Digital Technology and IPD - a case study
The Crystals Mall- Las Vegas

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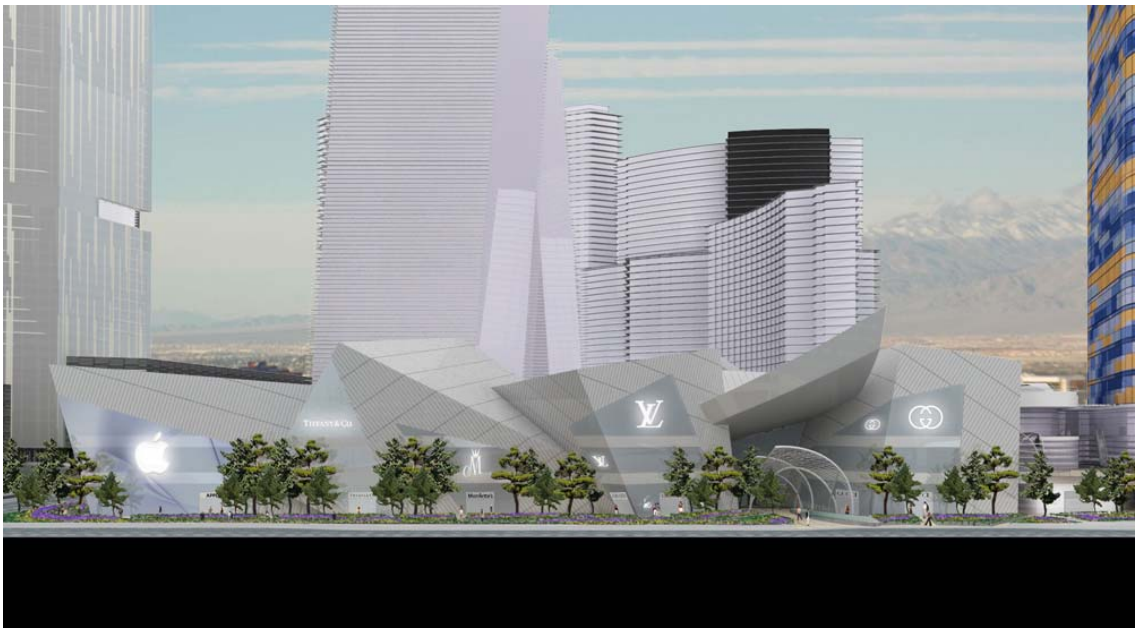
Summary

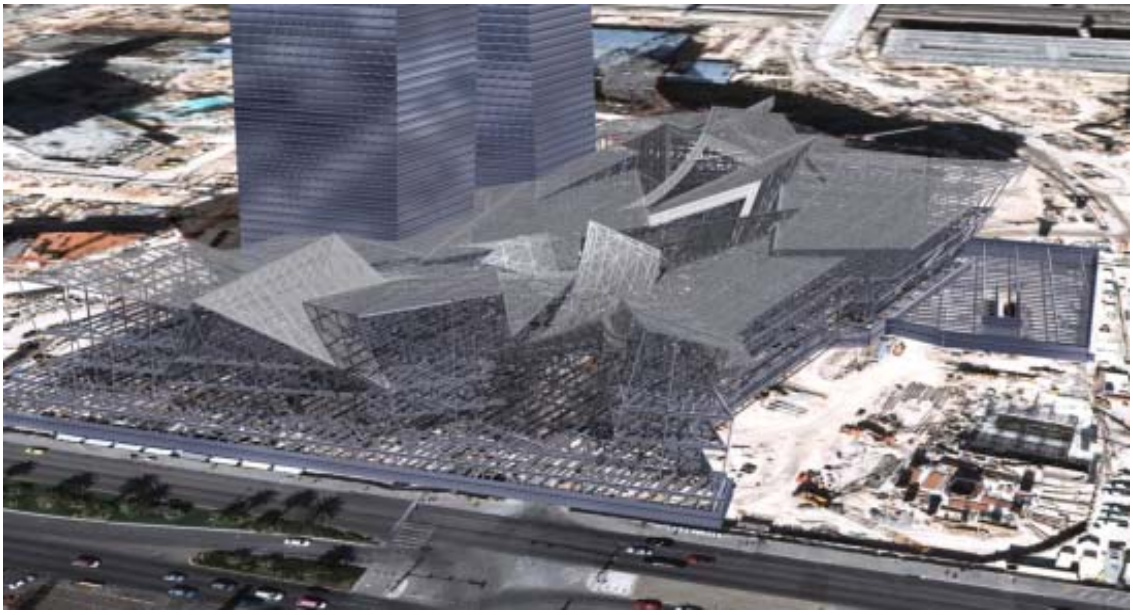
BDS VirCon was the detailing and modelling firm on the Daniel Libeskind designed The Crystal Mall in Las Vegas which, was part of the mammoth City Centre project. The complexity of the structure forced the key project participants to collaborate and work closely with BDS VirCon to develop a fully detailed, data-rich 3-D parametric model ("Detailing Model") often from engineering preliminary models and sketches. This collaborative process generated significant process efficiencies which saved engineering costs and compressed the project schedule. More importantly the early creation of the Detailing Model enabled the project participants to fully utilise its data-rich, sophistication to:

