PROJECT TOYOTA

The car company's new British headquarters provides a benchmark for EDI between consultants and fabricators

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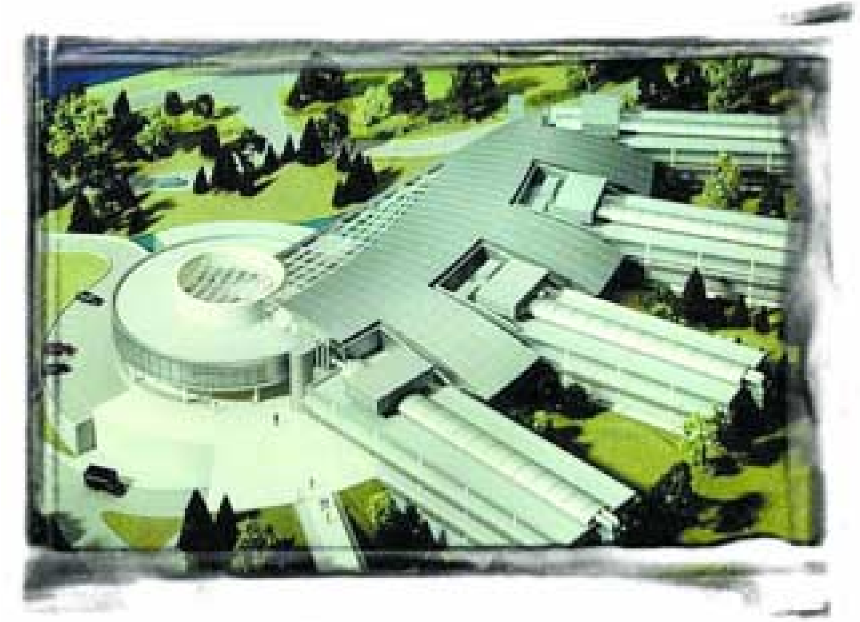


THE NEW GLASS AND STEEL ATRIUM FOR TOYOTA'S HEADQUARTERS in Epsom, England was the seventh project undertaken by structural engineers Whitby Bird and Partners utilizing the latest advances in electronic data interchange. On this project our aims were to:

1. Start the design process in 3D. By linking fabricator's modeling software to design software through CIS/1.0 translators, offer a family of fully designed options, communicated effectively to the design team, allowing the most appropriate solution to evolve.
2. Communicate this as a 3D model to the fabricator. Providing information in a clear and unambiguous manner that enables them to price the project quickly and keenly. With the model checked before leaving our office, checking of fabrication drawings could be largely eradicated.
3. Provide the client with a cost-effective building of high quality, completed to program.

IT BACKGROUND

In 1994, WBP recognized the potential for technology transfer from the construction industry to the design office through the appropriate use of fabricators' 3D modeling software. Since then, our target has been to demonstrate business benefits using a system of modeling/design/costing applications progressively implemented on successive case study projects. These case studies have been real projects with real deadlines, with each project examining one further aspect of our system until all the applications have been implemented and the 'integrated' process both complete and robust.

DESIGN

This 100m by 45m (330' by 148') structure with toroidal geometry forms a 'street' environment between low-rise office wings radiating from a common origin. The architectural concept is based on four office wings radiating from a glazed 'street' which houses all communal facilities. The 'street' links the ends of the offices and connects to an entrance rotunda containing a staff restaurant, conference facilities, computer suite and fitness centre as well as incorporating support functions such as lifts, toilets, meeting rooms, break out spaces and service risers to the offices.

The 'street' also provides space for the display of Toyota and Lexus vehicles.

By locating staircases, lifts, toilet accommodation and shared interaction spaces within the 'street', the main office floorplates are free to provide flexible, usable spaces to accommodate open plan or cellular office planning.

The buildings are predominantly two stories high with the entrance wing being three stories.

The office wing floorplate depth is 15m. The displacement ventilation system is the principal system for achieving comfortable internal conditions. However the 15m depth will permit natural ventilation through operable windows when occupants choose to do so.

