AIA California Council
The American Institute of Architects

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Organizing the Development of a Building Information Model

(Sacramento – August 25, 2008) At the core of architectural design is the process of moving from approximations to progressively more precise information. Representations of building elements in a BIM though, are exact, whether intended to be or not, and can give a false indication of the precision actually known at a given point in the design process. Add to this confusion the fact that it is possible to use a BIM for many purposes (costing, scheduling, performance simulation, code checking, visualization, etc.), some possibly not considered by the author of the BIM. The need for a framework defining a BIM's precision and suitability for specific uses becomes obvious.

To address this need Vico Software (then a division of Graphisoft – www.vicosoftware.com) began work in 2004 on a Model Progression Specification (MPS). Webcor Builders teamed with Vico to further develop the concept, and then brought it to the technology subcommittee of The AIA California Council's Integrated Project Delivery (IPD) Task Force. Here the viewpoints of architects, contractors, engineers, subcontractors, owners, and software developers were brought together to broaden the applicability of the MPS. The AIA National Documents Committee has adopted the approach, provided further development, and incorporated it into the new E202, an exhibit which formalizes the processes for development and use of BIM's for a specific project. This document helps teams agree on the purposes for which the project BIM(s) will be used, the level of detail to which specific elements of the BIM(s) will focus at the conclusion of each phase, and who will develop specific elements of the BIM(s) to the specific levels of detail. The E202 is slated for publication in the fall of 2008.

While the MPS is extremely useful in any project using BIM, the depth of collaboration in IPD creates a systematic approach which is essential. With this in mind, the MPS has been developed to address two principles of IPD:

1. The requirement "phase outcomes – milestones and deliverables – be defined succinctly" so that team members "understand the level of detail at which they should be working, and what decisions have (and have not) been finalized" (see *Integrated Project Delivery: A Guide,* www.aia.org/ipdg, p 23).

2. The idea of assigning tasks "on a best person basis, even when that differs from traditional role allocations" (*Integrated Project Delivery: A Guide,* p 13).

Level of Detail (LOD). The core of the MPS is the LOD definitions – descriptions of the steps through which a BIM element can logically progress from the lowest level of conceptual approximation to the highest level of representational precision. It's been determined that five levels, from conceptual through as-built, were sufficient to define the progression. However, to allow for future intermediate levels, the levels have been labeled 100 through 500. In essence, the levels are as follows:

100. Conceptual
200. Approximate geometry
300. Precise geometry
400. Fabrication
500. As-built

These definitions are further developed in the context of specific uses of the model. The current state of the LOD definitions is shown in Table 1.

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Table 1: Level of Detail (LOD) Definitions

Level of Detail ->	100	200	300	400	500
Model Content					
Design & Coordination (function / form / behavior)	Non-geometric data or line work, areas, volumes zones, etc.	Generic elements shown in three dimensions - maximum size - purpose	Specific elements Confirmed 3D Object Geometry - dimensions - capacities - connections	Shop drawing/ fabrication - purchase - manufacture - install - specified	As-built - actual
Authorized uses					
4D Scheduling	total project construction duration phasing of major elements	Time-scaled, ordered appearance of major activities	Time-scaled, ordered appearance of detailed assemblies	Fabrication and assembly detail including construction means and methods (cranes, man-lifts, shoring, etc.)	
Cost Estimating	Conceptual cost allowance Example $/sf of floor area, $/hospital bed, $/parking stall, etc. assumptions on future content	Estimated cost based on measurement of generic element. E.g., generic interior wall.	Estimated cost based on measurement of specific assembly. E.g., specific wall type.	Committed purchase price of specific assembly at Buyout.	Record costs
Program Compliance	Gross departmental areas	Specific room requirements	FF&E, casework, utility connections		
Sustainable Materials	LEED strategies	Approximate quantities of materials by LEED categories	Precise quantities of materials with percentages of recycled/locally purchased materials	Specific manufacturer selections	Purchase documentation
Environmental: Lighting, Energy use, air movement Analysis/Simulation	Strategy and performance criteria based on volumes and areas	Conceptual design based on geometry and assumed system types	Approximate simulation based on specific building assemblies and engineered systems	Precise simulation based on specific manufacturer and detailed system components	Commissioning and recording of measured performance
Other uses may be identified and developed					
Exiting and circulation					
Code compliance					
Etc.					

Table 2: LOD Examples

Table 2 shows some examples to help clarify the concepts.

Level of Detail ->	100	200	300	400	500
Element					
Interior wall	Not modeled. Cost and other information can be included as an amount per s.f. of floor area.	A generic interior wall, modeled with an assumed nominal thickness. Properties such as cost, STC rating, or U-value may be included as a range.	A specific wall type, modeled with the actual thickness of the assembly. Properties such as cost, STC rating, or U-value can be specified.	Fabrication details are modeled where needed.	The actual installed wall is modeled.
Duct run	Not modeled. Cost and other information can be included as an amount per s.f. of floor area.	A 3-dimensional duct with approximate dimensions.	A 3-dimensional duct with precise engineered dimensions.	A 3-dimensional duct with precise engineered dimensions and fabrication details.	A 3-dimensional representation of the installed duct.

The LOD definitions can be used in two ways: to define phase outcomes and to assign modeling tasks.

