Learning legacy

Lessons learned from the London 2012 Games construction project

Engineering content management and collaboration system deployed by ODA Delivery Partner

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Abstract

The London 2012 construction programme posed significant challenges, including the management of engineering information generated by hundreds of contractors. To address this challenge, the Olympic Delivery Authority's (ODA's) Delivery Partner (DP) implemented an engineering content management and collaboration system, and deployed a suite of integrated design tools for use by consultants and contractors.

This case study explores how the engineering technology was implemented; the problems that arose with adoption of the technology, standards and procedures; how these problems were resolved; and some of the innovations and best practices that contributed to successes in engineering information management.

The case study also examines the lessons learned for the future. The most notable of these are early introduction of design standards and procedures, programme-wide use of a centralised engineering content management and collaboration system, provision of a standard software suite for integrated design, contract specifications concerning use of the preferred engineering technology, training and support for interoperable CAD systems, automated document control and quality assurance, and integrated modelling for timely conflict resolution. It is also important to note the role of robust IT infrastructure and the need for uninterrupted connectivity across geographically distributed office locations.

Integrated modelling allowed timely conflict resolution

The engineering content management and collaboration system provided centralised access to AEC information, including a 'single source of truth'.

Introduction

Preparations for the Games began years in advance, and will culminate in a sporting event to be witnessed by millions of people worldwide. The ODA, a public-sector body charged with developing and building the new venues and infrastructure, appointed a DP to assist with construction programme. The enormity of the endeavour posed significant challenges for both the ODA and the delivery partner.

A consortium comprising CH2M HILL, Laing O'Rourke and Mace (CLM) is the ODA's DP, responsible for building the venues on the Olympic Park and its infrastructure – from roads and bridges to utilities. Successful delivery depended upon faultless design execution by hundreds of contractors.

The DP selected Bentley Systems as the IT provider to deliver a programme-wide software licensing agreement. This licensing agreement made available to the DP and its contractors a centralised engineering content management and collaboration system and a suite of integrated design tools.

Engineering content management and collaboration system

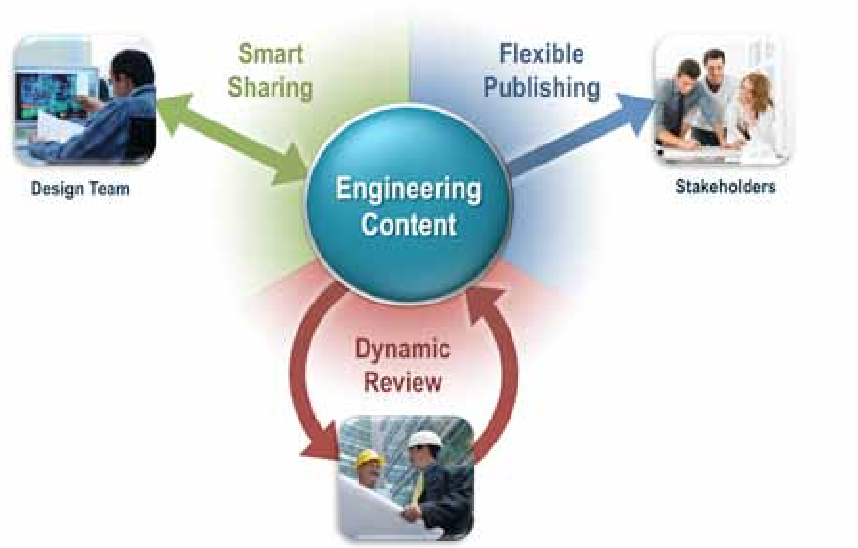
The engineering content management and collaboration system provided centralised access to Architecture, Engineering and Construction (AEC) information, including CAD data, and a 'single source of truth' for its users. Giving contractors the opportunity to use a common set of design tools provided a platform for integrated design, enabling the DP to create a coordinated information model for construction.

The DP's IT provider gathered requirements and prepared an implementation plan for programme-wide standards, design tools, and engineering data management. Although the intention was to deploy a single platform to be used by all programme designers and engineers, this goal proved to be unattainable due to the resistance of certain contractors to using an unfamiliar toolset.