- Producing the advanced bill of materials
- Programming the sequence break-ups
- Scheduling fabrication and delivery
- Assessing the truss splice locations
- Determining the lifting lug placement
- Erection planning and erection sequencing
- Performing constructability reviews

Introduction

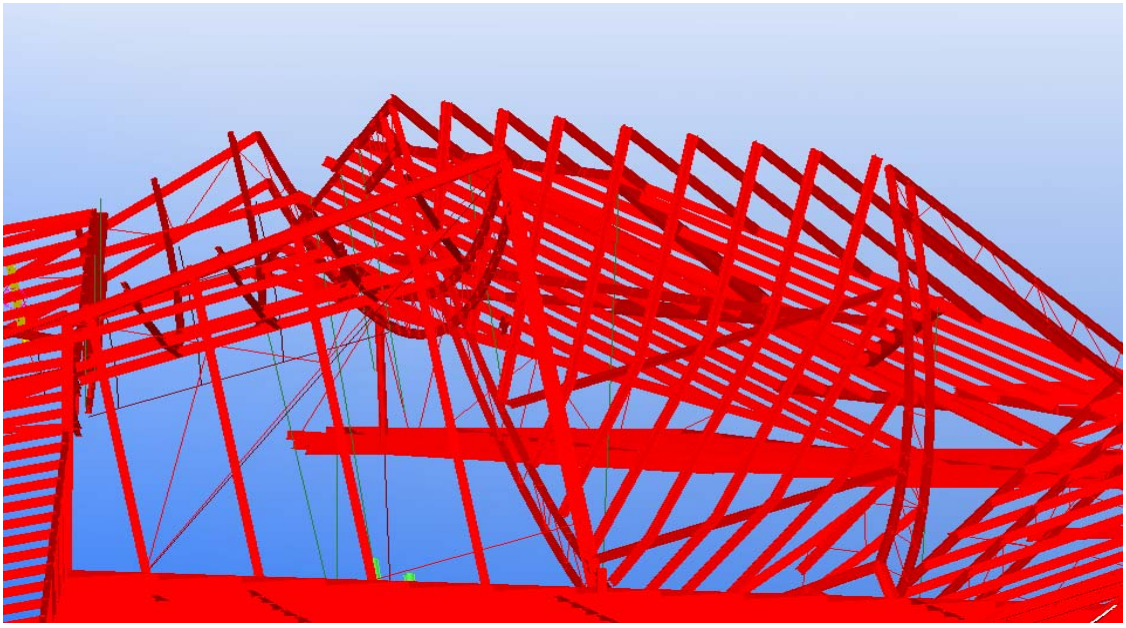
The City Centre project in Las Vegas - a joint venture between MGM Mirage and Dubai World, is the most expensive, privately-funded development in the western hemisphere at a capital cost of US$11bn. The project is located on 73 acres of the Las Vegas Strip, comprising of 61-story, 4,000-room gaming resort; three luxury non-gaming hotels; two large multi-residential towers; approximately 2,400 condominiums; and 'The Crystals Mall'- a retail and entertainment district.

