of millions of documents and other pieces of information collected in projects, on the Internet, or from specialized information service providers"*

6. Long-term versus short-term

Critical to the success of R&D is the timing of its entry into the market. Too early or too late can be equally bad. The conflict between market research to establish demand and timing for a new product or process can drive a wedge between research's long-term needs and development's short-term demands.

Over the past decade, there have been several ventures in which R&D capability in Australia and New Zealand has been brought together in both formal and informal collaborations (e.g Ensis). Similarly there are also R&D capabilities in both countries that service the same or similar commercial needs, but have little formal collaboration (eg. STBA & RPBC).

The purpose of this paper is to briefly assess the current state of R&D capability within Australia and New Zealand, and explore the potential for better harnessing and resourcing the trans-Tasman capability, to better serve the commercial needs in both countries. The following objectives have been addressed:

- brief assessment of past efforts of trans-Tasman coordination of R&D activity supporting the forest industry
- broadly address the fostering and management of productive collaboration of all possible trans-Tasman research capability to
  - assess industry's role in
    - priority setting
    - research uptake
    - adoption/commercialisation of research output.
  - enhance current and forecast R&D skills, expertise and capacity
  - develop optimal research teams to address research needs

## Observations on selected Trans-Tasman collaborations

Over the past decade, trans-Tasman R&D providers have developed collaborative structures with varying degrees of success and effectiveness. It is not the intention here to provide an exhaustive overview of each collaboration, but to provide a brief assessment of strengths and weaknesses.

### FRI-industry multi-client drying group

In the mid to late 1980's there was growing interest in high temperature drying of radiata pine lumber. Drying is a considerable expense in the production of lumber and reducing the drying time decreases, amongst other things, the amount of "warehoused" lumber at any point in time. However issues of rapid (high temperature) drying in producing distortion, residual stress and discoloration were some of the many problems that needed resolution. Ameliorating effects of HT drying, such as minimising twist or stability improvement also needed investigation.

In 1988 the FRI-industry multi-client drying group was established to resource the NZ Forest Research Institute (FRI) to address these problems, with industry fully-funding R&D costs by contributing according to the number of kilns they operated. Industry partners included most of the big processors in Australia and New Zealand, and equipment suppliers. The number of industry partners increased throughout the 1990's as the R&D outcomes transferred into operational practice. Research results were embargoed for two years. The US-based Weyerhauser company also participated, with their R&D facility in Seattle, USA eventually interacting with the FRI group.

Among the many R&D issues addressed was the development of regimes to optimise steaming conditions and energy demands, controlling variability, minimising colour changes and characterising emissions, as well as various issues along the process chain that influence drying such as sawing, planing, storage and transporting dried lumber. The group facilitated interaction between industry and FRI research staff, providing ready access by industry to advice and training. FRI became the main provider of training in kiln operation and other drying related procedures.

By the early 2000's, as many of the initial "easier-to-solve" issues had been overcome, agreement among industry partners on what R&D priorities should be and how to allocate resources became increasingly difficult to obtain. By the mid 2000's some companies had pulled out, particularly among smaller operators as business conditions became more competitive. The establishment of the WQI / SWI model (see below) effectively ended the group, as industry partner's redirected support, obtaining a dollar-for-dollar matching on R&D funding from the NZ government.

### Ensisjv

Ensis was an unincorporated joint venture between CSIRO and New Zealand's Crown Research Institute, Scion (formerly New Zealand Forest Research Institute). Formed in 2004, and expanded in 2005, the partnership combined Australasia's two leading government-funded forestry R&D organisations. The concept was to enhance the breadth, depth and scale of New Zealand and Australian forest research capabilities, thereby increasing the revenue stream above that achieved by both parent organisations individually, through becoming a bigger, global provider of forestry R&D. Ensis spanned the forest industry value chain through:

- Genetics: breeding better forests for maximum returns
- Sustainable production forestry: precision management of plantations
- Integrated environmental forestry: sustainable protection of forests for our future
- Forest bio-security and protection: protecting our forests from biotic and abiotic risks
- Wood and fibre quality: linking quality to value
- Wood processing and products: ensuring the place of solid wood in a modern market
- Pulp, paper and packaging: optimising fibre-based processes and products

The decision to terminate Ensis was made in 2007 after three years of operation. This decision was approved by both the CSIRO and Scion boards in the week commencing 20 August 2007.

The failure of Ensis can be attributed to a number of factors as follows

1. Lack of resources (dollars, time, patience, will) to make the venture a success. Ultimately if revenue had increased with parent organisation's expectations of year-on-year growth right from day one, the venture would have survived. However, the time / patience / will to weld two different organisations into a common entity with shared cultures and administrative processes was not available.
2. Insufficient external earnings. The expectation of increased revenue streams was not evident and placed undue pressures on the venture. This is largely attributable to the cost of R&D capability within Ensis. The price of R&D was higher than the market would bear, and the perceived return on investment (ROI) less than needed.
3. Different priorities within CSIRO (above divisional leadership), to those represented by the venture. CSIRO divested itself of much of its forest products capability within 1-2 years of the cessation of Ensis, representing a considerable loss of experience and corporate knowledge to the industry. It is possible this would have happened earlier if Ensis had not been attempted. CSIRO's decision to divert support away from commercial forestry R&D was probably based on its understanding that significant ongoing investment in R&D from the industry was lacking, and they would obtain better ROI of research expenditure in other sectors. CSIRO had mandated external earnings targets.
4. Different objectives between CSIRO and Scion, and the lack of an agreed strategic plan from day one. Scion's decision to leave out key aspects of its capability, while similar capability was contributed by CSIRO (e.g. molecular genetics) undermined trust.
5. Infrastructure differences, particularly in terms of administrative systems made administrative welding of the two organisations difficult. Within CSIRO, a new administrative software system (SAP) was being rolled out, and the IT problems that ensued in trying to streamline reporting within Ensis and to parent organisations was a nightmare, draining staff time and morale.
6. No direct funding to ensure culture change, with no ambitious game-changing project targeted to ensure teams worked together, with very little or no business support at the science level, meant that increased revenue targets were unrealistic

It was intended that Scion and CSIRO should continue working together through an ongoing Collaboration Agreement. This has not occurred to any significant extent, largely owing to the changes within CSIRO and its reduced commitment to commercial R&D in this sector.

## SWI / WQI

Solid Wood Innovation (SWI) is a research consortium that built upon the initial R&D conducted by the NZ Wood Quality Initiative (WQI). The focus of SWI is to create value for its shareholders (around 26 companies) in the area of solid wood processing. The value proposition for shareholders is in three areas:

1. Increased manufacture of appearance related wood products targeted at export markets
2. More efficient manufacturing through yield optimisation systems
3. Greater energy efficiency and reduced water useage in wood drying" (www.wqi.co.nz)

SWI operates as a vehicle for directing and resourcing R&D, rather than as a provider of R&D, providing industry partners with a mechanism to leverage their investment with dollar-for-dollar matching from the NZ government. Together with its WQI precursor it has been a major provider of resources for understanding and improving softwood wood quality and processing. While providing some resources for more fundamental basic research, its emphasis has been on development and optimisation of existing technologies. FWPA, as a shareholder, has represented

Australian interests, and consequently SWI services stakeholders in both countries. SWI also partners with Weyerhauser (US) in the area of log assessment and quality.

Industry participants in SWI are broadly supportive of the approach to R&D that it pursues. Leadership is customer focussed and responsive, and members are able to influence R&D effectively. In distinguishing between "research", "development" and "application" (RD&A) most SWI activities are focussed on development and application that incrementally improves aspects of processing. This generates concern that room for the new "good idea" needs to be made, in which under current conditions, the necessary role for public funding in maintaining a longer-term research capability is evident.

In assessing RD&A capability, the role of staff within companies is often overlooked as is the internal D&A done within companies. It was noted that increasingly SWI was accessing in-house capability to conduct D&A. To quote one Australian ex-government research scientist: "*any processing work should be done in partnership with industry in their mills. Collectively industry have the best equipment (and wide variety of equipment) and they have the experts to use it properly …….. industry collectively is in a far better position to do work than isolating the equipment into research institutes*." (Russell Washusen personal communication).