Interoperability among CAD platforms

The DP understood the potential problems associated with interfacing with hundreds of consultants and contractors. Because each firm had its own preferred CAD toolset, the DP decided to provide the IT provider's software and training to contractors as part of their negotiations.

The DP's IT provider issued a programme licence subscription (PLS) that allowed firms contracted to the ODA to use its solutions under one annual licensing agreement. This centrally funded PLS approach removed the cost barrier on the contractor end, making them agreeable to adopting the use of the CAD toolsets. This encouraged a programme-wide implementation of the toolset in an attempt to integrate the engineering environment across disciplines and contractors.



Engineering content management

100,000

Documents seeded on the system by mid 2007.

The problem with this approach was that many UK consultants used CAD files in DWG format and were hesitant to switch platforms. The DP's IT provider offered instructions for converting file formats and transferring data between its system and those of other vendors; the integrated environment provided the required interoperability.

Engineering technology implementation

The engineering technology was rolled out by a multidisciplinary team representing the ODA, the DP, the DP's IT provider, and six of the biggest design and construction contractors. Over an 18-month period, the team installed the software and connected 80 companies to the engineering content management and collaboration system.

The DP dispatched people around London and other locations to troubleshoot installation problems. In general, the system accepted common IT configurations as well as generally available hardware configurations and management tools, such as server clusters and network load balancing. In some cases, the service-wide technology platform was coordinated with the connected companies' IT environments and security protocols.

Early contracts did not specify the use of the products provided by the DP's IT provider, but later contracts did. Contractors had access to a full portfolio of tools for civil engineering, structural design, and building information modelling. Training and support, both on-site and remote, helped to overcome the learning curve.

Finding staff with the right skill set proved to be problematic for some consultants. For example, one Tier One consultant had a predominantly Autodesk shop. When the firm was commissioned for the London 2012 programme, they had a problem early on recruiting the right staff to use the software provided by the DP's IT provider. Over time, the consultant built a team of qualified users who had benefited from the training programme.

Engineering data repository

The London 2012 construction programme amassed a huge volume of engineering data. Many contractors who came on board before document control procedures were put in place preferred to work on drawings within their own systems. Controlling who had what documents and where the current versions were stored was an immense challenge. It was crucial to have a single source of accurate and up-to-date AEC and CAD data.

The engineering content management and collaboration system provided an engineering data repository for the high volume of information generated. The modular system was scalable, with a multi-tier architecture that enabled local deployment as well as deployment on a large-scale, distributed environment. The system was installed, configured, and seeded with more than 100,000 documents by mid 2007. Once the system was populated, users were able to quickly find documents by searching keywords, titles, drawing numbers, etc.

The engineering content management and collaboration system provided a single source of truth for the latest CAD drawings and other AEC information. All agencies involved in the construction programme were able to access the repository over the ODA extranet.

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British Standard 1192 conformance

Conformance with British Standard (BS) 1192 (Collaborative production of architectural, engineering and construction information code of practice) was a programme requirement. A methodology for managing the production, distribution, and quality of construction information, BS 1192 uses a disciplined process for collaboration and a specified naming policy.

One innovation was the interoperability among disparate engineering technology platforms.

The engineering content management and collaboration system provided the tools necessary to ensure compliance. It supported the standard stages for CAD model and drawing production: work in progress, share, document, and archive. For work in progress on a given task, the integration and collaboration team made model files to allow design coordination and integration. This enabled clash detection and resolution, thereby improving the quality of construction information.

Enforcing conformance with BS 1192 remained an unresolved issue. The DP made the tools available to ensure compliance, but the requirement to comply with programme standards and procedures was not included in the early contracts.

The lesson learned for the future was that these requirements should be determined early in the programme and included in contracts from the beginning.

Document Control System

As issues arose with engineering data management, The DP's IT provider developed customisations such as an automated Document Control System (DCS) for work in progress, and a CAD quality assurance (QA) procedure.

Managing how internal and external users accessed engineering data became difficult, because external contractors accessed the data repository through a direct connection to the main server (as opposed to a local caching server). Speed and bandwidth problems interfered with connectivity. The DCS solved the problem by providing a simplified web view and local caching, so users did not have to go back and forth to the main server to access properly synchronised data.