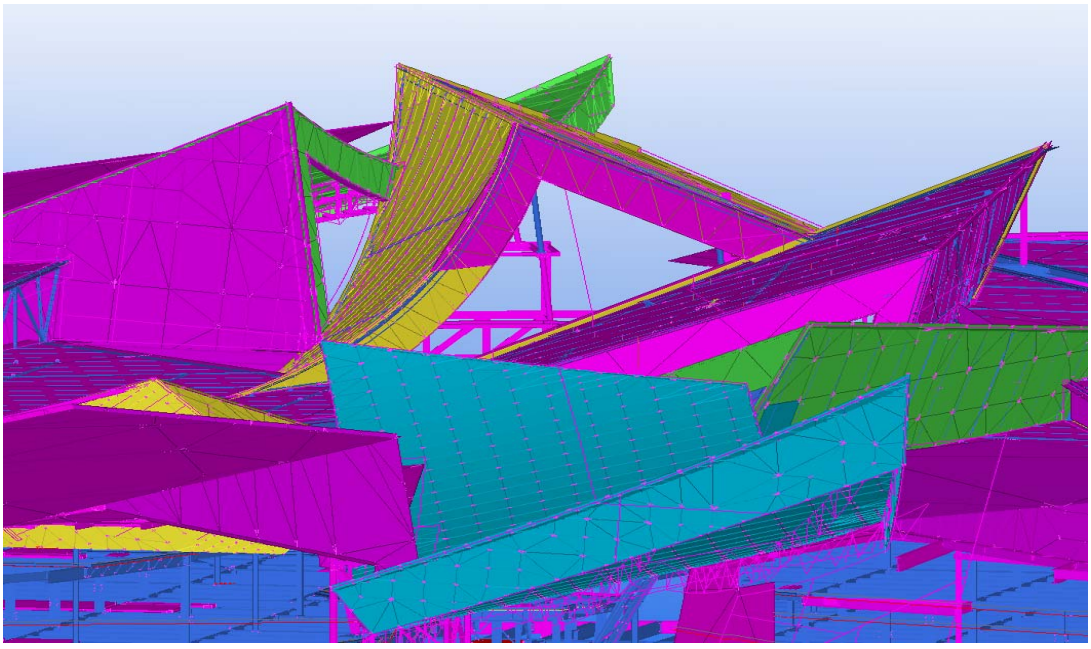




BDS VirCon was the detailing and modelling firm for The Crystals which was designed by Daniel Libeskind, engineered by Halcrow Yolles and Schuff Steel was the steel fabricators and erector. The Crystals is a 14,000 ton steel structure with underground parking, two levels of beam and column framing covered by a highly-complex roof featuring 19 separate but interlocking structures. Its construction required extensive collaboration between the architect, engineer and the detailer; particularly since the complex roof geometry could not be adequately defined by traditional 2-D documentation.

The use of 3-D modelling is not new and, its adaption by engineering, architectural and detailing firms for the past decades has enabled the construction of more complex structures, and also significantly reduced errors and site rectification and rework. The use of modelling technology alone has created significant project savings in the design and construction phases of projects. However, its benefits are still not being fully realised on most projects, as many firms don't fully use all the benefits of an Integrated Project Delivery ("IPD") methodology. Some of the critical, but often overlooked benefits of using digital technology in a collaborative IPD environment during the construction phase became apparent when the complexity of The Crystals roof design forced the participants to closely collaborate.