The role that the SWI has played in providing support for and access to trans-Tasman R&D capability and output has been extremely useful. Access to past reports has been valuable, primarily for processors rather than growers. As the SWI approaches the end of its term it is seeking to identify the focus of a next-generation entity. This might look at Innovative Building Systems. Different companies are considering their options in terms or whether to continue SWI for a few more years to complete some processing development projects or evolve into a new entity. While Australian companies interacting via the FWPA have enjoyed the access to RD&A that SWI has offered, the SWI activities are both NZ and radiata centric. Options for Australian industry is to (1) maintain and increase involvement with SWI or its successor, (2) focus on FWPA projects, (3) develop an Australian equivalent, or (4) put resources into specific internal projects, identifying outside RD&A capability as necessary. While the latter reduces the leverage gained by collaborative projects, the project can be better directed and potentially achieve a quicker, more targeted outcome.

## STBA / RPBC

Tree breeding is a key capability need in both countries. In contrast to the above interactions, R&D in this area has largely been addressed separately by the STBA in Australia and by the RPBC in New Zealand. Despite this general distinction, RPBC has serviced customers in Australia, largely NSW State Forests and Timberlands (Tasmania).

The RPBC (www.rpbc.co.nz) is primarily working at improving the radiata pine germplasm. The focus has been on rapid turnover of germplasm and speed to market. The STBA (www.stba.com.au) has a wider interest addressing eucalypt breeding as well as radiata pine. It produces improved germplasm for member companies, but is also developing software tools to facilitate tree selection in breeding, with a focus on dollar value rather than specific traits. It has a strong element of establishing genetic gain trials to underpin genetic selections. There has recently been exchange of seed between the organisations for use in each other's genetic gains trials.

Both organisations have strong support from their grower partners, with good uptake of new genetic stock. The cost of breeding new germplasm is always hampered by the time for financial returns to be realised, hence the RPBC's focus on early selection and speed-to-market. The different strategies pursued by the two entities could provide a basis for comparison of effectiveness. There is currently some collaborative work in GxE trails (FWPA funded and led by CSIRO geneticists) in which both the RPBC and STBA are collaborating. This project is due to be completed this year with no formal plans for extension. Quantitative genetics capability at CSIRO risks being deployed into other species such as cotton.

Merging the two capabilities into a single entity would seem sensible, based on the view that the market (Australia – NZ) is small, and a more co-operative approach would be more cost-effective. The STBA has a broader species focus than the RPBC, and over the past few years they have pursued different strategies. However, despite some member pressure, there seems to be little incentive to pursue a merger. The STBA has recently secured several years of funding for its operation and so has little incentive to merge.

## STIC

The Structural Timber Innovation Company (STIC) was a consortium, led by Andy Buchanan at the University of Canterbury. It was directed at developing and commercialising new technologies that enable structural timber to compete more effectively in the building and construction market (www.stic.co.nz/company). As such STIC was a vehicle for defining and co-ordinating trans-Tasman R&D, rather than an R&D provider in its own right. The R&D portfolio had three research areas:

1. 'Single storey timber roofs and portal frames': University of Auckland - Prof. Pierre Quenneville.
2. 'Timber floors for multi-storey timber buildings': University of Technology, Sydney - Prof. Keith Crews.
3. 'Timber frames for multi-storey timber buildings': University of Canterbury - Prof. Stefano Pampanin.

STIC funding finished in June 2013. There are still some ongoing projects, essentially as PhD students complete their studies. While providing a good foundation upon which to build, R&D capability is still lacking and below critical mass. There is no secured research funding for the next step to maintain the critical mass that exists between the Universities and fostered by STIC.

STIC consolidated existing R&D capability in this area, developing long-term healthy relationships between key R&D providers. It was a great enabler with a good pool of funding. It had a "CRC-like" quality that supported 30 PhD's. STIC allowed development work to be undertaken that was under-girded by basic research, while industry alignment helped keep PhD work focussed on commercial issues.

A technical advisory group supported by industry, mainly engineers, generated good industry engagement, which is critical to success. However, not many of the PhD trained people have been retained in the region or industry. There needs to be a better take-up of these people to fully capture the benefits of R&D. Several have secured positions in academia.

A move into smart manufacturing would be a logical progression as the timber industry moves from a commodity focus to become a building systems manufacturer. Involvement in consortia like STIC facilitates the maintenance of capability within University structures. The establishment of a CRC that included this area would develop the capability and build collaborations on an international scale.

## Summation.

Compared to other industries, the forestry sector has a lower investment rate in externally-sourced R&D. This is contributed to by the significant changes over recent decades in the structure of the value chain in response to the changing political, social and economic context. Industry perceives government R&D providers as expensive, contractually difficult to work with, and having different performance motivators. Complications over IP agreements can provide a barrier to getting projects started and this compromises the rationale for new R&D investment. The cost to partners of using developed technologies can cause barriers to uptake. In addition time pressures of industry staff limit the ability to take up and champion R&D within individual companies, reducing any potential ROI.

However, having access to a sustainable R&D capability requires ongoing support from industry. The closure of the CSIRO Forestry and Forest Products Division resulted in the loss to the industry of a resource of people with significant R&D experience and corporate knowledge. There are now fewer people for industry to contact when specific problems arise. Several small enterprises have been developed by ex-CSIRO staff, and customer experience has indicated this has made project development easier, improved access to limited R&D capability, allowed more targeted outcomes and improved the quality of R&D delivered. Specific mention was made to the work of Jamie Hague (http://www.afrcpl.com.au) and Laurie Cookson (http://www.ljcookson.com).

In synthesising the views of a range of people involved in researching the above interactions, some common themes emerge. I have endeavoured to incorporate these in the following list. While this summary is based on conversations with a wide range of people, generating occasional disparity, I have endeavoured to treat the views fairly. Any faults in the synthesis are mine.

- At the scientific level, trans-Tasman collaboration has worked extremely well. Researchers have formed strong and mutually supportive relationships that have often produced new projects and ideas of mutual benefit.
- There are insufficient financial resources to support a large combined trans-Tasman R&D capability that is expected to exist as a stand-alone institution undertaking both research and development in the forestry sector as a whole. To make institutions such as Ensis work, requires support and advocates from the highest level to create the institutional culture required for R&D teams to operate seamlessly across the Tasman. This would require significant government and industry support and patience. In the current economic and political landscape, there seems little need or demand for such an entity.
- Long-term support for R&D requires stable industry commitment. The rapidly changing appearance of the industry in response to investment funds taking over ownership of plantations often resulted in significantly reduced commitment to R&D. Likewise the sale and restructuring of processing companies reduces attention / commitment to R&D; better financial returns are considered to be available from marketing, economic or political activity.
- There is some market perception of too few R&D success stories, demotivating industry to commit to a general support of R&D, especially as activity moves further from D&A into the R. Many success stories do exist that have now become routine practice (e.g in timber drying amongst others) and their R&D past forgotten, or where the industry lacked the internal capability and will to implement findings. This has generated a culture where industry may support focussed H1[4] on an as needed basis, and even some H2. But blue-sky H3 probably needs to be done without industry money. This is important but, in the current economic system, may need to be funded by taxpayers.
- Entities such as SWI are successful in addressing H1 and H2 tasks that are close-to-market incremental refinements. STBA and RPBC are successful in as much as the R&D carried out can be shown to improve the economic bottom line.
- Large research organisations are too expensive for industry to utilise extensively and consistently. This was a common theme and perhaps needs a more considered evaluation. Given the time, equipment and organisational demands of maintaining an R&D capability, what is a reasonable "hire" rate? Especially when funding horizons are short and therefore

[4] The H1, H2, H3 classification of research was used within many Ensisjv discussions. H1 is considered to encompass routine analytical services (e.g. SilviScan analyses, pulp yield assessments) and close-to-market activities. H3 was considered the blue-sky research to explore new ideas, break new ground etc. H2 research was intermediate and sought to advance the knowledge or understanding of a process to achieve a particular customer objective.

attracting and retaining quality researchers and technicians is difficult. Working backwards from this would allow a better indication of the size and nature of the R&D capability that can be maintained, and possibly allow better identification of priority areas. For example R&D within universities may have lower overheads, with infrastructure subsidised by the teaching role they offer. In contrast R&D capability within institutions such as CSIRO, while being more expensive, could provide more focussed attention to specific projects with a less-transient capability.

