ANNUAL REPORT

FOUNDATION FOR AUSTRALIA-JAPAN STUDIES

2019-2020

I OVERVIEW

Ambitions for the Year

During 2019 -2020 FAJS supported the projects funded in 2018-19, conducted a new grant round and built public awareness of the work of the Foundation. We also invited new sponsors to join the work of the Foundation.

Achievements

- The first 2018-funded projects were completed.
- Four additional projects commenced in mid-2019.
- A grant round for projects commencing in 2020 was completed.
- We funded four new projects from 2020, which will start as soon as conditions permit.
- 90% of the proposals received had industry partners identified.
- One funded project without an initial industry partner is now in commercial-in-confidence discussions with a partner.
- We commenced discussions with potential new sponsors.
- We supported the launch of a network of Australian researchers in Japan in October 2019.
- In partnership with the Embassy of Australia in Japan, the Rio Tinto Fellow supported a successful conference on university-industry research collaboration between Universities Australia and the Japan Association of National Universities.

II GRANT PROJECT HIGHLIGHTS

The first project funded by the Rio Tinto-FAJS program, on Nanotechnology to Capture Greenhouse Gases, completed its work in March 2020. FAJS is immensely proud of their achievements: it is ground-breaking work that solves big problems and demonstrates the great potential in Australia-Japan collaborations.

When it comes to research that could help save the earth, nanotechnology is probably not the first field that comes to mind. But according to Professor Yusuke Yamauchi, it could be key to

addressing the most significant challenge humanity has ever faced: the warming of our planet.

BOX 1 2018 NANOTECHNOLOGY TO CAPTURE GREENHOUSE GASES

As the University of Queensland noted when they featured the first FAJS Rio Tinto Australia-Japan Collaborative Program project in QSWOWNEWS, "When it comes to research that could help save the earth, nanotechnology is probably not the first field that comes to mind. But according to Professor Yusuke Yamauchi, it could be key to addressing the most significant challenge humanity has ever faced: the warming of our planet."

University of Queensland Professor Yusuke Yamauchi and The University of Tokyo Associate Professor Toru Wakihara's research team was awarded the first grant under the Rio Tinto Australia-Japan Collaborative Program. The $150,000 grant was focused on finding new nanomaterials for chemically converting carbon dioxide and nitrous oxide into useful chemicals to simultaneously remove damaging greenhouse gases from the atmosphere and at the same time recover the valuable elements in them.

While the UQ group did ground-breaking work on building nanocrystals and nanoporous materials of the future the University of Tokyo group brought their expertise on zeolites to bear on the problem. UTokyo discovered that *natural* zeolite which features low Si/Al ratio and is cheaply available, had the best adsorption capacity for nitrous oxide. It turned out the natural variant was better for the purpose than man-made zeolites. They were the first team in the world to demonstrate this result and have gone on to develop a design based on the natural zeolite adsorbent.

Next the team had to do several things: 1) find the most energy efficient way to use zeolite in greenhouse gas adsorption (thermal energy? solar energy? Or no additional energy?); 2) work out how to deal with the presence of competitive gases H2O or CO2; 3) figure out how to make the new adsorption process fit into current systems; and finally 4) work out the optimal scale of the new adsorption process.

In the course of the project, Professor Yamauchi was named a Web of Science Highly Cited Author for the 4th year in a row and named by The Australian newspaper as one of Australia's Top 40 researchers to watch. Professor Wakihara was promoted to full professor at the University of Tokyo. Congratulations to them both.

The university teams worked with industry partners NBC Meshtec and Mitsui Mining and Smelting Co Ltd. Professor Yamauchi says while the work on new nanotechnology materials has potential to revolutionize manufacturing in many fields, he also cautions "Many people focus on the applications, but without new materials, we cannot expect huge breakthroughs in energy storage and environmental remediation. There is huge potential to create some target applications, and maybe after 10, 20 years we will see them commercialized in the market and industry. This is my dream". Along with his passion to promote collaboration between Australia and Japan, he and his partners epitomize the purpose of the Rio Tinto Program.
https://content.qs.com/wownews/latest/index_30.html#page=24

Four projects started in mid-2019.

Early Identification of Blood Cancers with Immuno-flowFISH. Prof Wendy Erber and Assoc Prof Kathy Fuller, University of Western Australia with Sysmex Corp, Japan

3D Printing of Bio absorbable Implant Components Using New Metals. Dr Robert Wilson and Dr Shirley Shen, CSIRO with Kumamoto University

Understanding Frost and Herbicide Resistance in Plants. Dr Roberto Busi, and Dr Satoshi Iwakami, University of Western Australia and University of Kyoto with Kumiai Chemical Industry

Superior Sensor Network (SSN) for Harsh Environments. Dr Dzung Dao, Griffith University with University of Tokyo, Aichi Institute of Technology and industry partners Eco-Road Hero Pty Ltd and TW Riley Pty Ltd (Box 2)

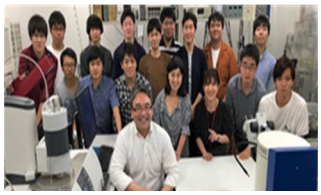
Dzung Dao says "over the past 50 years, silicon has been the dominant semiconductor material for sensing devices …in computers, mobile phones, automobiles and more. However, silicon is not suitable for electronic devices at high temperatures above 200°C... Silicon carbide …holds promise as the material for high performance sensors in metal ores and coal mining, combustion engines, energy conversion devices and so on." (Photo Dzung Dao with lab team, 2017)

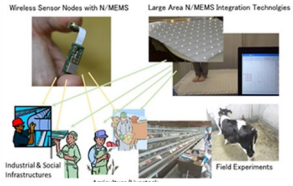
BOX 2 2019 SUPERIOR SENSOR TECHNOLOGY FOR HARSH ENVIRONMENTS.

