

# What is Building Information Modeling (BIM)?

ISA Project Team Report July, 2008

Wikipedia defines [Building Information Modeling](#) (BIM) as the process of generating and managing building data during its life cycle using three-dimensional, real-time, dynamic building modeling software to decrease wasted time and resources in building design and construction. This process produces the building information model (*also abbreviated BIM*), which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components, including the life-cycle processes of construction and facility operation.

**Building Information Modeling** (BIM, the process) began as a common name for a variety of activities in object-oriented computer-aided design (CAD) that support the representation of building elements in terms of their 3D geometric and non-geometric (functional) attributes and relationships. It gained widespread use after [Lessarian argued](#) in 2002 that it should be an industry-standard term. At the time it was recognized that BIM based systems are more expressive than CAD systems in that “abstract objects, such as a space, can be defined by the relationships between physical building elements, identified (e.g. room number, room name, etc.), described (e.g. area, volume, use, occupancy, etc.), and referenced (e.g. listed in a room schedule, counted to calculate total floor area, etc.)”.[\[Howell and Batchelor05\]](#)

**Industry Foundation Classes** (IFC) are a commonly used format for BIM (the data model). They are architectural, engineering, and construction (AEC) open data model specifications for data representation and file formats for defining graphic data as 3D real-world objects that enable CAD users to transfer design data between different software applications. They are intended to provide an “authoritative semantic definition of building elements, their properties and inter-relationships”.[\[Goldberg05\]](#) The IFC specification is developed and maintained by the [International Alliance for Interoperability](#) (a division of the International Standards Organization) as part of its [buildingSMART](#) mission, and has been included in several [ISO standards](#).

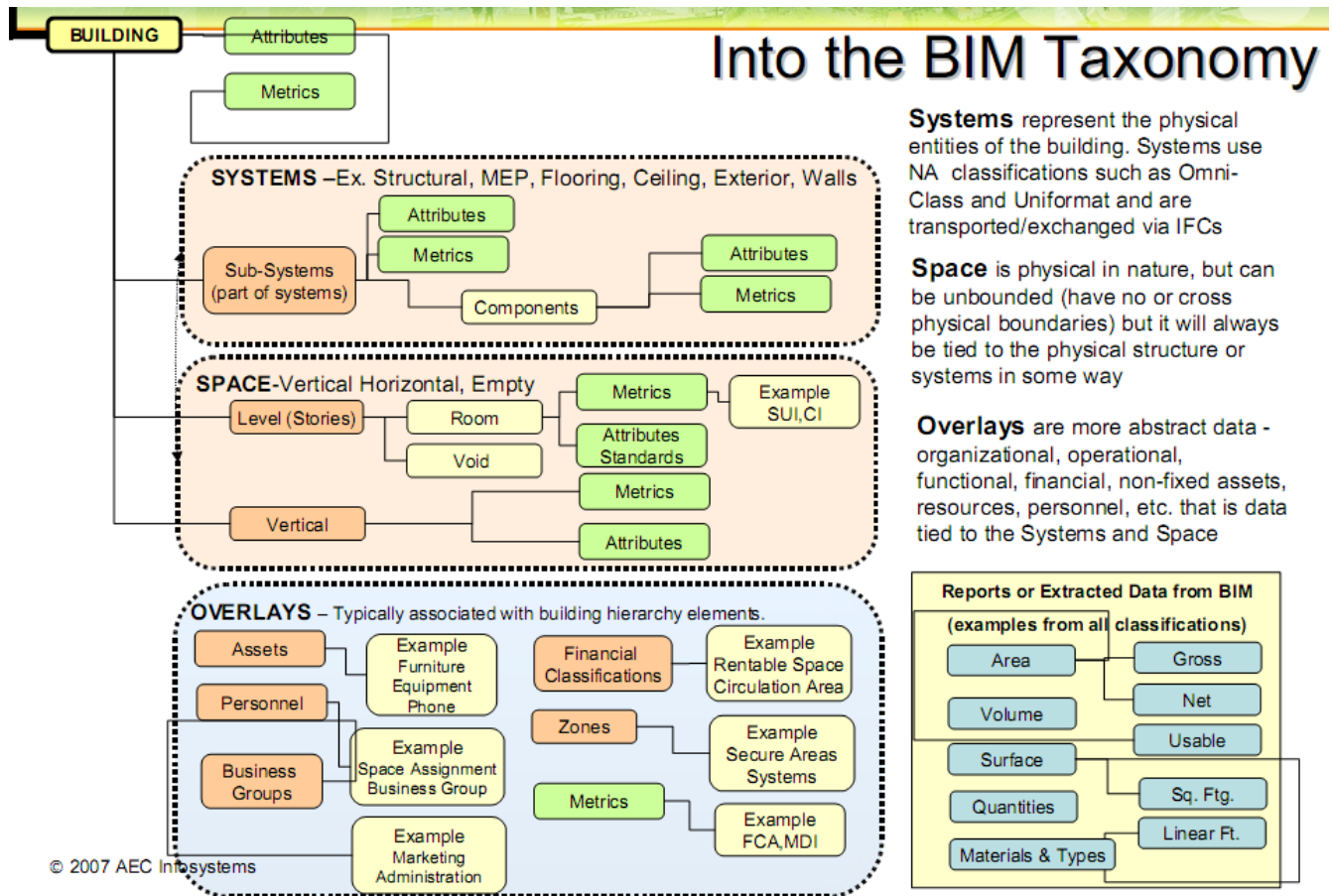
“**4D Modeling**” concepts were later coupled with Building Information Modeling, but when used by the facilities modeling community (for example, the National BIM Standard committee) the term refers to systems that can model life cycles of elements and sets of elements.

