# STANDARDIZATION OF BUILDING INFORMATION MANAGEMENT

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**Abstract**

*This article summarizes the history of the standardization efforts in the architectural, engineering and construction industry and focuses on the three phases of the life cycle of a building, namely design, construction and use phases. Data and information needs of each phase tends to be quite different than one another, thus leading to difficulty in seamless exchange and integration between different constituents of the AEC industry. Downstream data users expect the architect to generate digital design information that is usable in the construction and use phases of a building's life cycle. Recently American Institute of Architects have assembled a congress in Washington DC, bringing together representatives from the AEC/FM industry, government agencies, software industry and academic institutions. This paper is a summary of the presentation this author gave at this congress in April, 2004.*
***Key words:*** *CAD standards, data models, information models, standards development.*

**1. Introduction**

Integration of data through multiple phases of the life cycle of a building is important as it impacts the work done by a large number of constituents in the building industry. Seamless integration of building information has been a concern for those who are users of the data generated by the architect during design phase. Downstream users of data can range from structural engineers to construction managers, from facility managers to building asset managers.

A recent congress assembled by the American Institute of Architects in late April 2004 in Washington DC brought together major players in the industry to discuss how data can better be integrated through the design, construction and use phases of a building. Invited panelists, including the author of this paper, discussed methods of developing industry wide standards for the exchange of data and information. Representatives of software companies such as Autodesk, Bentley and ArchiCAD, construction industry representatives including Construction Specifications Institute, Industry Alliance for Interoperability, NIBS, General Services Administration, Code Officials Association and technical integration companies such as FIAtech were participants of this congress. This article is a summary of the presentation that was done by the author at this congress.

Currently the AEC/FM (architecture, engineering, construction/ facilities management) industry is primarily concerned about building information management (BIM) as opposed to CAD. For example, Autodesk now features BIM as their main concern with the release of Revit software [1]. One major implication of this for architectural firms is in the area of design communication, where, in the future, representation of buildings in 3-d will be the norm rather than the exception.

The issue is not to develop a drawing (CAD) standard/convention, but is to develop Building Information Management (BIM) standard. The latter also includes business processes that are used by the AEC/FM industry.

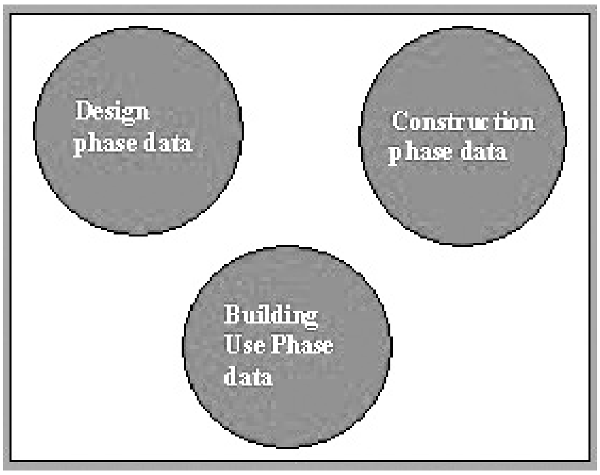


Figure 1: The great information disconnect

Initiatives to develop AEC standards in the last three decades can be summarized as:

- 1980's – CAD drawing standards/conventions for design communication.
- 1990's – product information exchange standards, such as STEP, IFC [2], [3] for design analysis.
- 2000's – standardization across all three phases of the life cycle of buildings, namely design, construction and use phases, including the standardization of building information and business processes.

Standardization of data/information exchange for the full life span of a building has proven to be a very difficult task, as reflected in the *great information disconnect* between data for (Figure 1) design, construction and building use phases. The lack of seamless integration of data impacts those who are at the downstream receiving end of design information such as facility managers, building asset managers, enterprise resource managers, etc., in short those who are involved in the use phase of a building. This is a major concern for the architect, since architects are now expected to generate digital design information that can be used in the later phases of the AEC/FM sequence.

## 2. Design phase standards

Design phase includes "information disconnects" between design communication, analysis and management. Design representation is an important aspect of architectural education and practice, since it must convey design and construction information to others. Unfortunately, data models created as a result of visual representation of designs are not useful in design analysis or in design management, since these lack the structure needed to describe the complex relationships between building parts or knowledge about how such objects behave in the real world.