Sensors are ubiquitous in household devices and myriad industrial applications. We rely on them to work safely and productively in all kinds of environments, but have you ever wondered what they are made of and how such small, thin components bear up under pressure?

Dzung Dao's work over many years has focussed on just that. With FAJS funding he and his Japanese counterparts take their research further to discover ultrasensitive physical sensing effects in silicon carbide (SiC) nanoscale structures. This will lead to extremely sensitive sensors that can operate in harsh environments like high temperatures and/or chemical corrosion. The outcome of the project will be an industry-ready high performance and robust sensing platform technology which can be applied in the energy and resources sectors, as well as in the chemical industry.

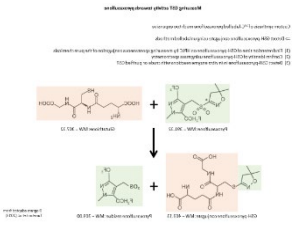
Nearly half way into the project the teams have been dividing tasks to match their respective skills. The Griffith team has been studying physical sensing effects in silicon carbide and designing sensors for harsh environments. Griffith team has been also working closely with the Aichi and Tokyo teams on fabricating the silicon carbide nanostructures and designing a low power consumption wireless sensor network system. The industry teams have been supporting the Griffith team by providing information regarding the demand and requirements for wireless sensor network in chemical and mining industries. By July the Griffith team had published four papers in top-tier journals (e.g. Science Advances, Nano Energy) and had demonstrated a tremendous enhancement in the performance of their silicon carbide pressure sensor using opto-electronic coupling. The sensitivity of the sensor is 1700 times higher than that of the most sensitive pressure sensors reported to date. In addition, the repeatability, stability, signal to noise ratio (SNR), and detectable pressure range were significantly improved. Furthermore, the novel sensor design is easier to manufacture, and the superior silicon carbide sensing layer is suitable for use in chemical corrosive environments. Combined with the Japanese team's work on low power wireless communication networks, the potential for a whole new class of sensor networks operating in remote and difficult locations is exciting. The Namazu Nanotech lab at Aichi Institute of Technology (below left) is working on the nano structures of silicon Simultaneously the Itoh lab at Tokyo University is working on the ultra low power wireless sensor part of the project (below right)





Despite the delays resulting from the COVID-19 pandemic, all 2019 projects are progressing. The UWA-Sysmex project on early detection of blood cancers met with their Japanese industry partners late in 2019 to sort out differences in data generated by the two teams as they work to optimize sample analysis. The Japanese visitors spent time in the Perth lab learning sample analysis from the consultant UWAS haematologist and the project has started analysis of multiple myeloma patient samples. (Photo Konishi-san and Yamada-san from Sysmex at Kings Park overlooking Perth)

The CSIRO team working with Kumamoto University to develop new materials for bioabsorbable 3D-printed implant components spent 2019 trialing different new materials to compare performance against a widely-used magnesium alloy. Handling magnesium alloys safely to avoid explosions requires controlled atmosphere facilities. The project benefitted from additional support from CSIRO to purchase equipment for the dedicated handling of the magnesium powders. The project teams have not been able to meet as planned in early 2020 to jointly characterize their new powders and begin building devices but the aim is to have patentable results from the process and they have been in discussion with an industry partner.

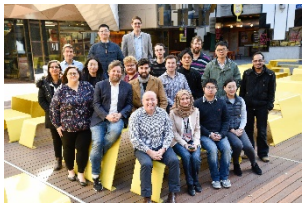


Early results from the UWA-Kyoto team working on the role of an important enzyme in frost and herbicide resistance in wheat, showed that two chemicals in commonly used herbicides provide no protection against frost damage and indeed one may reduce crop performance. Work-in-progress is examining the effect of a different chemical on the same enzyme in wheat and rye grass to understand how weeds develop resistance to herbicides. Both results help optimize the chemical content in herbicides, reduce inappropriate use and improve crop yields.

The four new 2020 projects are delayed by the COVID-19 pandemic, but we anticipate exciting developments when they re-start.

Improving Future Energy Storage Systems at the Molecular Level. Prof Debra Bernhardt, Australian Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland, and Prof Katsuhiko Ariga of the National Institute for Materials Science (NIMS) and The University of Tokyo, partner with three Japanese companies: Tayca Co, NK Energy Frontier Co. Ltd., and Yoshino Denka Kogyo Inc. The total FAJS funds awarded for this project are AUD $139,000. [Prof Bernhardt and Dr Baris Demir in front of a molecular model of a supercapacitor]

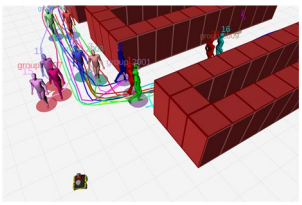
Quantum Diamond-based Geophysical Sensor Technology. Professor Brant Gibson, ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP), RMIT University, and Mr Takeshi Ohshima, National Institutes for Quantum and Radiological Science and Technology QST. Their large teams will link with 13 international and industry partners in the CNBP. The total FAJS funds awarded for this project are $AUD 120,000. [The Gibson team below]

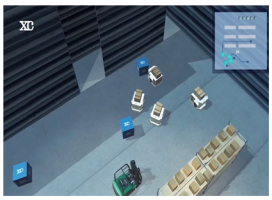


BOX 3 2020 SOCIALLY CONFORMANT ROBOTS.

Robots may be welcome as they take over dirty, dangerous and undesirable jobs, but they also need to observe some social norms to make them safe and acceptable in many contexts. This project aims to improve the acceptability of robots in service applications by developing their ability to navigate autonomously in changing and human-populated environments. The new robots will be tested in warehousing applications. The challenge for the research is to go beyond algorithms that "teach" the robot based on predetermined scenarios chosen by researchers and develop more dynamic capacity for the robots to navigate and anticipate movement by humans in the environment.

