Design of Heavy Movable Structures using Advanced Modelling and Visualizations

Keith R. GRIESING, PE
Principal Associate
Hardesty & Hanover, LLP
New York, NY USA
kgriesing@hardesty-hanover.com

Keith R. Griesing received his BECE in 1993 from The Cooper Union for the Advancement of Science and Art, USA and his MECE in 1998 from the The City College of New York, USA.

Summary

The Heavy Movable Structures (HMS) industry, which includes movable bridges, kinetic architecture, and stadium roofs, in general, has not implemented building information modelling (BIM) to the same extent as other sectors of the Architecture/Engineering/Construction industry. The use of the solid modelling and visualization concepts inherent in BIM can be beneficial to the design and construction of HMS. HMS are typically complex, dynamic mechanisms that require coordination of multiple disciplines of design professionals, such as structural engineers, architects, mechanical engineers, and electrical engineers. The development and advancement of computer aided design and three-dimensional modelling tools permit close coordination amongst these groups and overall project quality to be increased.

Keywords: movable, bridge, visualization, rendering, animation, electrical, mechanical, solid, modelling

1. Introduction

Design professionals have historically used three-dimensional views to convey their design conceptions beyond what could be achieved through the use of standard two-dimensional views.

With the advent of computer-aided drafting and solid modelling software, the use of visualizations and renderings has become more integrated with the design process. This paper will discuss the multiple roles visualizations can fulfil for a design professional and how they can be used as part of the design process for complex structures.

2. Visualization and the Design Process

In order to understand the role visualizations can perform it is beneficial to define the term in the context of a design professional. The dictionary [1] defines visualization as the "formation of mental visual images." The pencil and paper have been the common means to translate this mental image into visual data that others can utilize. However, in the context of the current design marketplace, the definition of visualization has evolved. The term is now used to represent the physical, in lieu of mental, three-dimensional image of a design concept. The visualization (meaning the produced image, not the process) has been removed from the mind of the designer and moved onto various forms of physical media (paper, computer images, etc.). This change in definition is indicative of a dramatic shift in the design process.

3. Comparison of Design for Vertical Construction and Infrastructure

The efficiencies and benefits of BIM have been well-documented. The use of BIM is becoming more commonplace in the vertical construction (buildings and similar structures) sector.

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The repetition and full advantages of BIM are not readily achievable in heavy movable structure design. Each movable structure has its own characteristics and the system layout is a function of the structure type (bascule, swing, or vertical lift bridge, for example).

4. Use of Visualizations in Heavy Movable Structure Design

Modelling and visualizations can be used in three main ways in heavy movable structure design:

- Communication with Client (Owner) and Public Outreach
- Marketing and Business Development
- Design Development

The use of visualizations for the first two ways noted above has been documented extensively and is not the focus of this paper [2].

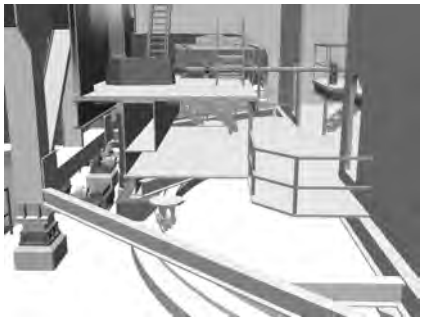

Fig. 6: Swing Span Bridge Pivot Pier Coordination

For heavy movable structures, modelling and visualization has been used in two manners. Modelling and visualization can be used as a quality assurance measure or it can be used as an integrated part of the design. The first method has been used on a number of projects and has yielded benefits in the overall incidence of field conflicts. The second manner has been used for critical detail areas and has shown promise. To date, a full heavy movable structure design has not been created utilizing this design approach.

For use as Quality Assurance, modelling is a post-design process and is used to verify both the technical accuracy of the design as well as the content of the contract documents (Figure 6).

As discussed above the use of modelling and visualization as a post-design process may not be the ideal solution when considering the schedule and budget for a design project. One means of reducing both the design time and the potential for rework is to integrate modelling into the design process. The model serves multiple purposes and is the primary coordination tool between disciplines. The model also can be used to generate the contract drawings, for geometric information for analysis packages and serves as the foundation for presentation media.

5. Conclusion

Modelling and visualizations have long been used for presentation media in this industry for movable bridges, kinetic architecture, and stadium roofs. With the increased availability and ease of use of the software, the use of modelling as a design tool in the heavy movable structure sector of this industry has increased. The use of modelling technology in this industry will only increase in the future and the heavy movable structure sector, due to the complexities inherent in the structures, will need to be at the vanguard of this movement in order to meet the demands and needs of the clients for these special structures. An integrated approach to design and modelling appears to offer the most benefit to the designer in terms of efficiency and quality.

6. References

[1] MERRIAM-WEBSTER., Webster's Ninth New Collegiate Dictionary, p. 1319.

[2] WALKER, DOUG, "Visualization as a Common Language for Planning", *TR News*, Number 252, 2007, pp 7-10

[3] © Lavigne Cheron Architects. Use of image courtesy of Vinci Construction, Jean Muller Int'l Architecture et Ourvrages D'Art, Michel Virlogeux, CIMOLAI, Hardesty & Hanover Int'l. LLC