

Mathematics in Industry Study Group (MISG) 2022



14 – 18 February 2022

University of Newcastle, Australia





Co-Directors

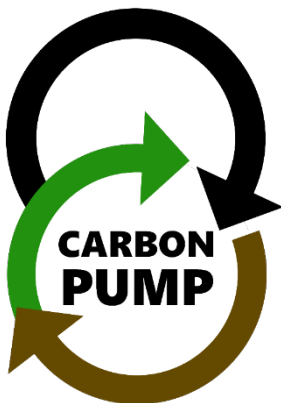
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Ignatius Verbeek
[CarbonPump](#)
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1. Welcome

Welcome to the 2022 Mathematics in Industry Study Group (MISG) Workshop. This is the third time that the MISG has been held at the University of Newcastle, Australia. Next year, we will hand over the MISG to Monash University. We wish them all the best for organising the workshop in 2023. We certainly enjoy the experience of working with all of the MISG participants using mathematics and statistics to solve various interesting industrial projects.

While we saw a great success of the MISG2020 with four industry projects solved and outcomes delivered, we have faced many challenges brought by Covid-19 for the past two years. This has affected the organisation of the MISG2021 and MISG2022. However, instead of cancelling the workshop, we focussed on the benefit of the MISG to the scientific community, especially to our research students. So we pursued despite having to run a smaller version of the MISG and having to introduce an online session to the workshop. MISG2021 was the first to run in a hybrid mode. There were ups and downs, and lessons were learnt, which we will apply to this year's MISG, but it worked better than expected.

This year, we are very excited by the projects put forward by **CarbonPump** and **Viper**. We thank their support, willingness to participate in the workshop, and recognition for the importance of mathematics/statistics to enhance their business design and operation. We hope that these two industry problems will cater to a range of interests and expertise, and we hope to provide the solutions the companies are seeking.

We gratefully acknowledge the support from the University of Newcastle and the School of Information and Physical Sciences. Notably, we would like to thank Mrs Juliane Turner for her help in organising the workshop. We also would like to thank all participants (online and in-person) who are making an effort to contribute to the MISG2022 despite all the challenges we face. We greatly appreciate your effort! We also would like to offer special thanks to our academic and student moderators, who we trust to deliver excellent outcomes for the projects.

Whether joining us in person or online, we hope you will find this week enjoyable and productive. We are very much looking forward to seeing what will emerge from this week and beyond. Finally, we wish for a successful MISG at Monash University in 2023, and we look forward to being there in person!

Natalie Thamwattana and Mike Meylan

2. Programme

Date: 14-18 February 2022

Venue: NuSpace, University of Newcastle, City Campus

Zoom Link: TBA via email to registered participants

Monday 14th February (Rooms X208 and X204)

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|---------------|--|
| 9.30 – 9.45 | Registration (Room X208) |
| 9.45 – 9.50 | Welcome from Head, School of Information and Physical Sciences, Professor Thomas Nann |
| 9.50 – 10.00 | Short address: MISG Co-Directors |
| 10.00 – 10.30 | CarbonPump – Industry Presentation |
| 10.30 – 11.00 | Morning Tea (Room X208) |
| 11.00 – 11.30 | Viper – Industry Presentation |
| 11.30-12.00 | Discussion |
| 12.00 – 13.30 | Lunch (Room X208) |
| 13.30 – 15.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 15.30 – 16.00 | Afternoon Tea (Room X208) |
| 16.00 – 17.00 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 17.30 – 19.30 | Welcome Drinks |

Tuesday 15th February (Rooms X208 and X204)

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|---------------|--|
| 9.00 – 10.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 10.30 – 11.00 | Morning Tea (Room X208) |
| 11.00 – 12.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 12.30 – 14.00 | Lunch (Room X208) |
| 14.00 – 15.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 15.30 – 16.00 | Afternoon Tea (Room X208) |
| 16.00 – 17.00 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |

Wednesday 16th February (Rooms X208 and X204)

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|--------------|---|
| 9.00 – 10.30 | Project Breakouts CarbonPump – Room X208 |
|--------------|---|

