ScionConnections

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Scion's extruder is the basis of our 'Extrusion Plus' research programme, that has developed several new ways to add value to biomass side-streams.

Mobile manufacturing

Manufacturing has long been important to New Zealand's economy. In 2007 the manufacturing sector was worth over 14% of the GDP, but in the past decade it has slipped to 12% ($23 billion), and discussion on how to rejuvenate the industry has begun. While this unfolds, a parallel discussion is taking place regarding the sustainability of materials used. Consumers are increasingly expecting manufacturers to switch from fossil fuel-based resources to renewable bio-based resources, and to adopt circular economy principles where materials are used and reused efficiently.

These drivers lend themselves to a new decentralised model for bioproduct manufacturing in New Zealand, and Scion is leading the charge. Our work with new technologies, processes and biobased materials will help to realise our bold vision to increase 10 fold the GDP from forests and manufacturing by 2050.

Distributed manufacturing

Distributed manufacturing breaks up the manufacturing process, so that different stages of production can take place in different areas. It is a direct contrast to standard, centralised manufacturing, which requires resources and materials to be transported to a central location where the processing takes place.

Scion along with international research organisations like VITO and VTT are putting a spin on this model – by making processing equipment mobile. The ability to take the equipment to the biomass resources will develop processing and provide opportunities for new skilled employment in the regions.

Why New Zealand?

Why isn't mobile or distributed manufacturing happening everywhere already? And why should New Zealand take it up now? New Zealand is a long country with a low density population and difficult terrain (like mountain ranges) that can make transporting voluminous biomass resources to one central processing place very expensive.

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Leading the big conversations

Evidence-based thought leadership is a key role of a Crown research institute. It's about contributing to industry and policy makers' conversations with original, evidence-based perspectives. It's about equipping decision-makers with the insights to help make sound and robust resolutions, and it's about sharing fact-based narratives about the future. Delivering on this role gives CRIs a valuable voice in the big conversations affecting our country and its people.

We see it as critical that our thought leadership strongly endorses the big picture approach so that we can identify not only opportunities but also gaps in how things might be implemented.

Scion's core purpose is to drive innovation and growth in New Zealand businesses, with a span of influence that is increasingly expanding as consumers are seeking sustainably produced goods with a good end-of-life solution. For us, therefore, it is critical that our thought leadership is followed up with tools, developments and technologies that support good decisions and get taken up by business.

To do this well, we must always take a wide picture view in assessing potential benefit or impact that could be achieved – short term and long term. We took this approach with our wood energy industrial symbiosis project (described on page 6) which used a tool – the Woodscape model – to map new opportunities in regional New Zealand for industrial clusters that collaborate to share resources, energy, by-products and value. Regional benefits include commercial growth and job creation.

This wide picture view is behind our drive for a new decentralised model for bioproduct manufacturing in New Zealand. Mobile manufacturing can make this happen, and Scion's extrusion technology is an example (see page 1). The ability to take equipment to biomass resources can develop processing in the regions, which provides new skilled employment among other benefits.

We see it as critical that our thought leadership strongly endorses the big picture approach so that we can identify not only opportunities but also gaps in how things might be implemented. With more than 70 years of science, research and development backing us, we firmly believe we must enable New Zealand to move from a non-renewable petrochemical based economy to one using biological processes and renewable materials from planted forests. This is what we mean by the bioeconomy, and the circular bioeconomy is intrinsically linked to the bioeconomy as the waste or residuals from one process becomes the feedstock for another.

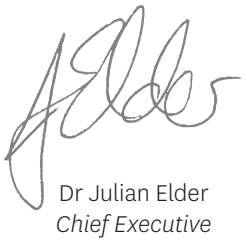
To bring the bioeconomy narrative to life we are investing in developing our Rotorua campus as a place where we can showcase and demonstrate research and technological innovations that enable the circular bioeconomy.

