Interoperability-based Collaboration Paves Way to AEC's Digital Future

By Lachmi Khemlani, Founder and Editor, AECbytes

Abstract

Building design is becoming more complex, specialized, and fragmented, as an increasing number of professionals from multiple disciplines are required to collaborate on a building project. The standards are becoming higher in terms of quality improvement, waste reduction, and cost optimization. And lastly, building designers are always expected to do more with less.

The ability for multiple disciplines to work on a building, often across several locations, to exchange project data is critical. Using methods such as manual drawings and CAD, it became difficult to share information accurately. However, since the advent of building information modeling (BIM), project team members have been able to seamlessly exchange project information.

Given that interoperability is an important part of a BIM workflow, the need for robust development activity is pivotal for the building industry. While there is a long-standing IFC file format developed by the buildingSMART organization, another more recent interoperability effort is the iModel by Bentley Systems. An iModel® is a container for the open exchange of infrastructure information. It is an open-source that incorporates the latest computing technologies developed by an individual company rather than a consensus-driven consortium.

The Collaboration Challenge in AEC

It is well known that the building industry is notoriously fragmented. Unlike products such as cars, planes, and phones, the production of which is controlled by the companies making them such as Tesla, Boeing, and Apple, a building project can be commissioned by a single owner but is built by a design and construction team that comprises several contractors and subcontractors. Each of these entities specializes in individual disciplines such as architecture, interior design, landscape architecture, structural engineering, mechanical engineering, electrical engineering, plumbing, acoustical engineering, general contractors, and subcontractors. As buildings get more complex, project teams expand to include even more specializations such as façade engineering, glazing design, sustainable design, and roofing design. These firms work together on a specific project, and then move onto other projects, often with different firms.

While working this way is endemic to the building industry, finding effective ways to collaborate and interoperate with software based on different platforms is paramount. In recent years, we have seen new business models such as integrated project delivery developed to enable multidiscipline firms to form a consolidated whole for the project's duration. While the building industry needs to retool its business practices, it cannot solely solve the problem of smoother information exchange among individual disciplines. This is where a lack of interoperability carries a heavy price. In 2004, a study by the National Institute of Standards and Technology found that inadequate interoperability places an annual cost burden of $15.8 billion in the capital facilities segment of the U.S. construction industry. Similar studies estimate that the lack of interoperability leads to waste that accounts for about 30% of the total building cost.

The good news is that because it is a technology problem rather than a business problem, a solution is easier to find. We can rely on the same expertise that is driving the development of solutions for the building industry to come up with solutions to the interoperability problem.

The Interoperability Problem (in General)

Interoperable applications can read and interpret data that is received from another application. However, when this data exchange is limited to two applications and is achieved by working with their native file formats using application programing interfaces, it is a one-to-one integration rather than interoperability. It is typically a response to a strong monopoly in the marketplace by one vendor. While a one-to-one integration can be helpful in specific situations, they are proving to be insufficient in any vibrant industry that is developing many applications by multiple vendors to address different tasks that need to be accomplished. All these applications need to communicate with each other and share essential data about the task or process on which they are working. Such a situation requires a common language that all the applications can understand and support. By its very definition, the common language needs to be open and nonproprietary, which is what interoperability is.

Interoperability in the Age of BIM

Before BIM, buildings were designed and constructed using electronic drafting or CAD. Interoperability was limited, as buildings were represented in CAD applications using geometric entities such as points, lines, rectangles, and planes, which had no underlying semantics. While several neutral file formats eventually emerged to allow building professionals exchange CAD files such as DXF, STEP, and IGES, to enable other project team members to be apprised of their work, the exchange did not do anything for collaboration.

With BIM, building professionals no longer use generic geometric entities to represent buildings. Instead, they create intelligent building entities that are programmed to encapsulate information about themselves and understand their relationship to other entities in a building model. Interoperability, enables project team members to exchange actual building information and collaborate on a project. Thus, with BIM, we not only have a smarter way to design and construct buildings, we also have the possibility of real semantic interoperability.

