



The Case for Virtual Building

With virtual building, the entire development cycle is based on a shared building model, begun early in the development process and growing throughout the lifecycle of the building. This model—a single knowledge base describing an entire project—generates the schematic drawings needed for public approvals and initial calculation of financial pro-formas and extends all the way to more accurate prediction of operating expenses, thereby reducing risk throughout the entire development process. It is a technology that enables process change throughout the building industry, creating significant opportunities for the design professions.

Why is this needed? The building industry—design, construction, and operations—is highly fragmented. Buildings are not produced by tightly integrated companies but by temporary, project-based organizations of many small firms. Communication and the exchange of data between these firms is critical to the success of any project. Failures of communication lead to cost overruns, delays, quality lapses and disputes. Information technology has been applied in piecemeal fashion to individual tasks but not to the entire process. As a result, communication has actually gotten worse rather than better because each player in the value chain uses mutually incompatible tools that don't readily exchange information with each other.

For example, an architect uses computer-aided design (CAD) to produce drawings, which are then printed on paper and given to a contractor for estimating and scheduling. The floor area of a building, which the architect's CAD program could easily calculate, will now be recalculated by an estimator simply because the CAD program couldn't exchange data with the estimating program. Similarly, contractors' project management software cannot exchange data with tools for energy analysis or facility management, so additional time and effort is needlessly spent in reentering data into new systems. Fabricators of structural and mechanical systems must produce shop drawings that are laboriously checked against the architect's design drawings. As each paper-based handoff of information is made, the opportunity for error and delay is significant. It has been estimated that this process inefficiency inflates the cost of buildings by at least 25%.

Building owners would be much better served if the entire chain of information from design and construction to operations, maintenance, and disposition could remain in one seamless digital format, accessible over the Internet. This is the idea behind the virtual building model. Modeling and simulation technology for product lifecycle integration and management is already well advanced in manufacturing, shipbuilding, and process-plant engineering, but it is still in its infancy in the commercial building industry.

The advantages are many:

- greater predictability of cost and schedule
- avoidance of construction conflicts through simulation
- higher quality, less rework
- shorter time to completion
- capture of design and construction data for use in operations and facilities management
- design is informed by feedback from building and operations

3D and 4D (3D + time) models enable much greater predictability and control over energy use, building performance, maintenance and repair costs and other building lifecycle issues. The virtual building model can be the platform for Web-enabled corporate real estate management. The advantages of virtual building can be applied to managing existing facilities as well. Some large building owners, such as the Coast Guard's Shore Facility Capital Asset Management group, are using 3D digital models to integrate all facility planning, investing, operating and divesting decisions.

At the core of the virtual building process is a parametric 3D model. Parametric computer modeling works like a row-and-column spreadsheet. By storing relationships between the various elements of the design and treating these relationships like mathematical equations, any element of the model that is changed automatically regenerates the model in the same way that a spreadsheet recalculates a change in numerical value in a cell. As can be seen in the work of Frank Gehry, it allows complex shapes to be fabricated directly from the design model without paper drawings. Properties including shape, behavior, performance data, and transport requirements, along with links to code requirements and test results, could all be included in the model. Cost, maintenance, supply and installation properties of the building are retained for use in project costing and scheduling, and later for facilities management. All the information generated in one project could then be stored and retrieved for possible use in the next project. It enables an enterprise-level view of the entire building process.

The technology for implementing a virtual building process is already available, but the industry has been slow to implement it. Long-standing cultural inhibitors have been holding us back. Large building owners will be the prime beneficiaries in the short term, but every member of the design and building team stands to gain from a process that could lead to a more equitable distribution of risk and reward throughout the industry. Early adopters will gain a distinct competitive advantage and will have the opportunity to shape emerging standards and influence the direction of the real estate industry for years to come.

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