Dr Chan and the Monash team with their robots (above).





Autonomous robots face challenges avoiding people (above left) and also other moving objects (above right)

The Cross Compass group and its research arm, Cross Labs, work on AI in industrial contexts. The founder and CEO Antoine Pasquali says "Nowadays many solutions exist that can automate robotic behaviors in industrial contexts, for navigation or operation. Typically, human safety is ensured by simply avoiding any human-robot interaction, forcing industries to fully separate the working environments and the tasks done by robots from those still managed by humans. But robots are meant to assist humans, not to replace them …our partners wish to keep humans in the loop, and thus they demand a new type of technology where robots and people can be mindful of one another and collaborate, not just to avoid incidents but also, to achieve more together. To answer this demand, we found that the areas of expertise of Monash and Cross Compass were complementary. Our colleagues in Monash happen to possess exactly the expertise needed, in advanced algorithms of collaborative human-robot interaction, to bring this technology to the next level once combined with our experience of the field. We view this collaboration as a first step towards achieving the goal of our company to reinforce the links between academia and industry in intelligence sciences, and through such to foster innovation and economic cooperation within the Asia-Pacific region for the benefit of our society as a whole."

Socially Conformant Behaviour for Autonomous Robots in Dynamic Environments. Dr Wesley Chan, Electrical and Computer Systems Engineering, Monash University, and Dr Antoine Pasquali, Cross Compass Ltd (Japan). The total FAJS funds awarded for this project are AUD $89,000. (Box 3)

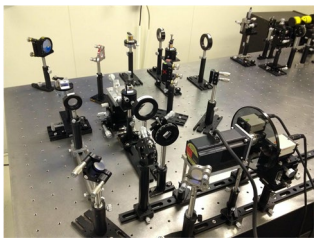
Contributing to Global Freshwater Security with Novel Solar-driven Desalination Methods. Dr Juan Felipe Torres, College of Engineering and Computer Science, Australian National University, and Prof Atsuki Komiya, Tohoku University with industry partner Nano Frontier Technology (NFT) company in Japan who will support the energy conversion part of the project. The total FAJS funds awarded for this project are $AUD 132,000. (Box 4)

Dr Torres spent 12 years in Japan and says his interests lie at the intersection between academia and industry, "I want my work to have a direct impact on society by solving real world tangible problems, in addition to generating knowledge and educating the next generation of engineers." He and his colleague Charles-Alexis Asselineau (pictured) both won grants under the ANU College of Engineering and Computer Science "Industry Engagement Advice and Investment Scheme" in 2019.

BOX 4 2020 DESALINATION CONTRIBUTING TO GLOBAL FRESHWATER SECURITY.

Better access to fresh water would increase the area of land available for agriculture, as well as supporting the forestry sector and industrial applications. We currently satisfy less than 0.5 per cent of human water needs with desalinated water because conventional methods require large amounts of energy. This project aims to develop a novel desalination method based on a solar-driven technique to achieve a 95 per cent salinity reduction in seawater. The project will use a process known as thermophoresis that has never been used before for desalination applications. There are significant challenges to overcome, including demonstrating that this can be a truly low energy solution.

Dr Torres built his links with Japan doing his PhD at Tohoku University and working in industry (Toshiba Corporation). The Tohoku team is led by Professor Atsuki Komiya with two decades of experience developing advanced optical techniques to visualise heat and mass transfer processes in various fields. The Institute of Fluid Science (IFS) at Tohoku University is particularly interested in tackling global problems where fluid science plays an essential role. Their expertise in flow visualisation will evaluate the new technology for desalination. The ANU team, including 2 undergraduate students, have begun building their own optical setup from a Tohoku U design (pictured). It is used to visualise the concentration fields of ions in water during a desalination process. This setup allows high-precision measurement of the high concentration regions that contribute to increase the brine salinity, as well as the low concentration regions that contribute to the quality of fresh water.



The industry partner, NFT has been collaborating with ANU since 2017 on developing new high-temperature absorber coatings for solar thermal applications. The proposed process will use some of NFT's low temperature coatings which absorb 99.9% of sunlight to drive the desalination process in a more efficient way.

More details of all projects can be found on our website www.fajs.org

III OTHER ACTIVITIES

Research collaboration conference between Universities Australia and Japan Association of National Universities, Osaka

The Rio Tinto Fellow supported the organization of the third annual meeting between Universities Australia and the Japan Association of National Universities on the theme of 'Reaching Higher – Lifting Japan-Australia University-Industry Collaboration to New Heights'. The conference, held at Osaka University on Wednesday Oct 9 following the Japan Australia Business Cooperation Committee -Australia Japan Business Cooperation Committee (JABCC-AJBCC) conference, was well attended. The keynote address by the South Australia Chief Scientist Professor Caroline McMillen gave a clear picture of both the national research collaboration landscape and how a State government strategy was developed and implemented. Case study presentations by Deakin University with NTT Australia, Hitachi Zosen with Osaka University and Toshiba Infrastructure Systems and Solutions Research with University of Melbourne were excellent examples of successful research partnerships. The Australian Ambassador to Japan, Mr Richard Court, attended.

Professor Jenny Corbett and Professor Caroline Benton, Vice President of Global Affairs, University of Tsukuba, chair a panel at the UA-JANU University Dialogue on Research Collaboration.

ANZOR Japan launch

The Australia-NZ-Oceania Researcher network, ANZOR Japan, came together during 2019 to link and support researchers based in universities or industry with a strong connection to any of the countries in the title. The group was formally launched at the UA-JANU University Dialogue conference in Osaka that followed the JABCC-AJBCC annual conference.

The network has been supported by the Embassy of Australia in Japan; the Rio Tinto Fellow has provided advice and guidance.