- The Forest industry has a comparatively low R&D spend. Does its desire for an R&D capability extend to the point that they are willing to deal with the broader issues of funding capability, especially within the context of what motivates people into an R&D career in this sector? Industry is more focussed on development than research leaving the higher-risk research activity to other sectors or fully government-funded projects.
- The forestry value chain is long and diverse. To maintain engagement with the socio-political landscape it needs to increase that diversity at the margins with new and qualitatively different products coming from it. Having an R&D sector closely aligned to it along disciplinary lines may be inefficient and hinder fresh ideas coming in from outside. An R&D capability aligned according to market categories might be more appropriate, with forestry-related R&D forming a subset within a large, broader capability. This raises the issue of how to engage with R&D capability not primarily engaged with the Forestry sector.

# Existing R&D capability within priority areas

The following section is intended to provide a brief contextual overview of the current R&D capability in the research areas listed. Thus, a limited insight is provided based on discussions with a range of industry and research people, and only intended to identify major and common factors.

## Forest health / biosecurity

- Australia
  - University of Tasmania / Forestry Tas: Caroline Mohammed ;Geoff Allen / Tim Wardlaw
  - QDAFF: Simon Lawson
  - NSW DPI:
- New Zealand
  - Scion: Lindsay Bulman

In NZ, Scion maintains its capability with over 30 researchers under the leadership of Lindsay Bulman. The NZ Forest Owners Association have a well-documented Biosecurity strategy[5], which lists support for a range of projects from providers at Scion and various universities. Much of the Southern Australian capability has been centred in the various incarnations of the CRC Forestry over the past two decades. Expertise within the University of Tasmania, CSIRO and Forestry Tasmania has supported this. The current capability is now centred at the University of Tasmania while QDAFF also have a R&D program. Within Ensis, the Scion and CSIRO capabilities enjoyed some interaction, however the Australian focus was primarily on plantation eucalypts via the CRC Forestry. NSW DPI maintains a strong forest assessment capability and probably represents the lead role within Australia at present.

At the research level, Ensis worked well in this area, providing a large body of expertise, instead of relatively few loners within CSIRO. Given the close proximity and different pests within the two countries a combined and co-ordinated capability was starting to produce a common focus. After

[5] http://www.nzfoa.org.nz/images/stories/pdfs/content/fbrcreports/strategy_130511.pdf

Ensis, CSIRO reduced its emphasis on forest health R&D apart from within the CRC Forestry, which has now ceased operations.

Lack of funding represents the major reason for declining capability, with existing expertise aging and retiring (Mohammed, Glen et al. 2011). There is little incentive or opportunity for young researchers to consider careers in this area. Existing expertise is walking away from the area due to lack of support. Supporting University-based capability and facilitating trans-Tasman activity through the provision of relevant and funded projects, addressing commercial needs could be productive.

## Genetics

- Australia
  - CSIRO:
    - Simon Southerton (molecular)
    - Milosh Ivkovic (quantitative)
  - STBA: Tony McRae
  - QDAFF: David Lee
  - University of Melbourne: Gerd Bossinger (molecular)
  - University of Tasmania: Brad Potts
  - Southern Cross University: Merv Shepherd (molecular)
- New Zealand
  - Scion: Heidi Dungey
  - RPBC: Trevor Butcher

The Australian capability in both quantitative and molecular genetics has undergone significant changes in the past few years, largely associated with the break-up of CSIRO Forest Biosciences. Most capability within CSIRO is now located within the Plant Science Division, where reduced but active programs are still in progress, albeit with pressure to move into more agricultural pursuits. For example the cotton industry supports around 100 scientists working within CSIRO, and the managerial comparison with forestry is not favourable. Simon Southerton has been developing a program that is progressing steadily towards operational forestry in the identification of genetic markers (SNP's) that can be associated with specific traits such as growth and pulp yield. The focus has been on *E. nitens* and more recently *E. globulus* and *E. dunii*.

Within the Ensis experience, Scion did not commit much of its molecular capability, limiting the potential to build an effective capability that combined parent institutions. In the molecular space, the Australian effort is eucalypt focussed, and to the extent that NZ is interested in eucalypts, it would be of benefit to support Australian capability. Given the cost of phenotyping, collaboration within the radiata context would seem sensible.

Milosh Ivkovic leads the quantitative genetics team within CSIRO Plant Sciences. They are currently engaged in an FWPA-funded collaboration in partnership with Scion, RPBC and STBA to explore genotype x environment relationships in radiata pine. Given the current reorganisations within CSIRO, the future of the existing capability is uncertain.

The activity of both the STBA and RPBC provides a focussed and commercial capability, while Scion maintains New Zealand interest in species other than radiata pine. At the University of the Sunshine Coast David Lee leads a Hardwood Tree Improvement program, part funded by QDAFF. Merv Shepherd, at the Southern Cross University, leads a team addressing both molecular and quantitative genetics research within primarily hardwood species.

There is considerable expertise in this space, but certain components are under-resourced. Equivalent R&D in the US (for example) operates on budgets an order of magnitude larger. Both molecular and quantitative genetics relies heavily on accurate phenotyping, especially with the growing importance on genotype x environment x management (GxExM) interactions. Thus for genetics research to be effective, it needs access to appropriate phenotyping capability. In the area of wood quality, the imminent loss of access to SilviScan (July 2014) will require sending samples to FP Innovations in Vancouver, or Innventia[6] in Sweden at additional cost and risk.

Adequate funding over sufficiently long terms is required for focussed progress to be made. It is possible the competition among capabilities (CSIRO, Universities) diminishes opportunities for building research depth at current funding levels. Limited access to phenotyping capability and expertise, coupled with changing industry interests (e.g. shifting emphases on growth and wood quality) affects progress and opportunities. For example selection for wood quality has been a commercial and research interest over the past decade, where access to technologies such as SilviScan and near infra-red spectroscopy is critical. The commercial interest in properties such as pulp yield fluctuates in much shorter cycles than do the generation times of the tree crops involved.

## Forest operations

- Australia
  - USC: Mark Brown
- New Zealand
  - Scion: Richard Parker
  - University of Canterbury: Rien Visser

New Zealand, via Scion, has a strong history of forest operations R&D. Current emphasis is on steep terrain logging. In Australia capability in this area was relinquished within CSIRO a decade ago, but recently rebuilt through the efforts of the CRC Forestry. The CRC group[7] built a successful and commercially-focussed capability, that since the cessation of the CRC, have housed their activities within the Sunshine Coast University establishing the Australian Forest Operations Research Alliance (AFORA)[8]. There is a strong focus on the development of tools that will enable forest operators to better manage and utilise their resources to reduce costs and improve operational safety. There has been informal collaboration between the AFORA group and NZ activity. Currently AFORA supports R&D at around one third of the budget experienced within the CRC Forestry. Virtually all of this is industry contributions with some leverage through the NCFFI (see below). AFORA rated 10 potential projects as important, but resources are only sufficient to run 3-4 of them. In order to maximise the trans- Tasman value of R&D, the Australian effort has focussed on flat-terrain operations not being addressed in NZ. Thus R&D is largely non-competitive and potentially synergistic. In terms of capability, the Australian and NZ resources are of similar size.

An informal collaborative group (Southern Hemisphere Forest Operations Research Alliance) has been established by Mark Brown as a mechanism for communication between interested partners in Australia, New Zealand, South Africa and Chile.