We are attracting significant interest from new entities to co-locate with us and participate in our soon-to-be-constructed Innovation Hub. We aim to create a 'destination' facility that will open our campus to broader communities, including the public, and to drive more interactions around ideas, opportunities and implementation. To successfully achieve this aim, we recognise that in addition to architectural design to heighten interactions on the campus we will need to design programmes that encourage dynamic connections and also foster a culture of exchange and excitement.

Our new strategy "Right tree, right place, right purpose" has set our path, our campus developments are creating the scene and our talented staff are energising the discussions.

Our new strategy "Right tree, right place, right purpose" has set our path, our campus developments are creating the scene and our talented staff are energising the discussions. I look forward to the big conversations ahead.

I welcome your thoughts on this topic and any other matters raised in this issue of *Scion Connections*.



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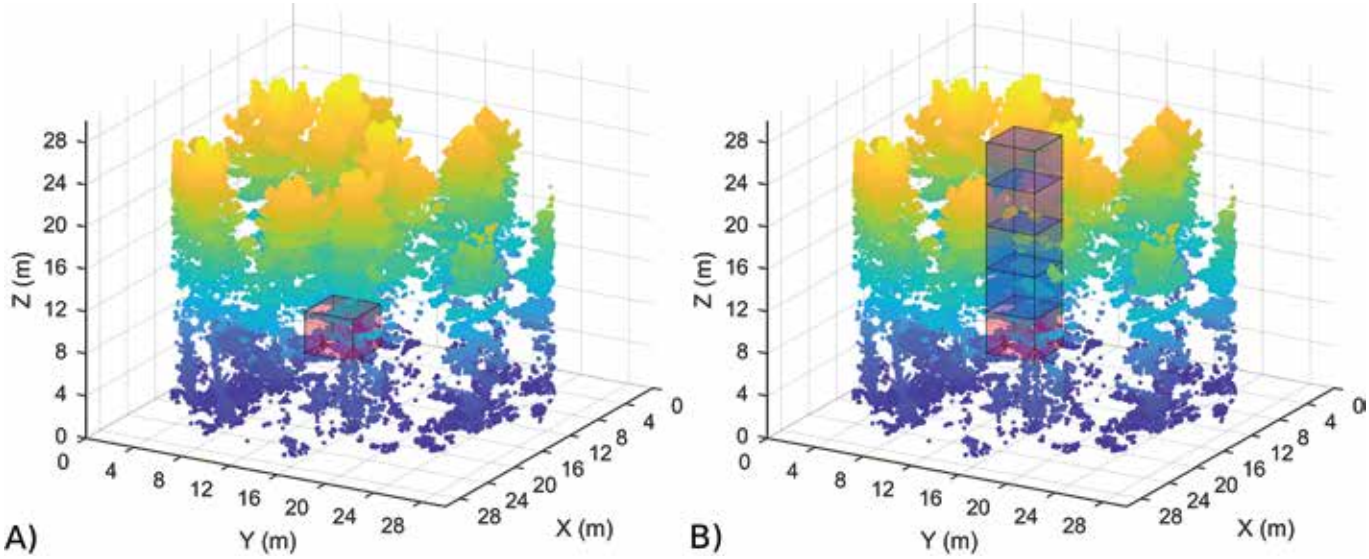

'A' identifies the voxel with the highest number of returns while 'B' examines the distribution of returns along a stack of voxels. 'A' and 'B' form the basis of voxelised metrics describing the properties of forest plots.

Voxel-based metrics prove more accurate for forest inventory

Using voxel-based analysis of aerial lidar is a promising new development in remote sensing.

In the past, high-density lidar has largely been restricted to terrestrial laser scanners. Now, high-density scanners are being mounted on helicopters and UAVs flying close to the tops of forests to provide very fine-scale imagery of trees. This kind of scanning generates very dense point clouds that demand new methods of analysis to extract meaning. One option is to borrow an approach from terrestrial lidar analysis to simplify the data by breaking the information into small parcels called voxels.

What is a voxel?