Paola Sanoni, Professor Jenny Corbett, Matthew Richardson, Mehrisadat Makki Alamdari and Dror Cohen (left to right) launch ANZOR

IV ACTIVITIES IN FIGURES

Grant Funding Round 2019-2020

A new grant funding round was opened in August 2019 for projects to be funded in 2020-21. There were 81 applications, of which only 14 were from prior applicants. This demonstrates the large pool of talent and the depth of interest in the FAJS-Rio Tinto program by qualified Australian and Japanese teams. Four new projects were funded. We have now received a total of 179 applications since 2018 for 162 separate projects, of which FAJS has been able to fund 9 large projects and 1 small-scale pilot (see Table 1 for details). $480,000 was awarded to the 2020 projects. A total $1,182,719 has been awarded to date. The fields of Health and Medical Sciences and Materials and Energy have been more heavily represented in the proposals to date than other fields. 2020 saw more applications in Computing than 2019 (Charts 1 and 2).

Table 1 All Funded Projects (2018-2020)

Year	Project Title	Leading Researcher	University	Partner University	Industry Partner	Field	Grant
2018	***Nano-architectured Functional Porous Materials as Adsorbents of Greenhouse Gases and Catalysts Converting Them into Valuable Chemicals***	**Prof Toru Wakihara and Prof Yusuke Yamauchi**	**The University of Tokyo**	**The University of Queensland**	**NBC Meshtec Inc., Mitsubishi Chemical Corp**	**Materials**	**$150,000**
	The Impacts of Public-Private Collaboration and Technological Innovation on Infrastructure Project Delivery Systems	**Prof Kazumasa Ozawa and Dr Petr Matous**	**The University of Tokyo**	**The University of Sydney**		**Infrastructure**	**$24,950**
Total 2018							**$174,950**
2019	***Australia-Japan Collaboration to Improve the Identification of Blood Cancers with Immuno-flowFISH***	**Prof Wendy Erber, Assoc Prof Kathy Fuller and Dr Konishi**	**University of Western Australia**		**Sysmex Corp**	**Health**	**$140,000**
	3D Printing of Novel High Vapour Pressure Metals and Metal Matrix Composites as Bio-absorbable Implant Components	**Dr Robert Wilson, Dr Shirley Shen and Prof Ritsugun Gen**	**CSIRO**	**Kumamoto University**		**Materials**	**$150,000**

	Superior Sensor Network (SSN) for Harsh Environments	**Dr Dzung Dao, Prof Toshihiro Itoh, and Prof Takahiro Namazu**	**Griffith University**	**University of Tokyo & Aichi Institute of Technology**	**Australian Eco-Road Hero Pty Ltd; TW Riley Pty Ltd**	**Materials**	**$144,573**
	Understanding the role of glutathione S-transferase: an important enzyme to protect crops and fight weeds	**Dr Roberto Busi and Dr Satoshi Iwakami**	**University of Western Australia**	**University of Kyoto**	**Kumiai Chemical Industry**	**Agriculture**	**$93,196**
Total 2019							**$527,769**
2020	***Socially Conformant Behaviours for Autonomous Robots Navigating in Dynamic, Human-Populated Environments***	**Dr Wesley Chan and Dr Antoine Pasquali**	**Monash University**	**Cross Labs**	**Cross Compass Ltd.**	**Computing**	**$89,000**
	Quantum Diamond-based Geophysical Sensor Technology	**Prof Brant Gibson and Prof Takeshi Ohshima**	**RMIT University**	**National Institutes for Quantum and Radiological Science and Technology (QST)**		**Materials**	**$120,000**
	Strategic Design of Nanoarchitectured Porous Carbon and Investigation of Charging/Discharging Mechanisms in Supercapacitors for Future Energy Storage Systems	**Prof Debra Bernhardt, Dr Baris Demir and Prof Katsuhiko Ariga**	**The University of Queensland**	**The University of Tokyo & National Institute for Materials Science (NIMS)**	**Tayca, NK Energy Frontier Co. Ltd.**	**Materials**	**$139,000**

	Novel solar-driven desalination and brine treatment methods for global freshwater security	**Dr Juan Felipe Torres**	**Australian National University**	**Tohoku University**	**Nano Frontier Technology**	**Infrastructure**	**$132,000**
Total 2020							**$480,000**
Total							**$1,182,719**

