# CFD modelling of turbulence in non-Newtonian fluids


## Summary

The turbulent flow of a non-Newtonian fluid in an open channel has important application to transport of minerals tailings suspension in the mining industry. In this project, we aim to use CFD to study these flows in detail to understand their properties. The project will be partially funded by a consortium of Australian mining companies and the successful Ph.D. candidate will have the opportunity to travel to international conferences as well as opportunities to interact with sponsor companies and make useful networks to further their career.


## Project

This Ph.D. project will consider CFD modelling of turbulence in a class of non-Newtonian fluids known as shear thinning fluids. This type of fluid approximates many minerals suspension, in particular high concentration tailings suspensions. Their flow in pipes, flumes and free-forming channels is an important consideration in the mining industry and impacts on energy use, tailings disposal stability, water recovery and sustainability of the operation.

The questions we aim to answer in this project are

1. How does rheology affect the transition to turbulence in shear thinning fluids, especially as the yield stress increases?
2. How does rheology effect the near wall turbulence structure and what are the implications of this for particle suspension, wall drag and pumping energy?
3. How does the free-flow of such fluids create channels in an existing bed, what shapes do these channels take, are they stable, and what is the turbulence structure in them?

Although these are fundamental fluid mechanics questions, their answers will impact on practical applications including the environmental impact and sustainability of the tailings disposal operation.

The project will focus on undertaking Direct Numerical Simulations (DNS) of turbulent flow using a Spectral Element code developed at Monash University and extracting an understanding of how rheology modifies turbulence as well as the likely consequences of this modification. We aim to investigate how to extend the code to simulate the creation and meandering of self-formed channels.

This project will be undertaken in collaboration with CSIRO, AMIRA and a number of major mining companies. Although the successful student will have the opportunity to attend sponsor meetings and network with major companies, this research will NOT be restricted from publication.

## Student

We are seeking a student who has a good understanding of fluid mechanics, has experience in Computational Fluid Dynamics (CFD) at the undergraduate level (prior experience in project work using CFD desirable) and good mathematical ability. Some experience with coding in C, C++ or Fortran is desirable (but not essential) as is some Supercomputing experience. Although the latter two are not essential, a preparedness to learn is.

## Opportunity

**Remuneration** will be at the standard indexed APA scholarship level ($24,653p.a. in 2013) ***with the potential*** for a scholarship top up of $6,000 p.a. being offered to a student with appropriate background. For international students, a fee scholarship may also be available.

This project will offer the successful candidate a unique opportunity to undertake leading edge research that has application to real problems, at the same time as developing an understanding of industry needs and developing industry contacts.

## HOW TO APPLY

If you are interested in this opportunity, please check if you are eligible to apply for a Ph.D. at Monash University at the following web site: http://www.monash.edu.au/migr/apply/eligibility/index.html.

Your current qualification and grades should be 1st class honours equivalent (H1E). Some guidance on what this means can be found at http://www.monash.edu.au/migr/apply/eligibility/scholarships/eligibility/common/index.html

For international students in particular, it is difficult to give precise guidelines, and your H1E status will be determined by Monash on a case by case basis depending on your academic record.

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If English is not your native language, you need to also meet satisfactory standards of English. These are detailed at http://www.monash.edu.au/migr/research-degrees/handbook/chapter-two/2-2.html

**PLEASE NOTE:** This industry-based scholarship is not included on the list of scholarships detailed on the web site mentioned above. However the requirements for applying are the same.

**If you are eligible**, read the following instructions carefully and prepare the listed documentation:

1. Please prepare a covering letter that outlines your skills and experience that is relevant to this research area (2 pages maximum)
2. Please prepare a statement that clearly details ***how*** you meet each of the selection criteria mentioned below. Give examples that demonstrate your experience. *If you do not explicitly address the Selection Criteria your application will not be considered.*
3. Please include a formal transcript of your academic record from your University (translated into English if necessary).
4. Please include a CV.
5. Please include the names and contact details (phone and e-mail) of two academic (or professional) referees that could comment on your ability and experience.
6. Please indicate when you would be able to commence this project (subject to Visas etc.)
7. Please let me know where you found out about this opportunity.

Send your applications via e-mail before 15th May 2013 to

Professor Murray RUDMAN
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If you have any questions regarding the project or anything else, also feel free to contact me on the above e-mail address.

## Closing date

May 15 2013

## Selection Criteria

### Prerequisite

A Bachelors degree with 1st class Honours (or equivalent) in a relevant mathematical branch of engineering or science.

### Essential criteria

1. Energetic self starter with a strong desire to learn new skills.
2. Proven knowledge of fluid mechanics at the undergraduate level.
3. Proven background in using numerical methods related to continuum problems, and preferably some experience with fluid mechanics simulation.
4. Good physical intuition.
5. Demonstrated ability and desire to work with other people, (preferably in multi-disciplinary teams)
6. Good personal organization skills
7. Evidence of well-developed written and verbal communication skills.

### Desirable criteria

1. Experience in modelling fluid flow using CFD simulation software
2. Scientific programming skills with expertise in Fortran 90 and/or C++.
3. Some knowledge of one (or more) of non-Newtonian rheology, hydraulic transport and liquid-solid 2-phase flow.