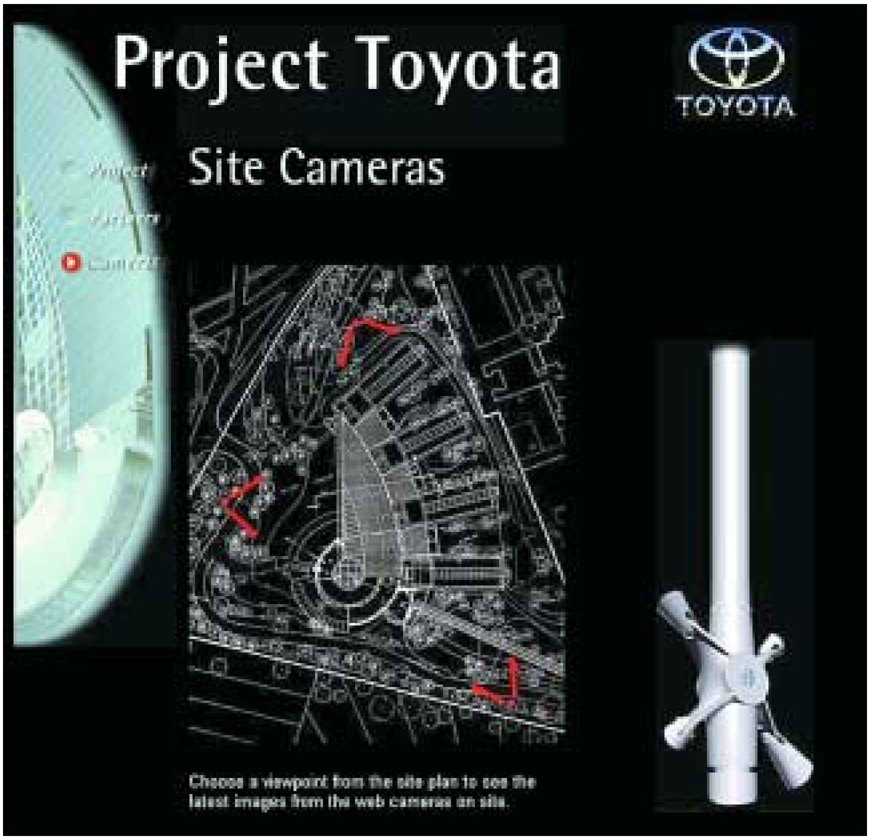
The offices are designed to maximize daylight potential by the use of large areas of clear glazing offering largely uninterrupted views of the magnificent landscape setting.

At concept stage, Microstation was used for establishing geometry for member centerlines, using engineering judgment to monitor the feasibility of the various options. Shortlisted forms were exported as .dxf files to QSE Space/Designer for more detailed checks, not only saving complex re-entry, but performing initial data entry using the most effective application. Each design would then be exported to fabrication software XSteel, via CIS/1.0 links, to produce materials/cost advice as well as visualization.

Once a successful concept was agreed upon, further examination in XSteel would ensure that the details worked out as the architect intended, developing the scheme as necessary. As a result of being able to run through many schemes and immediately visualize them in 3D, we were able to distill the essence of the solution, removing aspects that were either costly and/or inessential. This aspect of the process required more work up-front than a traditional approach, but paid-off further down the line with many problems being solved before they occurred.

The initial scheme called for an exposed, tubular, Vierendeel space frame that proved to be structurally inefficient, costly and required a significant amount of site welding. The scheme that was issued for construction was value-engineered into a series of similar Warren trusses, providing cheaper open-sections where they were not exposed and simple secondary beams. The weight of the structure was reduced to 30% of the original scheme and the buildability improved significantly, while still achieving all the architect's aesthetic objectives.

During the detail design phase, we realized quality assurance gains from having consistent information between the CAD drawings/model and the analysis/design model. To provide a coordinated set of information covering all the structural aspects of the project, 2D drawings were automatically created by Xsteel and then exported as .dxf to Microstation. The convoluted links with typical CAD software and limitations on the CIS/1.0 neutral file to linear members offset some of the efficiency of this process; however, the latest version of the CIMsteel integration standards, CIS/2.0 addresses these issues.



Project team members (and anyone else interested in the project) and view real-time images of the construction site by visiting **http://www.project-toyota.co.uk/index.html**.

