## Suggested PhD Projects

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- Project suggestions below **do not have funding attached**. Please **do not** ask me to find funding for you. Details of postgraduate fees can be found on the MACE website.

  The only University of Manchester competitive funding for which there is a worthwhile chance of success is for **Chinese nationals**, via China Scholarship Council (CSC), which may be supplemented by Faculty fee waivers:
  https://www.manchester.ac.uk/study/postgraduate-research/funding/opportunities/display/?id=00000205

- Candidates should have:
  - a 1st or 2.1 class degree (Masters level desirable) from a good university;
  - a first degree in engineering, mathematics or physics;
  - previous experience of CFD (Computational Fluid Dynamics);
  - computer programming ability in either Fortran 90/2003 (or later) or C++2011 (or later);
  - understanding of theoretical fluid mechanics;
  - ability to write scientific English.

- Other applicant-defined projects may be considered, provided that they align with our research interests.

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## CFD Investigation of Tidal-Stream Turbines in Waves

The project will use an in-house CFD code (STREAM) to establish a suitable modelling protocol (turbine representation and wave representation) for tidal-stream turbines in waves.

The project will:
- examine different CFD turbine representations (blade-resolved, actuator-disc, actuator-line);
- evaluate the response to regular, solitary, random and focused waves;
- compare with existing experimental data (turbine loads and wake velocity) from the wave-current flume in Manchester and elsewhere;
- examine the influence of turbine operating strategy (speed control) on load mitigation;
- extend, improve and validate blade-element-based actuator models for tidal turbines.

## Integral Plume Models For Particle-Laden Plumes

The project will involve both experiments and integral plume models / CFD to model the evolution and spread of particle-laden buoyant plumes and jets, the resulting plume dynamics and the deposition distribution of particles around the source.

Project aims are:
- To develop validated semi-empirical models based on integral-plume-based modelling of the time and space evolution of particle-laden buoyant plumes and jets in neutral and stably-stratified quiescent fluid;
- To develop predictive models for the spatial distribution of particle deposition from such emissions;
- To undertake laboratory experiments to establish a database, provide parameterisations needed by the numerical models (e.g. initial and final rise) and validate models.
- To improve understanding and parameterisation of "source effects": e.g. finite source dimensions, initial momentum and inhomogeneous particle distributions.

## Local Scour Induced by Turbulent Jets

CFD and experimental investigation of single and multiple near-wall jets, including sediment transport and scour. Applications include tidal barrages and marine or river outfalls.

A physical model will be developed in a water flume which will allow the discharge of single and multiple submerged jets at different heights over a particle bed.

In parallel, CFD studies will be conducted to provide more detailed flow behaviour and improve the modelling of sediment transport and scour.

## CFD Simulation of Sediment Transport and Scour Around Hydraulic Structures

Use an in-house CFD code (STREAM) to model sediment transport (bed load and suspended load) and the accompanying scour or accretion in disturbed flow, including

- bridge piers;
- river bends;
- under pipelines;
- locks and gates.

## Random-Walk Modelling of Particulate Dispersion

Computationally-efficient random-walk modelling of heavy particles will be used to simulate dispersion and fall-out. Applications include accident scenarios at chemical and nuclear plants, deposition around marine outfalls, crop-spraying and medical uses of aerosols.

The background flow and turbulence properties will be provided by an in-house CFD code.

## Wave Transformation and Interaction With Coastal Defences

The project will use the Stansby and McCabe 1-d shallow-water-flow code to improve modelling of overtopping, reflection and scour at coastal defences.

The project will aim to improve the underlying computational model (e.g. non-uniform mesh and discretisation of advection; reaction forces at boundaries; wetting and drying). It will also incorporate sediment transport (bed and suspended load) and bed evolution.

## Improved Surface-Following Finite-Volume Method For Free-Surface Flows

Improve the free-surface capabilities of the in-house CFD code STREAM. In particular:

- improve grid-evolution algorithms (currently, just vertical stretching) for more extreme waves;
- integrate cut-grid or other algorithms to compute over-topping of sea defences using surface-following rather than volume-of-fluid methods.

## Outfall Design: Effects of Alignment, Geometry and Assisted Motion to Prevent Backflow

Combination of experimental simulation (rig to be designed) and CFD (commercial code StarCCM+) to investigate outfall design.

Investigate passive (outfall geometry) and active (stream-assisted pumping) of outfalls to prevent backflow during high-river-flow events.