Chart 1 Applications Numbers 2019 & 2020

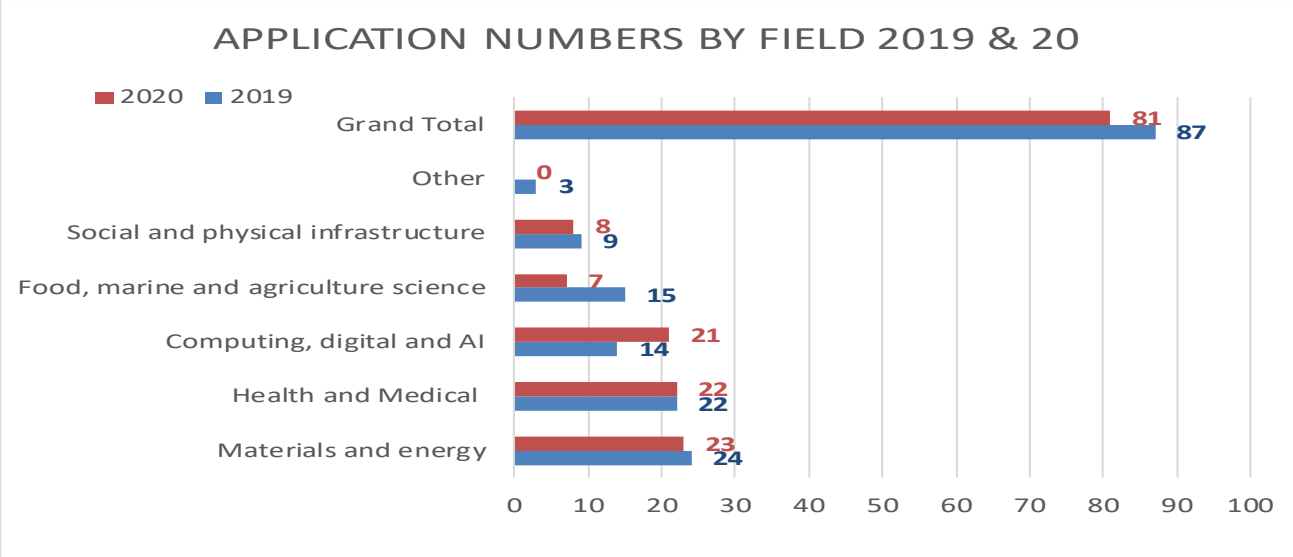
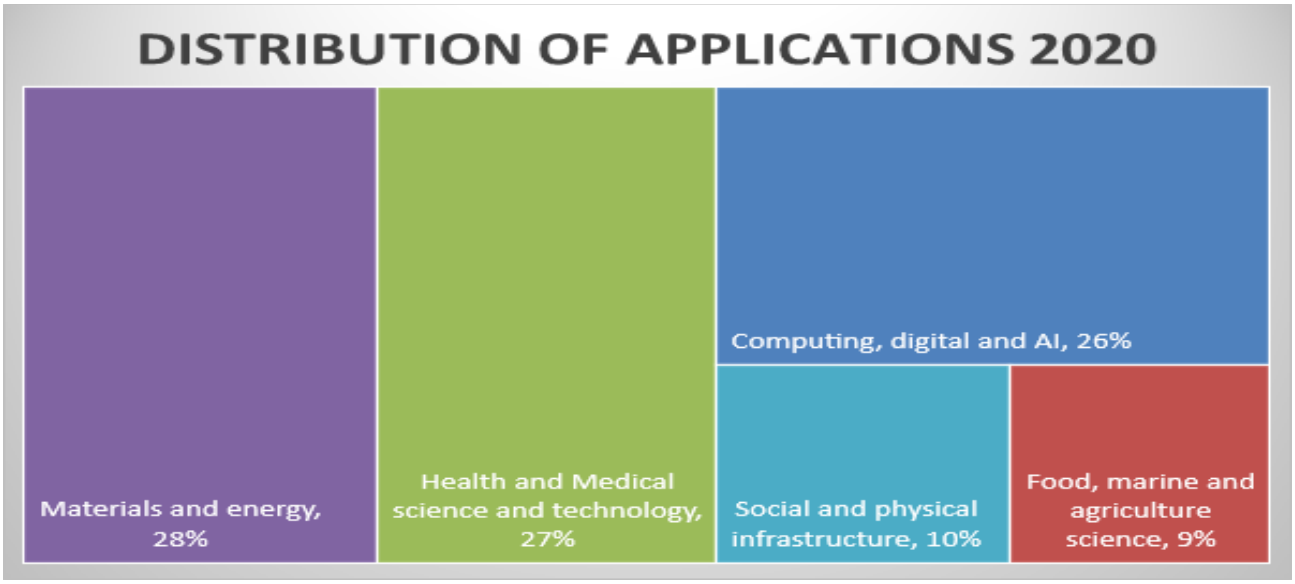
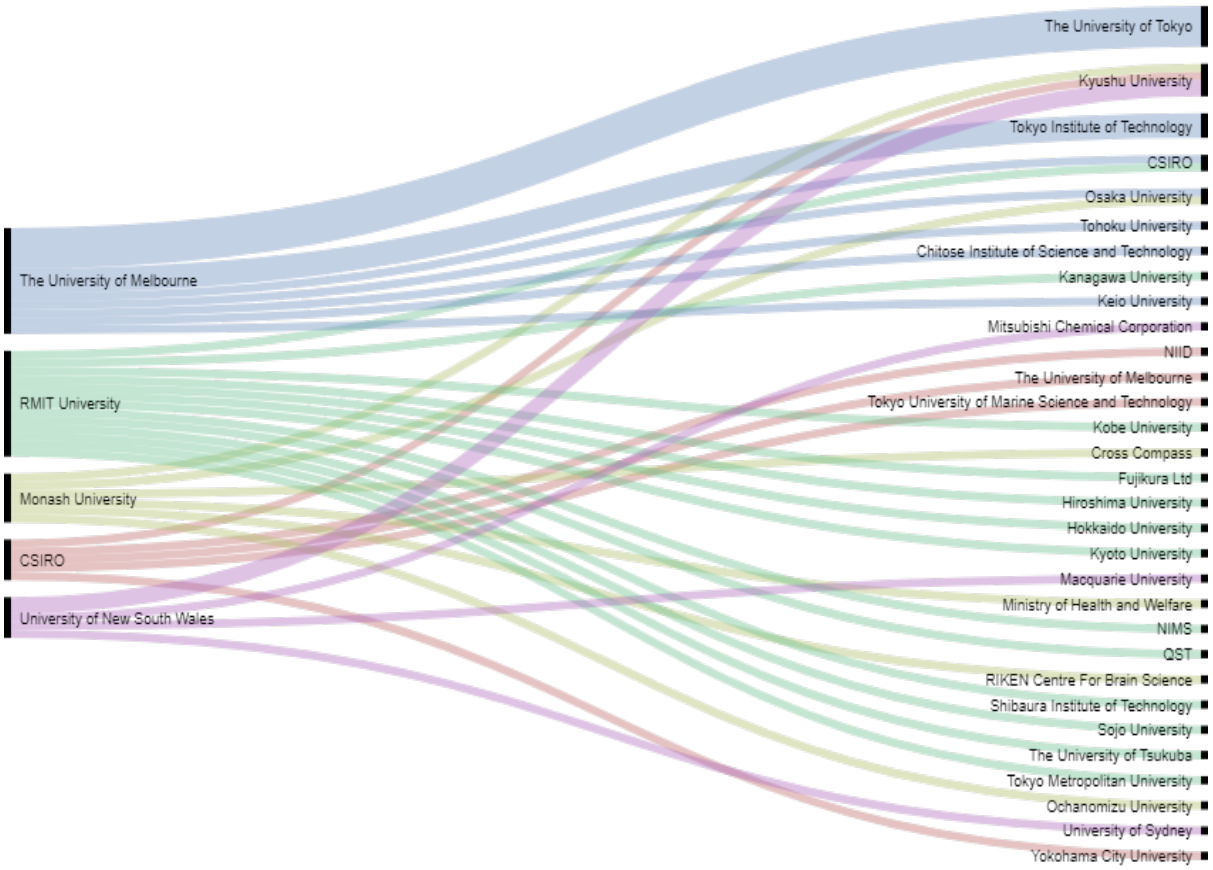


