Victorian Skills Authority

International Specialised Skills Institute

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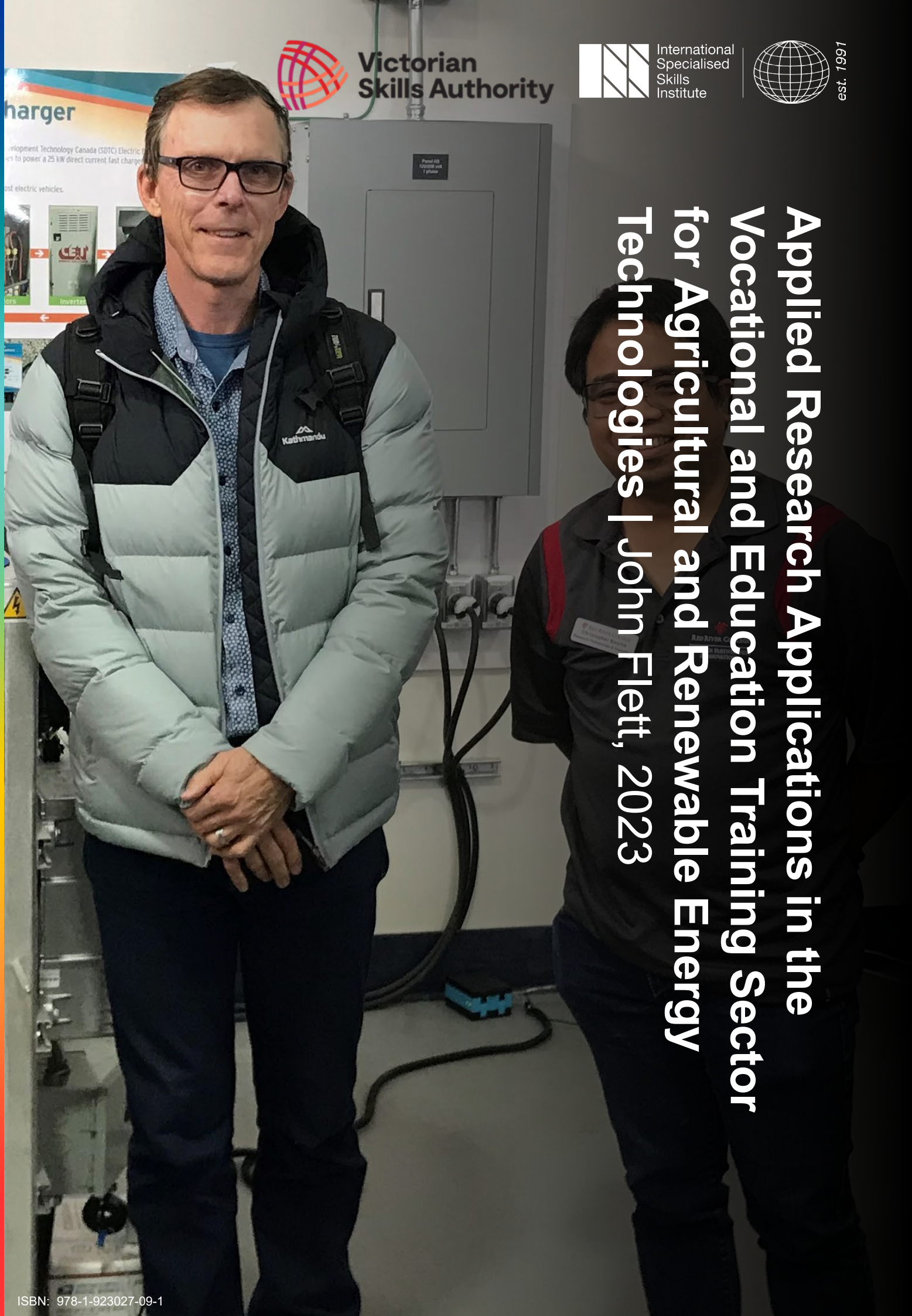
Applied Research Applications in the Vocational and Education Training Sector for Agricultural and Renewable Energy Technologies | John Flett, 2023



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1. Acknowledgments

The Awarding Body – International Specialised Skills (ISS) Institute

The ISS Institute plays a pivotal role in creating value and opportunity, encouraging new thinking and early adoption of ideas and practice by investing in individuals.

The overarching aim of the ISS Institute is to support the development of a 'Better Skilled Australia'. The Institute does this via the provision of Fellowships that allow Australians to undertake international skills development and applied research that will positively impact Australian industry and the broader community.

The ISS Institute was founded 29 years ago by a small group of innovators, including Sir James Gobbo AC, CVO, QC, and former Governor of Victoria, who had a vision of building a community of industry specialists who would lead the up-skilling of the Australian workforce. The Fellowship program builds shared learning, leadership and innovation across the broad range of industry sectors worked with. Fellows are supported to disseminate learning and ideas, facilitate change and advocate for best practices by sharing their Fellowship learnings with peers, colleagues, government, industry and community. Since its establishment, ISS Institute has supported over 450 Fellows to undertake skill and knowledge enhancement across a wide range of sectors which has led to positive change, the adoption of best practice approaches and new ways of working in Australia.

The Fellowship programs are led by our partners and designed to achieve the needs and goals desired by the partners. ISS Institute works closely to develop a Fellowship program that meets key industry priorities, thus ensuring that the investment will have a lasting impact.

For further information on ISS Institute Fellows, refer to www.issinstitute.org.au

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The VSA is the key link between Victoria's industries, training providers, employers and communities. It works towards matching Victoria's employment demands with training to ensure Victorian employers and communities can find workers with the skills they need, when and where they need them; and that Victorians can get training that will help them find a job and build a career.

The Victorian Skills Authority also works in partnership with the International Specialised Skills Institute by funding the VET International Practitioner Fellowships. The Fellowship program focuses on developing opportunities for building quality and excellence in the VET workforce.

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2. Executive Summary

In April of 2023 John Flett undertook an International Specialised Skills Institute Fellowship research program to the USA, Canada, and UK to look at applied research (AR) applications in the Vocational and Education Training Sector. The tour had a specific focus on agricultural and renewable energy sector programs, but revealed numerous applied research examples across all vocational areas in the Polytechnics and vocational colleges that were visited.

This TAFE Network Executive Summary has been prepared to provide a high-level overview of the key lessons learned and some recommendations that could productively impact the Australian TAFE system if implemented.

Why care about applied research in TAFEs?

The vocational education and training sector is under enormous pressure to remain relevant and responsive to the needs of its key stakeholders. Digital disruption, the 'Clean Economy,' automation, artificial intelligence, micro-credentials, industry engagement, training packages, over-regulation, funding models, and maintaining a teaching workforce, are major issues. Despite these challenges demands for higher quality training that better meets industry's needs continue and so our TAFE system needs to adapt. An applied research (AR) methodology offers a new and exciting way in which some of those demands may be met.

Applied research has at its core an industry-focused approach on solving practical or real-world problems using a workplace and educational research effort. Vocational training providers are ideally placed to have researchers, teaching staff and students involved in that type of work, with major benefits for all parties. Canadian vocational institutions are recognised as having responsive and effective applied research programs that address industry needs. While the core purpose of this study was AR applications in agriculture and renewable energy technologies the model has major benefits for all vocational areas.

The findings below are based on observations made at vocational colleges and polytechnics in Canada – Camosun College (Victoria), Olds College (Olds), Saskatchewan Polytechnic (Saskatoon), Red River College Polytechnic (Winnipeg); and the Centre of Technologies Aerospace, and Vestechpro (Montreal). The four-day World Federation of Colleges and Polytechnics Conference was also part of the study tour, and the Fellow presented Australian example as part of an applied research panel session. A copy of the full report can be found on the VSA/ISSI website.

The Six Big Takeaways:

1. Applied research applications in vocational and education training providers in Canada (colleges or polytechnics depending upon their size) have developed over time and now exist as a continuum. The Canadian model evolved from individual teachers in a faculty working on a single project, through to full scale research centres delivering multiple projects. This staged approach has allowed organisations to build capability, resources; and their reputation with industry. Government support for some initial demonstration projects would be ideal, and could facilitate the use of existing teaching staff in future projects.

2. Applied research (AR) centres, or Technical Access Centres as they are called in Canadian polytechnics, will be some time coming to Australia, especially smaller regional TAFEs. However, proposed centres of excellence currently being negotiated between the Australian State and Commonwealth governments may not be so hard to establish in the larger metro and dual sector TAFEs, or other larger TAFEs that support a dominant industry sector. That said, a lot can be achieved regionally with a range of smaller AR projects with funding from as little as $5k to $40k but State Departments of Education and Training will need to find a way to fund that type of project. Teacher professional on applied research techniques will also be crucial, as will some industry upskilling. There are Canadian online resources that can support some of that.
3. Available agriculture and renewable energy technologies used here and in Canada are not that different, apart from their colleges undertaking AR projects around existing and new industry applications. There are really innovative AR projects being implemented in Canadian vocational colleges ranging from the use of Geographical Information Systems applications for crop production, livestock production, through to innovative automation practices for specialised solar panels.
4. Australian TAFEs needs to begin incorporating AR into their teaching faculties and training their teachers as quickly as possible so that this type of research in new and emerging technologies can be included in their teaching programs. There will be significant and immediate benefits to student outcomes; as well as increased industry satisfaction levels.
5. There were several Canadian AR projects that were centred on reducing greenhouse gas emissions and using alternative renewable energy sources. There were also other polytechnics that have developed long-term sustainability plans that can inform Australian TAFEs looking to develop a future net zero carbon emission plan by 2050. Victorian TAFE institutes will need a long-term plan to achieve that goal and meet the State government's net zero targets. The scale of change needed means that realising these plans in full will be contingent on on-going specific government funding.

6. Hydrogen fuel cell electric buses and battery electric buses operating systems have been successfully operated for many years, and have many similarities. There are some positive implications for SWTAFE's H_2 bus project objectives and its EV project too. Currently, there are no industry accredited or endorsed upskilling programs offered to operators of fuel cell vehicles. A high level and easily implemented and delivered training approach would have applications here and overseas for any organisation about to introduce fuel cell electric vehicles.

The Fellowship has or will have a significant positive impact at a personal, professional, organisational and sector-wide level. The new contacts and networks established, and the strengthening of existing relationships has been particularly valuable. These relationships in turn have been able to be used to better inform not only professional practices and understandings of applied research, but directly impact some existing South West TAFE projects. There will also be ongoing work to influence and improve the Victorian VET sector's understanding of what applied research is, the variety of ways it can be introduced, and some of the challenges and opportunities it provides.

3. Fellowship Background

The Fellowship was focussed on researching how Canadian polytechnics have successfully used an applied research methodology to develop quality training with deep and meaningful connections with industry to meet their emerging or ongoing workforce skills and capability needs. As Director of Strategy , Research and Clean Economy Innovations a key aspect of the Fellow's role is to work with external industry and education partners, internal stakeholders, government departments, peak bodies and other agencies to identify how South West TAFE can best support its industry partners.

As training, education and industry operating environments becomes increasingly complex due to digital disruptions, pandemics, economic crises, and work force shortages, it is critical to have new ideas and ways to develop workforce solutions for industry. Much of what has traditionally worked in the past will soon no longer be fit for purpose.

There are two key specific areas of interest for this research project, the first being how are applied research models meeting the current and emerging needs of the agriculture, food and fibre sector. An example being explored is Saskatchewan Polytechnic's agricultural-focused applied research projects that have sustainability at their core, and include digital tools for smart farming and precision agriculture at its Langham demonstration site. The food and fibre sectors are south west Victoria's largest contributor to regional gross domestic product and employment. However, its growth is being hampered by workforce capacity and capability issues and new technologies are being used to address them. This has big implications for how training now needs to be delivered.

The second area of interest is in the renewable energy sector, and how polytechnics in Canada are working with industry with renewables and minimising energy consumption . There is much work being done there on the use of wind, solar, geothermal, and biomass energy as part of a circular economy. The technological advancements being made with industry and community partners will offer a number of insights on how we might approach our region's workforce and training challenges differently in future.

Amongst all of this change a student centred focus is critical for high quality training outcomes, and it involves having well qualified and experienced staff working in industry standard facilities, with key organisational support systems in place. Industry itself is often overlooked by training providers and educators as a key component and contributor towards delivering quality training. Engagement with industries that employ apprentices, or provide mandated work placements is often very transactional. While teachers may meet employers and observe and assess a student in a workplace, there is usually little opportunity sought, considered or created, so that students, employers and educators can work together to create a richer learning experience through an applied research project. Difficulties in envisaging and articulating the value proposition of such an applied research approach is another impediment to putting a proposal to an employer.

This research project identified the strategies, processes and support mechanisms that allow an applied research model with industry to be created. The work also investigated and quantified the training, financial and cultural benefits of this approach to students, staff and organisations alike. Findings are being shared with other Victorian VET professionals - educators, teachers and managers, through a variety of forums and communication methods. These include the Victorian TAFE Association, and its various sub-groups, such as the Education Leaders Network and Applied Research Group. At the conclusion of the Fellowship there will be opportunities to share the findings at presentations at other events such as the VET Development Centre Teaching and Learning Conference, the VTA annual conference, OctoberVET and other VET-focussed forums.

The basic methodology was a series of semi-structured interviews with each organisation that was visited, with some key questions to guide the discussions (Refer to Appendix 1). Not all questions were relevant to all those who were met and were adjusted according to organisations, roles and specific projects being discussed. The study tour itinerary is in the table below.

The Fellowship formally commenced on 19 October 2022 and will conclude by 3 November 2023.

