## BIM and Process Improvement

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Over the last couple of years the term "Building Information Model" or "BIM" has gained widespread popularity. It has not, however, gained a widespread consistent definition – it's like the blind men describing the elephant. But there's a lot of fuss being generated over this particular elephant. The Construction User's Roundtable (CURT) has recommended that owners *demand* that their project teams collaborate using BIM's, CURT's biggest member, the GSA, *is* demanding their use, and the AIA is actively redefining the practice of architecture to take advantage of this technology (see the "Change is Now" series in the AIA's online newsletter AIArchitect).

The ambiguity over the definition goes as deep as whether BIM is or is not fundamentally different from CAD. I'll come down on the side of "is". I'll also propose that BIM's value is not simply as a better drafting tool, but as an enabler of significant process improvement in the design and construction of buildings, and so we should work toward a definition of BIM based on function. BIM is already transforming the way many of us work - we should actively guide that transformation rather than simply following wherever it happens to take us.

### Process change

We continually hear and read that "it's not about the technology, it's about the process". This refrain has two problems. First, it's not about the process either – it's about the buildings! Neither a technology nor a process is worth the pixels it lights up unless it helps us design and/or build better, faster, and/or cheaper.

Second, the constant repetition of this mantra often leads to development of less than optimal processes. I've seen many process-improvement efforts start with a conscious decision to defer consideration of technology until after the process is designed. Since "it's not about the technology, it's about the process", the team designs the process and only then looks for technology to support it. The drawback to this approach is that processes often exist that would not be possible without certain technology. Deferring consideration of technology prevents recognition of these processes, and often leads to "paving the cowpath" - simply automating the old way of working. The adoption of CAD is a perfect example of this – what we've done is to simply replace the pencil with a mouse, and computerize the production of the flat drawings that have been the basis of architectural documentation for centuries. In *Reengineering the Corporation*[1] the authors stress the enabling role of technology in process improvement, and emphasize that we should be asking, "How can we use technology to allow us to do things that we are *not* already doing?"

In recapping the recent Australian National Museum project, Steve Ashton (Ashton Raggatt McDougall) and Robert Peck (Robert Peck von Hartel Trethowan) described the traditional design and construction process as follows (I suspect only partially tongue-in-cheek):

- Designer imagines an idea in 3D to solve a client's program.
- Designer deconstructs 3D ideas to 2D representations.
- Designer passes 2D representations to the construction team.
- Construction team gets fabricators to redraw parts, again in 2D.
- Construction team attempts to reassemble the 2D information into 3D objects.
- Designer is often amazed by the outcome!

I doubt that we're following this process because it's the best way of doing things. We're following it because for centuries we've had to communicate design intent via paper, and paper is 2D.

**Data, Information, and Knowledge**

In order to understand the fundamental difference between CAD and BIM, and to see BIM's potential for process improvement, it helps to look at some functional definitions of data, information, and knowledge.

- *Data* is raw facts, e.g., a tabulation of the stress-strain relationship of a given grade of steel.
- *Information* is data given relevance and meaning. For example, the above steel data compiled into the AISC Manual of Steel Construction.
- *Knowledge* is information coupled with experience and know-how - the AISC Manual in the hands of a skilled engineer.

CAD files are data. The elements are lines, arcs, and circles (and sometimes surfaces and solids) – purely graphical representations of building components. A line, for example, is described by its endpoints, layer, color, linetype, etc. While in some systems certain elements can be tagged with supplemental data, for the most part a line could be the edge of a wall, a property line, a leader arrow, or any number of other things. The CAD file itself does not include anything about the relevance and meaning of the line – that must be inferred by the viewer from the line's context and from accepted conventions.

The advance from CAD to BIM is the jump from data to information (after all, information is BIM's middle name). In a BIM, the elements are simulations of building components. A wall, for example, knows it's a wall. It can know about the types and quantities of materials it includes, its fire rating, sound transmission characteristics, etc. Since the element's relevance to other components and its meaning to the building are embedded within the BIM, the element can simulate an actual building component's behavior, such as its load-bearing capacity or its response to heating and cooling loads.

**Collaboration**

The most significant process improvement that this inclusion of relevance and meaning enables is radically improved collaboration among the wide-ranging skills and expertise needed to design and construct a modern building. Having such *information* readily at hand supports rich sharing of *knowledge*.

The fragmentation of our industry and the costs of that fragmentation are well known. Over the last century the number of specialists involved in a building has exploded, but the feedback from these specialists to the designer happens only at discrete points and with varying frequency. It is this discontinuity that causes much of the coordination errors and rework that plague the design and construction process.