The R&D capability in NZ (Scion & University of Canterbury) were not included in the recent NZ levy-funded activities; here were insufficient resources to adequately fund it. There is a tendency for each country to operate a closed-ship R&D operation largely to minimise the risk of R&D investment in one country being spent in another. The fact that the Australian R&D capability survived the demise of the CRC indicates that industry embraces its value. There are some indications that more positive times may be ahead.

---

[6] http://www.innventia.com/en/Our-Ways-of-Working/Measurement-and-testing/Wood-and-Fibre-Measurement-Centre/SilviScan-instrument/

[7] http://www.crcforestry.com.au/research/programme-three/index.html

[8] http://www.usc.edu.au/research/research-partnerships/australian-forest-operations-research-alliance-afora

A formal trans-Tasman capability would be beneficial if it could be administered cost-effectively, steered by industry, provide adequate funding and act as a mechanism to facilitate communication between vested interests on both sides of the Tasman.

## Remote sensing

- .Australia:
  - CSIRO: Glen Murphy
  - ForestryTas: Rob Musk
  - ForestrySA: Jan Rhombouts
  - Environmental Sensing Systems: Darius Culvenor
- New Zealand
  - Scion: Andrew Dunningham

The operational use of remote sensing technologies is increasing, ranging from the use of satellites, Lidar and various ground-based systems. Most R&D is in the application / operationalization of existing technologies and the development of appropriate software for data processing. CSIRO have strong R&D capability in this area and various state agencies have good expertise in application. The CRC Forestry provided a mechanism for developing the capability in time-series remote sensing. Forestry Tasmania is increasingly making use of Lidar through in-house development linked to the CRC Forestry.

The combination of Australian R&D expertise coupled with NZ skills in effective, cost-benefit analysis of the application of tools is valuable. Remote sensing R&D often falls short in the transition to operations and NZ has often been more effective in that area. Most work is done on short-term contracts which limit the ability to optimally utilise R&D capability. Long-term studies are needed to develop and apply new systems. Access to PhD students has been problematic, particularly when there has been need to co-locate within CSIRO.

The current capability is probably inadequate for this technology-intensive area. It is fine for the use of existing technologies, but there is little capacity to investigate new, emerging technologies. It is particularly important to track next generation applications; the failure to do so may interrupt the time-series applications of current operational estate monitoring. There is an ongoing need to know how to transition to new technologies.

## In-mill optimization and automation

- Australia
  - APPI: Gil Garnier
  - QDAFF, Henri Bailleres
- New Zealand
  - SWI: Marco Lausberg
  - Scion: Ian Suckling

Given the diversity of forest products firms, this capability should be diverse given the range from solid wood processing through pulp and paper manufacture to the emerging bioenergy technologies. However it is probably one of the most deficient.

Pulp and Paper: Appita provides a trans-Tasman industry body that promotes (but not fund) R&D, drawing on capability at APPI (Monash University) and Scion. APPI maintains a relatively strong R&D capability in the sector. Routine pulp testing that used to be available at CSIRO is now based at HRL[9]. Recently Forest Quality Pt. Ltd. established a relationship with FITNIR (www.FITNIR.com), a

[9] http://www.hrlt.com.au/assessing-pulp-and-paper-fibre-resources/w4/i1040344/

spin-off company from FP innovations in Canada, to market, install and service commercial NIR on-line monitoring systems for kraft pulp optimisation; they are still attempting to engage the local market. Scion has an extensive research capability in the area, with a strong track record in pulp processing.

Engineered products: QDAFF provides access to facilities for veneer production through their Salisbury facility. However this is more related to testing and evaluation rather than mill optimisation. This facility also has the best R&D kiln drying facilities available in Australia and has been working on optimising eucalypt drying. With the demise of CSIRO-FFP/ Ensis, capability in Australia diminished. Expertise at CSIRO (Clayton) has been lost to the industry, taking with it extensive corporate knowledge and decades of experience.

Solid wood: The SWI provides a vehicle for resourcing R&D in radiata solid wood processing, drawing on a range of private consultants and Scion. There is little solid wood processing R&D capability in Australia outside the commercial processors. Most capability seems to be sourced internally as needed. R&D into plantation eucalypt solid wood processing seems largely in abeyance, with the emphasis shifting to veneer production. NZ capability is minimal, SWI typically calling upon individual consultants working with capability within individual companies.

In this area, lack of industry take-up of development work reduces the incentive to fund more. In some cases industry hasn't been able to afford the capital equipment to make changes despite the R&D demonstration of the cost-effectiveness of particular changes. In other areas the lack of intra-company staff to champion the R&D uptake are lacking. In NZ the current high export log price is driving up the price for domestic processors such that processing is increasingly unprofitable and reducing the ability to fund R&D.

## Durability and timber design life

- Australia
    - CSIRO:
    - QDAFF: Leslie Francis
    - Private
    - Laurie Cookson consulting
    - Australian Forest Research Company
- New Zealand
    - SCION: Tripti Singh

The extensive capability that once resided within CSIRO / Ensis is now available to a limited extent through private enterprise, primarily in the activity of the Australian Forestry Research Company (AFRC) and LJCookson consulting. Most activity currently is in the provision of testing services; R&D activity is minimal. They provide an effective capability to evaluate new products and processes developed elsewhere under Australian conditions. NZ capability is centred at Scion. R&D in the field of new preservatives, different wood treatments or recycling / disposal of treated timbers is minimal.

Currently there is no significant demand for R&D in timber durability in Australia sufficient to maintain the capability required to undertake significant research. AFRC maintains some in-house research activity centred on termite-related durability. With sufficient demand this capability could be expanded to address broader issues. The purchase of companies by investment funds often cut off demand for R&D services.

The Ensis experience resulted in several collaborative projects between Australian and NZ based capability. At the scientific level interaction was productive and synergistic. In the testing field the CSIRO brand name was important and the name change to "Ensis" did not help.

Industry needs to assess the requirement for R&D capability, identify the costs associated in establishing the capability and decide whether the benefits warrant rebuilding it. There is considerable R&D elsewhere around the globe which is probably sufficient to meet Australian demands. The development of new treatments and products will then need to be tested under Australian and NZ conditions, so maintaining a testing capability seems appropriate. This capability could be utilised to interface with international research facilities and provide a conduit for new ideas to enter the Trans-Tasman market.

### Building systems and supporting standards and skills

- Australia
  - CSIRO: Greg Foliente
  - University of Technology, Sydney: Keith Crews
  - University of Tasmania: Greg Nolan
  - University of Melbourne: Barbara Ozarska
  - Timber Ed Services Pty. Ltd.: Geoffrey Broughton
- New Zealand
  - Scion: Doug Gaunt
  - University of Canterbury: Andy Buchanan
  - University of Auckland: Pierre Quenneville

There is growing interest in a more integrated approach to building and construction, essentially following European approaches. STIC fostered the development of a trans-Tasman culture, while other work at the University of Tasmania is providing some architectural-pull for wood products. CSIRO has capability in building life cycle analysis and built environment simulations.

As in all areas financial resources are the major limitation. STIC has been extremely valuable in this area, albeit a perception that it is too NZ focussed. The networks and collaboration has been productive and good trust developed between staff at UTS, UA and UC. The shift in commercial emphasis from supplying a commodity to supplying a building system (e.g. IKEA style house) would provide a driver for more R&D.

Traditionally universities get possessive of their “turf”. Long-term investment is needed with less competition for the same piece of the funding pie. An R&D structure is needed that minimises administrative costs, responds quickly to industry needs and is dominated by industry decision making. The cost (waste) of resources in competitive grant applications is counter-productive and inefficient. A more collaborative approach is needed.

## Obstacles to collaboration

Obviously R&D requires funding, staff, facilities and objectives. Good R&D requires sufficient funding, competent and motivated staff, excellent and accessible facilities and clear, well-defined objectives. These objectives need to be commercially driven / defined to give the R&D the best opportunity for surviving the transition into commercial operation. Anything that impairs any of these will provide some degree of obstacle to collaboration. When provided, there is sufficient experience at the science level to indicate that collaboration between Australia and New Zealand-based researchers can be productive. The Ensis and other experiences, resourced by WQI-SWI, STIC and FWPA demonstrate this.

