CARLETON IMMERSIVE MEDIA STUDIO (CIMS)

THE FUTURE OF BIM

TEXT Douglas MacLeod

THE NEXT GENERATION OF BIM OPENS UP NEW HORIZONS—AND FRESH CHALLENGES—FOR ARCHITECTS.

ABOVE Carleton Immersive Media Studio (CIMS) used BIM to produce a highly detailed model of the Library of Parliament.

With this article, I will have written for *Canadian Architect* for half my life. In that time, I have seen no development that has had—or will have—as profound an impact on the profession as Building Information Modeling (BIM). With Computer Aided Design (CAD), we merely emulated hand drafting and rendering using computers, but BIM challenges the very way we think about buildings and design.

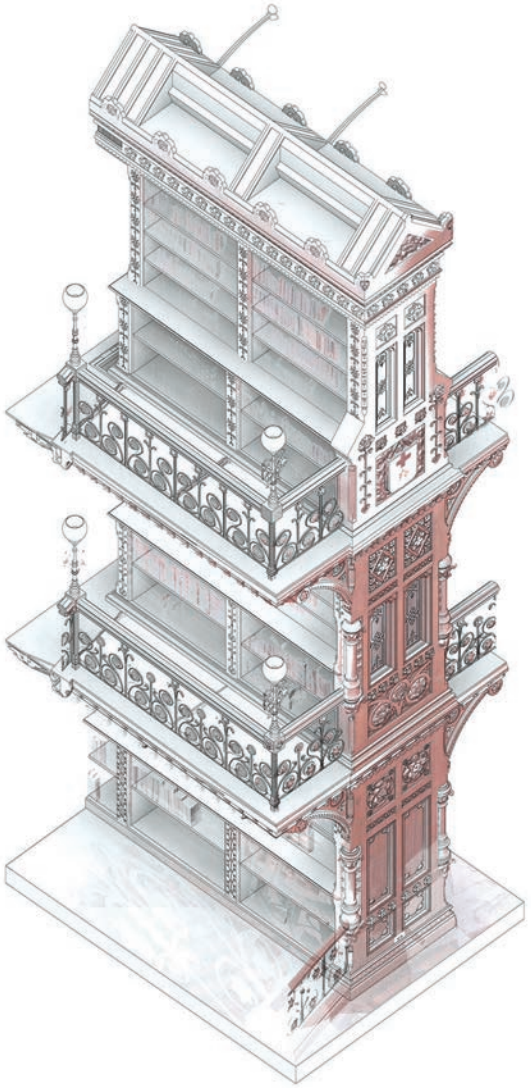
Getting a handle on BIM is itself difficult. As Bruce McGarvie, department head of CAD and BIM Technologies at Vancouver Community College, pointed out to me, "There's BIM and then there's BIM."

What he meant was that BIM cannot be separated from the dramatic ways that architectural practice is evolving in light of new approaches such as Integrated Project Delivery (IPD) and emerging technologies such as the Internet of Things, Cloud Computing and Blockchain. BIM is just one of a tsunami of changes that are flooding over the AEC industry. Scott Chatterton, formerly HDR's international BIM integration lead and digital design leader for BIM planning and quality, believes that "Drawing packages will go away eventually. Traditional contract paper delivery doesn't contain a tenth of the data contained within the Building Information Model."

BIM does, and will, play a critical role in these changes. The key to understanding BIM is to reimagine a building as a database of information in which the drawings, the specifications and the contracts are just different manifestations of the database.

The science fiction writer Bruce Sterling, in a remarkable non-fiction work called *Shaping Things*, took this idea even further. At the turn of the millennium, as BIM was just taking off, he anticipated a future in which "the model is the entity" and "the object is mere hard copy." In other words, he thinks of the virtual model as the true essence of the physical thing—even when that thing is a building. The logical endpoint of BIM technology is a future where a building is just a manifestation of its BIM presence.