When CAD files were submitted to the engineering content management and collaboration system, the DCS automatically checked for CAD QA. It maintained file versions to prevent storage of the same file multiple times, and prevented submissions from being distributed before they had been approved at some level. In effect, the DCS managed design changes in the detailed drawings that supported the whole programme.

The ODA worked in conjunction with the DP by ensuring that any issues highlighted, were resolved. For example, when final drawings were submitted, the ODA had to confirm that the delivery set was complete. The ODA developed procedures to ensure CAD drawings were submitted in accordance with required standards. This ensured interoperability and usability by others who used the CAD drawings.

If contractors failed to use standards as intended, or if their CAD drawing coordinates were incorrect, their deliverables required checking and rechecking, which was time consuming. In response, the DP's IT provider devised a customised CAD QA system to check data from contractors prior to entry into the engineering content management and collaboration system. This procedure enabled users to track data, and determine the issue date and purpose. In this way, users were assured models were fit for purpose.

Innovations and best practices

Design integration, document control and QA procedures helped to reduce the cost of clashes and aborted work. The integrated model enabled the DP to hold weekly meetings and learn how the contractors' work was progressing. If, for example, there was a conflict as small as a light post on an irrigation pipe, it could be resolved at once. The DP viewed this as a major innovation.

Use of a programme-wide design system and tools required configuration of the engineering content management and collaboration platform and DCS to administer programme standards. As a result, only validated data was exchanged among the ODA, the DP, and sub-contractors. The collaboration environment was secure, but still flexible and scalable.

Another innovation was the interoperability among disparate engineering technology platforms. The IT provider's information architecture allowed its products to work in conjunction with competitors' products. There was one caveat, however.

The intention was to use best practices in engineering data management, but the UK construction industry was not ready for that in 2007; for the next Games or mega-project, the organisers will need to understand the readiness of the industry for implementation of advanced engineering technology.

Contractors need to be incentivised to implement the specified systems and standards.

Lessons learned for future projects

The most difficult issues for the DP to resolve involved gaining buy-in on technology, enforcing design standards, and controlling quality. A Tier One consultant noted that it was essential to get buy-in from contractors as early in the programme as possible. It is beneficial to have engineering data readily available, but it is not a useful system unless everyone uses it. Contractors need to be incentivised to implement the specified systems and standards, and they need to commit to using the correct engineering data for the intended purpose.

In the face of resistance, the engineering technology had to be introduced as optional, but with instructions on how to convert and deliver CAD drawings in the required format. The earlier the standards and procedures were introduced, the better compliance was achieved among consultants and contractors.

Reliable connectivity to the engineering content management and collaboration system was also an issue that, in hindsight, could have been overcome by a more robust IT infrastructure from day one. For external users with poor connections, caching servers were required to allow access to the system locally. In the future, IT infrastructure requirements should not be underestimated, and connectivity issues should be anticipated.

The DP pushed through these problems to deliver the first five venues ahead of schedule. Still, there was a time lag on some venues before ODA received a complete and correctly assembled set of CAD documents. The lesson learned was that the contractors need to be contractually required to submit complete delivery sets from the beginning of the programme.

The CAD data and documentation were mostly assembled and accepted on venue completion.

Conclusion

The DP achieved on-time delivery of every venue that was due by June 2011 – the Olympic Stadium, Basketball Arena, Handball Arena, Velodrome, and Lee Valley White Water Centre. Moreover, the CAD data and documentation were mostly assembled and accepted for each venue. This was an unusual accomplishment in the UK construction industry, where a large percentage of drawings are rarely delivered on time.

The DP pushed programme participants to hit milestones and stay within budget on an incredibly complex undertaking. Money was exceptionally tight, but the programme has been delivered under budget. The engineering technology that was implemented helped to ensure the quality of the work that was delivered.

With so many contractors on site for a programme of this magnitude, the risk of interferences, clashes, and conflicts was significant. Use of an engineering content management and collaboration system enabled the DP to achieve a degree of design-construction integration that reduced this risk.

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