#### Cost of R&D

The high cost of R&D capability from organisations like Scion and CSIRO is off-putting for industry. The price seems high, even for relatively unskilled labour that requires little infrastructure support. The different motivators for such R&D capability (i.e. research papers vs commercial survival) further reduces the value of the R&D capability to industry. The high cost is augmented by the difficulty of demonstrating the value of past studies. Once a successful R&D project has transitioned into operation and become routine practice, it is often hard to clearly identify cost-savings or increased profits such that the value of R&D cannot be clearly demonstrated.

Ensis, CSIRO and Scion are all seen as too expensive given the commercial product they deliver. To what extent is this experience / perception warranted? The expense of providing and maintaining a research facility is not inconsiderable. And like any business, the less product sold, the more cost pressures are placed on the products that are selling, until you get to the point where they too become uncompetitive. Alternatively the real cost of R&D may be too high for the market to engage in.

### Relinquishing control

Collaborative research, involving multiple lines of funding, together with multiple R&D partners each providing some level of in-kind support often produces TMC (Too Many Chiefs) syndrome. Naturally each wants some degree of control in return for their investment. For effective R&D outcomes, realistic attitudes to control are required. R&D carried out to address industry needs should require the primary direction of industry partners.

### Different cultures and agenda

As great an obstacle to formal collaborations was the lack of organisational engagement and support at the highest levels. CSIRO during the Ensis-era was undergoing significant restructuring, implementing a major new approach cross the organisation to managing R&D. Scion wanted to keep transformational science capability outside the JV, while CSIRO was under pressure to move into transformational science platforms. Collaboration requires the welding of two or more entities to common purpose, and the consequent attention to ensure this happens.

An even bigger obstacle seems to be the motivational drivers between government-based researchers and industry needs. Government funding is often distributed with caveats on the need to address basic science needs, typically measured by KPI's such as publication in peer-reviewed journals, and increasingly the high profile journals such as Nature and Science. This is in addition to the external-earnings targets, which are increasingly expected to fund the time required to publish.

In general, however, while industry want access to world-leading scientists, and product branding with the CSIRO label is marketable, they primarily need an agreed product delivered at a reasonable rate in an agreed time frame. Researchers answerable to government bureaucracies (CSIRO and Universities) often do not perform well on these KPI's. This can be compounded by the use of post-graduate students to keep R&D costs lower.

### Lack of capability

In the current situation in many areas capability is simply lacking, especially in Australia, which may hinder trans-Tasman collaboration. However it may also foster it by identifying strengths where capability can be developed with an aim to minimise duplication.

## A review of issues pertaining to R&D management

Historically the value of R&D is undeniable (Griliches 1998). The question is, how should it be resourced and organised: Public vs private; co-operative vs competitive or various combinations of these?

## Historical trend in support for R&D

In a recent paper, Kellison (2014) indicated that US support for R&D has been declining since the early 1980's, associated with major changes in the industry, as plantation production was dissociated from processing. This was largely a function of changes in tax law. Increasingly companies that were vertically integrated saw the forest growing component as a cost centre rather than an asset. The purchase of forest assets over the past three decades has been pursued by TIMOs and REITs in developing balanced investment portfolios. These new forest owners had much less interest in R&D. In parallel, wood processors have typically reduced in-house R&D capability. In contrast there has been an increase in "*national public-sector civilian research enterprise whose scale and scope in most of the world's countries surpasses that of any previous period of their history*" (David, Hall et al. 2000). Over recent years various mechanisms have been tried by governments to stimulate private R&D expenditure (Bloom, Griffith et al. 2002, González and Pazó 2008, Clausen 2009).

## Public vs private

In 1985 Australia introduced a super depreciation allowance which reduced the after tax price of investing in R&D by 49%, and since that time various mechanisms for leveraging the private R&D spend against the public purse have been implemented. It is not in the scope of this review to explore these mechanisms apart from noting the effect of government "public good" research on the balance in the private-public R&D expenditure tug-of-war. Governments need to be seen to be accountable to the taxpayer on how they allocate tax revenues. Thus public expenditure carries the need for research to have an element of "public good". Davidson (2006) explored some of the definitional issues around defining public good, but it seems self-evident that the more R&D support is required to meet multiple requirements, the less effective it will tend to be in addressing specific commercial needs.

Since the second world war, governments have increasingly seen R&D as a key mechanism for driving national prosperity (David, Hall et al. 2000). This has naturally been accompanied by large increases in the financial obligations of government, sourced from tax-payers. There has been a large body of literature addressing the question whether public expenditure on R&D replaces or compliments private expenditure (Griliches 1998, Hall and Van Reenen 2000, Klette, Møen et al. 2000) which it is also not within the scope of this brief review to address. Suffice to say that privately funded R&D wants to minimise "spillover" effects where competitors gain a free ride on R&D expenditure (Bloom, Griffith et al. 2002, Greenhalgh and Longland 2005). "*Privately financed R&D expenditures were more effective, at the firm level, than federally financed ones*" (Griliches 1998). In contrast, for R&D funded publicly, spillover effects are a major driver for government investment (Klette, Møen et al. 2000).

However publicly funded R&D carries less private risk and is often best suited to innovation and new product development. Various studies have shown the effectiveness of tax-based incentives on stimulating private expenditure on R&D (Hall and Van Reenen 2000, Bloom, Griffith et al. 2002) however Bloom et al note "*It is not obvious in a world of international spillovers that a country would not be better off free-riding on the R&D efforts of other countries rather than attempting to subsidize innovation itself.*"

## Global vs local capability

In relatively small countries such as Australia and New Zealand, the construction and maintenance of a comprehensive R&D capability is difficult. The current situation in the Australian forest value chain is indicative of this. At some points required R&D capability will need to be sourced internationally (Gassmann and Von Zedtwitz 1999, Mahmood and Zheng 2009). As mentioned in the introduction to this paper, von Zedtwitz, Gassmann et al. (2004) noted six dilemmas for multi-national companies maintaining an R&D capability, one of which was the dilemma of global vs local capability. In the discussions held by the author with various industry personnel in Australia, this dilemma was evident with different firms being more or less comfortable with sourcing R&D capability internationally. There was a general preference to have access to local R&D expertise that was aware of unique local conditions, something that is probably more important for a forestry-based sector than others.

The ways multi-national firms have addressed their R&D requirements have been varied, driven by a multiplicity of factors (Lowe and Silver 1986, Belderbos, Carree et al. 2004). In this paper we are exploring the mechanism(s) to support a local R&D capability, not for a multi-national company, but a forest value chain. Von Zedtwitz and Gassmann (2002) identify four different archetypes of international R&D

- domestic research - domestic development: national treasure R&D;
- dispersed research - domestic development: technology-driven R&D;
- domestic research - dispersed development: market-driven R&D;
- dispersed research - dispersed development: global R&D.

These arose from two main drivers responsible for natural R&D internationalization: the quest for external science and technology, and the quest for new markets and new products.

The question then is, what local R&D capability needs to be supported / developed, and what can be resourced internationally? Into that equation the phase of the R&D requirement needs to be considered. Zedwitz et al (2004) defines the following two phases:

- **Creative phase**: The process in the early R&D phase is highly nonlinear. Good ideas require knowledgeable promotion. Although knowledge sourcing for new technologies is not limited geographically, invention is typically local. The definition of a system architecture is crucial and concludes the pre-project phase.
- **Implementation phase**: The development phase has to be carried out rigorously and efficiently. Discipline is dominating over diversity. Creativity may be detrimental to overall innovation and must be redirected. In this phase, global teamwork is possible and sometimes necessary, but clear definition of work packages and interfaces is required.

They then list five trends that characterize the evolution of organization in international R&D:

1. Stronger orientation of R&D activities towards international markets and knowledge centres
2. Establishment of tightly coordinated listening posts
3. Strengthening and reinforcement of foreign R&D sites
4. Increased integration of decentralized R&D units
5. Tighter coordination and recentralization of R&D activities at fewer know-how centres.