Conceptually CAD was initially seen as a continuation of manual drafting and blue print conventions, thus did not explore the potentials of the new digital media. These CAD conventions continue to dominate the way designs are represented in the AEC industry today. As a result of this, several efforts to develop CAD drawing conventions (standard layer names, sheet names/ numbers, etc.) came about [4]:

AIA (American Institute of Architects)

BS1192 (UK)

ISO 13567 (International Standards Organization)

NCS – National CAD Standards (US)

Version 1.0 of the AEC (UK) CAD Standard, released in May 2002, etc. [5]

The possibility of including design analysis and design management into the design process shifted the focus of design communication from visual to information representation and management.

### *2.1. Design analysis*

Digital design analysis is impacted by *the disconnect* between information for building components/ spaces, for building processes (behavior) [6] and for building content. New data/ information structures are needed to address this problem. The most important characteristic of this new structure is for it to represent building objects, their properties, and their relationship to each other and to the whole.

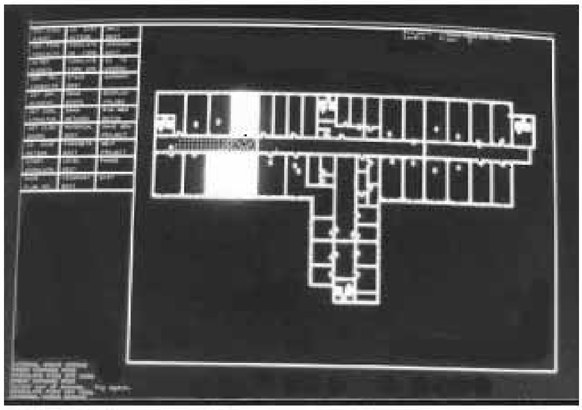

Figure 2: An early example of software with data structure that allowed design analysis, ArchFire based on CAEADS software data structure [7].

Early examples of design analysis software were isolated attempts to model data structures for building components and spaces for design analysis purposes (Figure 2). Therefore, a disconnect remains to this day between data models that will support three different aspects of design analysis, namely *buildings as objects*, *processes* such as energy, fire spread, acoustics, etc, and *content* such as furniture, people, goods and materials. Current efforts by ASHRAE and others now focus on the reconciliation of the first two for energy analysis purposes. Similar issues exist for life cycle analysis where one must calculate the environmental impact of mass and energy flow for each building component, making life cycle analysis the most complex and comprehensive of all design analysis efforts [8].

Another area where data disconnect is causing productivity loss is between design and construction phases [9]. Construction management software such as those for project scheduling/ management and cost analysis/estimation typically require the input of most data from scratch. Complex construction projects such as highrises, sports complexes, etc. require very versatile tracking and scheduling systems for the thousands of parts that need to be put together and thousands of tasks that need to be completed. Recently, due to its ability to manage spatially distributed data, geographic systems are successfully used to manage construction processes.

Furthermore, standardization of the way building materials are specified has been an important concern of the Construction Specifications Institute (CSI) for quite some time. CSI standards such as MasterFormat and Uniformat are now widely used in the industry, but are yet to be included in design communication software.

## 3. Use phase data needs

The use phase poses an important challenge, since building users and their data needs can be very varied.

This also considerably differs from the data and information needs of the other two phases, namely design and construction phases. Below are some areas that need building information at the use phase:

- Facility management (FM)
- Building asset management
- Enterprise resource management
- Real estate management
- Spatial/building information management, GIS, (CAD – GIS interface)

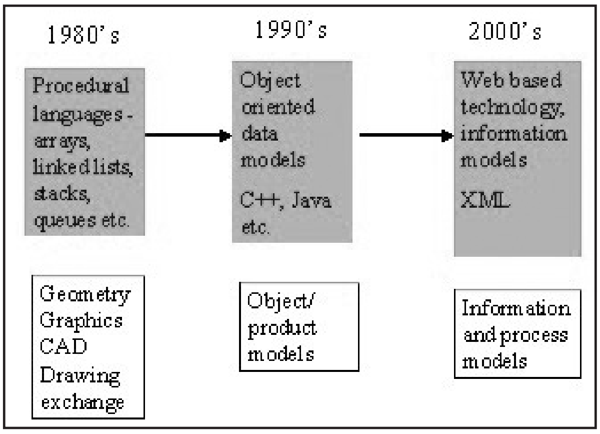


Figure 3: Data modeling to building information modeling

Companies such as FIATECH [10] are now gearing towards producing full building information management software and are a big part of the seamless data/information integration effort. FIATECH is proposing to build a Data Standards Clearinghouse, where they want to "maintain information on evolving standard participants have access to more complete [standards] information…" The titles of some of the upcoming conferences are enough to indicate the direction of the industry: "Life Cycle Data Management and Information Integration", "Scenario-based Project Planning", "FIATECH Capital Projects Technology Roadmap" and "Roadmap Champions Integration" by NIST, etc. *Design automation experts* are becoming indispensable and business-to-business software solutions are becoming the norm in the business world. The AEC industry is now, more then ever, seeing the need for standardization and seamless integration. Governmental agencies such as General Services Administration (GSA) who manages thousands of square footage in federally owned buildings has been also at the forefront of standardization efforts, since they are such a major downstream design data user.