Voxels can be thought of as 3D pixels or cubes that are formed around a 3D point cloud. The positional information of each lidar point determines which voxel that point falls within, and the metrics describing the 3D data are computed from the voxels rather than the individual points.

For forest inventory, we take the lidar point cloud, and place it into voxels of e.g. 1 x 1 x 1 m size. The distribution of lidar points (and their properties) within each 1 m cube can be used to characterise the forest in new ways that captures information not available from more standard metrics. We then use these metrics to model forest inventory attributes.

Trialling voxel-based metrics

Remote sensing scientist Dr Grant Pearse worked with Forest Wood Products Australia (FWPA) to test voxel-based metrics for forest inventory. FWPA provided high density lidar scans of 73 plots from two radiata pine forests in New South Wales.

> "Our results show that using voxel-based metrics will give forest owners a better picture of how their forests are growing."

Grant carried out modelling using standard and voxel-based metrics to create predictions for standard forest attributes: top height, basal area, stand density and volume.

A comparison of the results revealed that models using voxel-based metrics outperformed models using standard metrics – suggesting these metrics captured more information about the forest plots. Interestingly, the voxel-based metrics performed well even at lower pulse densities e.g. 5 ppm, suggesting it was the metrics not the density that drove improved predictions.

Here's what we found

Grant says, "Our results show that using voxel-based metrics will give forest owners a better picture of how their forests are growing. And thanks to new capabilities added to the widely-used LAStools lidar software suite, anyone can try voxel-based metrics on their lidar data."

"It's a promising start, but our next challenge is to work with our industry partners to roll out voxel-based metrics on a large forest estate and better understand what the metrics are capturing."

FOR FURTHER INFORMATION on voxel-based metrics contact Dr Grant Pearse at grant.pearse@scionresearch.com

PHOTO: TE ARAWA LAKES TRUST

Minister Shaw and MP for Waiariki Tamati Coffey with members of Te Urunga o Kea - Te Arawa Climate Change Working Group visit Ohinemutu, Rotorua, to better understand how Government can support hapū and iwi to build community resilience around the impacts of climate change.

Te Arawa tackle climate change

A sudden crash around midday on 5 January 2018 shocked residents at Mourea into thinking they'd experienced an earthquake. But it was the sound of a 10 m tree falling onto the kitchen and dining room of the nearby Taupari Marae on the northern edge of Lake Rotorua. The intense storm that brought the tree down was similar to a category 2/3 tropical cyclone. For Ngāti Parauharanui – the people of Taupari Marae – all they could do was stand by and watch as their marae; their refuge and the safe place of their stories and their tipuna, was lashed by wind and rain. Protecting marae with insurance is a $20 k annual bill, but their true value is well beyond a monetary figure.

The same storm caused problems elsewhere for Te Arawa iwi. Rain, nine metre waves and a huge king tide created a deluge of water that battered Little Waihi. It was the worst in a series of three storms that had assaulted the small eastern Bay of Plenty community and wet the floor of their homes with sea water.

Four months later, in April, another storm raged over Rotorua with rainfall so intense it became the catchment's wettest hour ever recorded. The rainfall caused the Awahou Stream to breach its banks and flood the homes of many Te Arawa whānau living in low lying areas of Ngongotaha. The cost of fixing the damage is in the realm of $21.2 m.

> Te Arawa Lakes Trust Environment Manager, Nicki Douglas, says that they're excited to tackle climate change, but they're realistic.

These incidents are not just frightening one-off experiences anymore, they are warnings of what climate change will bring. Their devastating destruction could be just a taste of what is to come.

But an enterprising spirit is strong in the people of Te Arawa, who have begun to prepare for climate change through Te Urunga o Kea: Te Arawa Climate Change Working Group, initiated by Te Arawa Lakes Trust (the Trust). The Trust partnered with Scion to support the successful application from Te Urunga o Kea to the Ministry for Business, Innovation and Employment's Te Pūnaha Hihiko: Vision Mātauranga Capability Fund to work with Scion to co-develop a Te Arawa Climate Change Strategy.

