Mathematics in Industry Study Group (MISG) 2021

27-30 January 2021

University of Newcastle, Australia

Co-Directors	A/Prof Mike Meylan Prof Natalie Thamwattana University of Newcastle
Academic Moderators	Dr Ognjen Orozovic A/Prof Mike Meylan
Student Moderator	Mr Edward Bissaker University of Newcastle
Administrative Support	Mrs Juliane Turner University of Newcastle

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1. Welcome

Welcome to the 2021 Mathematics in Industry Study Group (MISG). This is the second time that the MISG has been held at the University of Newcastle, Australia.

Last year, we saw a great success of the MISG 2020 with four industry projects solved and outcomes delivered. We were planning to carry this momentum forward to the MISG 2021. However, as we all experienced, the rest of the year 2020, we faced many challenges brought by Covid-19. While we were planning to cancel the MISG 2021 completely, we see the great benefit of the MISG to the scientific community, especially to our research students as we witnessed last year at the MISG 2020. As such, instead of cancelling the MISG 2021, this year we run a smaller, one-project, version of the MISG.

We are very excited by the project "Mathematical modelling of pneumatic conveying" brought to us by Dr Ognjen Orozovic from the Faculty of Engineering, University of Newcastle. We thank Dr Orozovic for his support and willingness to participate in the workshop as he was also a participant at the MISG 2020. We hope that this problem will generate interests from a broad range of expertise. We hope to provide the solutions that the industry partners of the University of Newcastle are seeking.

We gratefully acknowledge the support from the University of Newcastle and the School of Mathematical 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 this year who are making an effort to contribute to the MISG 2021 despite all the challenges we face. We also particularly want to thank those of you who are joining us online. We appreciate your extra effort!

Whether you are 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 to see you back in Newcastle in person in 2022.

Natalie Thamwattana and Mike Meylan

2. Workshop information

Date: **27-30 January 2021**

Venue: **Room X205**

Zoom: **TBA via email**

3. Programme

Wednesday 27 January

9.20 – 9.30	Welcome & Short address: MISG Co-Directors
9.30 – 10.00	**Project Presentation**
10.00 – 10.30	**Discussion**
10.30 – 11.00	Morning Tea
11.00 – 12.30	Group work
12.30 – 13.30	Lunch (not provided)
13.30 – 15.30	Group work
15.30 – 16.00	Afternoon Tea
16.00 – 17.00	Group work

Thursday 28 January

9.00 – 10.30	Group work
10.30 – 11.00	Morning Tea
11.00 – 12.30	Group work
12.30 – 13.30	Lunch (not provided)
14.00 – 15.30	Group work
15.30 – 16.00	Afternoon Tea
16.00 – 17.00	Group work

Friday 29 January

9.00 – 10.30	Group work
10.30 – 11.00	Morning Tea
11.00 – 11.30	**Project Update**
11.30 – 12.30	Group work
12.30 – 13.30	Lunch (not provided)
13.30 – 15.30	Group work
15.30 – 16.00	Afternoon Tea
16.00 – 17.00	Group work
18.00 – 21.00	Workshop dinner (venue TBA)

Saturday 30 January

9.30 – 10.00	**Project Summary**
10.00 – 10.10	Final Remarks: MISG Co-Directors
10.10 – 10.40	Morning Tea

4. Project detail

Academics Moderators:	Ognjen Orozovic, University of Newcastle Mike Meylan, University of Newcastle
Student Moderator:	Edward Bissaker, University of Newcastle

Mathematical Modelling of Pneumatic Conveying

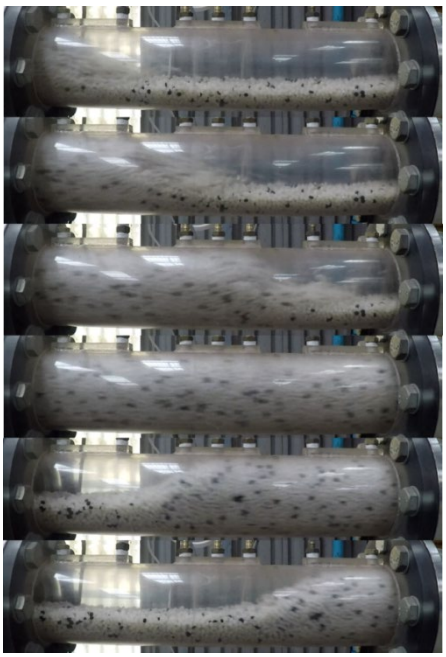
This project aims to develop mathematical models of the pneumatic conveying. This project has come from Industry partners of the University of Newcastle.

Pneumatic conveying is the transportation of granular materials in enclosed pipelines via a carrier gas, typically air (see Figure below). The advantages are enclosed conveying, minimising interactions between the material and the environment, and flexible routing. These advantages are highly suited to food and pharmaceutical applications, which make up over 50% of industrial systems, with the rest made up by the rubber and plastic, ceramic, and cement industries.

For a given material, several flow patterns can be observed depending on the combinations of solids and gas fed into the system. Slug/plug flow is a naturally occurring wave-like flow that is only exhibited by some granular materials. In horizontal pipes, the slug waves are separated by a layer of stationary material that partially fills the pipe and with which the slugs constantly exchange particles

The exact material properties required for slug flow are unknown. However, cohesionless materials, narrow particle size distributions and high particle sphericity are of importance. Operating conditions are also important, and so is the pipeline diameter, as slugs do not form in large diameter pipes. This interrelation of constraints in material properties, operating conditions and design have made slug flow a challenging problem to model and understand.

Apart from academic, the interest in slug flow is that it remedies issues stemming from high velocities and gas use of suspension flows. However, the complexity of slug flow has greatly limited applications. In 2018, suspension flows made up 73% of pneumatic conveying revenue, the market size of which was almost 25 billion USD.



See you again at MISG 2022

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