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|---------------|--|
| | Viper – Room X204 |
| 10.30 – 11.00 | Morning Tea (Room X208) |
| 11.00 – 12.00 | Mid-Week Project Updates (Room X204) |
| 12.00 – 13.30 | Lunch (Room X208) |
| 13.30 – 15.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 15.30 – 16.00 | Afternoon Tea (Room X208) |
| 16.00 – 17.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X204 |
| 18.00 – 22.00 | Workshop Dinner |

Thursday 17th February (Rooms X208 and X207)

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|---------------|--|
| 9.00 – 10.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X207 |
| 10.30 – 11.00 | Morning Tea (Room X208) |
| 11.00 – 12.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X207 |
| 12.30 – 14.00 | Lunch (Room X208) |
| 14.00 – 15.30 | Project Breakouts CarbonPump – Room X208 Viper – Room X207 |
| 15.30 – 16.00 | Afternoon Tea (Room X208) |
| 16.00 – 17.00 | Project Breakouts CarbonPump – Room X208 Viper – Room X207 |

Friday 18th February (Room X701)

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|---------------|-------------------------------------|
| 9.00 – 10.00 | Summary preparation |
| 10.00 – 10.30 | Morning Tea |
| 10.30 – 11.00 | Viper – Project Summary |
| 11.00 – 11.30 | CarbonPump – Project Summary |
| 11.30 – 11.40 | Final Remarks |

Breakout Sessions

| Project | Room |
|------------|---------------------------------|
| CarbonPump | X208 (Mon – Thu) |
| Viper | X204 (Mon – Wed) and X207 (Thu) |

3. Project 1 – CarbonPump

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|--------------------------|--|
| Academics Moderators: | Melanie Roberts, Griffiths University Fillipe Georgiou, University of Newcastle |
| Student Moderator: | Edward Bissaker, University of Newcastle |
| Industry Representative: | Ignatius Verbeek |

Tool to measure the carbon content of soil

Under the right conditions, soil can capture and store significant amounts of carbon from the atmosphere. Soil carbon can play an important role in addressing climate change while supporting food security and climate resilience. Moreover, capturing carbon in soil is a potential revenue source supporting farmers to improve soil and food health.

One of the critical challenges is measuring the amount of carbon in the soil cost-effectively. CarbonPump is a company focused on creating billion-tonne scale carbon drawdown projects, and soil carbon is one of their key focuses. To enable this, soil carbon stocks need to be measured, and CarbonPump are world leaders in designing simple methods to determine the carbon content in soil quickly and cost-effectively. There are many challenges associated with this process.

This project will investigate some of the critical challenges in this measurement process. In particular, methods to extract information about the soil density without breaking up the sample or using expensive methods. We will also investigate the practical design of the metal sheet used to hold the soil sample. In particular, the most efficient way to cut the metal sheet to induce a strong anisotropy in the bending moment so that it rolls and unrolls effectively.

4. Project 2 – Viper

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|--------------------------|---|
| Academics Moderators: | Phil Broadbridge, La Trobe University Kenneth Duru, Australian National University |
| Student Moderator: | Kyle Stevens, University of Newcastle |
| Industry Representative: | Sam Caldwell |

Role of vibration in solid-liquid separation using a vacuum belt filter

The science of solids and liquids separation is currently applied in many forms to a wide variety of applications at an industrial level all around the globe.

Focusing on processing plants in the Mining industry (for example, metallurgical coal and iron ore for steel making, and battery material minerals (lithium, rare earth, etc.) to support electric vehicles and renewable industries), it is typical that at some point in their process these plants will utilise a solid-liquid separation technology for the production of commercial bulk solids for sale as well as the processing of mining waste streams for storage.

One such solids-liquid separation technology is the Vacuum belt filter. This industry-proven technology has been in operation for decades as a reliable and robust continuous system to separate large volumes of solid-liquid streams.

A recent innovation to this technology has improved the system's efficiency dramatically. The efficiency gain unlocks this filtration technology for new applications such as mine waste dewatering for dry stockpile storage. It has the potential to save millions of dollars per year for existing and new operators. An introduction to the Viper technology will be provided during the group presentation.

In this topic we would like to:

- explore the mechanisms that facilitate the efficiency gain that has been observed with saturated to semi-saturated beds of particles,
- propose methods to validate these mechanisms and
- consider models that could be used to optimise the system's performance.