The **National Building Information Model Standard** (NBIMS), developed by a US based buildingSmart group, describes three categories of BIM:

1. a product or intelligent digital representation of data about a capital facility. BIM authoring tools are used to create and aggregate information which, before BIM, had been developed as separate tasks with non-machine interpretable information in a paper-centric process.
2. a collaborative process which covers business drivers, automated process capabilities, and open information standards use for information sustainability and fidelity.
3. a facility lifecycle management tool of well understood information exchanges, workflows, and procedures which teams use as a repeatable, verifiable, transparent, and sustainable

information based environment used throughout the building lifecycle.

A recently released overview of NBIMS [design principles and modeling](#) includes a BIM taxonomy:



A subset of this taxonomy is used in an influential set of requirements for building project contractors, the US General Service Administration (owner of over 300 million square feet of rentable space). It demanded in 2006 that all major building design projects submit a [spatial program BIM](#), whose requirements are described in a [2007 BIM Guide Series document](#).

**BIM Spatial Models** required by the GSA are based in geometric definitions. They note: “Spaces are one of the most important object types in conceptual building design. During pre-design, many, if not most, client requirements are described in terms of spatial program requirements; furthermore, throughout building design and operation many performance metrics utilize spatial data. Consequently, modeling spaces accurately is one of the most important tasks in creating BIMs”.

Requirements of any spatial model include:

- When spaces are defined by its surrounding walls, the area inside them is defined precisely. In a BIM process, the space itself is a 3-D object...typically created by aligning its geometry with the inside faces of surrounding building elements (e.g., walls, floors, ceilings, etc.). If the geometry of these building elements changes, the space object must also be updated to reflect the new geometry of the space.

- Some physically bound volumes may have several functional spaces inside them...spaces should be represented and broken down into functional spaces (i.e., office area, storage area, building common area, vertical penetration, etc.) even though they may be parts of a larger physical space.
- A physical space may contain several areas that are treated individually in the GSA spatial program. If two areas have different functional space classifications, even though they are within the same physical space, they shall be modeled as two separate spaces. For example, there may be a security checkpoint area within a lobby. In this case, the security checkpoint area (Office) and the remainder of the lobby area (Building Common) must be modeled as separate non-overlapping spaces. These spaces might also be grouped into a Zone, for visualization and analysis purposes (e.g., to differentiate private vs. public zones, for thermal simulation calculations).