So far this potential for semantic interoperability in the building industry – enabled by BIM – has been addressed almost exclusively by the IFC file format, an open standard developed by the International Alliance for Interoperability, a global consortium of commercial companies and research organizations founded in 1995 and renamed as buildingSMART in 2005. The IFC continues to be developed under the aegis of buildingSMART. Since it is developed by a consortium and is therefore dependent upon consensus, progress is slow – there have been only three major releases of the IFC format since it was launched in 1996. Also, while many building industry applications have made IFC compliancy part of their feature set to exchange data with other building applications, its adoption has been far from seamless.

iModel Platform for Interoperability

The iModel, Bentley Systems' format for exchanging project information among design, construction, and operations, is an open file format used to capture building and infrastructure information and use it as the basis of collaboration between multiple applications. Conceived as a

container for AEC information, the iModel is built from the ground up to manage change and store multiple versions of the model so that they can be compared. Its underlying structure is a relational database that connects different drawings, models, and specifications of the project in a meaningful way. In addition to being information-rich, the iModel is also very efficient in how it stores data, resulting in more compact files that are easier to exchange.

Despite being developed by an individual company rather than a consortium or an organization, the iModel is not a proprietary file format. While an iModel can be published from all of Bentley's applications for buildings and infrastructure and used as a common file format to exchange data between them, Bentley has also developed free plug-ins for several popular third-party applications to create iModels from them including Revit, AutoCAD, ARCHICAD, SketchUp, and Rhino. In addition, an iModel software development kit (SDK) is available to help enable the creation of iModels from other applications.

In addition, Bentley has created an iModelHub, the control center where all the individual iModels are stored and managed. The iModelHub acts as the common repository for a project, responsible for coordinating concurrent access to the iModels in it as well as the changes made to them (Figure 1). Thus, it keeps the latest project information in sync and tracks the changes that were submitted to get the project to its current state. This provides an audit trail for increased accountability, greater transparency, and improved communication.