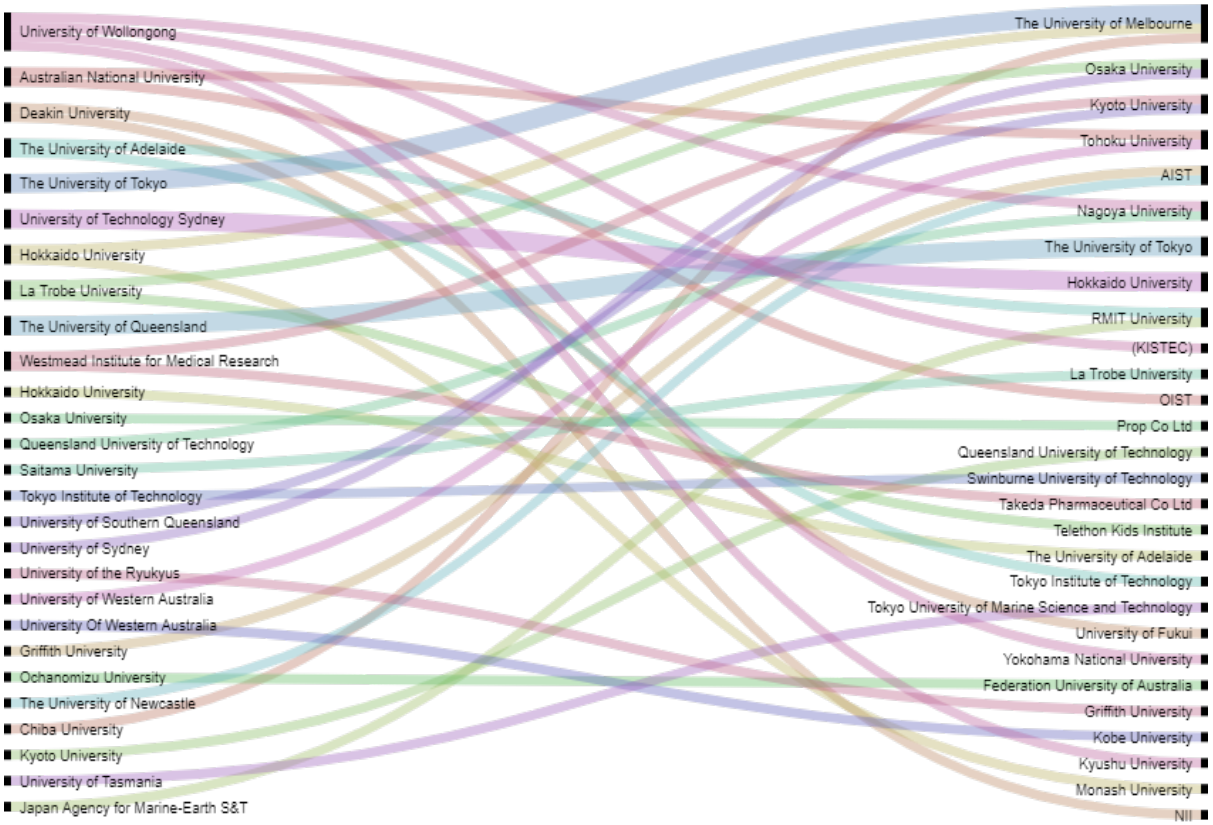
Chart 2 Applications by Field



Applications have been well dispersed across the two countries, involving a wide range of universities and institutions, not limited to those in the major cities or in the top group of research universities in Australia and Japan. (Chart 3)

Chart 3 Lead (left) and Partners (Right) in 2020 Proposals





While most applications come from universities, there is some representation from other types of institutions as leaders and greater variety among the other country research partners (e.g. where an Australian university leads there will be a secondary Japanese research partner and vice versa). (Charts 4 and 5) In addition to the secondary research partner more than 90% of project applications have an identified industry partner.