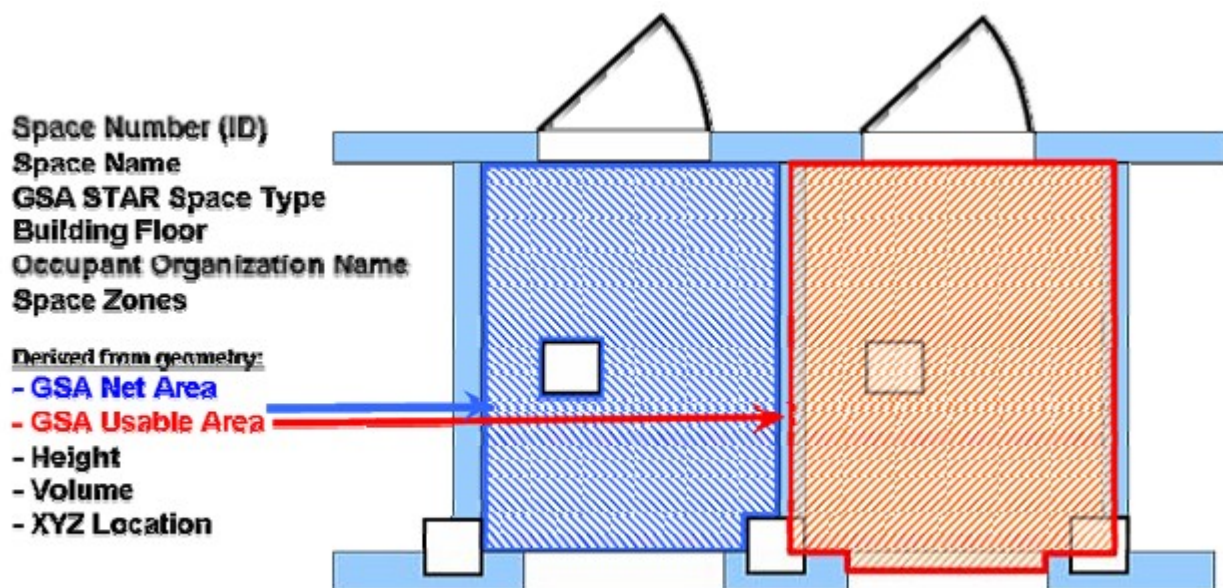


Figure 2: Spatial Information in the model (top view)

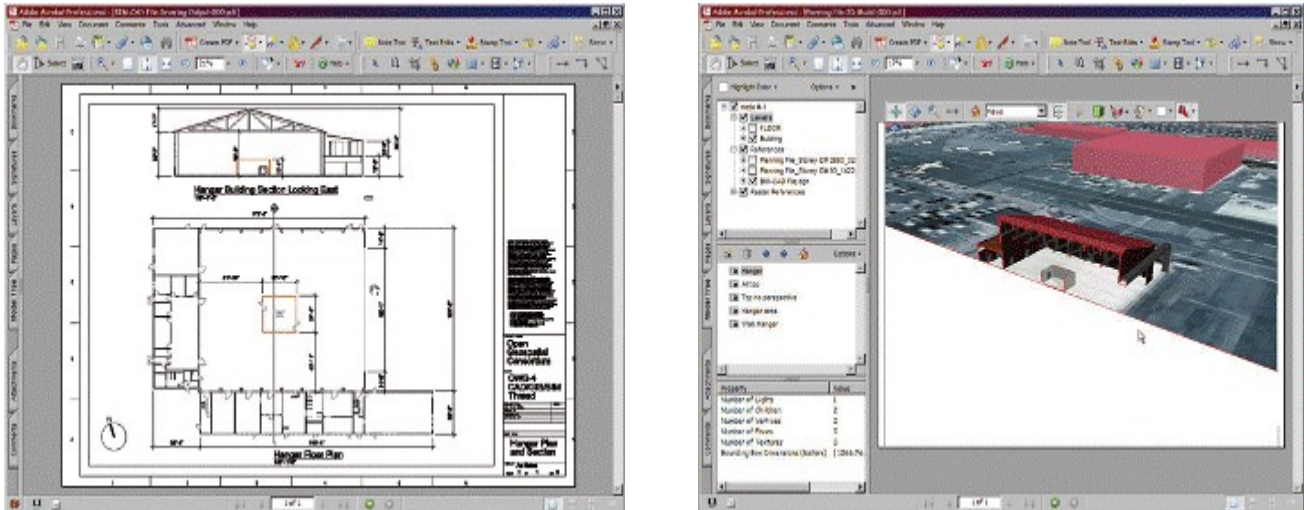
There are also some interesting rules associated with GSA spaces, for example: “for areas under 9 s.f. that do not have a defined space object, the BIM-analysis rules will treat this area as if it were a wall”.