Fellowship Itinerary

Date	Country	Location	Organisation	Type of activity	Purpose
9 April 2023	Australia	Melbourne	NA	Depart Melb Sunday	Travel to USA
10-12 April	USA	San Francisco	AC Transit	H2bus lines training resources	Industry meetings
13-14 April	Canada	Vancouver	BCIT	Applied Research	Education meetings regarding applied research methodologies
15-16 April		Victoria	Camosun College	Applied Research methods	Education meetings regarding applied research methodologies
17-18 April	Canada	Calgary Airport Bus to Olds	Olds College	Agriculture technologies	Education and industry meetings regarding agriculture technologies and industry projects

Date	Country	Location	Organisation	Type of activity	Purpose
19-20 April	Canada	Saskatoon	Saskatchewan	Agriculture & renewable energies	Education and industry meetings regarding agriculture technologies and renewable energy industry projects
21-22 April	Canada	Winnipeg	Red River College	Renewable energies	Education and industry meetings regarding renewable technologies and industry projects
23-25 April	Canada	Montreal	World Federation of Colleges & Polytechnics	WFCP Conference (23-25 April)	International VET conference
26 April	Canada	Montreal	Vestechpro CTA	Fashion & textiles, and aviation research centres	College and research education centre visits and meetings
27-30 April	UK	Perivale, London, UK	Metroline Buses	Fuel Cell technologies/ Buses	Education meetings regarding hydrogen fuel cells
2-4 May	Australia	Melbourne	NA	Travel	Return travel to Australia

Abbreviations and Acronyms

Acronym	Definition
AR	Applied Research
ARI	Applied Research and Innovation
ARIAG	WFCP Applied Research and Innovation Affinity Group
BEB	Battery Electric Bus
EV	Electric Vehicle
Faculty	Teaching staff
FCEB	Fuel Cell Electric Bus
FCEV	Fuel Cell Electric Vehicle
ISSI	International Specialised Skills Institute
Poly	Polytechnic
H_2	Hydrogen gas
Polytechnic	A vocational college offering Certificate, Diploma and Degree programs
OTCD	Office of TAFE Coordination & Delivery
RRC	Red River College Polytechnic
SP	Saskatchewan Polytechnic
TAFE	Technical and Further Education
TDA	TAFE Directors Association
TVET or VET	Technical Vocational Education and Training
VSA	Victorian Skills Authority
VTA	Victorian TAFE Association
WFCP	World Federation of Colleges & Polytechnics
ZEB	Zero Emission Bus (ie Electric or Fuel Cell)

4. Fellowship Learnings and Findings

AC Transit – San Francisco

AC Transit (ACT) operates a fleet of 628 buses across San Francisco. There are 15 different bus types using five differing fuel systems:

- Diesel
- Diesel-electric hybrid
- Battery Electric Bus (BEB)
- Fuel Cell Electric Bus (FCEB)
- Original FCEBs (4).

The company is working with the San Francisco district government to achieve a zero-emission status by 2040. It has acquired extensive knowledge and infrastructure associated with operating fuel cell electric vehicles (FCEVs). This knowledge has been built up since 2006 when their first FCEBs began operations. The local government has subsidized the cost of those buses but required the company to operate them for at least 12 years or 35,000 hours of travel. The original four FCEBs acquired have all achieved over 38,000 operational hours using the original fuel cells. This has exceeded the original equipment manufacturers advice that the cells would have an effective life of around 3,000 hours.

Figure 1. AC Transit Training Maintenance Depot, San Francisco

Figure 2. Janusz Sokara, AC Transit Training Maintenance Depot Supervisor

The Division 4 Maintenance Department is led by Janusz Sokara, and the facility contains a refueling island that supplies diesel and hydrogen (H_2) refilling points. The hydrogen refueling points have remote monitoring of FCEBs H_2 levels and temperatures, and are able to refueled in the same amount of time as a regular bus. The facility has a standing compressed natural gas electric fuel cell to supply power for the BEBs, and a hydrogen storage and production facility.

The storage facility is able to receive up to 9,000 kg of liquid H2, and also has its own electrolyser and high pressure H_2 storage tanks. The hydrogen storage facility is to be upgrade to a 25,000kg site as the company moves away from producing H_2 in large quantities. The current hydrolyser can produce 65kg per day which is enough to run four FCEBs per day; and the hydrolyser was a requirement under ACT's original funding grant.

Figure 3. AC Transit Training Maintenance Depot Hydrogen Storage Facility

There is a dedicated FCEB maintenance bay equipped with a range of additional safety features that include:

- H_2 sensors and alarms
- Closed doors
- Ceiling ventilation
- Special emergency procedures in the event of low or high H_2 leakages.

To date there have been no H_2 incidents in the bay since it was constructed.

Figure 4. AC Transit Training Maintenance Depot Hydrogen Re-Fuelling Station

In 2018 ACT have embarked on a “five by five” study project that is comparing the operational and economic effectiveness of the five different fuel systems in operation, over five years. This program is led by Jose Vega who has been part of the company’s H_2 program since its inception. Jose commenced as a diesel mechanic but now oversees the development of the company’s H_2 fleet and its related workforce training. The five by five program is large scale project involved collecting data from 25 different routes, with multiple drivers and the buses using the five different fuel systems. Some of the highlights of this data are that it has shown the effectiveness of FCEBs and that a long

Figure 5. AC Transit Training Maintenance Depot FCEB Maintenance bay

term zero emission bus (ZEB) fleet's ideal mix would be 70% FCEBs and 30% BEBs. The project has also identified a number of short-term issues with FCEBs, the most significant being the availability of spare parts from the OEMs. These shortages have resulted in the FCEBs on being available for 69% of the time compared to a diesel bus with a 96% availability. ACT expect that availability figure for FCEBs to increase over the coming years as OEMs improve the production and availability of spare parts for battery, fuel cells and drive train systems.

ACT operates a large-scale, and award winning, training centre at its Hayward Division 6 centre, which is managed by Michael Chorrito). The training centre provides comprehensive in-house training for its bus mechanics. The mechanics undertake a training program that consists of:

- Basic H^2 principles, high voltage electricity and safety systems 8 hours
- Energy storage systems 30 hours
- Fuel cell maintenance – basic 40 hours
- Powertrain systems – 40 hours
- Five-week face to face small group practical training in ACT workshops – 300 hours.

Figure 6. AC Transit Training Centre forum

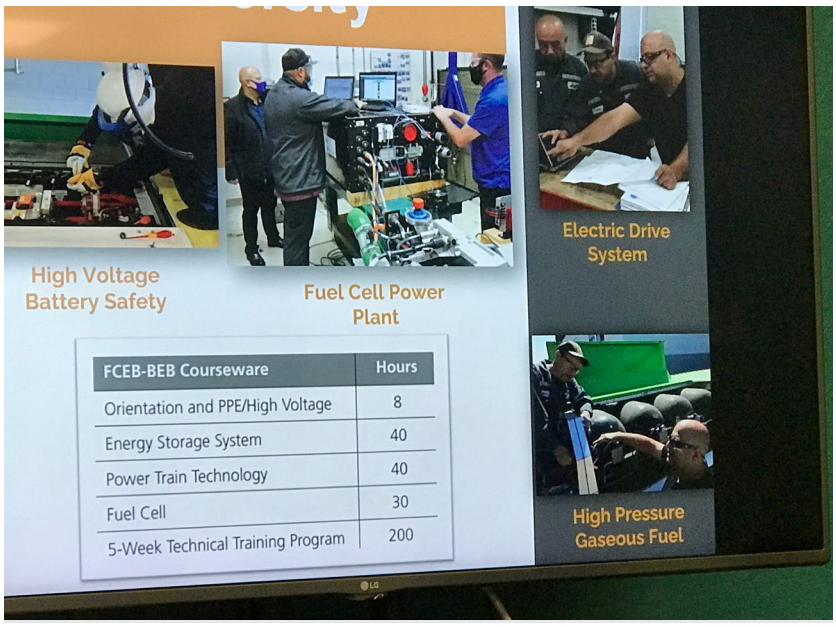


Figure 7. AC Transit mechanics ZEB training program plan

Bus drivers undertake a 10-week training program, with the first nine weeks involving a mix of face to face theory, bus induction training for the 15 vehicle types, system routes and practical driving exercises. Week 10 is undertaken on normal bus routes. There is a 300-page drivers manual that is included in the course that covers drivers' basics, plus all of the relevant Californian driving regulations and codes that apply to buses. Much of the content of the manual is information from the OEM user manuals that covers driving operations, monitoring fuel cell, battery and other systems, as well as drive train characteristics.

Figure 8. AC Transit Training workshop – FCEV simulator

The course also provides the drivers with their commercial license, as most enter the program with limited driving experience and just a commercial driver permit. A small percentage of new starters have some experience in driving heavy vehicles but are also relatively untrained or skilled in bus operations. While there was some initial reluctance from drivers in regards to the FECBs due to safety concerns there is now universal acceptance of these and BEBs. Drivers now value the quietness, and performance of the new buses when compared to the diesel fleet.

Figure 9. AC Transit Training heavy vehicle workshop

The company is developing a $17M proposal to develop an AC Transit Zero Emission Bus University model that will provide training for its own employees, other transit and bus operators, and work with universities and other education providers. To date ACT has not partnered with any educational organisations as it prefers to retain all the intellectual property it has acquired over the past 17 years. However, it is willing to work with education partners and share its information.

Figure 10. Jose Vega, AC Transit ZEB Program Administrator

Future action:

- Establish an on-going connection with Training and Education Manager Michael Chorrizo and the FCEB Project Manager Jose Vega.
- Connect with Cecil (General Manager Operations) and discuss access to some of ACTs theory resources.
- Develop a training resource site for SWTAFE where the photos and information provided can be centrally accessed.

Metroline Buses (a CDC Bus lines subsidiary)

On arrival in London a meeting was held with Alix Butler, Strategy and Finance Manager at Metroline Buses and CDC Bus Lines subsidiary at the Perivale Garage complex. Metroline operate 1,200 buses that include a fleet of 20 Fuel Cell electric buses. These were purchased as part of a deal with bus lines in Birmingham and Aberdeen, that acquired 40 and 50 FECBs respectively. Metroline's first experiences with FCEBs started in 2012 before being wound up in 2018.

Figure 11. John Flett & Alix Butler at, Metroline Perivale workshop

There is now a renewed interest in FCEBs and they are preferred by some in management over standard battery electric buses (BEBs). A key problem with BEBs has been their inability to travel far enough without running out of charge. There has been a combination of factors causing the BEB issues, including lack of driver training on how to drive and brake correctly, battery failures and recharging times.

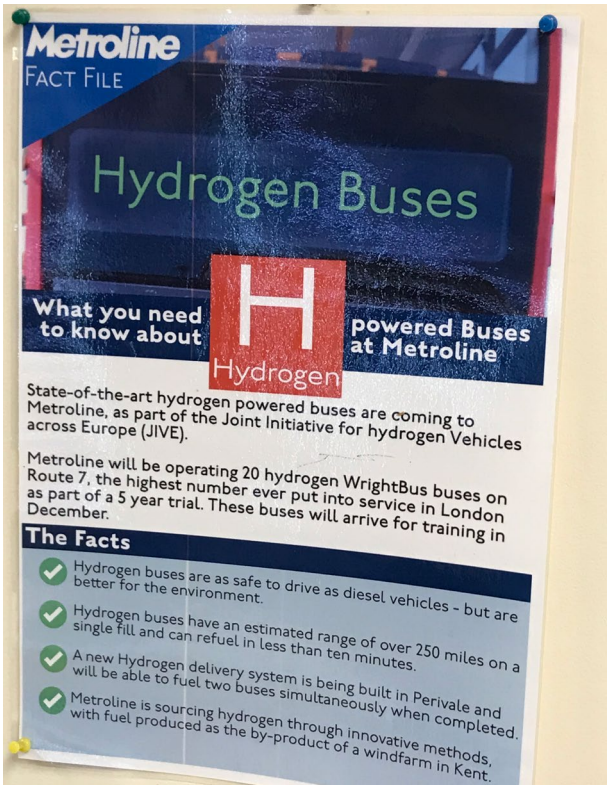


Figure 12. Metroline H2 Bus Poster, Drivers Lounge

The FCEBs have proven popular with the drivers and there is a relatively good economic case for them over the BEBs. However, the immaturity of the hydrogen sector has seen delays and failure in the hydrogen supply chain that have disrupted operations. The worst of these was a three-month shortage of hydrogen. The company uses Wright Bus bodies with Ballard fuel cells for the energy source. The company does not produce its own H_2 gas and instead relies on a contractor for the supply and installation of refilling stations.

The maintenance facility has been modified to handle H_2 buses with a dual refiling station supplied by five supply tankers that are rotated around. A contractor company is responsible for cleaning and refueling the buses, including the FCEB buses. Drivers are only required to operate the buses and report on any issues.

There are two H2 refueling stations at the depot, however fill times are about eight minutes if both are being used compared to a filling time for an FCEB of six minutes. These times are quite slow when compared to two minutes for refueling a diesel bus.

Figure 13. Metroline Perivale workshop maintenance bays

That time difference is significant, particularly if there were to be 100 FCEBs operating out of the depot. While some of that can be managed with scheduling and taking vehicles off a route for a refill, it is hoped that the extended range of a FCEB will minimise the need for that type of thing.

Driver training is relatively minimal, although every driver is inducted on to each type of bus that is operated. For FCEBs this consists of an hour bus familiarisation course for all drivers of FCEBs (or indeed any new model bus that is brought in). It is an area that the company is considering expanding given the issues it is having with BEB operations.

Figure 14. Metroline Perivale FCEB

The company does all its own fuel cell maintenance and has paid for three heavy vehicle engineers (aka diesel mechanics) to attend Ballard's US manufacturing plant to become fully accredited to work on the fuel cells. Ballard has been willing to support its warranty but has limited capability or capacity in the UK. By accrediting the Metroline engineers it means Ballards's do not have to attend for local repairs, replacing parts or service meetings. Metroline have paid for three technicians to go and study in Canada for two weeks to learn how to service and repair the Ballard engines. The engineers were trained on the proviso that they do not leave the company for two years, or if they do, are required to repay the cost of the training. The upskilled engineers are not paid any extra allowance for undertaking the training, or working on the FCEBs.