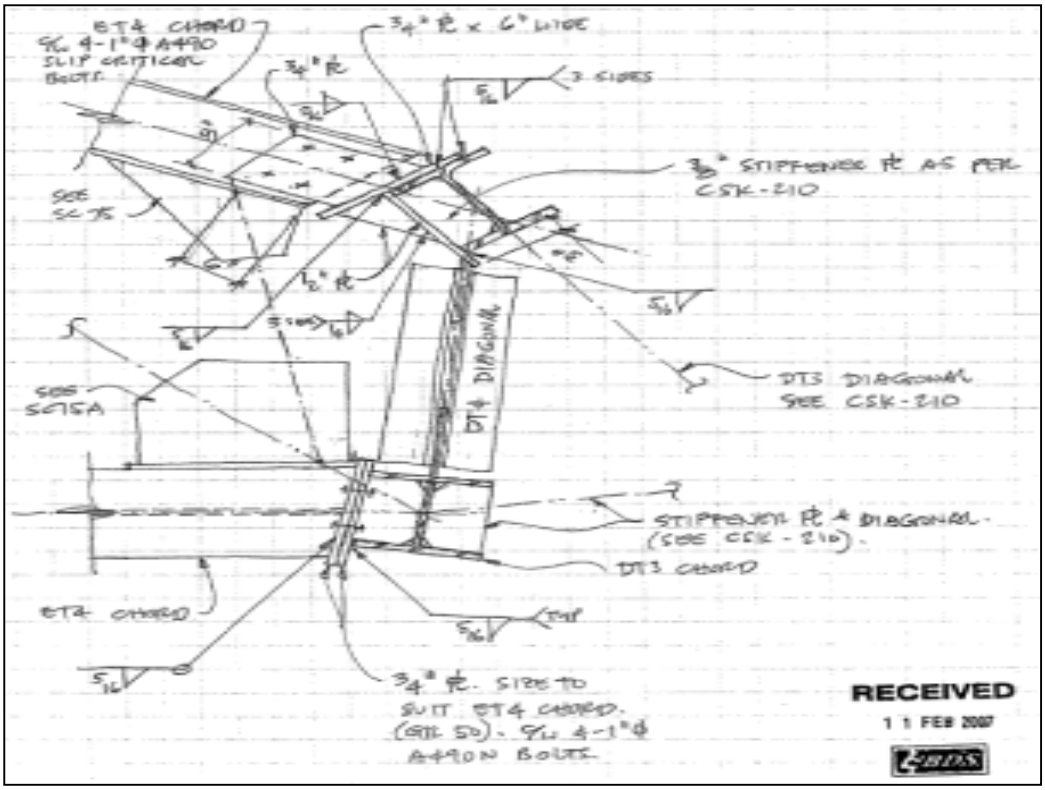


City Centre - Construction Planning Process

The City Centre project was designed by Daniel Libeskind who provided 3-D reference files for the roof skin. These files were reviewed extensively to ensure that not only the primary steelwork, but also the connection plates and bolts would not penetrate the roof skin; preventing on-site clashes and costly rectification. These files were also used to set-out the necessary curved bent-plate roof edge plates on the perimeter steelwork of the roof.

The complex, interlocking straight and curved roofs meant that the connection design could not be undertaken by traditional methods. To foster the collaboration, three engineers from Halcrow Yolles moved to Brisbane to work closely with the BDS VirCon modellers to resolve design and connection issues directly in the model. So the Detailing Model became a collaboration tool for the project team and was used by multiple parties and discussed extensively via phone calls and WebEx meetings. This then significantly assisted the engineers to understand the actual geometry of the steelwork members, so that they could develop the unique connection designs required for more than five hundred individual connections.

The connections were initially produced via simple hand sketches without the need for traditional (and formal) connection design documentation; these sketches were then interpreted by the detailers and incorporated into the Detailing Model. This simple collaboration saved the project enormous time in producing complex connections efficiently, thereby avoiding long-winded formal RFI[1] processes, and eliminated the need to formalise the connection designs in engineering drawings.



From the engineering's sketches BDS VirCon created a digital model and through a collaborative process it finalised the steel layout and developed the model in Tekla Structures[2] where all the elements were detailed in a parametrically perfect, data-rich model ("Detailing Model").