Co-developed research

Te Urunga o Kea is made up of individuals from Te Arawa who are interested in climate change. They are a varied group who work in different industries, have unique experiences, different concerns and interests. This panel of iwi members also have representatives from Te Arawa

Primary Sector and Te Arawa River Iwi Trust, and together they guide the research focus of the team working on the climate change strategy.

Te Arawa Lakes Trust Environment Manager, Nicki Douglas, says that they're excited to tackle climate change, but they're realistic. "At the end of the project, we want a strategy that identifies and addresses short, medium and long-term needs, and responds to the challenges and opportunities of climate change, using our mātauranga as the dataset along with other climate data.

She says, "The first phase of our strategy has to address the immediate needs of Te Arawa whānau and protecting our places; the second phase needs to look at the changes our mokopuna might encounter and the third stage should be multigenerational, looking far ahead.

"We know we can't do everything but guided by our working group and the wairua of our tipuna, we'll address the major concerns of our people and look after our tamariki. We are a facilitator and a connector, and we're here to bring the right people together."

Challenges for Te Arawa

The rohe of Te Arawa is centred around Lake Rotorua, it stretches to Maketū in the east and to Tongariro in the South. Like all iwi across New Zealand, Te Arawa whānau face unique challenges brought about via climate change. But Te Arawa face other struggles that make adaption to climate change difficult – half of their population is under 23 and half of the working population earn less than the living wage ($42,744 pa). In light of this, they are considering climate change from an holistic point of view.

Other interests, such as food sovereignty, health, healthy housing, freshwater and energy independence have also been identified by their community as areas to explore.

The research team led by Marie McCarthy with community researcher Lani Kereopa, has identified several concerns and opportunities that need careful thought. Beginning with the land – much of the whenua in the region is used for primary production and is vulnerable to climate change in many ways. Land use diversification will be key to economic survival and environmental sustainability. Issues like sea level rise will threaten coastal communities, marae and significant sites like pā and urupā. Other interests, such as food sovereignty, health, healthy housing, freshwater and energy independence have also been identified by their community as areas to explore. It is no small challenge ahead for the team, but a strength of this project is having been co-developed by Te Urunga o Kea and Scion, the project guidance is led by Te Urunga o Kea, ensuring research priorities stay connected to community needs.

Our next steps

The next steps for the research team and Te Urunga o Kea are to scope out and then to run hui around the rohe, talking to people and hearing about their experiences. They also hope to inspire other models from around the motu.

Project leader Marie McCarthy says, "We'd like this to be an example of how we can bring science and our community together – to make connections, realise commonalities and spark new collaborations that will really benefit our people."

FOR FURTHER INFORMATION on this project contact Marie McCarthy at marie.mccarthy@scionresearch.com

Bringing science and community together, Te Urunga o Kea visited Scion to meet with scientists and discuss new opportunities for co-developing research proposals.

Wood processors working together for energy efficiency

The most efficient use of existing wood resources in regional New Zealand is to cluster wood processors in places with significant forestry resources. There, they can use forestry residues as feedstock for other products or for heat in wood processors or other industries.

According to a recently completed Scion project, this strategy called industrial symbiosis will create jobs, increase GDP and reduce greenhouse gas emissions.

Industrial symbiosis is a local collaboration where different industries provide, share and reuse materials, energy, water, and/or by-products to create shared value. Resources are used more efficiently by the group than by any individual organisation.

Scion's Wood Energy Industrial Symbiosis project has mapped New Zealand's varying forestry, energy resources and fossil energy-using industries to identify regions where industrial symbiosis clusters of wood processing operations could be co-located with meat and dairy processing, for example.

Regional opportunities

Gisborne, Hawkes Bay, Northland and Southland/Clutha are all forecast to have a long-term supply of surplus logs, forestry and other woody waste. Each region has different energy resources, large wood processing and other manufacturing plants. These affect future wood processing options and opportunities to co-locate with other industries.