Figure 15. Metroline Perivale workshop H2 refuelling bowser

Figure 16. Metroline Perivale workshop H2 tube tanker storage bunker

When asked about “First Responder” training the response was that all relevant stakeholders were consulted, but that no training was required or expected. Typically, first responders such as fire and emergency services are reluctant to deal with battery fires as they are generally exceedingly difficult to extinguish, and left to burn out. A recent incident saw a Metroline BEB badly damaged in a fire. The London Fire Service has indicated that they will not attempt to put out BEB of FCEVs in the event of a fire.

The local council and London council governments have reacted with quite stringent safety standards, such as nine-inch thick walls around the hydrogen storage bunker, workshop ventilation, and earthworks and other security and environmental measures to support the initiative. There is some concern though that these are somewhat excessive, and some future fire boundary arrangements being considered by the Metropolitan Fire Brigade for within the depot could make a future hydrogen fleet unviable.

Figure 17. Metroline Perivale workshop bus yard

Camosun Innovates:

Camosun Innovates (CI) is one of 60 federally funded Technology Access Centres, with a focus on developing and supporting advanced manufacturing using digital technologies for small and medium sized enterprises. CI and TAC Manager Shaun McConchey were instrumental in assisting Top Soil Innovative Agriculture set up their small-scale vegetable processing plant (see the Topsoil case study below). Director Richard Gale and Senior Technical Officer Matt Zealey who provided a tour and summary of the Centre's capabilities and industry applied research collaborations.

Figure 18. Camosun Innovates – 3D printer

Virtual and Augmented Reality (VR/AR) applications are featured prominently in the work done by CI. Camosun Institute has worked closely with the Canadian Elite Disability Athletes Foundation to develop a range of assistive technologies for para-athletes. These have included customised rowing seat assemblies, and other prosthetics for athletes. CI also work with industry partners on larger scale projects and have CNC machines, and a huge range of 3D-printers using multiple types of resins/products.

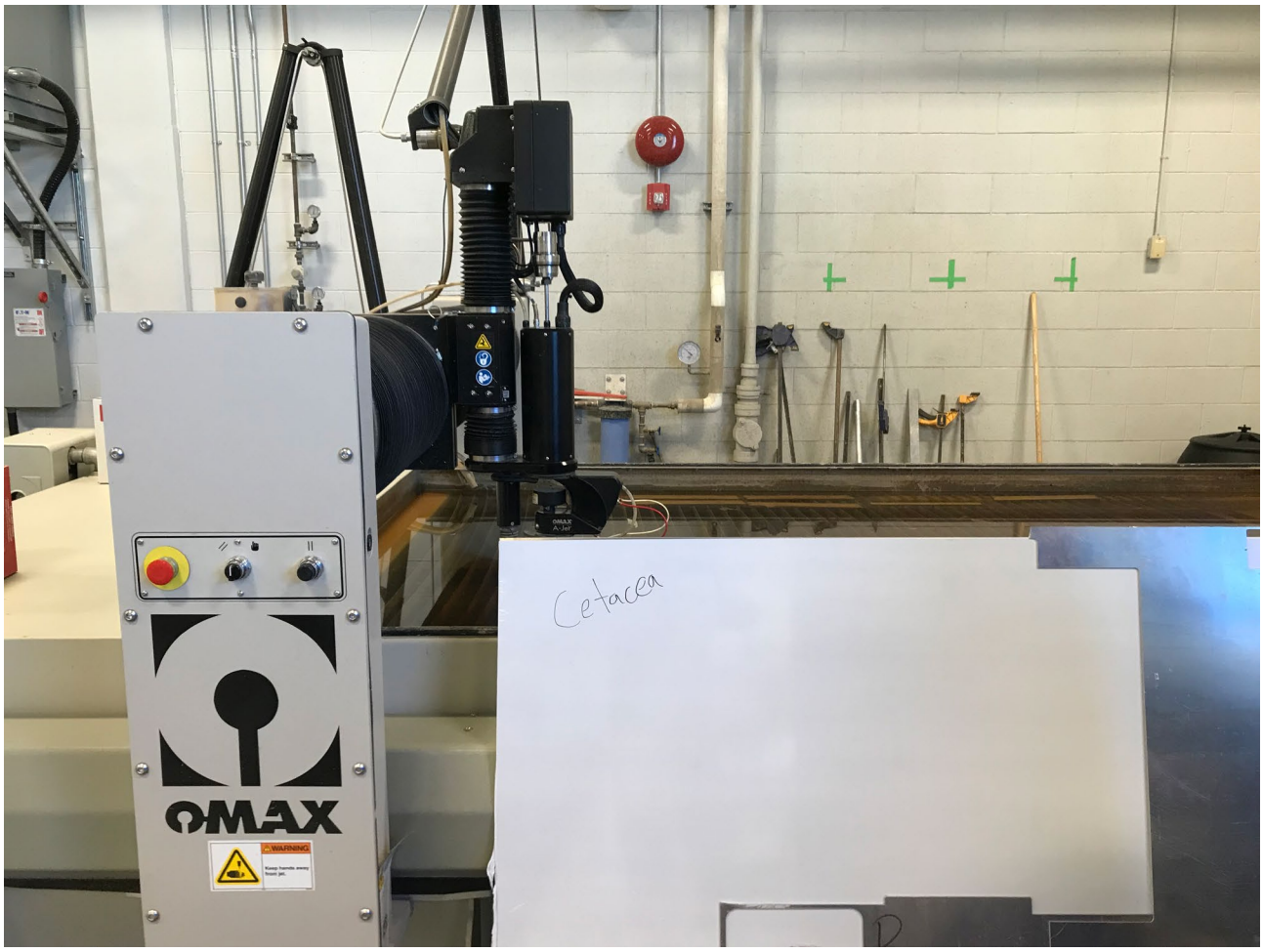


Figure 19. Camosun Innovates – Plasma water jet cutter

A significant project during COVID was producing a COVID vaccine vial system that allowed pharmacists to more quickly set up vials of vaccine for distribution. The system proved so popular and successful that it is now being used for other vaccine applications (see at right).

The TAC has $350k funded annually by the federal government for five years, and expected to match that with industry contributions and other fee for service work. However, it will not accept FFS work that competes with commercial businesses, so only takes on small

Figure 20. Camosun Innovates – 3D printed COVID vaccine dispensers

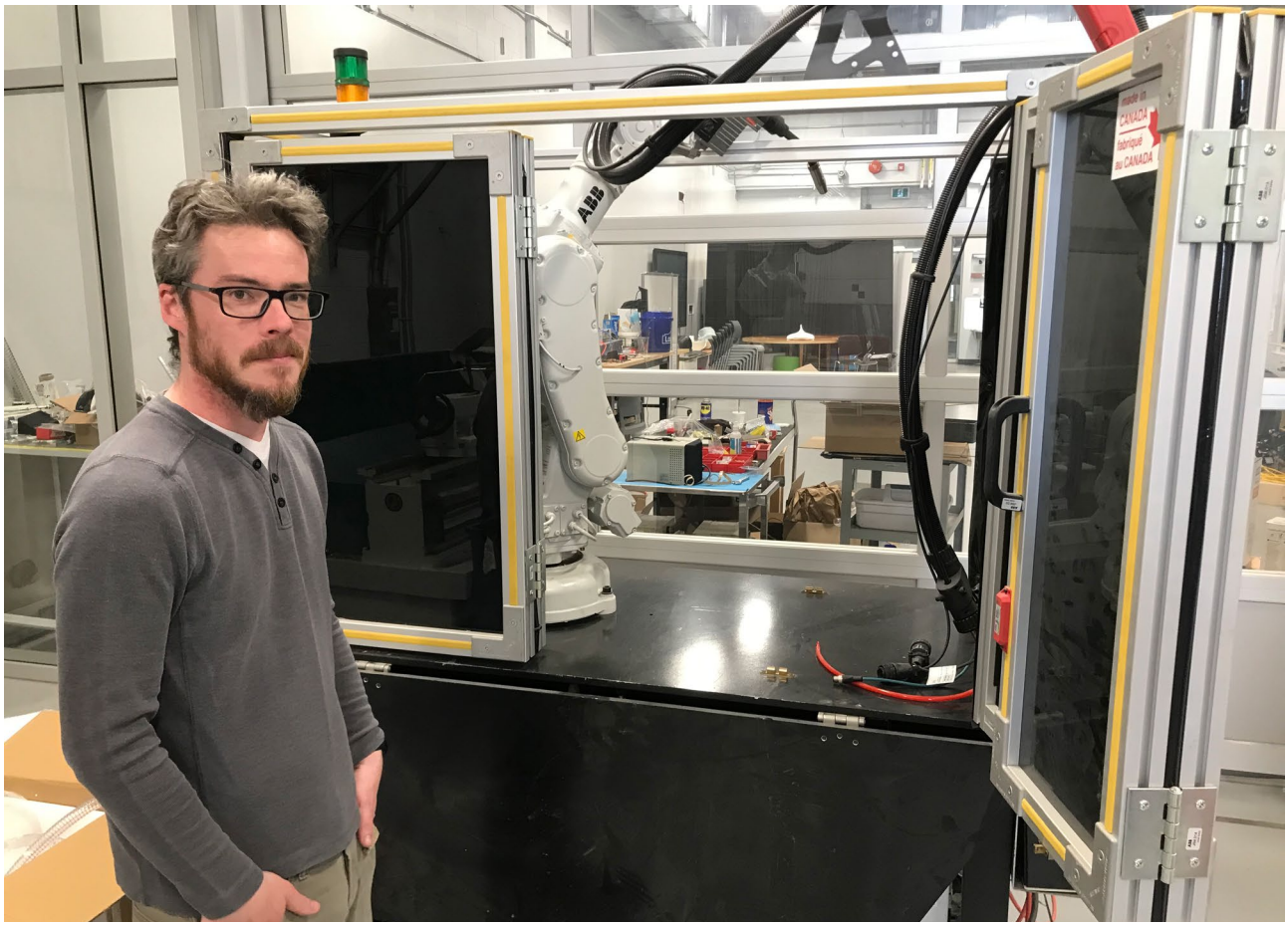


Figure 21. Matt Zealey, Camosun Innovates – Senior Technical Officer

production runs or highly specialised projects. CI has 16 full-time employees as well as eight student graduates that work on projects. The Centre itself is in a refurbished ($2.5M) workshop previously used by the automotive paint and panel department.

Future actions:

The federal funding model does not operate in Australia, but State governments, and the TDA should lobby for this type of model to be piloted here.

There is potential for future WTIF or RSTF grant applications to include an applied research element to them, however gaining industry interest and input will be key to that.

Future discussions with CI are needed on how SMEs find and connect with them.

There is some potential for the current south west Victoria, Pre-accelerator LaunchVic Project SWTAFE is part of with three LGAs, to engaged with SWTAFE to work on some of the proposed initiatives.

Figure 22. Camosun Innovates – CAD research lab & researchers

Case Study 1 – Topsoil Innovative Urban Agriculture

Figure 23. Chris Hildrith & Mobile Production Plant

Figure 24. Topsoil Urban Innovation plots

Figure 25. Topsoil Urban Innovation plots & watering system

Chris Hildrith is founder and managing director of Topsoil Innovative Urban Agriculture (Topsoil) and has established a team and work site in Victoria, British Columbia. Founded in 2015 the company started out with a 4,000 square foot pilot that has grown to a 20,000 square foot enterprise. Fast growing and "cut and come again" crops; mostly fresh vegetables and herbs, are grown on waste industrial land using a proprietary geo-fabric potting system. Vacant blocks, roof tops and other empty sites are being utilised to produce organically grown produce that is sold to direct to local restaurants in Victoria, British Colombia, as well as to community shareholders and the public.

Chris is a self-taught horticulturist, although now employees a worker with a Masters in Environmental Sustainability who brings some significant plant production knowledge.

With a budget of around $30k this applied research project with Camosun Innovates involved the design and construction of a modular processing and packing plant using a repurposed shipping container. Computer Aid Design work was undertaken and the construction, plumbing and electrical installation works were carried out by Camosun College students. The next step is for TopSoil to commercialise the processing plant and crop production process.

Camosun College

Plumbing Department:

The Plumbing Department at Camosun College (CC) was represented by James Smyth a senior plumbing and solar instructor at the College. James has been at Camosun College for over eight years, having come back into the polytechnic after many years of running his own solar heating company. He has Red Seal qualifications in plumbing and solar heating installations and trains apprentices and foundational students, and industry plumbers undertaking upskilling and short courses.

Within the plumbing centre there are multiple workshops that provide training for apprentices and others, and also have a number of unique specializations. These specializations include – commercial fire service systems, marine plumbing, ground water pumps, refrigeration technicians, multiple under-floor heating systems, solar and geothermal heating systems, and pipe making.

The foundation program runs for 10 months and has three rolling enrolment periods. Teachers manage three groups at a time, with six students in each group. Almost all the students graduate into employment. A new lock-step delivery model is planned that will see groups of 18 study at one time. This will reduce the complexity of training for the instructors, as there is no formal training required to teach in the trades other than the Red Seal qualification, which requires 10 years industry experience to attain. During the visit the Fellow was able to observe small groups and individuals working

Figure 26. James Smyth Plumbing teacher plumbing student lab

Figure 27. Camosun College Plumbing Centre

Figure 28. Camosun College Plumbing Centre – vocational education plumbing students

on individual and group self-paced activities. The students come from a range of backgrounds, often with limited prior education, but all seemed engaged and motivated to do well.

The solar plumbing team led by James was involved in the design and installation of a solar heating system at a local community centre. These systems are very efficient and James was particularly impressed by Apricus an Australian manufacturer of vacuum tube solar heating assembly, supplied by an Australian owned company. These systems can operate in very low light levels and temperature differentials of only two or three degrees. The heated water produced can be used for commercial or residential hot water systems, or linked in to other systems to produce steam heating for commercial cooking applications. Students learn to connect and service a variety of solar heating systems including the more traditional flat plate collector types (See Pictures 2, 3 and 4.

Figure 29. James Smyth Plumbing teacher & vocational education plumbing student (Vacuum solar arrays)

Heat pumps or heat exchangers feature prominently for many of the applications delivered in the workshops.

