IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

CSIRO

Project Title:	**Modelling wear in industrial multi-phase flow applications**	
Project Number	**IMURA0724**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address? *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	

1	***Material Science/Engineering (including Nano, Metallurgy)***	***1***	***Advanced computational engineering, simulation and manufacture***
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*	2	*Infrastructure Engineering*
3	*Math, CFD, Modelling, Manufacturing*	3	*Clean Energy*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*	4	*Water*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*	5	***Nanotechnology***
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*	6	*Biotechnology and Stem Cell Research*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*		
8	*HSS, Design, Management*		

The research problem

Define the problem

The handling of particulate materials in industry often involves equipment subject to highly abrasive conditions leading to progressive wear of the equipment and reduced process efficiencies. Despite the significant costs of wear and erosion, there has been little work done in its numerical simulation. In particular, there is sparse knowledge of the wear rate of materials subjected to erosion by multi-phase (granular-fluid) flows. Experimental measurements of this type of erosion are challenging and are limited to specific materials and regimes of flow. There has also been little done in modeling significant equipment wear in complex industrial processes such as mixing, crushing and milling. This means designers currently have limited ability to predict the life-cycle of their components and to make informed assessments about the design and optimisation of their process.

This PhD topic will involve development, application and analysis of a multi-scale wear modeling capability. The project will focus on the simulation of wear in engineering processes involving multi-phase (liquid/solid) flows.

Project aims

Define the aims of the project

The aims of the project are :

1. Develop a detailed micro-scale model of material wear using CSIRO's Smoothed Particle Hydrodynamics (SPH) and Discrete Element Method (DEM) solvers. Currently there is sparse knowledge of the wear rate of materials subjected to erosion by multi-phase (granular-fluid) flows. Numerical modelling and simulation is the most optimal way to predict this type of wear for a range of material, multi-phase flow combinations. The first aim then will be to combine an SPH damage model with CSIRO's coupled DEM-SPH multi-phase flow solver to create a micro-scale wear model. This model will be able to predict the damage (and therefore wear rate) of a material using (readily available) elasto-plastic properties of the material.

2. Validate this model against available experimental data where possible.

3. Apply the micro-scale wear model in a series of parametric studies to determine the variation in material wear with parameters such as flow speed, direction and solid/liquid concentration in the multi-phase flow. This will be used to construct a macro-scale model for the wear rate of materials subject to solid/liquid flows like slurries.

4. Combine this macro-scale wear model with CSIRO's mesh evolution capability to study the effect of equipment wear in two industrial multi-phase processes such as mixing and milling.

Expected outcomes

Highlight the expected outcomes of the project

The expected outcomes of the project will be as follows:

1. the development of a multi-scale framework to predict wear in a broad range of industrial systems involving solid/liquid flows.

2. construction (and publication) of wear models for various combinations of material-solid/liquid flows.

3. further insight into the effect of equipment wear in two industrial processes such as mixing and milling

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

The project will develop a predictive simulation capability of equipment wear in industrial processes involving multi-phase solid/liquid flows. This capability will be a valuable design and analysis tool which can be used in evaluating and optimising processes, material and/or equipment designs.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

- Engineering or Physical Sciences Degree with good physical intuition
- Experience in Numerical Modelling and Analysis of Partial Differential Equations and/or Ordinary Differential Equations
- Good operating knowledge of Linux and Windows operating systems
- Some experience in a programming language such as F90 or C++ or Python
- Good oral, written, presentation skills

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Computational Fluid Dynamics and Mechanics
Smart Manufacturing
Modelling and Simulation
Computer Simulation