AUTONOMOUS SYSTEMS INITIATIVE

ASI Newsletter Volume 2 Issue 6 Summer 2021

Welcome to our summer edition of the ASI Newsletter. We feature an exciting project from Dr. James Hogan and his team in Theme 5 Industrial Communities, and we meet Postdoctoral Fellow Boyuan Zhou. We also summarize the successful Annual Symposium held June 2nd. In addition, we are developing some 'new look' features over the summer, so we look forward to bringing those to you in the Fall!

ASI News and Updates

New website is almost complete

New blog-style e-newsletter will launch for Fall 2021

Theme-specific workshops are currently being planned for Fall 2021

Research Spotlight

Wear and corrosion of equipment, pipes, tools and general infrastructure are prevalent and ongoing issues for heavy industry out in the field. Not only can this mean costly damage that can disrupt industrial activity, but the safety of workers can also be at stake. For our Research Spotlight this summer, we look at the cutting-edge research and development work within the Predictive Design of Coatings for Improved Performance project under Theme 5 Industrial Communities that tackles these issues.

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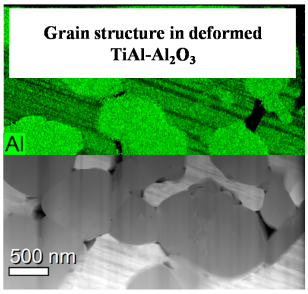
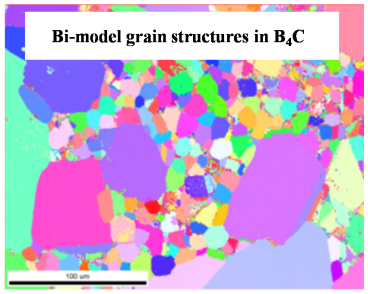
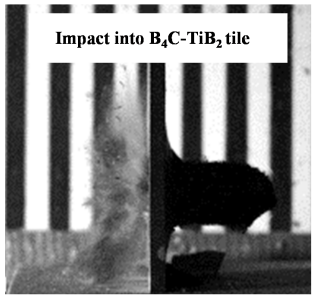
I. Experimental Mechanics and Materials Science







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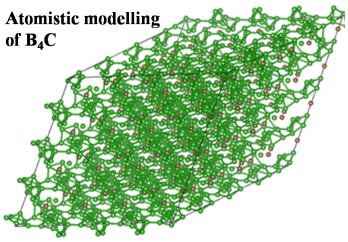
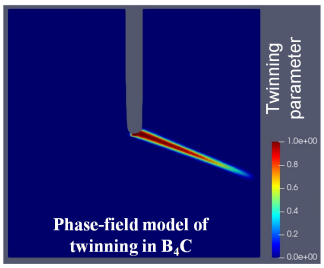
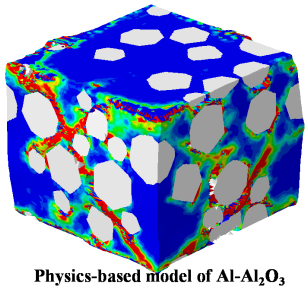
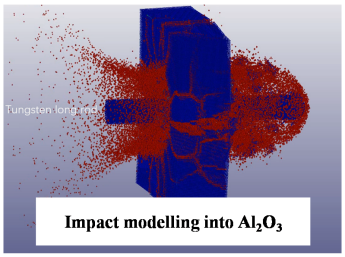








II. Computational and Applied Mechanics

The development of tougher, longer-lasting materials, including high-temperature and wear-resistant ceramic-based composites and coatings, are of significant interest to the natural resource, defence, and aerospace industries to combat corrosion, decay and malfunction. Autonomous systems can play a crucial role in the design, manufacture and application of these materials, something addressed by the work of Dr. James Hogan and his team.

Their research has three main thrusts:

1. Manufacturing: The team uses autonomous thermal spraying and additive manufacturing technologies to manufacture multi-functional high-performance ceramic-based materials. Here, they prioritize deposition and manufacturing efficiencies and tolerances.

2. Performance Characterization: The team uses Canadian-leading dynamic-impact testing facilities coupled with ultra-high-speed imaging to gain insights into the microstructural features and mechanical properties that govern the performance of materials in extreme environments. Their discoveries link structure-property-performance relationships using machine-learning-based approaches.