Architects tend to emphasize the importance of individual buildings over the means of production but, in fact, those means are crucial. Prior to the Renaissance, for example, there weren't a lot of scaled and measured architectural drawings, because buildings such as cathedrals were constructed with full-scale templates and onsite discussions between craftspeople. After the Renaissance—and particularly after Alberti exhorted architects to work with "true angles" and "specific and consistent



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measurements"—there were plenty of them. And, of course, scaled, measured drawings were essential for everything from the scientific revolution (designing microscopes requires exacting drawings and dimensions) to the industrial one (such drawings are the only way to ensure that widgets made in Birmingham as the same as those made in Manchester).

Architectural drawing really did change the world—and BIM has the potential to do the same. Drop the word "Building" and you are left with "Information Modeling"—precisely what the world needs in order to take advantage of the Internet of Things (IoT). Without a common data structure, the data generated by the IoT will be largely gibberish, but with Information Modeling, information from multiple sources can be shared, manipulated, analysed, used and reused in ways that we can't even imagine.

This includes the idea of "Digital Twins," in which an exact and functional virtual model is created and maintained to mirror the presence and activity of a physical-world system or entity. As Chatterton explains, "You maintain a model that is an exact replica of the final building, that, for example, a city can use as part of their larger planning for infrastructure, community planning and sharing of resources." The virtual model can alert you when the real-world building's HVAC systems need to be maintained, or windows upgraded; or you can run a simulation on the digital twin to see what its energy consumption will be. The only way to accurately maintain these digital twins is by constantly updating their data and status with an array of sensors of various kinds placed throughout the building. This is why the integration of BIM and IoT is so critical.

As BIM evolves, it is like a snowball rolling down a hill that gets larger and larger as it collects more data. It is even gathering dimensions. The three dimensions of the physical world are just the beginning. There's 4D BIM (which adds in scheduling, or the dimension of time), 5D BIM (which adds in costing information), 6D BIM (sustainability) and 7D BIM (facilities management)—although people disagree about what's included in any given dimension. Others are now talking about 10D BIM and more. The fact of the matter is that BIM should be able to accommodate any and all data about a building.

That, however, is not a simple task. In 2008, to bring some order to the chaos, the American Institute of Architects established five Levels of Development (LODs) that establish what kinds of information should be included at each stage of the design process; from LOD 100 (concept design), where only basic information such as height and location is required, to LOD 500 (as-built), which requires non-geometric information for maintenance and management. Since then, they have also added LOD 350 (construction documentation).

Ten dimensions and six LODs only begin to suggest the cognitive overload that is so much a part of BIM. It's not just about learning a new software package—although that can be difficult enough. It's about a new way of working that affects everyone from the newest intern to the oldest partner.

When I was a practising architect, I was always secure in the knowledge that the boss could roll up his or her sleeves and sketch, draw and draft as well as (if not better) than me. Today, however, it is rare to find a partner or principal who could even open a model in Revit let alone do anything useful with it. Most of the experts I interviewed for this article—and they are some of Canada's best in BIM—are not licensed architects. If we, as architects, lose control of the means of production, then how long will we remain relevant to the building process? It's not that senior management needs to know how to operate BIM software, but they must understand its potential and the extent to which it will change their practice.