Chart 4 Type of Lead Institution

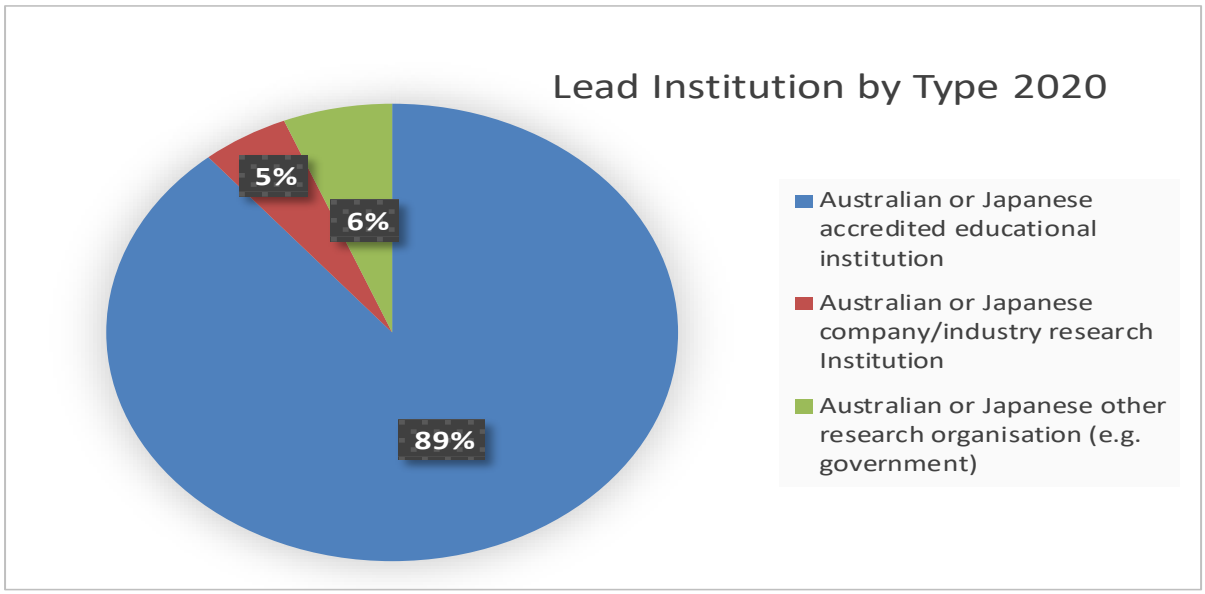
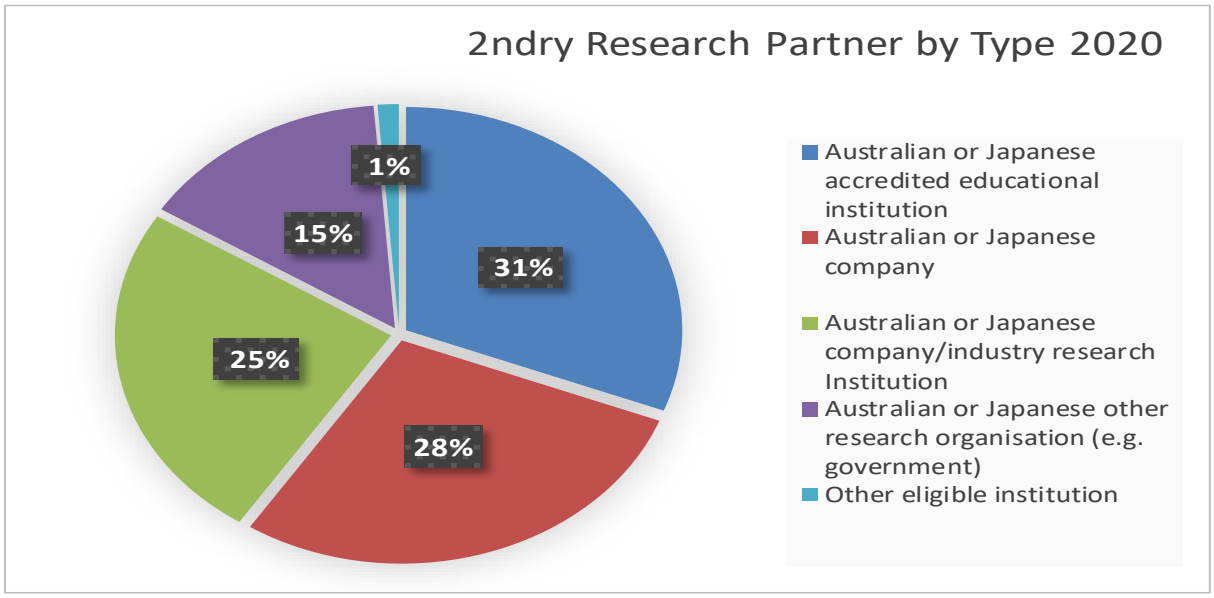


Chart 5 Type of Main Research Partner



We stress diversity of research teams in the selection criteria and proposals are all required to address the issue in their applications. Most proposals have women and early career researchers in the teams, and many have international members. As yet, very few have minority groups represented. 2020 had a slightly lower percentage of female-led project

proposals compared with 2019 but was still close to one quarter overall (Chart 6). Among all proposals headed by women the most frequent field was Health and Medical in both 2019 and 2020. Materials and Energy followed in second place in 2020, a change from 2019 when Physical and Social Infrastructure was second (Chart 7). Note the grant round in 2018 was a pilot with a small number of applications.

