IITB-Monash Research Academy

An Indian-Australian research partnership

Indian Institute of Technology Bombay | MONASH University

Project Title:	**Fractional Factorial and Related Designs– Optimality and Construction**	
Project Number	**IMURA0451**	
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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

The recent rise of popularity of supersaturated designs in industrial experimentation is mainly attributed to the cost efficient nature of these designs. In the initial stages of an industrial experiment the set of factors which may influence the response is chosen to be large. However, the number of factors actually affecting the response is small, known as the effect sparsity problem. To accommodate the large number of factors the experimental runs increase, leading to an

elevation in the cost of experimentation. In these situations, supersaturated designs in which a number of factors may be much larger than the number of runs are usually employed. Using these designs the researcher is able to screen for the few active factors actually affecting the response. However, analysing the data from these experiments can pose computational challenges due to the use of less number of experimental runs than factors.

For enhancing product quality in industry experimentation, Genichi Taguchi advocated the use of robust parameter designs. Taguchi identified that there are two types of inputs in a production process: some easy-to-manipulate inputs known as the control factors and some-difficult-to-manipulate inputs known as noise factors. The noise factors are the sources of variations in the process response when the system is used in practice, but they can be controlled in an experimental environment. The main objective of robust parameter designs is to determine the settings of the control factors that achieve a desired mean response as well as making the process robust, or insensitive, to the effects of noise variables. However, when the number of factors affecting the response is large, the huge number of experimental runs needed to fit all the factors and their interactions adds to the cost of the experiment. In these situations, application of supersaturated experiments in robust parameter designs proves to be economically beneficial to the researcher.

Project aims

- ❑ Improved lower bounds for $E(s^2)$.
- ❑ Obtain supersaturated designs or lean designs for both symmetric and asymmetric factorials.
- ❑ Study estimability of fractional factorial designs obtained.
- ❑ Application of fractional factorial designs in choice experiments.
- ❑ Selection techniques of the active factors under the effect sparsity principle.
- ❑ Efficient blocking of experimental runs when some two-factor interactions are important.
- ❑ Computer intensive construction of optimal block designs for above objective.

Expected outcomes

Outcomes expected from the project.

- The project will result in new improved bounds for $E(s^2)$ and determination of optimal supersaturated designs and efficient blocked designs for models involving main effects and two factor interactions.
- It will also result in development of new computer search algorithms for finding the optimal designs.
- Fractional factorial designs optimal under the $E(s^2)$ criteria.
- Optimal designs for choice experiments through use of fractional factorial designs.
- The research output will result in publications in high impact factor international journals.

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

The project addresses the first theme: advanced computation engineering, simulation and manufacture. The model selection part of the project will be using computer simulations to choose the active factors. The construction and selection of supersaturated designs will require wide range of computer algorithms. Usage of supersaturated experiments along with robust parameter designs will give us a

cost efficient tool to enhance product quality in manufacturing industries. We will also look at real world industrial problems and provide solutions for enhancing product quality in the supersaturated case.

Capabilities and Degrees Required

Applications are invited from students with Bachelors/Master's degree in Statistics, Mathematics and any other engineering sciences

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.

Please provide a few key words relating to this project to make it easier for the students to apply.

Experimental design, Factorial designs, Supersaturated designs, Choice experiments