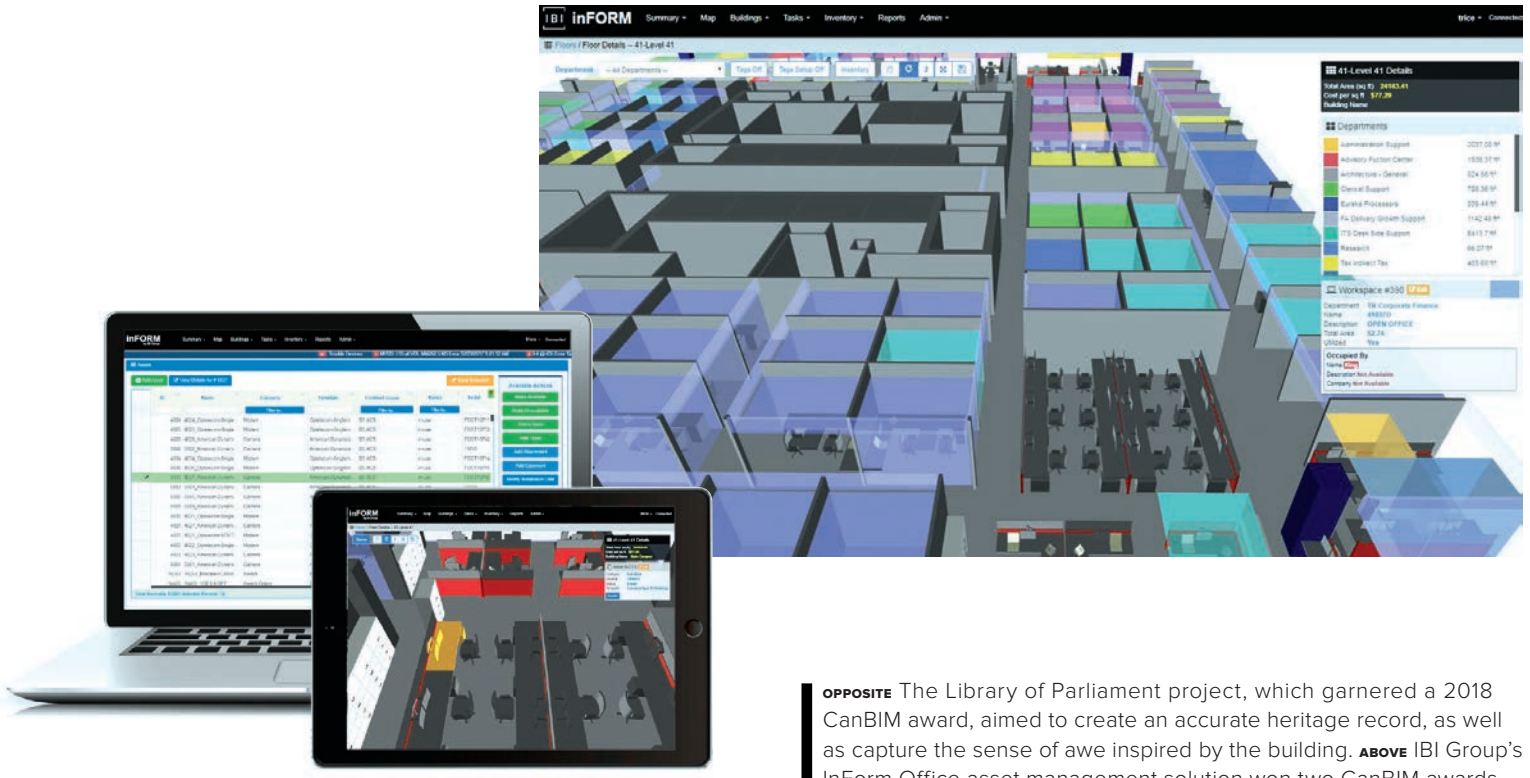
On the other hand, we may be "de-skilling" the profession with an emphasis on tools like BIM. As an educator, I often see students who move their designs too quickly into BIM software, with the result that their designs are not as fully explored (and hence not as creative) as they could be. The software itself often seems to constrain their designs, much as the early use of CAD once did.

Chatterton also notes, "My colleagues and I have found a decrease in the ability of our newly graduated staff members to bring together a drawing package, or even the ability to 'cartoon' the development of a project's drawing package, as required during the early stages of a project."

BIM is also disruptive to the finances of architecture firms. Early on, practitioners noted that BIM requires a lot more information in the early phases of the design process than we usually provide. Given that design fees are usually lower during schematic design and design development, this can upend the economics of a building project.