This collaborative approach matched the fabrication and constructability skills of the Detailer with the design intellect of the Engineers by drawing on their respective core disciplines. The process of collaboration and engagement in the design office facilitated the quick resolution of design, fabrication and construction issues as-and-when they arose and maximised efficiency in project design. Further efficiencies were achieved by eliminating the need for completed 2-D design

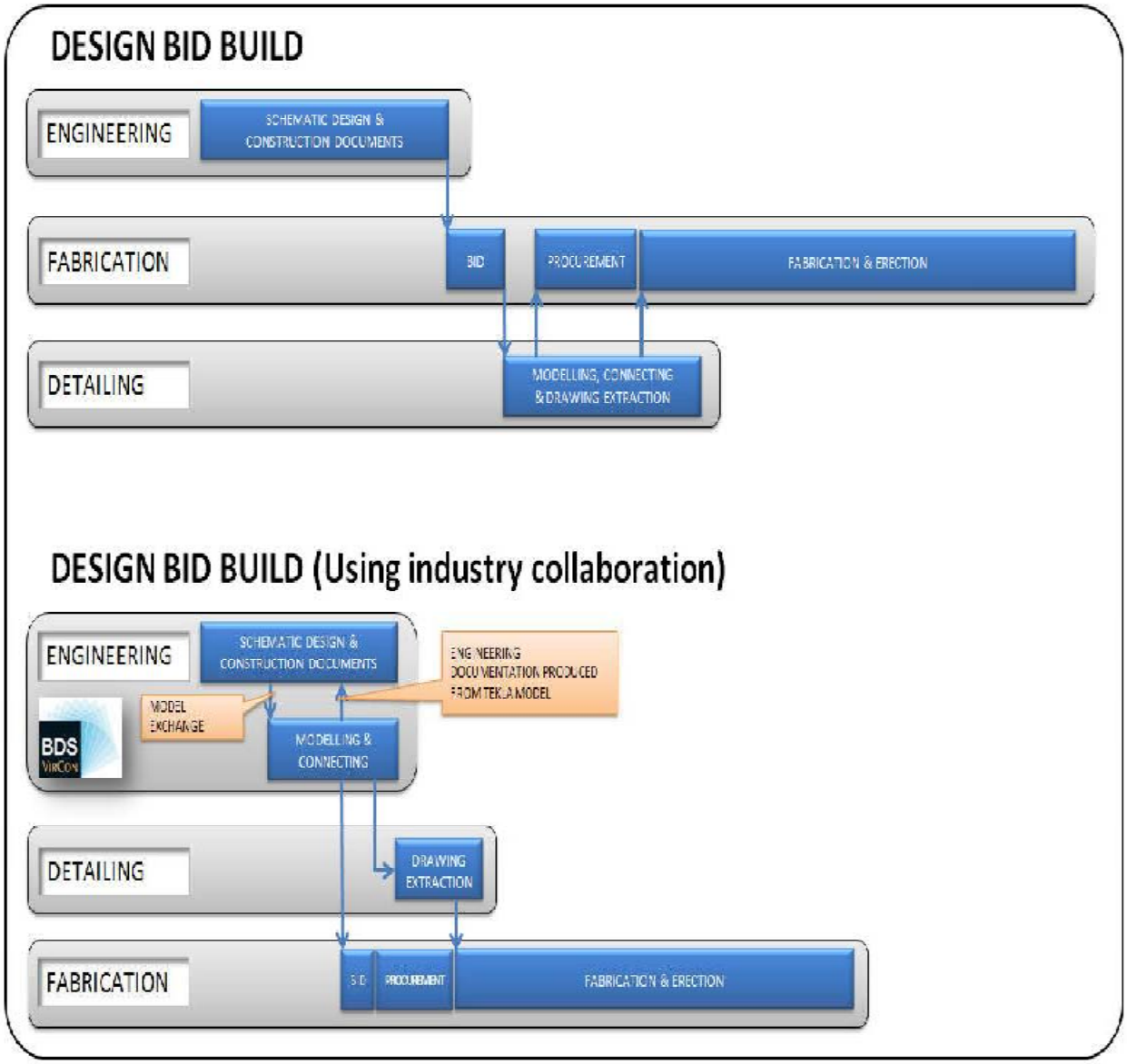
[1] *Request for Information*

[2] *Tekla Structures is the leading 3-D modelling and steel detailing for structural steelwork and concrete.*

documents through the creation of a single integrated, fully detailed 3-D model as opposed to the traditional process of developing separate Engineering and Detailing Models.

