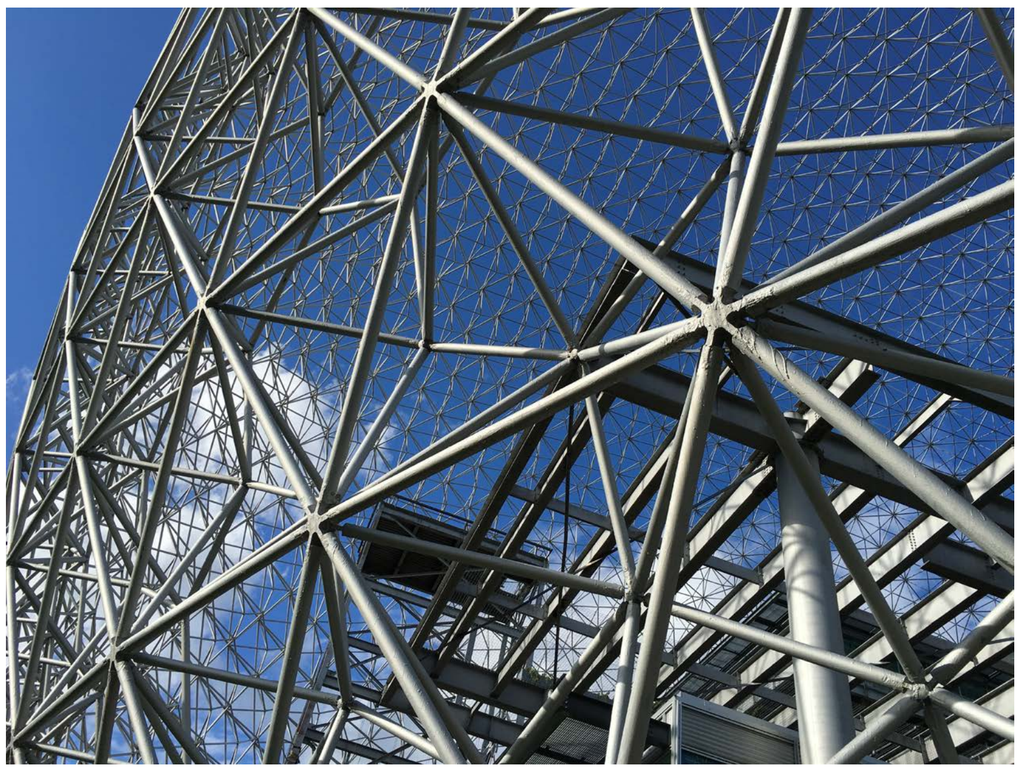

FROM REPETITION TO CHAOS:

Complex Fabrications in Contemporary Steel Structures

The Emergence of Complexity in Architecture

The architectural definition of complexity as defined in Robert Venturi's 1966 book "Complexity and Contradiction in Architecture" was written well before the onset of Deconstructivism and subsequently, Parametricism. It was written when structural system design was still being governed by sliderule-based design. Complexity in a structural steel system, as could be seen in High Tech style projects such as the Pompidou Center or Sainsbury Center for the Arts, was based in the modular repetition of a more finely detailed major structural element that could still be calculated by the same means. Force differentiated decision making to express the compression and tensile forces via member type selection introduced a level of visual complexity. Compression members made use of the then new Hollow Structural Steel sections and tension was resisted via rods or cables. Prior to this forces were seldom expressed and the main of projects employed wide flange (Universal) sections for the majority of structural elements, regardless of their loading requirements.

The heightened level of complexity that we are currently seeing in exposed/expressed steel structures reflects a design shift from Mies van der Rohe's "Less is more" toward Venturi's "Less is a bore", and from the Modernist era of mass production reflected in Fordism to the mass customization that dominates design in the Post-Fordist era. Such a shift has been facilitated by digital design software that is fully capable of handling highly complex angular geometries as well as curves. Where early software offered no interoperability between architectural design, engineering and fabrication software and the associated technical requirements, more recently the level of interoperability has soared. At this point Cloud based systems permit architects, engineers and steel fabricators to simultaneously create a comprehensive set of documents for structures. This level of communication has the potential to speed up the design and detailing process as well as minimize conflicts in all aspects of the construction process.

The demands on the design and fabrication of steel systems that are characterized by chaotic and non-repeating geometries require a significant understanding of the implications on fabrication by design intentions. There is still a wide gap between what can be designed within an advanced 3D architectural model, and what can be realistically fabricated. Contemporary fabrication processes, though using high level digital design tools themselves, still rely on a significant level of craft and human intervention for optimally successful results. Although some computer assistance is used to cut complex shapes (particularly plate material) and control repetitive procedures such as the drilling of holes, the majority of the process has remained a craft that is carried out by the ironworker. This means that the success of the project still largely rests on the expertise of the welder and the judgment of those involved in the erection process.

The paper will focus on comprehensive strategies in the design and detailing of complex steel structures, based on a recently established set of criteria for Architecturally Exposed Structural Steel, by CISC (Canadian Institute of Steel Construction), AISC (American Institute of Steel Construction), SCNZ (Steel Construction New Zealand), and AIS (Australian Institute of Steel Construction). These will be related to a wide range of example projects and close view fabrication details arising from the application of high level digital design and craft based fabrication to extraordinary projects.