Moreover, a full implementation of BIM involves much more than just a drawing package. Increasingly, to organize and monitor the complexity of a BIM-based project, design teams are resorting to BIM Execution Plans that, according to McGarvie, include "which firms are going to use what software; levels of development; agreements to share models; server sites; and how things are going to be named and numbered."

This level of complexity and disruption, however, does raise the question: Why bother? The reasoning is that BIM and other technologies are exactly what the AEC industry needs to lift it out of its productivity doldrums, its schedule delays and its cost overruns. One study by the McKinsey Global Institute suggests that construction productivity could be improved by 50 to 60 percent using tools like BIM—with a corresponding rise in the value of the industry of $1.6 trillion USD!



INFORM BY IBI GROUP

OPPOSITE The Library of Parliament project, which garnered a 2018 CanBIM award, aimed to create an accurate heritage record, as well as capture the sense of awe inspired by the building. **ABOVE** IBI Group's InForm Office asset management solution won two CanBIM awards. The cloud-based platform allows organizations to plan and manage spaces, as well as track assets, including desks and phones.

But when the industry itself is in such a state of flux, how can we hope to prepare our students for the changes wrought by BIM and other technologies? Andre Lucena, Senior Technology Instructor at NAIT and a PhD candidate at the University of Calgary, is preparing an in-depth study of BIM instruction at architecture schools across North America. In general, he finds that we are not doing a very good job. Some schools, such as Carnegie Mellon and Yale, have embraced digital design and are exploring its possibilities, but he notes that, on the whole, "there is resistance in academe to using a tool to support design activity."

This is a shame, because for educating architects, the pedagogical opportunities of BIM are enormous. It's not so much about digital twins that mirror buildings in the real world, but about what Klaas Rodenburg, president of the Alberta Council of Technologies Society, calls "Crash Test Models." These are models that students can change, query and interact with to learn about the essential aspects of architecture. Crash Test Models could be used to simulate earthquakes, fires and floods, so students could see how buildings respond. Or they could model the energy performance of buildings, allowing students to swap in different kinds of insulation or glazing, or change the orientation, to see (and understand) the difference it makes. Such intelligent and interactive models could help teach everything from building codes to cost estimating, and once created, could be shared online with students everywhere.

Lucena believes they can do even more. The thrust of his research is how BIM can be used to help design. This can be accomplished, he explains, by using BIM to "give support to design decisions." As an example, he cites how the Dynamo plug-in for Revit can provide BIM with parametric modelling capabilities for form generation using customized code. Dynamo is a visual programming language—much like Grasshopper for Rhino—that can be used to quickly and efficiently create complex shapes and forms, such as a set of beams where each one is a different size.

The combination of Dynamo and Revit is another example, like the Internet of Things, of how the power of BIM is greatly enhanced when it is combined with other emerging technologies. Blockchain is another such technology, which provides a secure digital ledger for all information, by encrypting a user's data so that only that user has the key. Blockchain's proponents speak of Blockchain+, when it is combined with another application. In this sense, it is possible to speak of BIM++—where BIM is combined with the Internet of Things and Blockchain to enable a whole host of new kinds of activities, ranging from energy management and modelling, to secure real-time payments for contractors and subcontractors, to supply chain management and data analytics.

Experts agree that, to realize BIM's potential, it must be part of a new approach to project delivery—one that integrates tools and team members into a coherent and efficient workflow. Some even feel that the focus on BIM itself is misleading. As Bruce McCallum, principal and digital practice leader of Calgary-based Next Architecture says, "The future of BIM is collaboration. BIM is just the tool or the hammer we swing. The future is BIM because the future is collaboration with smart contracts, rapid iteration and a project environment that responds instantly."

A blog post on Next's website expands on this idea: "The future of making buildings lies in no longer having distinct design and construction activities—but rather a Master Builder process that seamlessly transitions through design, procurement, assembly and operation using non-linear, fully-iterative and non-traditional approaches, to move any building from design to assembly and beyond at considerably less cost and in less time."

