IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Complex systems approach for sustainability assessment	
Project Number	**IMURA0385**	
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Research Academy 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. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

Sustainability is defined as the development that meets the needs of the present without compromising the ability of the future generation to meet their own needs. Achieving sustainable development requires balancing the long-term economic, environmental and social objectives, and is one of the most complex scientific problems of recent times. This topic goes beyond the traditional areas of engineering design and industrial ecology and encompasses the ecological and social implications of technological decisions. Moreover, the systems of interest are highly complex exhibiting multi-scale phenomena and interactions of multiple disciplines

Project aims

The goal of this research is to use complex systems theory based approach of agent-based modelling to study the sustainability of dynamic systems. These systems evolve over time in the presence of uncertainties, and the components adapt dynamically to achieve the desired objectives. The agent-based approach allows the modelling of such complex behaviour, and is therefore preferred over the traditional equation based approach. The theory of chaos and network can also be applied to study the fundamental aspects of such systems.

We will develop a representative model capturing the important aspects of a human-economic-ecological system such as resources, industries, and waste generation. The model will be parameterized to simulate a specific physical system, such as an industrial complex within a case study of interest. Multiple scenarios relevant to the system will be identified and modelled. The simulation studies will be used to first understand the implications of development and then to evaluate the impact of different corrective measures. We will also study the differences between the agent-based approach and the traditional equation based approach.

Expected outcomes

The expected outcomes include the assessment of design and management decisions for achieving sustainability, and making policy recommendations. The work will also aim to develop new modelling approaches to model these complex engineering-social-ecological systems. That will be the theoretical contribution of the work.

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

The proposal work will be based on using advanced computational engineering and simulation techniques to solve the problem of sustainable development. While the theoretical and conceptual development will be generic, we will take up specific problems that could be in the area of water, clean energy and/or infrastructure. Therefore, the applications might cover many of the Academy's themes.

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.

Successful completion of this research will require the following skills:

- Strong mathematical foundation
- Experience in simulation modeling
- Basic training in engineering with some appreciation of the allied field such as ecology, policy, social sciences, and humanities
- Experience in data collection, interpretation, and processing, and their integration with models.

This is a highly interdisciplinary topic and would require someone to be open to exploring concepts in ecology, humanities, and social sciences in addition to foundation of engineering.