



## Designing with big DATA – Design, Analysis and Fabrication of a Complex Geometry Gridshell

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### Abstract

This paper will examine the impact of big Data on structural engineering design. With continuing advancements that liberate the geometrical form, as well as the increasing structural efficiency created by digital fabrication, structural engineers are dealing with unprecedented amount of data related to both geometry and analysis.

Taking as a case study the work done on Jewel, a 12,500m<sup>2</sup> gridshell at Changi Airport in Singapore, we will examine strategies and opportunities for new ways of working with the large amount of information and options generated by a project of this size and scope.

**Keywords:** Geometry, Gridshell, Steel, Complex Forms, Dynamic Relaxation, Form Finding, Node Construction, Glass, Airport

### 1 Introduction

We are all familiar with the myriad ways the computer has revolutionized our approach to building analysis. The impact of digital manipulation of data in the building design process, however, as well as digital fabrication in building manufacturing, is much less clear.

As we shall see, some of this impact is upstream of the familiar design and construction process itself as engineers have to grapple with an understanding of how digital generation of forms and fabrication processes will change the way that they look at projects and the types of decisions that they make.

This shift has opened the door to accepting other important drivers into our design process that are not necessarily directly related to structural engineering. Of course, good engineering design

has always contemplated the drivers that exist in projects that are not necessarily structural behaviour; however, with the tools now at our disposal, these other drivers can include choices that might be related to manufacturing limitations, project aesthetics, environmental performance, or digital fabrication processes -- each with its own level of complexity.

In this paper, I will explore the design process that was part of the development of a very large gridshell project. Although the structural analysis of this project is significant and will be of interest to many readers, what will be explored here is the other design drivers that both influenced the design and had to be considered and manipulated by the structural engineering team in order to provide the best project. The amount of information was very large (big DATA) and needed to be rapidly synthesized and understood in order to provide meaningful insight into the design