3. Predictive Modelling: Insights gained in experiments guide the development and validation of multi-scale physics-based models that then inform the design and manufacturing of better-performing materials. The length scales of interest range from the atomistic, using LAMMPS simulation software, to the structural, using Abaqus finite element analysis software. Models describing material performance across these scales are linked using machine learning; in turn, these can inform autonomous robots on repair processes.

Through this technical research, autonomous manufacturing systems enable immediate diagnostics and repair of materials in extreme environments (e.g., nuclear reactors). “We use autonomous manufacturing and repair technologies to develop better performing ceramic-metal composite materials for wear and corrosion protection in natural resource industries,” says Dr. Hogan. “ The predictive capabilities of the models developed within the program improve as they become refined through integration of sub-scale models, experimental observations, and practical implementation.” In other words, these systems become smarter when coupled with virtual design tools, experience, and inputs from experts.

The beneficiaries of the research are both industry and government end-users in the natural resource sectors, as the coating and structural materials developed in this program reduce maintenance costs and improve operational efficiencies.

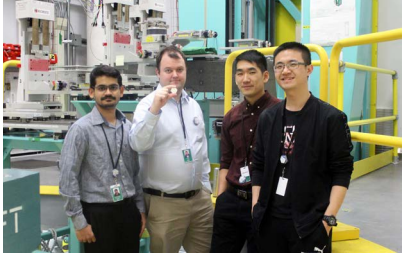
We work directly with end-users to implement project outcomes as applications that benefit Albertans.

As you might expect from a team dedicated to Industry Communities, industrial partners play a crucial role in the work they do, as highlighted by Dr. Hogan. “As a cross-sectoral and interdisciplinary research team, we can effectively strategize to ensure cutting-edge and comprehensive multi-scale design work, manufacturing, modelling, testing, and optimization to

develop next-generation ceramic-material coatings that meet the needs for natural resource industries. We work directly with end-users to implement project outcomes as applications that benefit Albertans."

While Alberta-based Imperial Oil is an important industry stakeholder in the program, other project partners from Alberta include educational institutions (Red Deer College) and government bodies (InnoTech Alberta). National and international government partners are also included (Defence Canada, US Army).

The team works closely with these partners, keeping a strong focus on applied technologies useful in the field. Predictive modelling outcomes are continuously being transitioned to partners for implementation in design, manufacturing, and research activities. Partners are also involved in planning the research directions, mentorship of the students, and implementing knowledge and models developed within the highly collaborative program. And while close partnerships with industry and government are guiding integration into daily operations of Canadian companies across many industries (e.g., aerospace, defence, manufacturing, autonomous vehicles), high-impact publications drive interest in the scientific community.



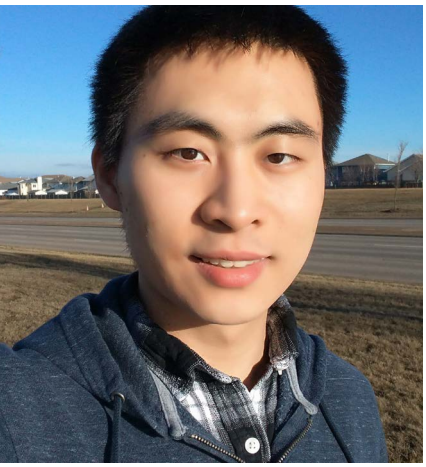
Altogether, the focus on autonomous systems will promote advances in manufacturing high-value commercial products and training a highly skilled Canadian labour force, which is a highly valuable combination.

The team, based in the Mechanical Engineering Dept. at the University of Alberta, includes Dr. James Hogan, Asst. Professor; Mohammed Parsazadeh, Postdoctoral Fellow; Chenwei Shao, Postdoctoral Fellow; Sara Sheikhi, Ph.D. Candidate; Hannah Farid, Ph.D. Candidate; Saman Savahlatifi, Ph.D. Candidate.

HQP Profile

Industrial facilities are controlled and monitored by human operators who conduct fault diagnoses in abnormal situations. It is possible, though, that this function could be automated in the future, allowing for accurate, rapid diagnoses of industrial facilities' operations systems.