## R&D consumer motivation

As noted above, some literature questions the value of R&D in the current climate and suggests firms may be better off "free loading" on international activity. Greenhalgh and Longland (2005) comment "Thus in all the dimensions of IP and R&D, it seems that firms have to run to stand still and they have to run faster to grow their business." Obviously a prime motivator for a consumer of R&D is the ability to increase revenue, maintain market share and/or reduce costs. In the current Australian and New Zealand situation where compulsory levies are extracted from private firms, and the funds will be spent regardless, establishing projects with a clear commercial outcome would seem to be of major benefit for levy payers and require the provision of significant industry oversight.

## R&D provider motivation

A productive R&D capability requires motivated scientists and engineers. Managerial career orientation is related to organization-based performance, while scientific career orientation is related to scientific performance (Aryee and Leong 1991). In a study based in Greece, but involving R&D providers from a range of companies and nationalities, Manolopoulos (2006) state "*Since motivation is an amplifier of human abilities, one of the major challenges faced by any manager is to keep his employees motivated in the context of a successful organization including a highly effective workforce*." They made the following observations based on their studies

1. In general, professionals in decentralized R&D laboratories are motivated by job attributes that do not promote cooperation and teamwork within the firms, but are rather derived from individuals' goal-oriented behaviour.
2. The opportunity for hierarchical advancement and financial rewards (salary and bonuses) were ranked higher than other motivators than one could expect to be prevalent for R&D professionals, such as the advance of science and the need for creative work.
3. Despite research that provides evidence that extrinsic rewards are positively related with better employees' performance (Arnolds and Boshoff 2002), managers should introduce intrinsic motivation to R&D departments by using a multifaceted set of motivators dependent on the research environment and the technological strategy of the corporation.
4. Emphasis only on monetary rewards will cost organizational financial resources and may lead to only short-term productivity effects.

# Current plans for R&D investments

Following is a brief overview of the main sources of R&D funding to the trans-Tasman forest industry, indicating, where available, the level of funding provided.

## FWPA

FWPA is a public company and currently the major source of commercial R&D funding for the sector. Funds are sourced from industry levies and when applied to R&D activities matched dollar-for-dollar by Commonwealth Government funding. Current research priorities are

- Timber construction in commercial and industrial buildings
- Wood products in sustainable buildings
- Maximising product yields and values from current resources
- Improving wood quality and yield, and tools for forest management
- Water use, efficiency, access to resources and balanced policy outcomes
- Mitigation of and adaption to climate change and the management of the carbon cycle in plantation and native forests.

In 2011 – 2012 FWPA invested $4.7M in R&D, decreasing to $2.7M the following year. If one estimates that the cost of a research contractor (salaries, overhead, facilities, operating) is in the order of $200K pa, then $4.7M equates to the support of 23.5 research FTEs.

## AFPA

The Australian Forest Products Association (AFPA) was formed through the merger of the Australian Plantations Products and Paper Industry Council (A3P) and the National Association of Forest Industries (NAFI) to provide a single industry representation to government. As such it is not a source of R&D funding primarily. AFPA recently submitted to government a proposal to establish a national institute (Duff and Kile 2014) with the argument that "*the delivery of forest industry* *research is poorly co-ordinated and grossly underfunded*". At present it manages some R&D activity but is not a source of funding for R&D providers.

## NCFFI

In 2012 the National Centre for Future Forest Industries (NCFFI) received $2.5M over three years to help drive R&D, innovation, extension and training for future forest products and industries. It was initiated upon the cessation of the CRC Forestry to facilitate the windup of the CRC program and contribute to the redevelopment of the national forestry and forest products R&D capability. The past and current model that industry supported is based on competition between R&D providers. NCFFI is endeavouring to facilitate change to a more collaborative model. If the value chain is represented as

Forest management => supply chain integration => (1) construction (2) biomaterials (3) biofuels

NCFFI is currently seeking to address the construction pathway, and recently submitted an application for industrial transformation funding. Ultimately a distributed network model is envisaged with each node having a discipline focus.

## APPPI /BAMI

The Bioprocessing Advanced Manufacturing Initiative (BAMI) was recently announced as a successful bid for primarily ARC-based funding. The initiative will be based at APPI / Monash University receiving $3.5M over three years. Eleven interlinked projects are grouped into two platforms

- Functional materials
- Green Chemicals and Energy solutions

## Scion

Scion is the predominant New Zealand R&D provider in the forest sector. It is the leading Crown Research Institute in

1. Sustainable forest management and tree improvement.
2. Forestry biosecurity, risk management and mitigation.
3. Wood processing, wood-related bioenergy, waste streams and other biomaterials.
4. Forestry and forestry-based ecosystem services to inform land-use decision making.

Scion staff are located within three science portfolios

- Forest Science
- Manufacturing & Bioproducts
- Sustainable Design

Scion receives a $17.7M pa core funding allocation, retaining control of where and how it will be allocated across teams.

In October 2013 Scion was successful in obtaining additional major funding over a six year term for a research programme titled "Growing Confidence in Forestry's Future". Funding will be allocated from NZ Ministry of Business, Innovation, and Employment ($3.375 m/yr) and Forest Owners Association ($1.6 m/yr); the latter being sourced via the new Forest Growers Levy (http://www.forestvoice.org.nz/index.html). The R&D is directed at helping the sector address the New Zealand Forest and Wood Products Industry Strategic Action Plan to increase the value of forestry exports to more than $12 billion by 2022.

## Considering the future

Kellison (2014) recently proposed "*A new model for forest sector research and development in the United States*". After a useful overview of the historical and current situation, the descriptive details of his new model are disappointingly minimal: "*A public-private partnership with an independent steering committee could move rapidly, make investment decisions efficiently, operate transparently, and obtain and leverage public funding for R&D.*" However he raises the key ingredient to any successful R&D capability: "*Regardless of their focus, public-private partnerships need sustained, reliable funding*." Without this R&D provider's cannot develop or sustain an effective R&D capability.

Obviously there is no one right way to manage R&D (Lowe and Silver 1986, Belderbos, Carree et al. 2004), and the intention here is to contribute to and facilitate productive discussion, rather than present a definitive proposition. Recently Duff and Kile (2014) prepared a paper canvassing issues around the national RD&E model. The CRC currently being developed is aimed primarily at optimising the existing manufacturing industry to enhance competiveness.

### CRC for Transforming Wood Fibre

FWPA is currently leading the development of a CRC bid "*focussed on optimising existing manufacturing facilities to improve international competitiveness and to assist in the characterisation and deployment of the next generation of wood fibre technologies*". The research team will consist of Australian and international research organisations, including Scion in New Zealand. The primary goals to be addressed are

1. A robust value chain for the growing and processing of Australian wood fibre resources to maximise international competitiveness and attract new investment to expand the plantation estate and its economic returns.
2. Better understanding of the materials and customers for key markets, especially in the built environment of 2030 and beyond.
3. Decision support tools to assist in the optimisation of existing and new products that capture key variables and outputs along the full value chain.
4. To develop the next generation of technically-skilled experts that can help the industry make the transformation in its products and markets.

While acknowledging their importance, the current intention of the CRC is to not address R&D in the following areas:

- Tree genetics and deployment
- Silviculture
- Forest health
- Ecosystem services such as biodiversity, water and carbon
- Harvest and haulage
- Fire management
- Remote sensing

Given the importance of these areas to the broad-scale operation of the forest industries, alternative means of resourcing R&D capability needs to be identified The aim here is to consider how best to resource those "more traditional" capabilities listed above, within a trans-Tasman context.

### Industry's role

A greater involvement by industry in defining and steering R&D tasks is essential. Despite their already significant involvement in many projects within the current FWPA portfolio and previous CRC incarnations, a greater and often clearer role in providing direction and relevance is important to maximise ROI. Of equal or greater importance is seeing the outcomes of R&D championed within a firm and getting them evaluated, resourced and implemented. Ideally R&D champions would be identified within firms that have sufficient authority and access to resources to make things happen. This will require robust mechanisms for assessing the cost benefit of projects, comparing predicted benefits at the start of the project and refined at the end, with actual measured benefits once implemented.