Figure 30. Camosun College Plumbing Centre

Figure 31. Camosun College Plumbing Centre – Hot water lab

Much of the equipment used in the plumbing department is donated by industry or supplied on a buy one get one donated basis. There is some significant teaching resources and equipment provided by the Victorian Plumbing Union, who partner with CC to deliver a range of industry designed and mandated short courses.

Figure 32. Camosun College Plumbing Centre solar wall

The trades building also features a pre-heating system fixed to the outside of the building. This consists of black perforated colour-bond panels that have air drawn into them by the heating and ventilation system. This is a highly effective system when there is direct sunlight, even in winter months, and heats the incoming air by several degrees Celsius (see image 5).

Future Action:

There are several examples from Camosun College that would have application to SWTAFE's Clean Economy initiatives, both from a training perspective and its future facilities and infrastructure improvements that will assist it move towards its net carbon zero targets.

Solar thermal heating is not widely used in south west Victoria, apart from the mandated heating systems on new homes. There are numerous ways in which these systems can be used in residential settings, including retro-fitting existing homes with underfloor hydronic heating.

Olds College, Olds, Alberta

There were several opportunities to have really constructive conversations with the Faculty leaders, permanent teachers as well as the research arm (OCCI) that included the Olds College Centre for Innovation (OCCI) Director and Vice President of Applied Research.

Figure 33. Olds College OCCI Farm & College buildings

David Fullerton, Director of the OCCI, organized a series of meetings between the Fellow and College staff, managers and an executive (Joy Agnew, Vice President of Applied Research). Olds College was established in 1923 as a purpose-built agriculture college, and includes over 3,000 acres of farmlands and infrastructure. Today it has over 1,700 students enrolled in a range of courses that include in one-year certificates and two-year diplomas. In September 2023 the college is introducing a new four-year Bachelor of Digital Agriculture. The programs are divided into several areas – livestock studies, soils, crops, digital agriculture, and autonomous machinery. The college is also the site of the Olds College Centre for Innovation (OCCI), and one of 60 Technology Access Centres – but with a focus on livestock research and development.

The OCCI is responsible for much of the research done on the Old property, but its operations are funded from federal grants under several different funding bodies. The OCCI employs 18 researchers, and has a summer research program that employs up to 12 agriculture students. The research students are paid around $18 per hour for their work, but

Figure 34. John Flett, Banff, Alberta

it is sometimes difficult to attract students to the roles as they can be paid more in most retail and hospitality stores. Research grants are usually for three years, and this means that researchers are continually looking for new or additional programs to ensure they have ongoing employment.

Figure 35. Olds College OCCI Farm Machinery Yard

The type of research done by OCCI was previously conducted by the Alberta Department of Agriculture, however a new competitive funding model that allows multiple research agencies to apply for funding is in place. Agencies such as OCCI apply for funds based on specific small to medium sized companies needs. The federal funding is typically matched dollar for dollar by industry, although in some cases that can be less. Examples of research projects include geoinformation systems (GIS) modelling of crop hail damage forecasting for a provincial insurance company. The livestock feedlot is used by primary producers to determine the growth rates and feed efficiencies of cattle to inform breeding practices and for marketing breeding livestock. The town of Olds is located in the Mountain View County, and is a major agriculture centre. Cereal and oil crops are the main forms of agriculture undertaken. Agriculture has overtaken the oil and gas industry as the region's major economic contributor and employer.

Figure 36. Olds College OCCI

Figure 37. Olds College OCCI Wi-Fi Silo project

The College and OCCI have benefited from a recent $100M refurbishment grant which has allowed the refurbishment and fit out of a number of buildings, workshops, storage areas and new equipment to continue research operations. The funding was obtained on the basis that the farm and its infrastructure is an integral part of the research activities and that OCCI could not continue to operate effectively without further investment.

Figure 38. Olds College Farm, Alberta

Researchers liaise with the full-time farm manager on what areas or assets are needed for research trials, and any areas not needed are put under crops. The winters in Olds are quite harsh with temperatures as low as -40 degrees Celsius, and this can limit some research and training activities, given the summer growing season usually coincides with the teaching faculties ten-week summer break from late May to early August.

There was a great discussion held with Jay Steeves (Dean) and Lisa King (Associate Dean) of the Werklund School of Agriculture and Technology that reviewed some of the similar challenges and issues that face the teaching departments both in Canada and Australia. New courses are designed and developed by the teaching faculties and are institute-issued, as there is no national course accreditation system in place. There is the

Figure 39. Olds College OCCI Machinery Centre

Curriculum Alberta Qualifications Authority that has oversight of all provincial courses.

There are three very different types of applied research programs that form part of Olds operations:

1. The OCCI – these are applied research projects carried out for specific industry partners – this accounts for the majority of the applied research effort
2. Teaching faculties delivering the new Bachelor of Digital Agriculture – at least 25% of degree teachers workloads must include research activities. These activities are likely to be also funded by research grants, but from other sources that do not duplicate OCCI's funding
3. wTeachers using research projects as part of their certificate and diploma courses – this is less structured and entirely dependent on individual teachers having students carry out research activities as part of their course.

Figure 40. Olds College Feedlot

The research degree-based research model is creating some challenges for the College teaching faculties, as the current industrial (collective) work place agreement does not have a category for research related activity. While the College's Dean and Associate Dean are keen to see the degree program's research programs be supported they are also wanting to have applied research become part of the scholarship of teaching and learning. However, this concept is still very new and they do expect resistance from some teachers and instructors who do not want to have to include research activities into their teaching.

Figure 41. Olds College Crop monitoring trial site

While the focus of OCCI research projects is on livestock production it also covered a range of other agricultural activities. The OCCI has supported 175 clients through 95 different research projects, some of which are listed below:

- Feedlot cattle production – automated feeding and weighing systems being developed for commercial cattle producers
- Animal recognition using artificial intelligence (ie face recognition)
- Treatment of feedlot run-off using native wetlands and floating island technologies
- Virtual fencing systems for cattle
- Comparing differences in weight gain, health and reactivity at handling in imprinted against non-imprinted calves weaned
- GPS mapping of farm soil fertility and crop production to minimise inputs and maximise yields
- Analysing soil moisture deficiencies and mapping to potential yields; and evaluation of new types of probes
- Autonomous vehicle operations (herbicide spraying, sowing operations)
- Using Bluetooth to monitor storage bin/silo conditions and quantities
- Measuring and minimising combine harvesting losses
- The use of drones to measure and predict crop losses due to hail damage
- Re-purposing of biofuel exhaust emissions into a carbon-based biofertilizer

- In-field micro-climate sensors to model and apply disease control (eg fungicide applications) strategies
- Measuring protein and moisture content of harvested grain, oil seeds, and pulse crops in near-real time as harvested
- Using weather information and crop measurements for predict their yields
- Evaluating the potential of using remote sensing technology to aid in the completion of detailed site assessments for land reclamation

Figure 42. Olds College Machinery Shed

Teachers at Olds College are keen to see their employment agreement changed to include a teacher/researcher role, and were of the view that these activities would see them doing less teaching to allow for the research component. The teaching load foregone for research would be picked up by casual or contract teachers, but the permanent teachers were not keen on having a large number of casual teachers employed as they usually are not around to assist with the college's long-term planning or course and resource development. The faculty administrators are hoping a model that does not impact the number of teaching hours can be agreed on, where the AR work would happen in some of the non-teaching related portions of their workplans. That may mean less faculty meetings or curriculum development work as a trade-off.

There was a good discussion with the Associate Dean and the newly appointed Research Communications Officer on how the change management process for introducing AR activities into teachers' workloads, and developing the necessary skills to oversee and conduct research was progressing. Ideas being considered are establishing a mentorship program that could see OCCI researchers providing some mentorship for faculty teachers. There was also discussion around the OCCI researchers doing guest presentations for staff and students on the research model.

Discussion on how do students and staff acquire the necessary research skills and understandings

Figure 43. Olds College plant research lab

to be able to make good researchers was also had. With government and industry providing significant sums of money it is obviously imperative that any research data is valid and accurate. Establishing delivering professional development in AR was discussed and the concept of an Applied Research Micro-credential was proposed. The micro-credential would cover the basic themes such as developing a research proposal, project and budget management, monitoring and sampling skills, data analysis, and reporting results and outcomes. That type of program could have application for teachers and students, especially those who go on to work as summer researchers.

Figure 44. Olds College Rodeo training facility

Saskatchewan Polytechnic (SP)

Robin Smith, Director of Sustainability-Led Integrated Centres of Excellence (SLICE) took the Fellow out to SP's Discovery Farm about 45km northwest of Saskatoon, to meet with Blake Weiseth, Research Chair for Agriculture with SLICE. The 620-acre site is owned by Glacierfarm Media, a communications company that has expanded into events and new farming technologies communication activities. Blake runs a number of funded research projects at the site with various partnering stakeholders.

Federal government research grants underpin much of the work, with private enterprise and other government agencies also contributing to specific projects (eg the Saskatchewan Conservation and Development Association (SaskCDA), or the equivalent of a Victorian Catchment Management Authority).

Research projects funded currently include a salinity monitoring program, a water drainage and retention project (including measuring fertiliser run-off), and a variety of projects looking at mapping soil fertility and moisture levels, pasture cover groups for saline area, and winter pasture trial. The Research Chair role is jointly funded by Glacierfarm Media and SP - SLICE.

The site has a large annual field day called Ag in Motion – Western Canada's Outdoor Farm Expo. The event has over 500 exhibitors and 30,000 people attending over three days. Many exhibitors have significant permanent structures on the site such as the Nutriens pavilion and the Westel grain silos complex.

Four exceptionally well-resourced Saskatchewan Polytechnic research labs were also included as part of the visit to SP:

- Research and Additive Manufacturing (RAM Lab)
- Centre for Health Research, Innovation and Scholarship (CHRIS)
- Bioscience Applied Research Centre (BARC)
- Mechanical Engineering Technology (MET Lab).

These labs are used by Diploma level students undertaking two-year program, however the students generally have capstone workplace or on campus applied research projects undertaken in their final semester.

Figure 45. Dr John Flett & Dr Blake Weiseth Research Chair, Agriculture

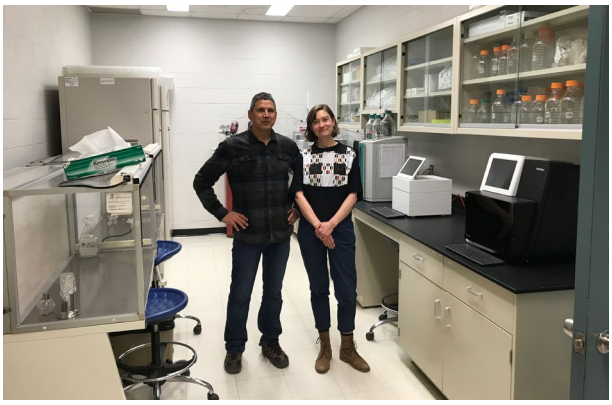


Figure 46. SLICE Director Dr Robin Smith & BARC Manager Dr Blain Chartrand

Figure 47. BARC Year 2 Diploma Student – Genetic sequencing project

SP has 13 sites across the Saskatchewan Province, with the Moose Jaw Campus being a major centre for agriculture related training. There are only a couple of agriculture technologist courses offered in Saskatoon itself by SP as the Saskatchewan University has an extensive agriculture program. The agriculture technology program area has a 35-week pre-app/pre-employment entry level program for people of all backgrounds. There is also their four-year Red Seal Journeyman course (equivalent to an Australian apprenticeship). They have around 250 apprentices studying each year, including a “John Deere” stream that is contextualised for apprentices working at that dealership. John Deere provide six new pieces of large equipment each year for having their program being delivered. The John Deere apprentices also have an extensive online company certification program that needs to be done, and the SP teachers provide some initial training for that and some ongoing student support.

Figure 48. EV charger converted from heating station

Figure 49. MET Lab Fuel Cell Solar Array project

The other apprentices do a more generic program that is not linked to any one type of manufacturer. The program lead is Chris Thompson and he has for the past three years become involved in leading applied research programs from his teaching department (ie not linked specifically to Saskatchewan Polytechnics TAC, SLICE or DICE centres. Greater support from SLICE is now coming as some larger projects have been funded.

Figure 50. Dr Satya Panigrahi, Dr Robin Smith, Dr John Flett at Saskatchewan Poly Sustainability Day stand

Figure 51. Picture XX 'Dr Robin Smith and Leon Lipoth RAM Lab Manager (3-D metal printing project

Case Study 2 – First Nations Wild Rice Harvesting

An example of a major AR project ($800k over three years) that Chris Thompson is involved in is with a First Nations Wild Rice Harvesting project. This project involves upgrading the type of engines and boats used by the indigenous people of Metis Nation in the north eastern Hudson Bay region of Canada.