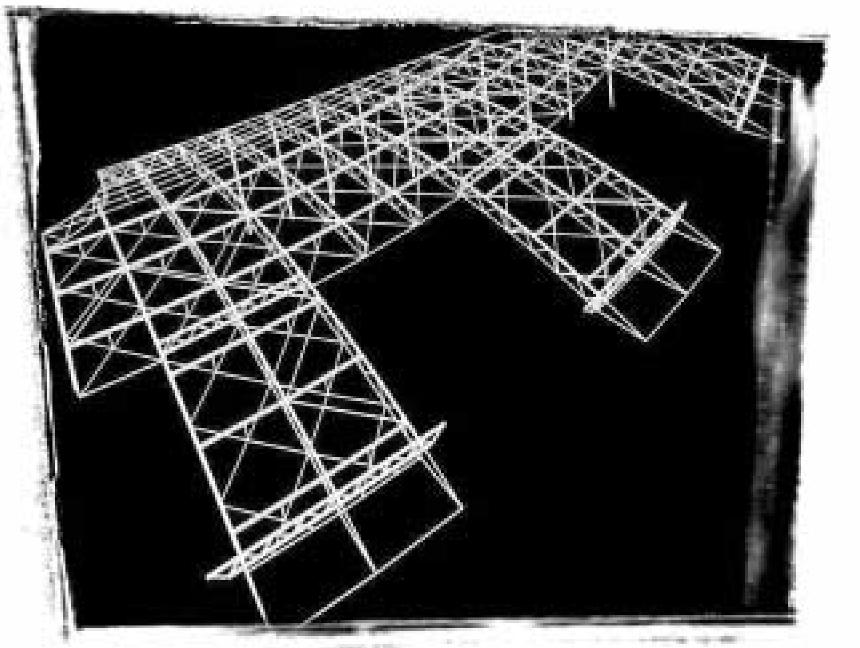
Tendering & Construction

A full XSteel Model was issued on CD for Tender and Construction, with a CIS/1.0 file and a full set of tender drawing files. The exchange of model information in this manner initially encountered resistance due to perceived risks associated with new processes, technology and responsibilities. However, drawing upon our previous experience in this area, we were able to resolve these issues, our efforts being justified when some fabricators suggested that savings could be offered. The model enabled them to more effectively understand the project and consequently reduce the risk contingency associated with complexity and clarity/completeness of information, as well as understanding the full impact of the value engineering process undertaken by the design team.

Returned tenders showed a 40% spread with both short-listed fabricators able to receive the 3D-model information. The successful fabricators used the XSteel model file without having to refer to the CIS/1.0 file.

Detailing/Approval

One of our aims was to



enhance rather than replace the current approval process. In issuing a model containing Quality Assured information regarding section size, level and orientation we aimed to reduce the level of technical queries and fabrication drawing checking to a minimum.

The number of technical queries and the level of typical checks required were nominal; however, although reduced paper flow had been agreed, the incorporation of additional cladding information meant that we were issued with a full paper set of information.

Our continuing goal here is to avoid the need for part/piece drawings by being provided with enhanced fabrication plans covering all the information we would normally check, such as section size, level, orientation, material, paint specification connection detail type and load. All of this information can be automatically added the member labels by many fabrication applications. We are aiming for less paper rather than paperless.

Discussion

Project Toyota is the seventh case study project and represents a major breakthrough as we are now at the stage where the full process of has been implemented, to a greater or lesser extent, is increasingly robust and we are seeing the realization of some of our aims.

To quantify the benefits of such a system and process, we believe that there are sophisticated tools in this and other industries available and appropriate to measure what is often deemed intangible, however, here we have used simple measures to highlight the gains to be made.

Qualitative Benefits:

- Rapid processing of alternative including value engineering, optimization.
- More effective communication of structure, and the 'bigger picture'.
- Inherent consistency of information.
- Ambiguous information can not be created.

Quantitative Benefits:

- Tender returns from those able to utilize the tender model were of the order of £850,000. The returns from some of those not using the model were of the order of £1.2 million.
- The number of technical queries was less than 40, compared to well over 100 for projects in our office of similar type, scale and complexity.
- The approvals process proceeded with only nominal checking of typical aspects of the returned information (section size, setting out, level, material grade, paint specification).

Many of the benefits associated with proper use of EDI, like many feats of engineering, can go unrecognized because when they work properly, they are invisible, they do not impact negatively on our daily lives and we come to expect the facility that they provide. For this to happen in the steel industry there must be widespread implementation of a data standard, CIS/2.0, so that the new EDI-enabled processes can evolve.

The evolution of new processes will identify some areas ripe for change and other areas that will require significant investment in software development. Industry must challenge it's current working practices in light of emerging EDI technologies, to reduce wasted time and money and to enhance the service provided to the client. EDI offers the potential for process improvement; CIS/2.0 is the catalyst for change.

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For more information on Electronic Data Interchange (EDI) and CIS/2.0, please see AISC's website at www.aisc.org