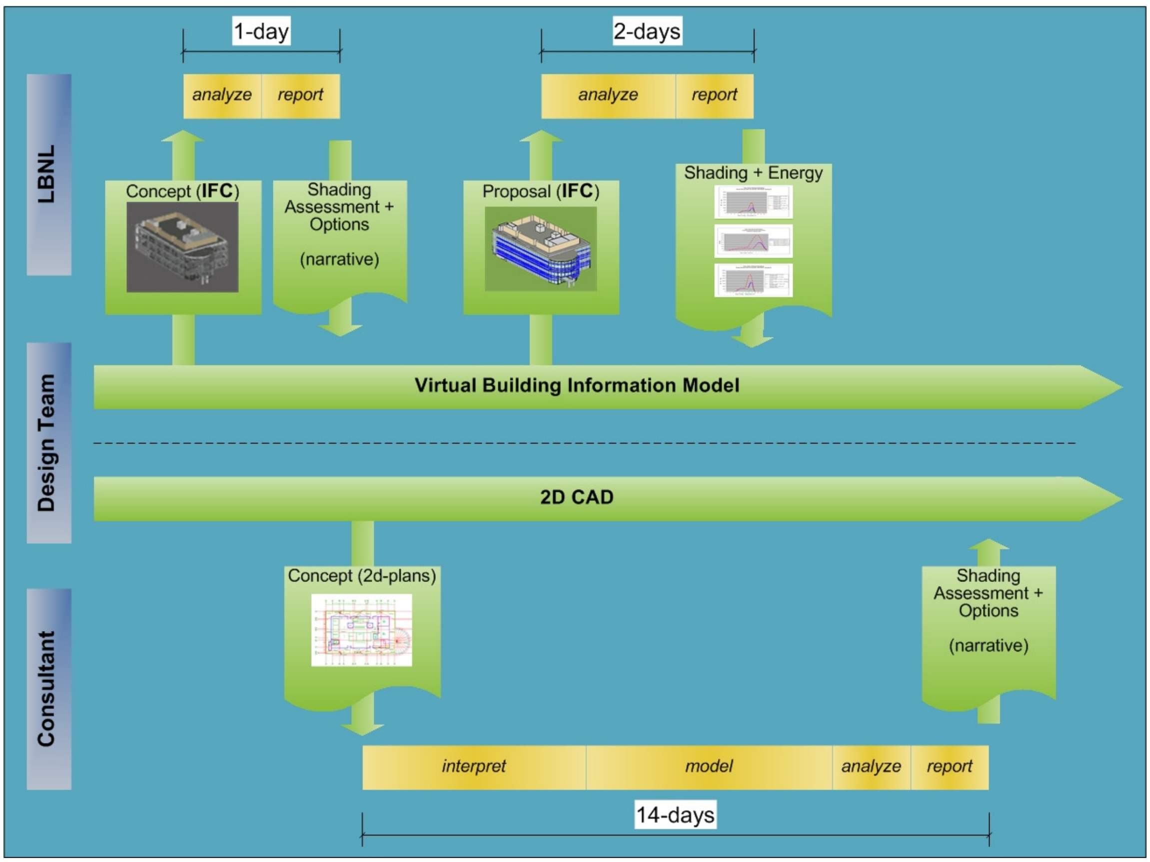
Take cost estimating as an example. At best, the architect will usually get a cost estimate at the mid- and end-points of each of the design phases, and it will take two to three weeks for the builder or cost consultant to produce each estimate. A lot of design work goes on from one estimate to the next – if the architect has inadvertently gone down a path that is driving the project over budget, the delay in feedback can cause a great deal of work to be wasted.

Today's full-fledged BIM tools, however, can extract material and assembly quantities directly from a model and feed them to a cost database, radically increasing the speed, accuracy, and possible frequency of the estimates. In this scheme cost feedback can be used to *guide* the design rather than *repair* it through so-called "value engineering" – after-the-fact cost-cutting that often compromises the design.