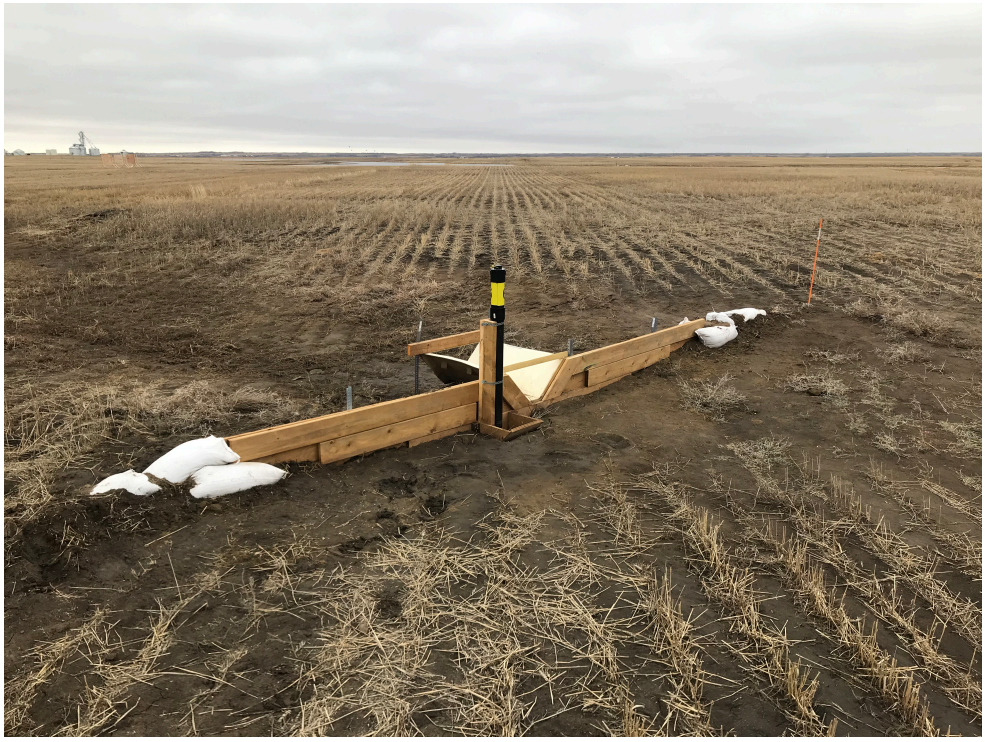
There will be some research done on the best type of engine and vessel design for the people there to use. The research will consider a range of engine types and fuel sources; and the type of material for the construction of the hull. A range of composite materials will be included in the study.

A complementary, large training resource development for the local first nations people is also included in the project. That will result in 15 micro-credentials being developed. The project will support 1.5EFT in research effort.

Figure 52. Chris Thompson Program Head - Agriculture Technology Programs

Other applied research projects being delivered by SLICE include:

- Biochar for soil reclamation
- Enhancing workplace charging for electric vehicles across Canada's prairie region and investigating current infrastructure and establishing demonstration sites
- Working with a company specializing in custom contoured solar panels for RVs, boats, trucks and other vehicles (see Photograph 2 below)
- Optimizing nutrient and water use efficiency to encourage use by the crop and prevent nutrient losses in runoff water
- Develop a biocarbon masterbatch that could replace traditional carbon black as a solid additive in plastics
- Repurposing landfill waste into alternative energy sources and valuable by-products that demonstrate a circular economy initiative.



Photograph 1: Discovery Farm wetland research site

Earlier projects run by Chris were done 'off the side of his desk', which is to say were not part of SP's formal AR programs. Some of these were in the order of $8-10k per project and included:

- A proof of concept for electronic emission-controlled diesel engines for the mining sector (which was reluctant to give up using its traditional engines).

- The Saskatchewan Insurance company approached the department for assistance in better identifying accidental damage to harvesting equipment as it had had issues of claims for damage that was simply wear and tear. The project was successful in demonstrating how genuine damage can be identified.
- The Alcholyte fuel project was done for another industry partner, and looked at substituting diesel fuel for a bio-fuel that was more environmentally friendly. The power and operational output of a range of different engines was tested.

Chris summarised the benefits of the AR projects as:

- Being new activities and ideas, they can motivate a number of the teaching staff in the faculty
- Industry is able to develop new tools or processes or systems that save money or are more productive
- It is great industry experience for students, but is challenging to get students involved due to timetabling and workplace issues.

Chris has offered to share under a brokering arrangement his programs content with SWTAFE if relevant. Much of this is in micro-credential short-courses in BrightSpark Learning Management System. These could be used as an additional offering to SWTAFE trainees undertaking a Certificate III or IV in Agriculture wanting some additional skills in diesel mechanics or specific implement maintenance and servicing (eg harvesters, seed combines).

The Fellow also met with Dr Terry Peckham the Director and Research Chair of the Digital Innovation Centre of Excellence (DICE), which is also a Federal Technology Access Centre (TAC). DICE employs around 50 staff and four program managers, with around 20 of them short-term (1-year) research projects. The DICE projects involve wide digital capture, storage, analysis and protection activities; which often overlap and complement some of the SLICE project activities.

The TAC designation provides $300k in funding for administrative support and costs, however the key projects being delivered are funded from other external funding sources, including industry and corporate contributions.

DICE AR projects included:

- Designing an intelligent restaurant management system
- Particle size classification for gravel aggregate
- Using machine learning to locate geological deposits
- Mental wellness application for current and post Covid-19 self-help training and assessment

- Data visualization of GIS data for managing land access
- Underground Beacon Positioning System via a prototype mesh network to allow accurate positioning in underground environments.

Red River College Polytechnic

Red River College Polytechnic (RRC) is located in Winnipeg, Canada, and has around 30,000 students. It has three city campuses and five others across Manitoba. The Fellow met with Dr Jolen Galaugher, Director of Applied Research at RRC, who has recently commenced in this role three months ago, having moved across from a Winnipeg University research faculty. She outlined a couple of current projects being worked on: Enterprise Machine Intelligence & Learning Initiatives (EMILI), in conjunction with Macdon Company, a vehicle manufacturer looking to develop an autonomous vehicle production.

Agriculture technology projects are being run out of the School of Business, ICT & Digital; and are looking at “project space models.” In these projects industry submits challenges for students to solve as a capstone project. Industry contributes funding to the projects for IT based solutions. Key student benefits according to Dr Galaugher are students building team and workplace skills, and innovative thinking practices.

Most funding for applied research at RRC comes from what is called the Tri-Council Funding (a mix of federal, provincial, and municipal bodies). It appears that this was a result of changes in 2003 when polytechnics became eligible for some of the $1.2B in research funding that was made available to the university sector. This was largely the result of strong lobbying from the college and polytechnics in Canada. While only around 2.5% of this money is available for polytechnics, it is still a sizeable sum for distribution. In 2023 and additional $140M of federal funding was provided to the polytechnics for AR.

RRC also receives $160M from Alberta Innovation, and $12M per annum from Research Manitoba.

A meeting was held with Dr Dele Ola Director of the Advanced Manufacturing Technology Access Centre (also known as the SmartLab), and employed at RRC for 11 years. He explained that the TAC has $350k in annual funding for five years from the Natural Sciences and Engineering Research Council of Canada (NSERC), a federally funded program as per the other TACs. This is largely for administrative costs, and would cover the costs for the director and assistant director, administration support, a project manager and a technician. The salaries and operating costs of all researchers and their work is covered by grants for projects submitted to the applied research funding bodies. A considerable amount of the Director’s time is assessing incoming projects for their suitability to be supported, and if so, developing a funding application to the most relevant body.

TACs cannot compete with industry for commercial work, and that type of activity if referred back to industry.

RRC Polytechnic is unique in that it has three TACs – Advanced Manufacturing and Technology TACAM), Building Efficiency, and the Culinary Arts.

The TACAM specializes in robotics, PLC automated operating production systems, autonomous vehicles and advanced metal 3D printing; and has multiple facilities across Winnipeg. TACAM has:

- 15 full time researchers (who do no teaching at all)
- Federally supported for AR (as RRC is an NFC college)
- Project funding is typically a blend of government and private enterprise. For example, a $50k project would have $40k government and $10k in company support.
- Operating costs are in the order of $1.5M per year
- Funding for capital works or specialist equipment is via a competitive grants system separate to the AR grants
- Around 50% of all AR grants are RRC are successful and that is somewhat better than the national average.

An example of a recent TACAM project was working with a mining drilling company undertaking core extractions and testing. A new lighter and cheaper rock cutting saw was the challenge, and the team has been able to create a prototype. The second stage of the project is to automate it for improved operator safety.

Figure 53. Dr Dele Ola, RRC Polytechnic, 3D printers

Figure 54. RRC Polytechnic, TACAM Robotics lab

Industry is now aware of what RRC and TACAM can do and usually comes to it with a problem or potential project. There are also business development people whose role is to promote the TACs, but not with a 'hard-sell' approach.

Early AR at RRC started with student capstone projects (that is a project with industry in year 2 of a Diploma course). This then developed into pockets of AR in the faculties or teaching departments, with partial industry support. Eventually, this resulted in researchers imbedded within faculties (as per the Saskatchewan Poly model), which then became dedicated AR centres. Since 2004 RRC has had an Office of Applied Research, but always under the Dean of the faculty. In 2017 AR became a stand-alone Division in the polytechnic.

Figure 55. RRC Polytechnic, TACAM 1/3rd scale Battery Electric Tractor

Figure 56. RRC Polytechnic, TACAM 1/3rd scale Battery Electric Tractor

The stages can be summarised as:

1. Student capstone projects
2. AR undertaken within the teaching faculty
3. Standalone AR division.

Meetings were also held with Chris Basilio and the MotiveLab team looking were responsible for a range of AR projects including eVs. Activities range from:

- Heavy vehicle test facility
- Industry anchor tenants
- Climate and load bearing testing
- Testing of bus, truck and agriculture equipment
- Portable generator testing
- Airport snow blower development (using a 500HP and 450HP Cummins engine for a blower and tractor respectively
- A triple axle, climate controlled (-40 to + 30 degrees C)

- The $40k SwitchLab 3-wheel training EV (imported from California, USA).

Figure 57. John Flett, Chris Basilio & Jeongsoo Bae, RRC Polytechnic, MotiveLab

Figure 58. RRC Polytechnic, MotiveLab eV charging point

The centre has $12M in capex funding from Federal, Provincial and College funds invested into it.

Figure 59. RRC Dynot lab -40C to 40C, 6kL coolant system

Their current project (CARSI) is using recycled electric bus batteries donated by a local transit company to run recharging stations for eVs. The batteries are no longer suitable for bus operations, but are able to store energy from solar or other power sources for small eV charging points. The team has also refitted a small all-terrain vehicle as a small eV for training and demonstration purposes.

RRC also has a large scale HV training and research facility. Its showpiece is a 40mx 15mx8m test dyno-meter test facility capable of testing the performance of heavy vehicles (trucks, buses, prime movers) at temperatures as low as minus 40 degrees Celsius. The facility has been used by a number of businesses wanting to test the performance of vehicles in extreme temperatures. The most recent example was a hydrogen fuel cell bus being tested the week prior to my arrival.

The light vehicle teaching faculty also has a number of eVs used for training including a recently acquired second-hand Tesla and a purpose built small sized but drivable demonstration eV (see picture below). This vehicle was sourced from the USA for around $40K US and would be a valuable training aid for any eV training courses.

Figure 60. RRC Polytechnic, MotiveLab, 3-wheel EV car

Figure 61. RRC Polytechnic, MotiveLab, donated battery electric bus

Figure 62. RRC Polytechnic, MotiveLab, donated battery electric bus interior

Figure 63. RRC Polytechnic, Dynotesting facility graphic

Centre Technologique en Aerospataile (CTA) – Montreal

Figure 64. CTA Aerospace research workshop

This is a TAC which undertakes AR for the aerospace sector, principally aircraft component design, testing and fabrication. The facility was established in 1993 and has Air Canada, Bombadier, and AirBus as major sponsors, along with a range of Canadian companies. There are 76 staff (50 who are researchers) and they work with over 60 SMEs each year, and a total of 100 projects. The facility occupies 30,000 sq ft, and has an annual operating budget of $6M.

Key areas of expertise are composite and advanced materials; metal machining, robotics and automation, non-destructive testing, artificial intelligence (AI), and the development and integration of aircraft systems. There is also an $18M

propulsion test system that was funded predominantly by government grants, with some private investment. The CTA is able to provide formal engineering and safety certifications for its project partners too, for example with drones and emerging e-aero vehicles.

AR projects have looked at measuring the stress on wing components in real time, designing new aircraft components, and more recently eV aircraft, drones and autonomously operated air craft. The TAC employs students from Cegep Edouard Monpetit (CEM) polytechnic to work on AR projects over summer for up to 12 weeks as intern. It also employs university masters and PhD students for longer term projects from one to three years depending on the project fund sources. These longer projects are usually funded by the federal government under its Mitacs program.

Figure 65. CTA Aerospace student workshop

The CTA has a range of approaches to working with CEM, and as well as the internships, they are involved with knowledge transfer to the teachers and students as guest speakers, and contributors to the development of new curriculum resources. There are teaching labs and secondary school projects that are also supported by CTA. They are also developing a new “101 Introduction to Applied Research course” for the polytechnic to start in 2024. The CTA plans to increase its connection to the polytechnic in a stage 2 process. Currently, teachers or professors of the college are co-opted to work on research projects – generally for a minimum of 30% of their available time. However, teachers are expected to teach at least 20% of their regular course load each year. The CTA usually “buys out” the teaching time from the college with project funds, and the college then backfills with casual or contract teachers.

Factors that influence a teacher’s participation include their desire to enrich their teaching curriculum and provide additional learning opportunities for their students, to develop their own industry skills, or simply personal interest. Current and past projects include testing and certifying drones and other e-aero vehicles, and recycling materials for old air craft.

CTA has its own Board and is a separate business entity, but its budget is linked to the polytechnic as the college is the conduit for all AR funds for CTA.