This is the research problem currently being investigated by postdoctoral fellow Boyuan Zhou working under Dr. Tongwen Chen for the project Control and Monitoring Tools for Complex and Networked Autonomous Systems. His research focuses on the alarm systems of large-scale industrial facilities that are critical assets ensuring process safety and efficiency. There are continued challenges for alarm management in practice, particularly for a phenomenon known as an alarm flood. During an alarm flood, operators are overwhelmed by vast numbers of alarms set off simultaneously. Consequently, these human operators can miss those that are critical, thereby increasing the risks of operational faults and failures. To address this vital issue, Boyuan is proposing data mining methods to extract alarm flood patterns. Identifying the patterns could facilitate the analysis of alarm floods and help identify generalized solutions. He sees significant application possibilities to more industrial facilities and improved safety and efficiency of process operations.



Boyuan came to the University of Alberta in 2016 after completing his B.Eng. degree in Electrical Engineering and Automation from Southwest Jiaotong University, China. Studying under Dr. Tongwen Chen, he went on to complete his Ph.D. degree in Electrical and Computer Engineering at the University of Alberta in 2021. Dr. Chen then took him on as a Postdoctoral fellow to continue his research work in automated control systems until February 2023.

He is particularly proud of his achievements at the University of Alberta, where he has been involved in developing and improving an alarm management toolbox known as the AMtool. He tells us that "The AMtool is the first alarm management toolbox available in Canada, and it has been tested and used by some industrial partners."

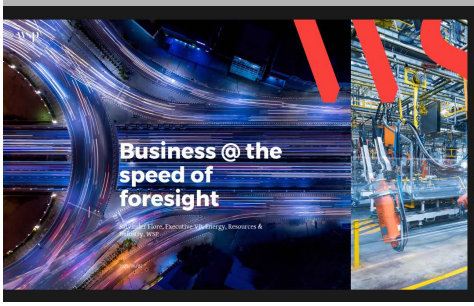
One thing for sure, he appreciates the opportunities that Alberta offers. "I would like to try to find an industrial-related job in Alberta, perhaps as a data scientist or control engineer. I have developed important practical skills, such as data analysis and alarm management, which are highly desirable in the Alberta energy sector."

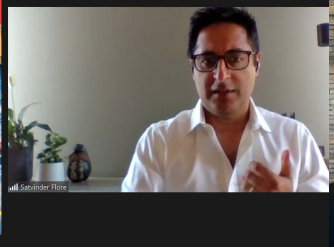
In addition, Alberta offers him a connection to nature that he can appreciate through his passion for hiking. "Over the past five years, I have developed a fascination for Alberta's spectacular landscape in the many provincial and national parks. They offer so many possibilities for hiking, which is a simple way to be part of nature and free my mind."

Symposium News

ASI's recent annual symposium welcomed 193 registrants on June 2nd for a day of discussion and debate on autonomous systems' next steps for research and development. This year focused heavily on industry, with a range of representatives from different sectors connected to machine learning and automated systems. After valued opening remarks by Assistant Deputy Minister Chris Shandro, the keynote speaker, Ibrahim Gedeon, Chief Technology Officer at TELUS, offered an in-depth look at the importance of 5G's low latency and high bandwidth to enable autonomous vehicles. Delegates subsequently heard from the Alberta Motor Transport Association's president, Chris Nash, who discussed their current test trials in cooperative truck platooning. The day also featured an industry discussion panel with speakers from WSP, PolyControls, AltaML and 3M Canada where lively discussion featured perspectives on barriers and developments in automated systems, the workforce skills required, and the relationship between academic research and industry development. Participants said afterwards that the day was informative, with many commenting that they appreciated the breadth of autonomous systems sectors that were covered. We look forward to welcoming everyone back next year!

Top left: Keynote speaker Ibrahim Gedeon, Chief Technology Officer, Telus; Above right: Debi Larkin, Application Development Specialist, 3M Canada; Below from left to right: Satvinder Flore, Executive Vice-President of Energy, Resources and Industry WSP presenting 'Business @ the speed of foresight'; Chris Nash, President, Alberta Motor Transport Association (AMTA); Nicole Janssen, Co-CEO AltaML.





About ASI

The Autonomous Systems Initiative (ASI) is a forward-thinking, multi-million-dollar research program that teams up research and industry experts across Alberta to develop automated technologies spanning key areas of health, transportation, sustainability, and industry. Understanding and developing these systems will help us to remain economically competitive in a global context while effectively addressing the challenges of climate change, efficient energy production and use, transportation needs, advanced manufacturing, and medical advancement. This program develops new Information, Communications and Technology (ICT)-enabled Autonomous Systems to support healthy and sustainable communities with a focus on sensing, communication, control, and computation technologies, all linked together by artificial intelligence.

Contact Us

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