To address the *great information disconnect* in the AEC industry, numerous attempts can be cited. Among the collaborative efforts, the most widely known ones are:

- STEP – exchange of product model data based on an information modeling language (SDAI – standard data access interface) [2]
- IAI – Industry Alliance for Interoperability, IFC – Industry Foundation Classes – 3d object representation [3]. IFC compliance is becoming a standard for these as well as other specialized software.
- National CAD standard – AIA-CSI-NIBS through NIBS' consensus building process

AEC software industry has mostly responded by developing propriety software and by using their own seamless integration framework:

- Autodesk Architectural Desktop and Revit [1]
- Bentley – Microstation Tri Forma, Bentley Architecture, HVAC, ProjectWise, etc. [11]
- ArchiCAD [12]
- Nemetschek Allplan, etc.

### 4. Web based data/information sharing

In her recent article [13], this author has focused on the potential of XML [14] technology for building information sharing. Standardization efforts can benefit from the use of XML (Extensible Markup Language) in areas such as:

- E-business applications [15]
- Collaborative design efforts
- Project management servers
- Web based technology helping with the standardization effort -

The flexibility of XML is both a curse and a blessing. Due to its infinite flexibility, it increases the need for a common data/information model even more.

#### *3D Building information exchange*

- aecXML (Bentley) – primarily non-graphic data [16]
- IfcXML (Industry Alliance for Interoperability) – primarily graphic data [3]
- BlisXML (General object relationship builder)
- General 2d/3d CAD/drawing data exchange – DesignXML (Autodesk) [17]

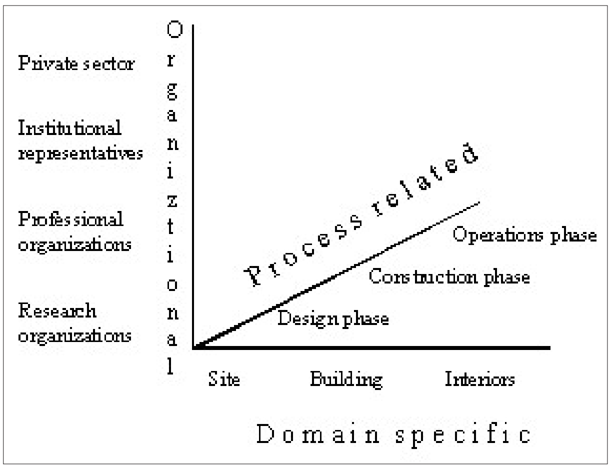


Figure 4: Issues in standardization

***Design Analysis information exchange***

- Landscape/surveying information (subpart of aecXML) – LandXML
- Energy Simulation – enerXML
- Simulation/performance analysis – bmXML (General building model)
- E-business applications in design- ebXML [18]
- Center for e-business in Construction – citeXML
- Building Construction – bcXML

**4. Summary**

The need for a common data/information model for the full life cycle of the built environment has become urgent with the increased data use by downstream data users. The scale of the building industry and the variety of professions/businesses that contribute to this industry is a challenge in the development of a standard model. Issues in data/information modeling for buildings can be summarized as seen in Figure 4. Organizational aspects of standardization is most complex, since it requires leadership as well as collaboration of many parties involved in the AEC industry. There is a need for a standard scalable model that can be small enough for simple applications, but robust enough for use for software spanning the whole life cycle of a building, a model that is based on typical business processes used by businesses in all phases of the life cycle of a building. The adaptability of the standard model to variations in the business models that are employed in the AEC/FM industry is also of utmost importance.

**Incentives:** Increased marketability of software that are based on standard data models

More effective research and development – eliminating the need for reinventing the wheel

Potential for integrating business processes across multiple phases of the life cycle of a building

Challenges:

- Organizational
  Private industry representativesProfessional organizations
  Academia/research representatives
  Institutional representatives
- Intellectual property rights
- The nature of the enterprise (large, distributed, very varied) and the software needs of the industry as summarized before
- Buy-in from the general AEC/FM community needed
- Coming up with a consensus building model

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