Like all TACs CTA cannot compete with commercial providers of materials testing services, and will refer projects that fall into that category to the private sector. As a TAC the CTA work is typically

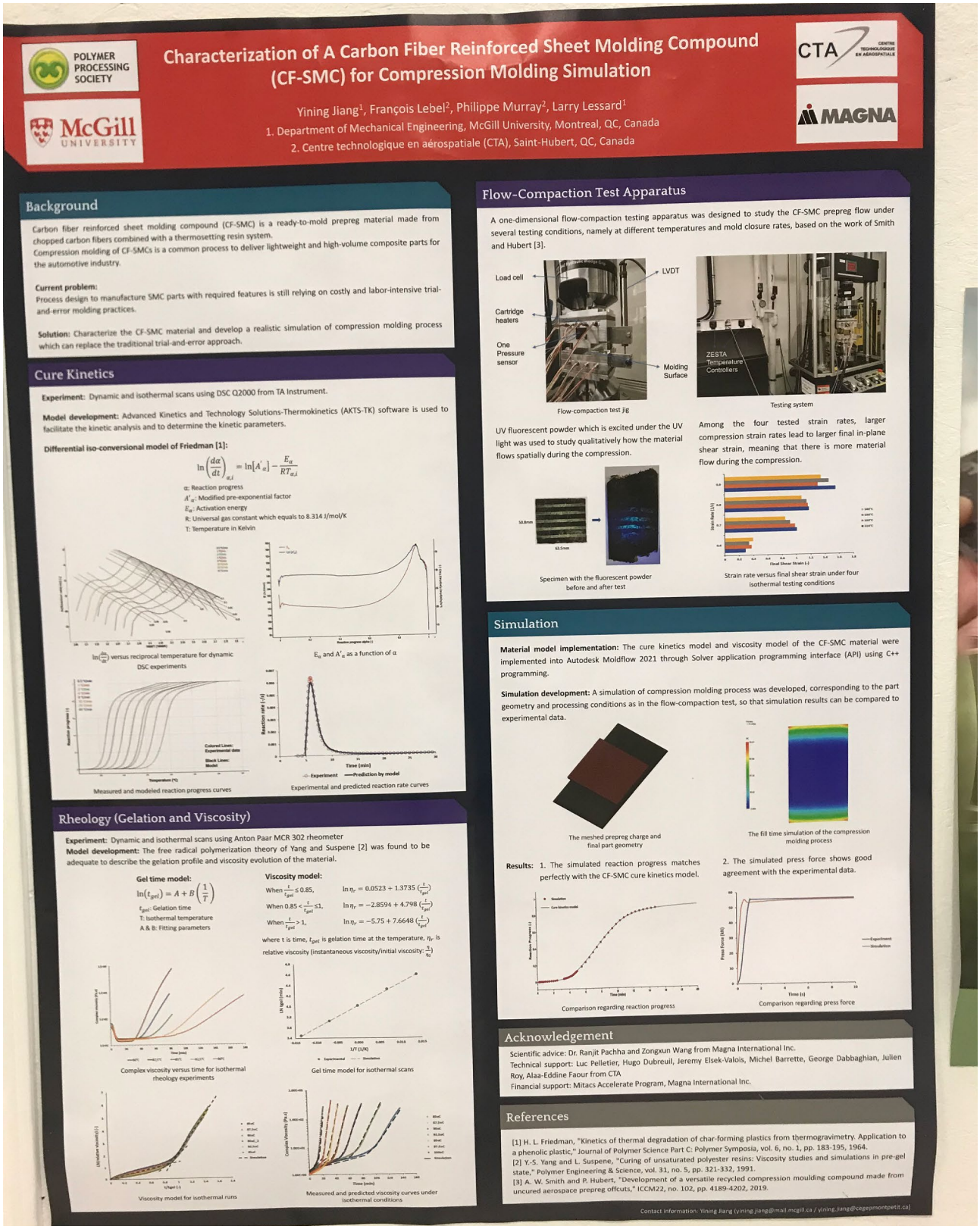


Figure 66. CTA Aerospace research workshop research poster

Figure 67. CTA Aerospace student workshop & Victorian delegation

regarded as Technology Readiness Levels 4 to 7. Universities by contrast are TRL 2 to 3, and original equipment manufacturers seen as TRL 8 or 9. Project selection is based on its alignment to the CTA strategic plan's priorities, the availability of other providers, and the areas of expertise needed or being developed.

Vestechpro – Montreal

Vestechpro Apparel Research and Innovation Centre has been a TAC for the past five years specializing in textile and fashion design and testing. It has five main objectives: Innovate, Optimize, Develop, Inform and Train. This involves delivering a range of R&D, Information and Training (including teachers and students), recycling/circular economy, product testing activities. The AR labs have a team of about 15 people, including graduate student researchers.

Vestechpro describes its areas of specialty as: smart, connected, specialised and adaptive clothing, medical garments, digital transformation, technical clothing and the circular economy. Their target markets are private companies and satellite companies, academics and researchers, and government agencies (especially the police and emergency services).

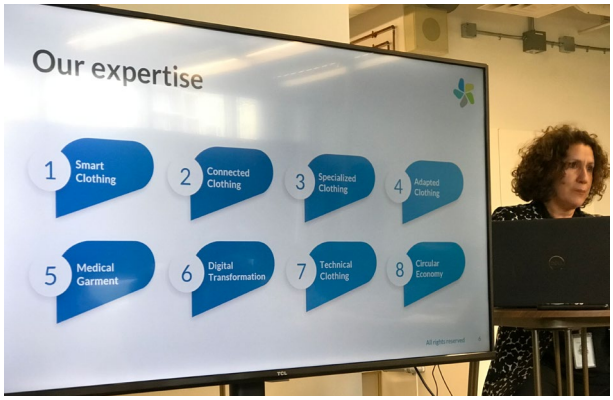


Figure 68. Paulette Kaci, Vestechpro Director & presentation

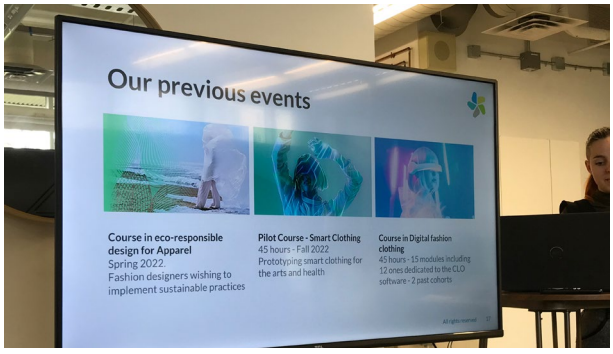


Figure 69. Vestechpro presentation

Figure 70. Vestechpro presentation – wearable technology project

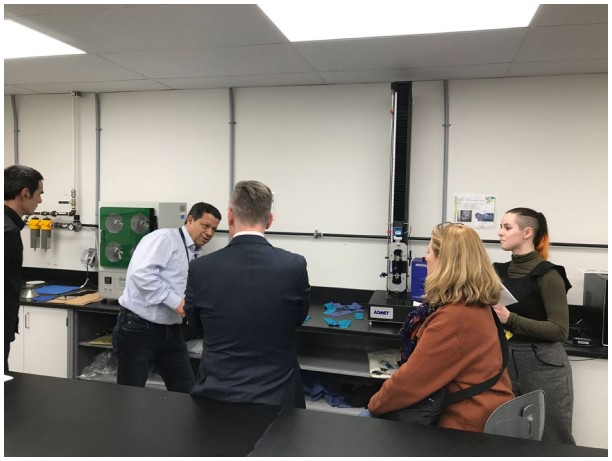


Figure 71. Vestechpro Materials testing lab & Victorian delegation

Figure 72. Vestechpro Materials wind permeability testing machine

The TAC ran a number of courses in 2022 for fashion designers, students and industry people such as the Course in eco-responsible design for apparel; Pilot Course – Smart Clothing; and a Course in Digital fashion clothing.

There is a controlled atmosphere lab equipped to test for a range of fabric properties that include: tensile strength, wind resistance, water resistance, water absorption, virus transmission, color fastness and pilling. There are other spaces that are set up to test how to best recycle and repurpose used clothing – both for other fabric options or as new fashions.

The lab is a great example of how an AR facility like this can support new, emerging and existing SMEs to solve real-world problems. The facilities are relatively new and cost just over $1M CA to establish and fit out (not including the building cost). The centre has been researching a new adult panty that has electronic circuits to monitor its temperature and moisture content, and when it is damp and whether that is a result of sweat or urine. There is also the Euveka Smart Mannequin that can be programmed to match an individual's precise body shape.

There is a new fabric shredding machine being prototyped that can be used for recycling materials. Uses for the shredded materials including felting for carpet and furniture or filling or fillers for insulation and even concrete. An industry partner is looking to scale up this technology subject to financial backers being found (around $5M is needed for the startup).

Figure 73. John Flett & Vestechpro & programable Euveka Smart Mannequin

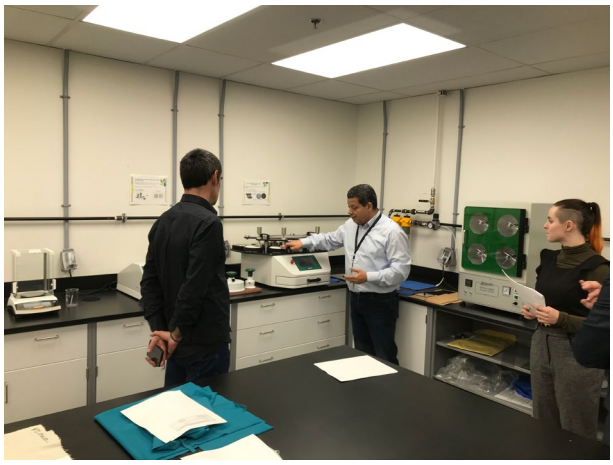


Figure 74. Vestechpro Materials testing lab

Figure 75. Vestechpro Materials PPE testing machine

While the AR lab is located with the Circus de Solei College, there does not seem to be a clear link to the AR work and the Circus college programs.

Applied Research Findings Summary

The visits and discussion held suggest that there are three very different models of applied research programs that form part of the Canadian Applied research (AR) landscape, and that these could be thought of as existing as a continuum of sorts:

1. Teachers-led “off the side of their desk”: This involves individuals working with an industry client but could include having students undertaking capstone research projects as part of their certificate and diploma courses – this type of AR is less structured and entirely dependent on individual teachers having a strong interest in AR or connections with industry partners. Having students available and willing to carry out research activities as part of their course is also a pre-requisite.

2. Faculty-based Research Centres: These are a precursor to a TAC and initially financed internally but now able to apply for national, provincial and peak body AR funding. These activities are also funded by research grants, and other external sources. College or polytechnics appear to support the staffing costs in some cases though. Other examples include teaching faculties delivering the new degree courses where at least 25% of degree teachers workloads must include research activities.

3. The Technology Access Centres and/or Centres of Excellence: These are funded under a competitive bid model with Federal funds from the Natural Sciences and Engineering Research Council of Canada (NSERC) supporting AR centres working on projects carried out for specific industry partners. This model accounts for the majority of the applied research effort. Base funding of $350k is provided for a small management team, with the AR funding coming from other national fund sources such as the National Research Council Canada (NRCC). These funds may also be augmented with some provincial and/or peak body funds. Industry partners also contribute and this is usually around 25% of the overall project budget.

It has taken the Canadian’s around 20 years to get to the point that the Technology Access Centres model has reached. The success of the model has seen the NSERC increase AR funding for 2023 by an extra $100M, with total available AR funding now over $500M annually. This type of model is unlikely to happen quickly in Victoria or Australia without a significant change to the way research funds are allocated. The discussion between the Australian and State governments here in relation to future “Centres of Excellence” that could carry out industry-based research and training projects is encouraging and these could become the start of a sustainable AR program embedded in the Australian TAFE system. These initial centres would need to have an industry focus and be equipped and/or funded for the specialised equipment, and some ongoing operational costs.

There is some scope for Faculty-based research centres albeit without a degree program being involved. To be successful students would probably need to be at Certificate IV or Diploma level. In addition, the TAFE teachers involved would need some professional development on how to

develop, plan and undertake a research project that would produce valid research findings. These type of AR projects could be linked to future Regional Skills Training or Workforce Industry Training funded projects.

An applied research program under the Faculty-based model would also require some type of grant assistance to cover a project's operational costs, or to purchase equipment or services. Some of that cost could be offset by a co-financial requirement by industry partners (which could be in-kind via equipment or other resources). These types of projects could become included as options for future RSTF or WTIF funding models. Professional development would be needed for teachers who were going to become involved in an AR teaching role, and the micro-credential program discussed earlier could be an enabler for that. This model would also need to have some organisational support with Business Development officers or other industry engagement focused roles working to promote the program with local industries. The promotional piece is something that would also need to be factored in as regional industries will need some assistance and examples to enable them to understand the benefits to them of being part of an AR project with TAFE.

The Teacher-led model is the mostly likely that could be introduced into Victorian TAFEs without requiring the significant investment required from Federal funding, or the requirement to be involved with the delivery of degree programs. Professional development would however be a probable pre-condition for these teachers.

The teacher-led model is much more organic and will be quite teacher-dependent on its success. As such it is not a first-choice option, but would go some way to introducing students to better real-world problem solving, and if done well could involve students in a workplace-based project or an on-campus one. The upside to this model is that it can be introduced gradually, and with interested teachers or teaching departments, and could be more easily supported. Ideally the research projects that are conceived will also form part of a student's formal assessment so that there is an additional benefit for them.

All models would require more input from many stakeholders (including the education unions), but could be one way to encourage a research mindset in teachers, starting with those with an interest in that or in building stronger partnerships with industry.

The World Federation of Colleges and Polytechnics 2023 Conference

The following section outlines some information obtained from the more relevant sessions for this Fellowship – AR and the United Nations Sustainability Development Goals (SDGs); and how they may apply to the state and national TAFE systems.

Figure 76. WFCP Opening Address Dawn Ward

The World Federation of Colleges and Polytechnics (WFCP) 2023 conference had the theme of “Collective Intelligence” with sessions and keynotes looking at examples of how the Technical and Vocational Education and Training (TVET) sector can work more closely together at a provincial/ state, national and international level.

There were seven conference streams consisting of Leadership & Governance, Building and Maintaining Strong Partnerships, Ensuring Safety, Security and Well-being, Advancing Indigenous Education, Embracing Equity, Diversity and Inclusion, and Supporting Teaching, Learning and Student Success.

Figure 77. WFCP Keynote Wes Hall (No Bootstraps when You're Barefoot)

There were also eight Affinity Group breakout sessions – Applied Research and Innovation, Sustainable Development Goals, Construction, Global Citizenship, Indigenous Education, Teacher Professional Development, Cyber and Data Security and Social Engineering; and Brand TVET. This report's author attended a range of presentations and affinity sessions, with a small selection of the most relevant outlined below.

Figure 78. Dr John Flett - AR Session at WFCP

The author of this report also presented an Australian example of an applied research project as part of an international panel in an Applied Research and Innovation Affinity Group session on Day 2 of the conference.