> Co-locating wood processing to take advantage of and share resources makes economic and environmental sense.

New opportunities for wood processing clusters in these regions were identified using the WoodScape model and predictions of future log availability to calculate return on capital investment (ROCE).

Results showed that industrial symbiosis in Gisborne would be focused on standalone wood-processing powered by forestry and processing residues. In Ngawha, in Northland, the availability of geothermal energy frees up residues for secondary manufacturing. In Hawkes Bay and Southland, residues from wood processing clusters would be used to replace coal or LPG energy sources used by other nearby industries.

The new wood processes with the highest ROCE's include sawmills, Optimised Engineering Lumber (OEL™), plywood, oriented strand board, cross-laminated timber and remanufactured timber. Where geothermal heat is available the range of options expands and includes bio-chemical recovery and manufacture of solid biofuels from wood processing residues that might otherwise have been used to provide process or drying heat.

Win-win-win

If each of these clusters were established, the increase in onshore processing would provide an additional ~1000 jobs in each region, add a total of $2 billion to New Zealand's bottom line and reduce emissions of carbon dioxide by 67,000 tonnes a year by replacing coal with biomass.

Growing on-shore processing will be necessary if New Zealand wants to achieve a 10-fold increase in GDP from forests and related manufacturing. Co-locating wood processing to take advantage of and share resources makes economic and environmental sense. New wood processing clusters would create jobs and wealth in the regions and increase people's overall quality of life.

Other opportunities

An existing example of industrial symbiosis is the town of Kawerau in the eastern Bay of Plenty. Surrounded by forestry, Kawerau is a well-established wood-processing centre, and has the world's largest application of geothermal energy for industrial use. Analysis has shown that further development in Kawerau, such as a new plywood mill and an OEL™ plant with the residues being used for chemical production and fuel for industrial heat, could have a significant positive impact on GDP and jobs.

Opportunities for full industrial symbiosis around the Marsden Point oil refinery and Golden Bay Cement/Portland Cement in Northland hold similar potential.

There are also opportunities to replace fossil fuels used for industrial heat with biomass in the central North Island, Blenheim, Tasman/Nelson, Hokitika, Greymouth and Canterbury.

FOR FURTHER INFORMATION on the Wood Energy Industrial Symbiosis project contact Peter Hall at peter.hall@scionresearch.com

Microplastics pollution of Auckland beaches

Sampling team member Timothy Hopley from Auckland Council, takes notes on the Wenderholm sample site, north of Auckland.

Plastic microparticles were first found on the New Zealand coastline in the 1970s, and they've been found in many places since.

Now, the results of a Scion-led study taking place in Auckland will also tell us what kind of plastics are found around Auckland waterways and coastlines and provide clues to where they came from and how they were transported to the coast.

Sampling soil and sand

Sampling work in the 'Turning the tide on plastic microparticles' study began in July with the collection of sediment samples. Auckland was chosen as the sampling area because it is New Zealand's most populated city with diverse zones including industrial, commercial, residential and parkland next to aquatic environments. Samples were taken at the high-tide mark and intertidal area from 39 sites across Auckland.

Scion is now analysing the samples in its laboratories in Rotorua. Analysis will identify, quantify and characterise the microplastics found in each location. Information about the local land use activity and environment will be included as part of the plastic microparticles litter profiles for different locations.

The research results will be used to increase understanding of the nature and source of plastic microparticle contamination in New Zealand's aquatic environment so that long-term solutions to minimise contamination can be established.

An international issue

"Microplastics in waterways and marine environments are a growing global issue," says James Walker, Deputy Secretary Partnerships and Customers at the Ministry for the Environment.

"We need to improve our understanding of the nature and origins of microplastic contamination in New Zealand, so we were pleased to support this study by Scion through the Waste Minimisation Fund as a first step."

Florian Graichen, Scion Science Leader for Biopolymers and Chemicals, says results will be used initially to increase public awareness and educate relevant industry sectors about the problem and consequences of plastics in our waterways.