Proof-of-concept represents a minor component of the cost of implementation, which often requires changing existing habits of operation, customer expectations, or customer's customer expectations. Consideration of the costs of implementation requires robust industry evaluation and attention. This involves assisting R&D providers to be more aware of the difficulties in the commercialisation of a good idea, possibly even offering researchers in appropriate areas the opportunity to experience the day-to-day activities within firms to better understand how new ideas and technologies could be implemented. A proportion of project budgets could be directed at defining and costing a commercialisation path. This would place each project within a larger context, enabling it to be considered in a longer development context.

## Government's role

As a response after the second world war to the value western government's placed on R&D in building national wealth, current industry, government's and the public have come to see public funds as the primary vehicle resourcing higher risk, longer-term strategic research. The dependence of the economy on the short-term effects of changes in government policy makes long-term (> 5 years) planning difficult if not impossible. This poses particular problems for forestry where crop rotations typically exceed 20 years. Consequently governments have, over recent decades embraced the need to resource and provide R&D capability (David, Hall et al. 2000). The question of how to do this most effectively will always remain and require consideration and change with changing circumstances.

In addressing the resourcing of trans-Tasman forestry R&D capability there are circumstances where a thoughtful and combined Australian / New Zealand approach would provide improved capability for both countries based on the similarity of the two nations industries and the non-competitive nature of the potential benefits.

Australia and New Zealand share geographical and cultural similarities, that have contributed to the development of similarly structured forest industry sector. The dependence on a largely softwood (specifically radiata pine) resource, together with similar processing industries and markets, indicates that a more co-ordinated resourcing of the R&D capability could provide better ROI. Resourcing RD&A at the national / international scale research can then flow though to targeted regional development customised for local application. However this will require each country's government / industry sector accepting the risk of funding RD&A that will be undertaken in another country.

## Fostering and management of productive collaboration

Given the current unsteady state of the Australian industry and the looming challenges, it seems worthwhile to explore the basic requirements of any RD&A capability.

- Purpose: No capability exists in the absence of purpose. The purpose(s) needs to be clear, well-defined and appropriate.
- Expertise: Motivated, flexible, and capable intellectual capital is fundamental
- Facilities: Researchers need access to appropriate facilities in the form of laboratory / analytical equipment, administrative support, transport and IT.
- Funding: Consistent, reliable funding, suitable to the defined purpose to allow the maintenance of suitable expertise and facilities.

- Commercial awareness: No one establishes an enterprise to lose money. RD&A is not an end in itself but a means to help generate profit. Profit funds R&D.

It is not appropriate to elaborate on these in detail here, but within the context of identifying the best means of sustaining and building a trans-Tasman capability, past experiences indicate that confusion and variance around the above points will exacerbate ineffectiveness.

As numerous papers and conversations have indicated, the more partners in a research project with differing (competing) expectations, combined with multiple lines of reporting, the less effective R&D outcomes are. Typically government stake-holders in R&D have qualitatively different expectations to those from private industry. The concept of "public good" research, typically required by governments usually sees return on investment in the form of refereed-journal publications, well-leveraged income from external sources, and good public image. Ideally this is accompanied by improved commercial efficiencies across the sector, broadly increasing profits and employment opportunities. In contrast, private partners need improved financial returns that make their individual business more profitable, to sustain investment and finance adaptation to changing circumstances. These competing stakeholder demands need to be balanced or avoided. Below, four discussion points for supporting an R&D capability are presented for consideration in the current context.

### *Discussion point 1: Collaborative not competitive research*

Competition is good up to a point, as long as it does not result in the loss of productive capability. The current emphasis on competitive research grants can result in less capable teams submitting lower-cost proposals, often predestined to under-achieve. In addition it can encourage the proliferation of smaller, less-than-critical-mass groups when competing for scarce resources. In the current climate of meagre research funding, the industry sector[10] could be more proactive in identifying the teams they want to support, the level of support they can provide and its duration. A management committee comprising researchers and industry then identify together projects and deliverables. This avoids the uncertainty that currently exists for R&D providers and allows then to be more pro-active in planning their capability development and addressing the actual research tasks[11].

### *Discussion point 2: Single line accountability*

"Too many chiefs" is a real problem for those undertaking the actual R&D and also for those actually interested in the research itself (typically industry partners). Expensive time can be consumed keeping various management regimes informed. Agreements need to be reached that limit project reporting to the committee overseeing the project(s). R&D providers need to accept reporting oversight via that committee, and reduce / eliminate other lines of reporting. This means they need to relinquish some degree of control over the R&D staff, basically seconding them to the authority of the project committee. This is easier when staff are allocated more extensively to projects, rather than having multiple fractions of FTE allocation to a plethora of projects.

### *Discussion point 3: Full cost funding*

Related to the above, "he who pays the piper calls the tune". When multiple lines of funding support are involved, resources can be consumed unnecessarily in keeping all stakeholders engaged. Full cost funding would minimise this and may help produce a more focussed outcome. As noted by one industry manager, more value for money is gained out of targeted small projects

---

[10] By industry sector I mean whatever mechanism is used to deliver the funding. E.g FWPA, private company, CRC etc.

[11] Authors note: There can be a tendency within R&D providers to see the securing of a successful research proposal as the end not the means. Organisational pressure is then resumed to prepare and secure more research funding, potentially at the expense of the just funded project.

funded directly by the company. Larger projects requiring leverage from other sources can often water down objectives. This raises the issue of what “full cost” actually is, and may require high-level interaction with the large R&D provider organisations to define.

*Discussion point 4: Clear identification of Research, Development, Application*

- *“Research is geared towards discovery rather than invention, while development aims at invention rather than discovery” (Von Zedtwitz and Gassmann 2002)*
- Research addresses the needs of the ‘‘day after tomorrow.’’ Development addresses the needs of ‘‘tomorrow,’’ while engineering (application) is concerned with problems of ‘‘today.’’

What does the Australian – New Zealand sector need most over the next 5 years? Fundamental, blue-sky, H3 research or projects focussed more on development, meeting the needs of tomorrow? What degree of balance is required? How much effort is needed at taking existing solutions and applying them? Clear answers to these will assist in determining how to allocate scarce resources.

## Enhancing current and forecast R&D skills, expertise and capacity

To attract new intellectual capability into a sector, there has to be a reasonable opportunity of obtaining interesting work over a reasonable period of time at a sufficient level of remuneration. At present, that opportunity in Australian forestry R&D is unattractive. For example the norm now in ARC funded projects seems to be for 2 year post-doctoral fellowships. This means that the post-doc fellow really needs to start looking for their next job not long after they start, with the consequent risk that, if successful, they leave the current position early.

People with a research bent are obviously (as noted previously) attracted by financial remuneration and employment security. But that provided, they are motivated by an interest in finding out new stuff, exploring new ideas, or building new technologies. Rightly or wrongly studies indicate that loyalty can often be to the research direction rather than the institution. Institutions that reward R&D staff with excessive administration, or careers in management are unlikely to be attractive or satisfying to good young researchers. The value of mid-career R&D needs to be regarded and sought after.

Building good and motivated capacity requires more secure funding (adequate and over longer time frames), fewer lines of accountability and clearer definition of purpose. It is better to have fewer teams with greater depth addressing fewer topics than allowing the R&D capability to be spread too thinly.

## Developing optimal research teams

A step in this process is to quantify the resources that are available to support research, estimate the resources that this level of funding can sustain and use this as a basis to prioritise research needs.

Based on the above experiences and assessment of existing capability, following is an attempt to identify a means of supporting what exists to commercial advantage, and facilitate the development of a more targeted capability. The intent is to identify where enhanced collaboration can be usefully gained. The proposed management method to pursue this is the formation of an appropriate industry-led advisory group(s) which identifies the personnel and organisations to work with, nominating the funding that will be made available over a specified time frame.