Other panel members spoke of the AR programs that they ran in their countries and were:

- Unai Ziarsolo from TNIKA in Basque Country, Spain
- Richard Gale from Camosun College, Canada
- Nathalie Methot from Mohawk College, Canada
- Miriam Korstanje from Hanse Parlament, Netherlands
- Dr Seong Woo Boon, Temasek Polytechnic, Singapore.

The AR session was attended by over 100 delegates including a group of Australian and Victorian TAFE and VSA participants. A poster session followed the AR session.

Figure 79. ARIAG Applied Research Group Members

Figure 80. ARIAG Applied Research Group Members

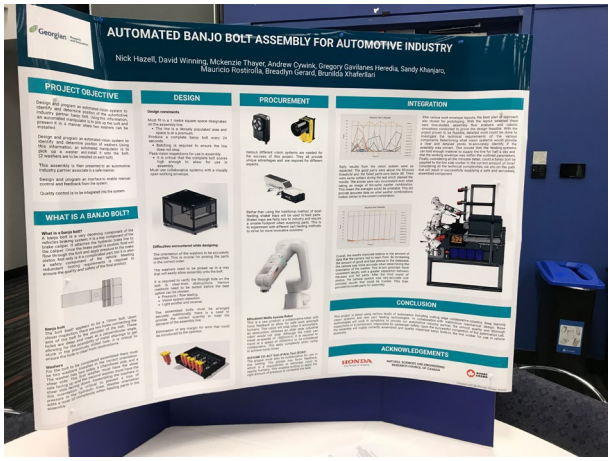


Figure 81. WFCP ARIAG Poster examples

The session on Implementing an Integrated Energy Management Plan (IEMP) in line with the United Nations Sustainability Development Goals (SDGs) was very informative. Presenters from Humber College (UK), Henry Ford College (USA) and Lambert College (Canada) presented their

journey towards net zero greenhouse gas (GHG) emissions. Each College outlined their vision and challenges as they began understanding and planning for long-term environmental sustainability. They had shared their ideas and progress with each other and were all committed to a shared vision. Lessons to date were the need to have buy in from the Executives and Boards of Management of a College or Polytechnic; the changes will take 20 or more years; a significant investment is needed to achieve the cultural and infrastructure changes required (about $10M per 15,000 students); and an integrated plan is required that includes substantial energy and water savings, as well as looking at ways to generate renewable energy.

This session has provided some really valuable lessons and information that can be shared with the Victorian TAFE network, as well as specifically at SWTAFE which is developing its new Environmental Sustainability Plan that should incorporate most, if not all the IMEP features. The three organisations that presented all provide their IMEP online and accessible to all.

A great example of international collaboration in the health sector was demonstrated by Holmesglen Institute (Australia) and Northwest Polytechnic (Canada) titled “Nothing about me without me” – the indigenous voice in an international nursing collaboration. The project set out to identify and reduce some of the barriers to learning often faced by First Nations people such as racism, socioeconomic disadvantage, health and social exclusion. An immersive program was developed using people from the Metis nation to share their experiences via a Collaborative Online International Learning program. Using personal stories and Virtual Reality (VR) inputs the indigenous led module became an authentic way to teach culturally safe clinical encounters to students and teachers. This program can be readily replicated in Australia with a relatively small additional investment of time and effort.

There were three great key note presenters at the Conference with the standout being Gerd Leonhard a well-known futurist who presented his interpretation of the rise of artificial intelligence (AI) in a session title “Heaven or Hell,” and there were several key messages in this presentation that concerned the use of digital information and the application of new emerging AI technologies such as ChatGPT.

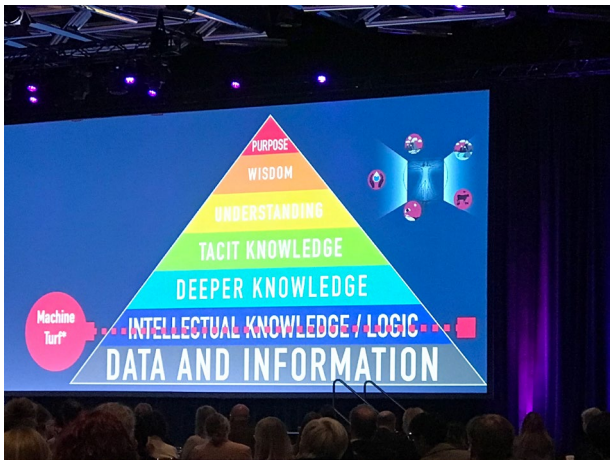


Figure 82. WFCP Gerd Leonhard Keynote Presentation

He noted that modern computers are being built that can process data a trillion times faster than humans, and is one of 1,000 eminent scientists and world leaders calling for a freeze on new AI applications for at least six months to allow for better guidelines and safeguards to be considered and developed. Despite these

concerns it was also noted that “Data is not knowledge, and knowledge is not wisdom,” meaning that a capacity to access vast amounts of data and create ‘apparent’ knowledge, does not in itself create useful knowledge that can be then applied by machines – there will still be a place for humans at some stage.

Building and maintaining strong industry partnerships in AR & Innovation was a highly interesting and relevant session delivered by four Canadian speakers from an “Atlantic Colleges Alliance”. The alliance is a number of smaller colleges who work collaboratively together and with key stakeholders to undertake applied research activities. They noted that collaboration drives innovation and socio-economic growth and this was their underpinning philosophy. A key take-out from this session was the development and available access to an online AR Module for beginning AR teachers. This is hosted and made available through Mohawk College. These resources could be a great starting point for Australian teachers looking to start offering AR activities for industry partners or students. There is also a great network and partnering opportunity with these colleges for Victorian TAFE and their teachers that should be investigated, most probably by the Victorian Development Centre.

The following section outlines some information obtained from the more relevant sessions for this Fellowship – AR and the United Nations Sustainability Development Goals (SDGs); and how they may apply to the state and national TAFE systems.

Key takeaways:

- There is a very active WFCP Applied Research and Innovation Affinity Group (ARIAG) consisting of people from across the globe who have significant experience in AR work in the TVET system. ARIAG has people that are willing and able support or advise new teachers, managers and policy makers in understanding and implementing an AR model that can be developed in Australian TAFEs.
- There are international colleges that have developed great systems for supporting AR in them, and their teachers. These colleges and their resources can be utilised by Australian colleges willing to contact them.
- AR can take many forms and be sponsored by governments in different ways. There is no one ideal or correct model, and Australia TAFEs and their state and federal governing bodies should not be deterred from trialing or piloting something that fits Australia’s unique circumstances.
- The UN SDGs are well understood and regarded well by most European and north American countries, whereas in Australia there is far less consideration given to them in the TAFE networks. There are some compelling reasons why Australia might want to give more consideration to the SDGs – climate change, zero GHGs and sustainable environmental, business and government practices being just a few examples.

5. Considerations and Next Steps

Considerations – Renewable Energy Technologies

Institute Sustainability Planning

The World Federation of Colleges and Polytechnics 2023 Conference in Montreal has provided some excellent insights into what other institutes around the world are doing in relation to achieving a 2050 net-zero target. There were three excellent examples of how Humber College, Sheridan College and Henry Ford College planned and prepared for setting up a sustainable college or TAFE.

In addition, a number of Canadian colleges and polytechnics had incorporated and mapped the UN SDGs into their AR projects, as well as day to day operations. While several of those visited had sustainability plans none were as detailed as those put forward by the three colleges at the WFCP Conference. Saskatchewan Polytechnic held a Sustainability Day showcase that demonstrated how a wide range of technical and social research projects had addressed the UN's SDGS, but these were not directly linked to their own sustainability plans. There were some stunning examples of AR projects that involved converting biomass into printable 3-D plastic components for use by industry, as well as recycling plastic into reusable pellets, that a specialist biochemist researcher at Saskatchewan Poly had led on.

Potential opportunities for SWTAFE:

Reviewing Humber and Sheridan Colleges IEMPs (Institute Environmental Management Plans) will provide some valuable insights as to the steps, processes, time and funding needed to implement an effective sustainability plan. A discussion with one of the session's key presenters and now an environmental/sustainability consultant provided some additional detail. Key to success is gaining Board level approval at the outset. To do that requires doing the appropriate research and due diligence so that the Board is able to make an effective decision. The IEMPs cover a full range of initiatives that include water savings, energy efficient lighting, heat pumps, HVAC systems, energy usage and renewable energy sources (eg solar, geothermal, wind). The three colleges that presented each had 20-year plans, with an investment over that time of around $10-12M per 6,000 students.

SWTAFE should make it a priority to engage an energy consultant to undertake a full-scale renewable road-map for the Institute.

Potential opportunities for Victoria's VET sector:

There is a great opportunity for the Victorian TAFE network to learn from and leverage off the work done by international vocational colleges in regards to planning for net-zero greenhouse gases and sustainable environmental management plans. These overseas examples can provide an excellent template for Victorian TAFEs to follow, or at the very least provide a basis for some very sound

guidelines for things that should be included. These learnings also extend into aspects such as how to include energy saving initiatives and programs into an educational institute's learning programs.

Hydrogen Bus Project

The two meetings with the fuel cell electric bus (FCEBs) companies were extremely helpful for SWTAFE's current hydrogen project that will involve Warrnambool Bus Lines (WBL). The scale and length of time of AC Transit's FCEBs operations have run in San Francisco have seen it take a much more substantial approach to training its workforce. AC Transit have a sophisticated and purpose designed training facility for bus drivers and their heavy vehicle mechanics (that also include traditional apprenticeships). FCEB mechanics have to undertake a 300-hour training program, that includes online and a two-week face to face block. AC Transit are open to further discussions about the licensed use of some of their driver training resources; and perhaps those used for their mechanics.

Metroline Transit (a CDC Bus Lines subsidiary) in London have a far simpler one-hour induction process for their drivers, and a specialised approach to training their FCEB mechanics. Three Metroline mechanics have been sent to the USA to become Ballard fuel cell trained specialists. This allows them to do all the warranty works on behalf of Ballards when required.

Potential opportunities for SWTAFE:

These findings have implications for the funded WSSF accredited short-course project at SWTAFE. The planned driver training module may well be able to be completed within four to six hours, depending upon WBL's feedback. The training requirement and resources for WBL's mechanics will be somewhat more problematic, particularly for a blended, shorter duration program of 8 to 10 hours. Neither company had anything that addressed the need of others in the organisation, including the public or travelers; or for first responders, and these units may become the most important ones to be developed. All those likely to come into contact with fuel cells or electric batteries, will need to undertake some training on how to handle those components safely. The current disconnect and reconnect high voltage batteries resources may be able to be contextualised for this purpose.

The visit has also informed the amount of future research needed regarding the resources, and some project funds allocated to this may be able to be used to acquire some specialist equipment and simulators.

Potential opportunities for Victoria's VET sector:

There are lessons from the experiences of the two bus companies that can inform how the Victorian TAFE network may undertake or use the resources that the SWTAFE and other government

funded projects may produce. For example, the SWTAFE project's course and resources will once developed support training for companies operating any type of hydrogen fuel cell heavy vehicle. However, the delivery of such programs is probably going to be most cost effective if done by a local training provider. There will be future opportunities for the TAFE-network to develop their own modified program as the volume of learning or training can be adjusted to meet different training requirements taken by various heavy vehicle operators.

The EV project

SWTAFE's existing EV project has already acquired and modified some of the resources available from the Victorian Automobile Chamber of Commerce. There are still a number of EV simulators yet to arrive and be installed and commissioned to fully complete the project. However, the project does not provide access to a full EV vehicle, and that is an asset that the Institute needs to acquire. Red River College Polytechnic in Canada were able to source a three-wheel electric vehicle that has all braking, driving and lighting systems operating.

Potential opportunities for SWTAFE & Victoria's VET sector:

A vehicle like that used in RRC would be an invaluable training aid for apprentices and upskilling mechanics alike. There may be an opportunity via future projects with other TAFE's that could support acquiring an asset like that; or a future small-scale Workforce Training and Innovation Fund project. It would also be useful in training HV mechanics on the practicalities of disconnecting and reconnecting high voltage batteries.

Considerations – Agriculture Technologies

The Olds College visit provided some interesting insights into the work being done in Canada on applied research front, and something of what is happening in their teaching programs. Much of the work being done is around the use of soil temperature and moisture probes, GPS mapping for soil fertility and fertiliser applications, the application of drones, the use of Wi-Fi for monitoring silo storages, feed lot monitoring; and a significant amount of effort on autonomously operated spray, fertilizing and tillage equipment.

Saskatchewan Polytechnic has an extensive agriculture faculty, and a 620-acre research site that is used for a variety of applied research functions, as well as the province's largest agriculture field day each year. AR work being done on the site include remote monitoring of water flows in natural wetlands, GPS mapping of soil fertility, irrigation practices, and various crop and seed trials. Student involvement in most of these projects is relatively limited to summer internships for students going into year 2 of their studies, or who have completed their agriculture diplomas. In some cases, there

are projects that do include students carrying out AR work as part of their final capstone project (that is course-based project that examines a particular problem or issue).

Red River College Polytechnic also has had some limited involvement in agriculture technology and is involved in autonomous farm EV project that has developed an autonomous 1/3rd scale electric tractor that has been successfully deployed. It also offers a specific agriculture technician certificate, that essentially combines heavy vehicle diesel mechanics with units on servicing and maintaining large combines and harvesters, often with industry certification included.

Potential opportunities for SWTAFE:

Our teachers need to undertake training and professional development as a priority in small but targeted range of agriculture technologies that would include:

- Use of remote monitoring equipment (eg soil moisture and temperature probes, electric fencing, gates, and livestock)
- Use of GPS and GIS systems for mapping soil fertility applications and weed and pasture identification.

In the next two to three years the use of EV operated farming equipment should be considered. The use of EV's on farm may even form part of a future WTIF and AR project with an industry partner.