Chart 6 Gender Diversity 1

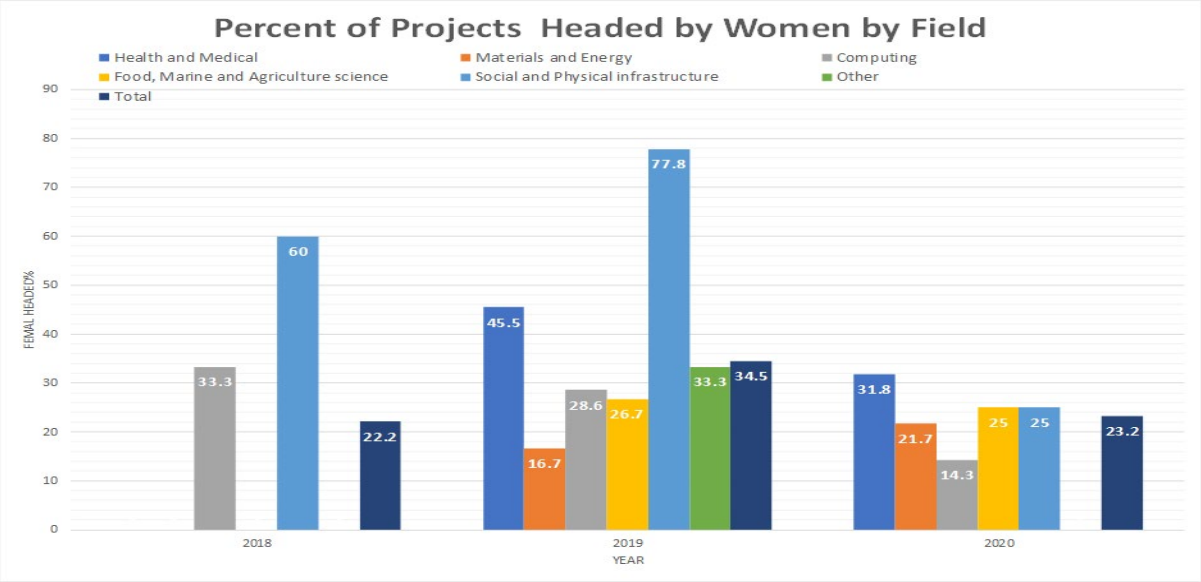
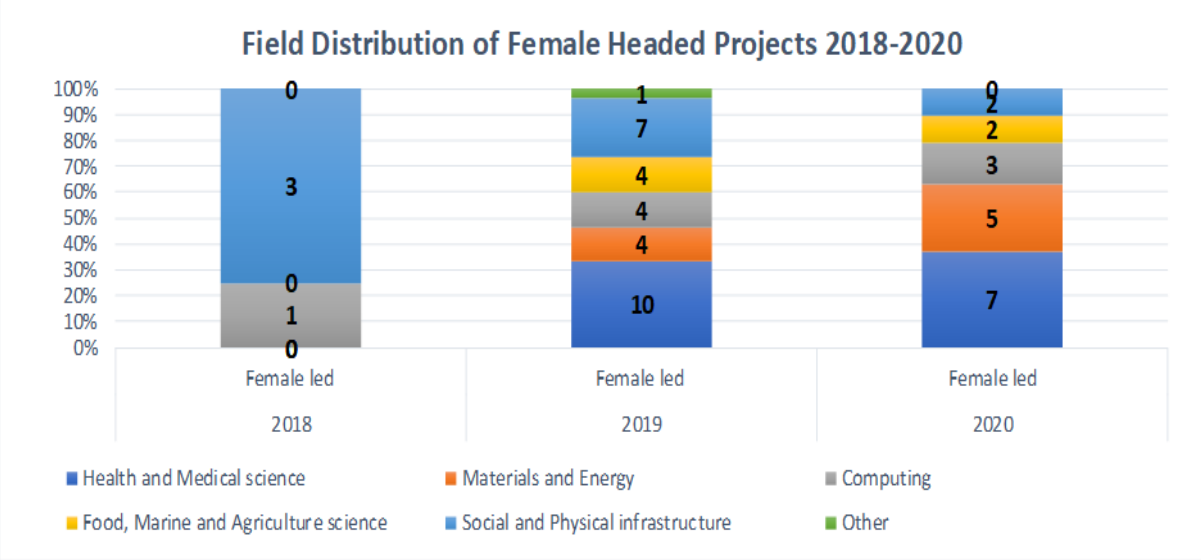


Chart 7 Gender Diversity 2



V FUTURE DIRECTIONS

Australia and Japan's shared future prosperity and security depend on innovations in science and technology. While we have a large and strong visible trade relationship in resources and manufactures, the invisible part of the Australia-Japan bilateral relationship is our deepening collaboration in engineering, science, technology and medicine.

This is vital for the future of the relationship because solutions to the world's complex questions -- of artificial intelligence, climate, energy, environment, health equity, natural resources, robotics and space – require teams.

The Foundation for Australia-Japan Studies' mission is to identify and celebrate the teams that work bilaterally on innovations in science, technology and medicine. Through the Foundation, Rio Tinto pioneered a program of funding to accelerate the efforts of researchers and industry partners in Australia-Japan teams. The success of that program, in supporting chosen projects and uncovering the wealth of other collaborations, is clear from our report.

Now, it's time to support at scale: 90% of the Australia-Japan research teams we've been privileged to review need funding to accelerate, test, scale and commercialize their work.

Our bilateral relationship is unique, and the promise of the new directions is immense. The Foundation has just begun to uncover the potential. But breakthroughs can only come when the private sector, government and academic institutions come together. FAJS will continue to facilitate that cooperation and looks forward to welcoming more partners to join us in that work.

VI ACKNOWLEDGEMENTS

Establishment

FAJS was established early in 2017 as a company limited by guarantee. The definition of membership includes "funding member" of which there is one at this time: Rio Tinto Services Limited (RT).
The objects as set out in the Constitution include:

- Enhance the understanding of Australia in Japan through funding and other support provided to centres for studies of Australia located across Japan at universities and tertiary level institutes
- Provide funding and other support to a position … [for] … the promotion of bilateral research collaboration and other bilateral programs as appropriate, involving both academic institutions and industry

RT entered into a funding agreement to provide AUD1 million per annum for a three-year period ending 31 December 2020.

FAJS has been registered with the Australian Charities and Not-for-Profits Commission (ACNC) and has to date fulfilled its reporting obligations to that body. FAJS has been registered for Goods and Services Tax with the Australian Taxation Office.

Professor Jennifer Corbett was appointed to the position of Rio Tinto Fellow, Foundation for Australia-Japan Studies, Visiting Researcher, University of Tokyo in April 2018.

Acknowledgements

The Foundation gratefully acknowledges the generous support of its inaugural sponsor Rio Tinto Corporation. The Foundation has also received valuable in-kind support from The University of Tokyo, Griffith University, PwC, Australian National University and Stanbury Consultants.

APPENDIX FINANCIAL STATEMENT

Available here