Phase outcomes. As the design develops, various elements of the model will progress from one LOD to the next at different rates. For example, in the traditional phases, most elements will need to be at LOD 300 at the conclusion of the CD phase, and many will be taken to LOD 400 in the shop drawing process during the construction phase. Some elements though – paint, for example - will never be taken beyond LOD 100, i.e., the layer of paint is not actually modeled, but its cost and other properties are attached to the appropriate wall assembly.

Task assignments. Beyond its 3-dimentional representation, there is a great deal of information that can be linked to an element in a BIM, and this information may be provided by a variety of people. For example, while a 3-dimentional representation of a wall may be created by the architect, the GC may provide a cost, the HVAC engineer a U-value and thermal mass, an acoustical consultant an STC rating, etc. To address this multiplicity of input the AIA Documents Committee developed the concept of “Model Component Author” (MCA), stating who is responsible for creating the 3-dimensional representation of the component, but not necessarily for other discipline-specific information linked to it.

In a traditional project, it is likely that MCA assignments will align with the design phases – the A/E team does the modeling up through CD's, and subcontractors and suppliers will do any shop-drawing modeling required. However, in an IPD project, with tasks assigned "on a best person basis", it is likely that handoffs will occur at various points in the design process. For example, the mechanical subcontractor may take over as MCA for ductwork during the Detailed Design phase.

The Model Progression Specification. Figure 1 shows a portion of a completed MPS. While the example shows phase names, LOD progression, and MCA assignments typical of an IPD project, these entries can be changed to fit the specific project.

Figure 1. Completed Model Progression Specification

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	The content in G5:O83 is shown for example only - it is expected that each project team will validate and adjust the content to align with the particular needs of the project and capabilities of the team members. The Level of Detail by Phase entries shown here are the minimum that would satisfy the phase descriptions in the **AIA/AIACC IPD Guide***. See "**Level of Detail Descriptions**" tab for descriptions of LOD 100 - 500.						**PD** Prime Designer **DC** Design Consultants **PC** Prime Constructor **TC** Trade Contractors **S** Suppliers							
2	*Integrated Project Delivery: A Guide													
3	**Model Component (ASTM Uniformat II Classification)**						**Level of Detail and Model Component Author by Phase**							
4							**Conceptual-ization**		**Criteria Design**		**Detailed Design**		**Implemen-tation Docs**	
5							**LOD**	**MCA**	**LOD**	**MCA**	**LOD**	**MCA**	**LOD**	**MCA**
6	A	SUBSTRUCTURE	A10	Foundations	A1010	Standard Foundations	100	PD	200	DC	300	TC	400	TC
7					A1020	Special Foundations	100	PD	100	DC	300	TC	400	TC
8					A1030	Slab on Grade	100	PD	200	DC	300	TC	400	TC
9			A20	Basement Construction	A2010	Basement Excavation	100	PD	200	DC	300	TC	300	TC
10					A2020	Basement Walls	100	PD	200	DC	300	TC	400	TC
11	B	SHELL	B10	Superstructure	B1010	Floor Construction	100	PD	200	PD	300	PD	300	PC
12					B1020	Roof Construction	100	PD	200	PD	300	PD	300	PC
13			B20	Exterior Enclosure	B2010	Exterior Walls	100	PD	200	PD	300	TC	400	TC
14					B2020	Exterior Windows	100	PD	200	PD	300	TC	400	TC
15					B2030	Exterior Doors	100	PD	200	PD	300	TC	400	TC
16			B30	Roofing	B3010	Roof Coverings	100	PD	200	PD	300	TC	300	TC
17					B3020	Roof Openings	100	PD	200	PD	300	TC	300	TC
18	C	INTERIORS	C10	Interior Construction	C1010	Partitions	100	PD	200	PD	300	PD	400	TC

The spreadsheet shown is in the public domain – the latest version can be downloaded free of charge from www.ipd-ca.net (click on "Technology"). This is a work in progress - it is likely that through use on actual projects shortcomings may be found and improvements proposed. We encourage project teams to use the spreadsheet, modify it, and provide feedback to ipd@aiacc.org.

We thank the members of The AIACC IPD Task Force Technology Subcommittee for their hard work in developing broad-based consensus around this process:

Paul Audsley, NBBJ Architects
Jim Awe, Autodesk
Jim Bedrick, Webcor Builders (chair)
Dan Gonzales, Swinerton Builders
Mario Guttman, HOK Architects
Atul Khanzode, DPR Construction
Greg Luth, GPLA Engineers
Tony Rinella, Anshen + Allen Architects
John Wynne, Lucasfilm (owner)

About the Author

Jim Bedrick, AIA, is Vice President of Virtual Building and Design for Webcor Builders. A registered architect, Jim holds degrees in both Architecture and Electrical Engineering, and has over 25 years' experience in the AEC industry. After practicing architecture for ten years, he moved into the design and management of information systems for architecture firms. In 1998 he joined 3Com Corporation, directing information technology for their worldwide construction and facilities management division. In 2001 he joined Webcor, where his focus has been the use of information technology for simulation, coordination, communication, and knowledge sharing in design and construction teams. Jim is active in many organizations working to advance information technology in service to the AEC industry, including Stanford University's Center for Integrated Facilities Engineering, the International Alliance for Interoperability and the American Institute of Architects, where he serves on the Board Knowledge Committee and is a major contributor to the Integrated Project Delivery effort.

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.

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