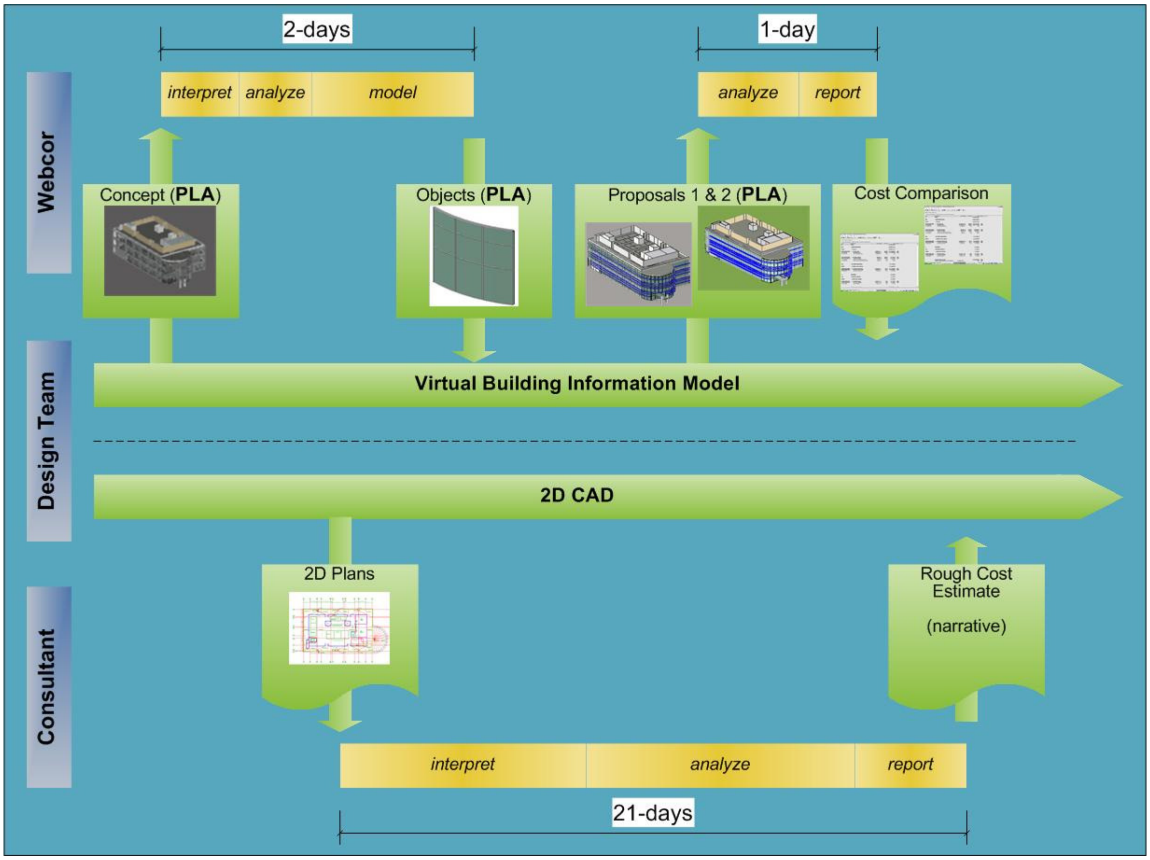
In a collaboration between Anshen + Allen architects, Webcor Builders, and Lawrence Berkeley National Laboratory, the architect was interested in exploring the trade-offs between cost and thermal performance for some options for the building skin. For comparison and validation, the BIM-based collaboration was run in parallel with the traditional consultant feedback process.

The architects were developing the design in a BIM, but the traditional process required them to extract 2D drawings to pass to the consultants. For the energy analysis, the consultant required fourteen days to provide a narrative report on the effectiveness of the shading. However, LBNL was able to take the model directly, apply a simulation program, and produce the same narrative in one day. This allowed Anshen + Allen to try another option, and LBNL provided a full energy-consumption analysis of the new configuration in two days.

Using the traditional 2D -based process, a cost consultant took 21 days to provide a cost estimate for the first option, while Webcor was able to extract the quantities directly from the model and provide a comparison of the two options in three days.




Medical Clinic Solar Analysis (courtesy Tony Rinella, Anshen + Allen)




Medical Clinic Cost Analysis (courtesy Tony Rinella, Anshen + Allen)

**BIM and VDC**

What building information models allow us to do that we couldn't do effectively before is what Stanford University's Center for Integrated Facilities Engineering (CIFE) calls Virtual Design and Construction (VDC). In a nutshell, this is the use of models coupled with analysis and simulation tools to prototype the building in the computer – to simulate the building, its performance, and its construction before breaking ground.

The value of such prototyping is obvious. It is support of this process that we should be thinking about when we provide feedback to software vendors, when we "vote with our wallets" and select BIM tools for purchase, and when we implement BIM technology in our firms.

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[1] Michael Hammer and James Champy, *Reengineering the Corporation*, HarperBusiness, 1993

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Webcor Builders is ranked #1 as the largest general contractor in California, and is consistently ranked among the ENR top 400 General Contractors and the Forbes 500 largest privately owned companies. Webcor has long been recognized as an innovator and leader in commercial construction.