Beyond the obvious cost savings to engineering, the most significant benefit of this process was the compression of the overall project schedule. In eliminating the need to produce a completed set of 2-D design/engineering documents before detailing commenced, the development of the Detailing Model was completed much earlier as illustrated in the figure below.

Therefore when the Detailed and Connected Model were approved by the design team, both Engineering Drawings and Fabrication Drawings were produced from the one model. With the guidance and overview of the design team, the Engineering Drawings were then generated to ensure contractual and engineering compliance.



Fabrication Savings, Risk Mitigation and Efficiencies

From the final connected Detailing Model, BDS VirCon exported 3D files to the cladding contractor which formed the basis for the cladding set-out and its manufacture. Similarly files were also provided to the fire sprinkler and decking suppliers which then formed the basis for their set-outs and manufacturing.

This ability to constantly import and export data from the Detailing Model saved the project significant time and effort in averting the need to provide formal documentation to all parties. Furthermore, all the information including email exchanges, images of the hand-sketches etc were captured in the Detailing Model providing an easily accessible information database right through the construction process including inspection and certification. The early completion of the Detailing Model also expedited fabrication, as steel could be procured with certainty with a model providing accurate quantities and detailed connections.

Ensuring fabrication quality and accuracy was critical to minimizing the overall risk in the construction process. This was achieved because the Detailing Models generate not only 2-D shop drawings but also create Numerical Control ("NC") files for the CNC machines that fabricated the steelwork. The Detailing Model was used to directly feed into Schuff Steel's automated fabrication control software program Fabtrol[3] which controlled fabrication efficiency through plate and shaft nesting, material order management and prioritising the steelwork through the workshop. These NC files then fed into automated fabrication machines that cut, drilled and notched the rolled sections and plate steelwork to millimetre perfect accuracy.

The shop-drawings from the Detailing Models were then only used to assemble, fit and weld the elements of each assembly; and for quality assurance.

Project Management Efficiencies

In a project delivery, downstream control and management of fabrication and construction is critical to driving efficiencies and the project's outcome. In addition to fabrication, the data rich 3-D Detailing Model was used in part to manage and control the construction process such as:

- Producing the advanced bill of materials
- Programming the sequence break-ups
- Fabrication and delivery scheduling
- Assessing the truss splice locations
- Determining the lifting lug placement for large sections
- Erection planning and Erection sequencing including the temporary props
- Performing constructability reviews

The Detailing Model was also used to track aspects of the project graphically using its inbuilt relational database, status the project and present graphical visual reports that enabled better decision making by the fabricator and the erector.

[3] *FabTrol Systems Inc is a leading steel fabrication and material requirement planning system*

Conclusion

BDS VirCon has worked and partnered with many prominent firms to realise the vast potential and benefits of using the Detailing Models more effectively to generate efficiencies, mitigate risks and compress schedules and ultimately optimise profitability on projects. These firms are renowned for proactively seeking the best technology and partnering with innovative subcontractors to achieve outstanding project outcomes. As technology continues to progress, the competitive advantage that these leading firms have over their peers will continue to widen, enabling them to be progressively more efficient as they harness the latest technologies and methodologies to drive down costs, minimize project risks and undertake increasingly complex projects. We conclude that the collaborative process to develop and construct the highly complex steelwork geometry of The Crystals Mall would have been significantly more difficult and expensive without the extensive use of the data rich Detailing Models by multiple parties.