SWTAFE's recently announced $1.98M Agriculture TAFE Training Fund project to develop an Agriculture Tech Skills Centre at its Glenormiston site is the ideal foundation from which to trial an AR model in south western Victoria. The Agriculture Tech Skills Centre's focus on agricultural technologies and training TAFE and secondary teacher would complement nicely one or more industry agri-tech suppliers applied research projects.

Potential opportunities for Victoria's VET sector:

The extent and depth of agriculture research at Olds College and Saskatchewan Polytechnic is extraordinary, and is of great importance to industry partners and stakeholders. There appears to be no comparable activities at most TAFEs or private Registered Training Organisations, with much of this research done by Agriculture Victoria here. The key differences between Victorian and Canadian colleges is the lack of relevant specialist equipment; and/or research skills and capacity to deliver an AR project for industry.

However, Longrenong College and Sunraysia TAFE do have a range of equipment with advanced agriculture technologies capabilities that they use with their students. That equipment would give them the capacity to quite easily take on applied research projects with industry partners. With some

additional encouragement, teacher professional development and financial support, either of those organisations could provide a very good location to pilot an AR model in Victoria.

The potential regional opportunities

Working with regional industry and education stakeholders such as Deakin and Federation Universities there are some opportunities and areas to explore that could be mutually beneficial. The key areas of potential collaboration on AR projects that would support industry initiatives are:

- Clean Economy
- Circular Economy
- Agriculture & Agri-business
- Health & Social Assistance.

There are some necessary pre-conditions that would need to be present to facilitate those opportunities and they include:

- Funding from State and Commonwealth sources
- Suitable facilities and workshops/laboratories
- Specialised equipment
- Industry engagement
- Industry entrepreneurship/new ideas
- Staff – research and training
- Staff capability building programs
- Proof of concept or pilot
- Leadership.

6. Impacts of Fellowship

An ISS/VSA Fellowship has several types of impacts – professional, sectoral, and personal and the immediate and future impacts that may result from this study are described below.

Professional impacts:

- The Fellowship has resulted in a much deeper understanding of the types of AR that may be undertaken in an Australian vocational institution, the challenges and opportunities arising, and some insights into potential examples that can be initiated in Victoria
- Use the findings and learnings to assist SWTAFE, with the support of participating industry partners, establish an Agriculture Tech Skills Centre that incorporates AR applications into its operations
- Developing an Applied Research (AR) Community of Practice at SWTAFE drawing on the findings from the Canadian research, and WFCP experiences. The target cohort would be those who have completed a Boyer unit as part of upskilling as a leading teacher; and/or those interested in undertaking a small AR project
- Professionally the Fellow is much more connected and enabled to support others looking towards implementing applied research into their teaching or program delivery operations
- A greater capacity to work with internal and external stakeholders in the development of organisation-wide environmental management plans that have net zero greenhouse gas emissions as long-term targets
- Much better prepared and able to add the Clean Economy Innovations portfolio to my role as Director of Strategy & Research at SWTAFE
- Greater confidence in contributing to training, workforce and industry solutions addressing Victorian Clean Economy priorities.

Future sectoral impacts:

- Preparing a high-level industry pitch for support for a Victorian-specific AR demonstration project with TAFE and an industry partner. A potential opportunity may exist negotiating with Dairy Australia to fund an on-farm research/innovation involving teachers and students.
- Facilitating an online AR workshop via VET Development Centre. A potential one-hour online session could cover the benefits of AR to students, educators and organisations, how to develop a project brief and gain management support, and strategies for how to engage with industry partners.
- Develop a Workforce Training Innovation Fund project that linked AR, TAFE and Industry together as part of implementing a workforce training innovation using the Canadian findings

as a ‘template’. An example might include developing specific micro-credentials for Koorie park rangers and tour guides.

- Offer to run a regional TAFE roadshow for teachers, educators and managers, with view to building an understanding of how AR can be incorporated into day to day operations, and creating a regional AR network.

- Multiple and varied informal meetings with individuals or small groups of internal colleagues and external colleagues of partnering and stakeholder organisations. These have included: discussions with Deakin University Hycel Project team, Wodonga TAFE Environmental Sustainability Coordinator, Corangamite Shire Council Sustainability team.
- In conjunction with the VTA and other TAFE partners lead the development of a set of TAFE wide environmental management strategy (EMS) guidelines or EMS template.

Personally, an immediate benefit of this project has been an improved understanding of international vocational training systems, and how they are pro-actively approaching the issue of engaging with industry with an applied research focus. The Fellow also wants to determine how to maximise South West TAFE’s future opportunities in agriculture and the renewable energy sectors through new and innovative methods. A better insight into how AR-based technologies in a country like Canada, which also has a major food and fibre sector, can greatly assist in researching and identifying how to do this better in south west Victoria.

7. Key Recommendations

This project has found that there are significant benefits to vocational colleges being supported to provide applied research solutions to small and medium sized organisations. These benefits can be summarised as:

- Enhanced organisational and sectoral recognition by industry and regarded as the ‘go to’ place for industry innovations
- Improved teacher industry currency and skills; and development of more entrepreneurial mindsets
- Vastly improved cutting-edge specialised equipment and facilities
- Improved student training and post-training learning opportunities
- Significantly improved perception for potential international students to study in Australia
- New revenue streams that complement existing funding models.

There are several pathways to creating an effective applied research system in the Australian VET sector, and it can learn much from Canada on how TAFEs can incorporate industry research into their day to day business. The recommendations below draw heavily on Canada’s approach:

- In Victoria enable applied research to be a funded activity for Regional Specialist and Technical Fund, Workforce Skills Set Fund, or Workplace Innovation and Training Fund project grants.
- The Victorian Office of TAFE Coordination (OTCD), the Victorian TAFE Association (VTA) and TAFE Directors Australia to jointly lobby for State and Federal funding to pilot two Australian Technical Applied Research Centres (TARCs) for a three-year pilot in each State (eg $2M set up costs, $350k in annual operating costs)
- A specific “Small Industry Applied Research Grant Fund” be piloted in Victoria, this may provide grants for small or medium sized organisations capped at $40k and require at least a $5k cash contribution from industry
- The Victorian VET Development Centre commence offering a short course program in Applied Research Project Methodology for TAFE teachers. This may be modelled on some existing online programs, or partnering with an existing provider such as Mohawk College in Canada
- Promotion and education for teachers and teaching divisions of the benefits and application of AR to the VET sector
- The Victorian OTCD to support an agriculture-tech pilot at Sunraysia TAFE, Longrenong College or Glenormiston College
- The VTA and OTCD collaborate with the TAFE network to develop a set of guidelines and/or template for writing a TAFE Environmental Management Plan using some of the international examples available through the WFCP network.

There is some urgency to commence a more innovative and active approach to applied research if Australia is not to risk being regarded internationally as having a second-rate VET sector. There is also the opportunity to re-purpose some existing government funding directed at new start-ups and entrepreneurs, or in some cases link these types of projects to a relevant TAFE that can provide design, production and intellectual property management support.

8. Sector Dissemination

Activity	Forum	Target Group
IET update	SWTAFE	Executive managers/CEO
Deakin Uni meeting	Meeting	Deakin Uni Regional CEO/SWTAF CEO
VTA – ARI presentation	VTA ARI network	VET applied researchers VET managers/executives
VTA ELN Presentation	VTA ELN	Education executives/senior managers
AR session	VTA Annual Conference	Victorian TAFE Executives
Report summary disseminated	Department of Education & Training	OTCD & VSA executives and managers
Report summary disseminated & Future meetings and/or discussions	Victorian Skills Authority	VSA executives and industry managers
Workshop or breakout session	VDC Teaching and Learning Conference	VET applied researchers VET teachers and managers
	TDA Conference	
Workshop or breakout session	TDA Conference 2023	VET applied researchers VET senior managers
Webinar presentation	October VET (via (AVETRA)	VET applied researchers VET teachers and managers
“Lunch and Learn” session	Webinar	TAFE teachers and SWTAFE & other interested TAFEs
Institute Leadership Team presentation	SWTAFE Institute Leadership Team	Senior Managers & Executives
Applied Research Community of Practice	SWTAFE CoP	Teachers undertaking Boyer Competency or research units and/or those interested in the AR concept and how to start
VTA Environmental Sustainability Planning forum	VTA ARI network	Senior Managers & Executives

9. Conclusion

This study investigated the benefits to vocational colleges that are able to support or provide applied research solutions to small and medium sized organisations looking to innovate, improve production efficiencies, or trial new technologies. While the research had a primary focus on agricultural and renewable energy technologies, it was also evident that many of the applications of the applied research programs in Canada span industry sectors.

The report has detailed a number of learnings and findings accumulated through industry meetings, visits and tours of multiple Canadian polytechnics and vocational colleges, and attending the 2023 WFCP Conference “Collective Intelligence.” Each aspect of the study has described the key learnings, considerations, key opportunities and potential next steps that may be taken. Applied research occurs as a spectrum that can be effective at different levels, ranging from individual teachers to dedicated research centres. This continuum allows organisations to build capability and capacity over time.

Potential TAFE Opportunities:

- Teacher training and professional development as a priority in small but targeted range of agriculture technologies:
- Use of remote monitoring equipment (eg soil moisture and temperature probes, electric fencing, gates)
- Use of GPS and GIS systems for mapping soil fertility applications and weed and pasture identification
- In the next two to three years the use of EV operated farming equipment should be considered. The use of EV’s on farm may even form part of a future WTIF and AR project with an industry partner
- Trialing new applied research projects at TAFEs and training providers with relevant specialist equipment
- A shared approach to structuring institute environmental management plans.

Potential regional opportunities:

- Working with regional industry and education stakeholders such as Deakin and Federation Universities.
- The key areas of potential collaboration on AR projects that would support industry initiatives are:
- Clean Economy
- Circular Economy
- Agriculture & Agri-business

- Health & Social Assistance.

The next key steps for this Fellow will be to continue to disseminate and share the findings at an organisational level, and the wider Victorian TAFE and VET sector. The findings from the report also have national TAFE and VET significance. There is a real benefit to the TAFE sector to have a strong financial investment in the sector by State and national governments. A targeted investment would lift the status and capability of TAFEs to better support and work with industry; and allow Australia to match or exceed innovation efforts in other countries.

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10. Appendices

(1) Polytechnics, Colleges & Industry – Key Questions

Institute Name: _____

1. What is your definition of applied research and innovation used here?
2. Where does most of your funding for ARI come from?
3. Roughly what amount of funding for ARI do you get annually?
4. Is it applied for annually or run for 3 or so years?
5. What are your key ARI projects or flagship programs
6. What type of industry partners do you work with?
7. How do you connect with them for such projects?
8. What B2B or marketing do you do for partners?
9. What expectations do you have for your partner contributions (eg $s, facilities, staff)
10. How are your students and staff involved in ARI projects?
11. How are ARI projects integrated into a student's course?
12. How are your qualification frameworks established?
13. How are courses here checked or validated for currency?
14. What do you do differently or better here compared to other Polytechnics in Canada?
15. What do you see as the benefits to:
    a. Students
    b. Staff
    c. The institute/organisation
    d. The industry partner
16. What are your main ARI opportunities?
17. What your main ARI challenges?
18. What key lessons or learnings can you share for organisations just starting out on the ARI journey?
19. What recruitment and PD processes are used to attract and retain teachers?
20. What sort of course and program marketing do you do?

Industry Questions

1. How did you first get connected or involved in an ARI project with a Polytechnic?
2. What time commitments are there for the business?
3. What other contributions do you have to make (time, $s, staff, facilities)?
4. What are the benefits for your business? Eg new products, skills, profits, recognition)

(2) Red River College Polytechnic Research Partnerships & Innovation funding sources

(https://www.rrc.ca/ar/)

RRC Polytechnic provides industry partners with applied research, technical services and training in areas that align with our expertise, resources and facilities, and with regional socio-economic demand:

- Advanced design and manufacturing
- Clean technology
- Digital technology and health
- Nutrition and social sciences

We are Manitoba's research partnerships and innovation resource for:

- Applied research proposal development and assistance
- Coordination and facilitation of industry-focused applied research
- Identification and assessment of applied research opportunities and the resulting knowledge and innovations
- Intellectual property management
- Knowledge/technology transfer and commercialization
- Management and administration of applied research grants and contracts Networking, business development, and external relations
- Start-up and operation of applied research pilot projects

Track Record of Success

- 15 years of Research Partnerships & Innovation
- RRC Polytech is one of Canada's top 50 Research Colleges

- $85 million in capital investments
- RRC Polytech applied research involves more than 1,800 students, 170 faculty, 60 courses
- Synergy Award from NSERC (2015)

Collaborative Approach

Our research and innovation is applied—meaning its purpose is to deliver a measurable return on investment for you and for our economy, through increased productivity, competitiveness, jobs, exports and more.

Driven by the needs of industry, we work as a team to find solutions for today's challenges—as well as tomorrow's. We own our intellectual property but freely share it. We grant commercial rights freely to support economic development, which means IP is not an impediment to successful collaboration and commercialization.

Funding Partners

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- Canada Foundation for Innovation
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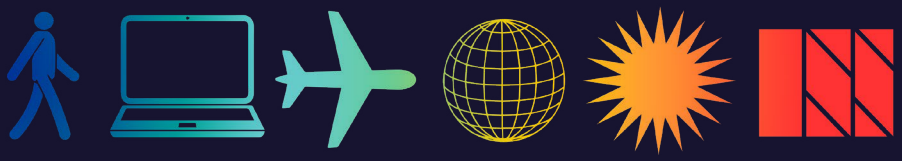
- Government of Manitoba
- Mitacs
- National Research Council of Canada (NRC)
- National Research Council of Canada Industrial Research Assistance Program (NRC IRAP)
- Natural Resources Canada
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- College and Community Innovation (CCI) program
- Research Manitoba
- Social Sciences and Humanities Research Council (SSHRC)
- Western Economic Diversification Canada
- Work With Us

We are always seeking out and evaluating new opportunities to collaborate with industry on applied research projects that solve problems, fulfill needs, and drive innovation.



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