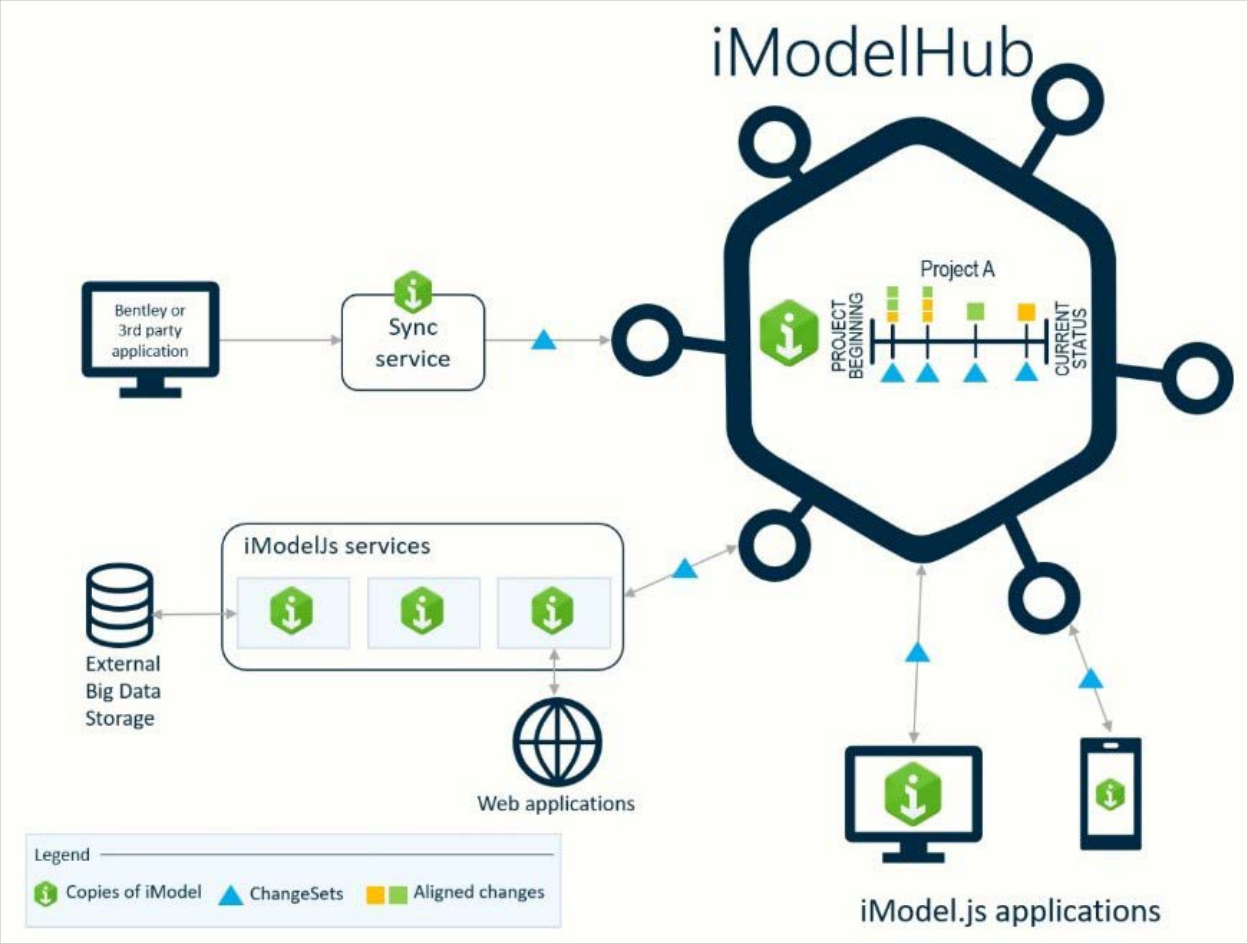

Figure 1. iModelHub is the control center for iModels, responsible for coordinating concurrent access to iModels as well as changes made to them in a form of ChangeSets.

Any project team member can find out who made a specific change, when, and why. All the teams can coordinate their designs in real-time, and everyone is on the same page.

To make the iModel more open, Bentley has created an open source set of tools and libraries (in JavaScript) called iModel.js. Any developer can use these tools and libraries to work with iModels and create a variety of web, cloud, or mobile applications for creating, visualizing, querying, mining, and synchronizing project data in iModelHub. This development can be done entirely independent of Bentley since the source code is freely available.

Thus, with the iModel platform, Bentley is developing an open ecosystem, going beyond creating an open standard like the IFC file format, but providing actual source code that is freely available to anyone who wants to create custom applications or utilities with iModels. At the same time, Bentley is continuing to support the IFC format, not just by ensuring that all its building applications are IFC-compliant, but also by developing an "iModel Bridge for IFC," which will allow the iModel technology to work better with IFC models.

Conclusion

Interoperability is critical for collaboration in the building industry, allowing diverse professionals to use the "best of breed" software applications for their tasks while still being able to exchange project data, stay informed of the work of all project team members, and make faster progress on their individual tasks. With BIM, there is the opportunity for more meaningful collaboration based on actual building entities instead of the geometric-only entities that were the basis of CAD.

Given the importance of interoperability in collaboration, it is extremely beneficial to have more options for it in addition to the consortium-developed, consensus-driven IFC file format. The iModel provides such an alternative. It incorporates the latest computational technologies by virtue of being more recent, and evolves a lot faster. Additionally, the availability of open-source tools and libraries to any developer who wants to work with iModels should help to expand it faster.

About the Author

© Lachmi Khemlani is the founder and editor of AECbytes (www.aecbytes.com), a publication that has been researching, analyzing, and reviewing technology products and services for the building industry since 2003. She also consults on the development and implementation of AEC technology, author research reports, and white papers, and serves on juries for technology awards.

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