Three areas are proposed as follows. The area titles are intended as descriptive of their focus rather than actual names.

*Estate management:*

1. Tree Breeding: Good capability within Scion, CSIRO to undertake R&D, with D&A[12] integrating through STBA and RPBC to deliver improved product to growers.
2. Molecular Genetics: Australian and NZ capabilities are effectively distinct and non-competitive. There appears little opportunity or value for enhancing collaboration. Consolidating Australian support into fewer teams would allow greater capability depth to develop.
3. Forest Inventory:
    a. Ground inventory: D&A is primarily via Scion, with some Australian based private effort.
    b. Remote Sensing: RD&A capability predominantly within CSIRO, but working with Scion is valuable to facilitate ground-truthing. The enhanced interaction of trans-Tasman capability could lead to better outcomes.
    c. Forest Health: Capabilities at SCION, NSW DPI and the University of Tasmania, would benefit from collaboration, especially linking with the remote sensing capability.

The capability could be better utilised and supported by encouraging and resourcing collaboration. Facilitating interaction would allow the development of more productive proposals, that might (in the area of biosecurity for example) enhance their competitiveness for other resources.

A trans-Tasman advisory group could help address needs of biosecurity, insect and fungal vectors affecting the plantation estate, and facilitate the application of new and existing remote sensing applications.

*Forest Delivery:*

Forest operations R&D has been rebuilt in Australia over the past 7 years, with current capability surviving within the USC. Informal linkages with the NZ capability has seen Australian R&D focus on flat terrain harvesting, while NZ capability (UC) has focussed on steep terrain applications. Recent H3 activities in robotics (Scion - UC) offers new possibilities.

Because of the relatively high cost of harvesting and transport, and the short-time frame over which it occurs relative to the growing phase, opportunities for more rapid ROI should be higher than other areas. A more formal and better resourced trans-Tasman focus offers the potential to reduce harvesting and transport costs significantly. Coupled with other opportunities emerging from around the world in log segregation, a viable trans-Tasman R&D capability would facilitate the uptake and adaption of new technologies developed elsewhere.

*Forest Usage:*

The closer one moves towards the market, the more diverse, complicated and IP sensitive RD&A becomes. Consequently it is harder to resource effectively. Many R&D issues are or can be better addressed internally within firms, which can obtain specific R&D capability within Universities or CSIRO if it exists. As such a formal broad-scale trans-Tasman R&D capability that adds value is difficult to envisage. That said specific needs and opportunities do exist.

- In-mill optimisation (solid and engineered wood products): The NZSWI has provided a mechanism to test, optimise and evaluate various technologies for both NZ and Australian manufacturers. While the immediate future is somewhat uncertain, its role in conducting short-term, close-to-market development has been valuable. Maintaining capability that can identify and adapt new or existing technologies to local manufacturing is important. Australian capability at QDAFF can assist in this role in several areas around veneer and

[12] Development and Application

timber drying if local political agendas can be "expanded". The value of RD&A capability (staff and equipment) within existing industry could be better utilised.

- Building systems: The role of STIC to develop and foster trans-Tasman R&D was valuable and generally well regarded. Fostering and expanding this to include groups such as the "Centre for Sustainable Architecture with Wood" at the University of Tasmania would enhance activity and develop capability individual firms could access privately.

There has been discussion that the role of SWI might change to address building systems, with many firms not renewing their financial commitment to SWI. An entity with an "SWI-like" role, in which industry personnel can engage, direct and contribute to RD&A projects is important. Ideally this would develop a role in identifying mid to longer term R&D. The balance between softwood (radiata, slash, DFir) and hardwood (eucalypt) needs discussion and requires separate programs. Initial momentum with a radiata / slash focus is potentially more tractable, adding other species according to industry demand.

## Conclusion

RD&A capability within the forest sector in Australia is in disarray. This contrasts markedly with New Zealand, where a relatively strong forest sector is supported by significant government and levy-payer investment. That said both countries have both shared and unique strengths that will require ongoing support from the public sector to maintain and utilise to support an important part of the economy. NZ-based R&D capability can and does provide a resource that Australian industry can better utilise, allowing both countries to benefit. Significant and productive Australian capability does still exist, providing a foundation on which a better targeted RD&A capability needs to be built. A shared trans-Tasman effort in the direction and allocation of funding, rather than the construction of a common research entity, can build capability in key prioritised centres that will attract new skills and allow national-scale depth to develop.

## References

Arnolds, C. and C. Boshoff (2002). "Compensation, esteem valence and job performance: an empirical assessment of Alderfer's ERG theory." International Journal of Human Resource Management **13**(4): 697-719.

Aryee, S. and C. C. Leong (1991). "Career orientations and work outcomes among industrial R&D professionals." Group & Organization Management **16**(2): 193-205.

Belderbos, R., M. Carree and B. Lokshin (2004). "Cooperative R&D and firm performance." Research policy **33**(10): 1477-1492.

Bloom, N., R. Griffith and J. Van Reenen (2002). "Do R&D tax credits work? Evidence from a panel of countries 1979–1997." Journal of Public Economics **85**(1): 1-31.

Clausen, T. H. (2009). "Do subsidies have positive impacts on R&D and innovation activities at the firm level?" Structural Change and Economic Dynamics **20**(4): 239-253.

David, P. A., B. H. Hall and A. A. Toole (2000). "Is public R&D a complement or substitute for private R&D? A review of the econometric evidence." Research Policy **29**(4–5): 497-529.

Davidson, S. (2006). "Why government funding of science is a waste of our money." IPABackgrounder **18**(4): 1-20.

Duff, G. and G. Kile (2014). Priorities, capability and potential models for RD&E for the forest and wood products in Australia-- if the model is broken, what is the new model? Prepared for the Forest and Wood Products Sector RD&E Forum.

Gassmann, O. and M. Von Zedtwitz (1999). "New concepts and trends in international R&D organization." Research Policy **28**(2): 231-250.

González, X. and C. Pazó (2008). "Do public subsidies stimulate private R&D spending?" Research Policy **37**(3): 371-389.

Greenhalgh, C. and M. Longland (2005). "Running to Stand Still? – The Value of R&D, Patents and Trade Marks in Innovating Manufacturing Firms." International Journal of the Economics of Business **12**(3): 307-328.

Griliches, Z. (1998). Introduction to" R&D and Productivity: The Econometric Evidence". R&D and Productivity: The Econometric Evidence, University of Chicago Press**:** 1-14.

Hall, B. and J. Van Reenen (2000). "How effective are fiscal incentives for R&D? A review of the evidence." Research Policy **29**(4–5): 449-469.

Kellison, R. (2014). A new model for forest sector research and development in the United States. U.S. Endowment for Forestry and Communities as follow-up to "The State and Future of U.S. Forestry and the Forest Industry" convening. http://.

Klette, T. J., J. Møen and Z. Griliches (2000). "Do subsidies to commercial R&D reduce market failures? Microeconometric evaluation studies." Research Policy **29**(4–5): 471-495.

Lowe, J. and M. Silver (1986). "R&D strategies and variable demand." R&D Management **16**(4): 325-333.

Mahmood, I. P. and W. Zheng (2009). "Whether and how: Effects of international joint ventures on local innovation in an emerging economy." Research Policy **38**(9): 1489-1503.

Manolopoulos, D. (2006). "What motivates R&D professionals? Evidence from decentralized laboratories in Greece." The International Journal of Human Resource Management **17**(4): 616-647.

Mohammed, C., M. Glen, T. Walshe, T. Wardlaw, C. Stone, C. Beadle and S. Lawson (2011). "An audit of forest biosecurity arrangements and preparedness in Australia." FWPA Project **Number: PNC159-0910**.

Von Zedtwitz, M. and O. Gassmann (2002). "Market versus technology drive in R&D internationalization: four different patterns of managing research and development." Research policy **31**(4): 569-588.

von Zedtwitz, M., O. Gassmann and R. Boutellier (2004). "Organizing global R&D: challenges and dilemmas." Journal of International Management **10**(1): 21-49.