Educators such as McGarvie and Lucena echo this sentiment. McGarvie runs a nine-week integrated BIM course at Vancouver Community College, in which architectural and structural technology students work together on a design with linked models in Revit, then bring their models together in Navisworks, with a steel fabrication model produced in Tekla. Partway through the course, they are asked to integrate a fully developed

COURTESY POMERLEAU

LEFT CanBIM's General Contractor's Award went to Pomerleau for Place Ville Marie's revitalization, a project that uses in-house-developed VR together with BIM360, Holobuilder, laser scanning, and other technologies to assure productivity, safety and quality.

mechanical system into their models. Lucena says, "We need to expose them to interdisciplinary processes. An integrated design studio—that's the holy grail, but it's a nightmare in terms of logistics and finding external critics." His research is documenting examples, such as at the University of Washington, where professors from architecture, engineering and construction management come together to jointly teach studios.

McGarvie proposes that this interdisciplinarity will go even further when he suggests that "the future of BIM is manufacturers, parts suppliers, and mechanical and glazing system providers, each building their own Revit families. Someone trying to source materials could go online and select a window company, and put their fully developed window components directly into their models. We could have exact and complete modelling."

Here, however, the issue of control raises its ugly head. Who decides (and who verifies) the data that is attached to that window or any other component? What if data (such as lifespan) is exaggerated or simply wrong? Who's liable?

As a profession, we need to think carefully about what we want BIM to do for us and how—because if we don't, then others will dictate it to us. This includes everything from quality assurance, to access to software, to cost for clients, to level of detail.

BIM is simply too important for any one company or organization to control—a fact that emphasizes the need for what's called OpenBIM. OpenBIM is a standard developed by BuildingSmart (an industry alliance that includes software companies such as Graphisoft and Vectorworks). It is based on an open, neutral data format called Industry Foundation Classes, or IFC, which allows BIM files to be easily shared between applications. It also includes the xBIM (for extensible Building Information Modeling) toolkit, which is a free, open source software development environment that would allow anyone to create new BIM applications (such as energy analysis) that could easily be used by any software package that complies with the standard. OpenBIM is absolutely critical to keeping the BIM market both competitive and innovative.

Governments too, have a role to play. Countries such as the United Kingdom now require that all government building projects use BIM at a mandated level of development. Finland and Norway use the IFC standard. Canada has no mandate, strategy or standards for BIM. We desperately need to catch up with the rest of the world, or we'll be left behind.

In the end, however, the large-scale diffusion and popularization of BIM (and by extension the Internet of Things and Blockchain) may hinge on something trivial. Human beings like to pretend we are serious, but most of the time we are not. Often, it is frivolous, social applications that make or break new communications technologies.

The Internet, for example, was supposed to facilitate computer-to-computer communications—but email became its killer app. The World Wide Web was designed for information management, but it became a place to post pictures of cats. The telephone, the telegraph and even the postal mail were meant to be business tools, but only hit their stride (and generated enormous economic activity) when people began using them for socializing—purposes that were originally frowned upon. Even looking back to the Paleolithic period, there are a few examples of cave art, but hundreds of examples of handprints—which can be considered prehistoric "tweets."

It could end up being something completely nonsensical, like your house posting a selfie and a "like" for its new coat of paint, that will popularize Building Information Modeling.

We may soon enter the era of the Facebook of Buildings (rather than the Internet of Things) in which architecture becomes not just intelligent, but emotional and social as well. Just like Facebook itself, this will have positive and negative impacts. Your building may well become smart and sustainable, but it (and its digital twin) will track your every move and know everything about you.

We need to address the future of the profession in terms of these new tools, techniques and opportunities—and we need to do it now.

Back in 1999, a small Boston startup company contacted me, offering to provide an information session about their software. I even wrote about it in this magazine, in August 2000. I wondered if the profession was ready for their data-driven approach to architecture. In 2002, that company—Revit—was purchased by Autodesk for $133 million USD. Twenty years later, I'm still wondering. ◖▲

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