"The next stage will be coming up with a plan to remove the dominant sources of these microplastics before they enter the New Zealand environment, and ideally introducing alternative options, such as biodegradable plastics, into manufacturing applications," says Dr Graichen.

The scientific team is a collaboration between Scion and the University of Canterbury, with support from the Waste Minimisation Fund, Packaging Council New Zealand (PACNZ), Auckland Council and WaterCare.

The research findings will be reported in March 2019.

FOR FURTHER INFORMATION on plastic microparticles pollution in Auckland, contact Dr Florian Graichen at florian.graichen@scionresearch.com

Mobile manufacturing

(Continued from page 1)

New Zealand also does not have a large legacy of older manufacturing technology that would need to be incorporated to minimise financial outlay. We have a relatively blank slate, allowing us to move immediately to a modern state of manufacturing.

If New Zealand were to adopt a distributed manufacturing model for wood products, for example, we could grow our own high-value wood product manufacturing sector in regions with a lot of forestry, and create new uses from side streams like forestry residues.

Making the most of manufacturing opportunities

Extrusion technology is an example of Scion's work in this area. Extruders are small enough to fit into a shipping container, and capable of taking biomass waste from our primary industries and turning it into something new and valuable.

In pioneering research, Alankar Vaidya, Marc Gaugler and Dawn Smith demonstrated the use of an extruder as a chemical reactor to modify sander dust for further use.

This novel use of an extruder shows proof of concept to what is possible with mobile distributed manufacturing. To implement this technology, an extrusion set-up could be run by a wood processor or even a juice manufacturer as another way to utilise their resources. Alternatively a mobile plant operator could move to the biomass resource as it becomes available e.g. seasonal food processing.

Scion has also manufactured several examples of compounding with an extruder including biodegradable plastic vine clips for the wine industry using a grape marc composite, a biodegradable utensil for Zespri utilising kiwifruit skin, and more.

This work was carried out as part of Scion's 'Extrusion Plus' programme. Extrusion Plus is supported by the Ministry for Business, Innovation and Employment. Our collaborators include the University of Auckland, University of Waikato, Massey University and Auckland University of Technology.

FOR FURTHER INFORMATION on Extrusion Plus contact Dr Dawn Smith at dawn.smith@scionresearch.com

Annual report a song of success

Scion's 2018 annual report is available on our website, presenting another successful year.

The 2018 theme 'Forestry unleashed' provides 12 new examples of how our research is contributing to New Zealand social, environmental and economic wellbeing.

A milestone achievement was the completion of the world-first draft assembly of the radiata pine genome, which marked the beginning of a new era of precision forestry for this dominant plantation species.

In other work, Scion researchers found that optimising radiata pine stand density could increase the net value of the plantation estate by $1.7 billion. A newly developed model can predict the optimum final crop stand density for producing structural grade timber. The model will be released for use by forest owners and managers to plan targeted operations optimising stand density and maximising the value of their crop.

Biosecurity work was intense during the year with Scion involved in the myrtle rust incursion response both as leaders of specific projects and as collaborators in multi-disciplinary and multi-organisation programmes. We also continued to be a key player in the kauri dieback response via a highly collaborative research programme.

Scion's launch of the *New Zealand Biofuels Roadmap Summary Report* in February by the Minister of Energy and Resources was successful in stimulating discussion on domestic large-scale production and use of liquid biofuels among major industry players and policy makers.

Financially 2017-18 was a strong year for the institute. Revenue growth of 9.3 per cent to $56.7 m (budget $54.6 m) provided a net profit after tax of $2.3 m (budget $1.7 m).

Scion's complete Annual Report can be downloaded from www.scionresearch.com/annual-reports

Meri Kirihimete

Our offices will close for the year at 5pm on Friday 21 December and re-open on 7 January.

The Scion Board and staff would like to wish all our clients, partners and colleagues the very best for the festive season. We look forward to working with you again in 2019.

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