**Building Information Model** (BIM the data model) had its origins in Chuck Eastman's Building Product Model. His discussion on [What is BIM?](#) stresses that BIM involves representing a design as “objects - generic or product-specific, solid shapes or void-space oriented (like the shape of a room), that carry their geometry and attributes. If an object is changed or moved, it need only be acted on once...Parametric objects automatically re-build themselves according to the rules embedded in them. The rules may be simple, requiring a window to be wholly within a wall, or complex defining size ranges, and detailing”. Eastman is currently the director of the [Architecture, Engineering, and Construction \(AEC\) Integration Lab](#).

**Taxonomy of BIM terms (subset)** ([http://bim.arch.gatech.edu/content\\_view.asp?id=454](http://bim.arch.gatech.edu/content_view.asp?id=454)):

<b>Object(s)</b>	Objects are the internal representation of real world items or concepts in the discourse of the application domain. In BIM, objects could be recognized as building elements for instance a piece of geometry, a solid primitive, a beam, a column, a window, a staircase, etc. An object can also be assembled and represented by multiple objects. At the implementation level, an object usually can be instantiated through a class that constructs the particular object.
<b>User Definable Object</b>	User definable objects is where users can build an object from scratch and have full control on the design of an object in terms of 1) the geometric representation; 2) properties; 3) constraints and variables for its parametric behavior...
<b>Parameter</b>	variables used in an equation to assign values : coordinate, dimension, material, distance, angle, color, unit price, energy coefficient, ...
<b>Geometric Parameter</b>	One type of parameter especially used to define the intrinsic properties of geometry, for example, coordinate, surface parameters, and angle. Also measurements of a shape: distance, area, volume, and centroid.
<b>Geometric constraints</b>	one type of constraint especially limits mathematical relationships between geometric parameters. For instance, a dimension can be constrained by fixed length or by range, and the parallel of two lines is a geometric constraint which limits the angles of two lines to be equal.
<b>Parametric behavior</b>	the reaction of parameters or variables by changing of a parameter according to the defined relations and constraints among the parameters.
<b>Parametric shape</b>	(= Dimension-driven creation and modification of building components) A type of shape, which is defined to have parametric behavior (= parametric control). In order to have parametric behavior, all geometric elements of the shape should be related and constrained to each others.
<b>Parametric curved surfaces</b>	(a type of parametric shape): A type of surface model, defined to have parametric behavior. For instance, Bezier, spline, b-spline, and Nurbs surface are all parametric curved surface, because the surfaces can be controlled by control points.
<b>Parametric solid</b>	(a type of parametric shape): a solid model defined to have parametric behavior. In order to have parametric behavior, all geometric elements of the solid should be related and constrained to each others.

## CAD-GIS-BIM Integration



An example of a CAD-design that can be saved as a 3D-PDF and imported in Google Maps.

The above example is from: [OGC Workgroup: BIM Data Exchangeability with GML](#)

More interesting BIM examples came out of the June 2008 [Build London Live](#) event in which 10 teams from 5 different continents were given 48 hours to design a part of London from scratch in a huge online collaborative effort that used BIM methodology and tools. The [winning team](#) of the June 2008 [Build London Live](#) event created a highly detailed IFC model for their BIM.

See also:

- [ERSI support for CGB](#)
- [Federal Facilities Report on CGB](#)
- [OGC Workgroup 2007 talks on Geospatial Web Services for Infrastructure and Buildings](#)