AALBORG UNIVERSITY

Building Informatics

Produkt og Procesmodeller (PPM) i byggeriet.
Product and Process models in Construction.

4. BIM for Architetcs and Engineers

Cand. Scient. Bygningsinformatik.
Semester 1, 2010.

CONTENT

- Scope of Design Services
- BIM use in Design Process
- Building Element Libraries and Libraries
- Considerations in Adoption for Design Practice
- New and Changed Staffing within Design Firms

Our emphasis in red from the BIM Handbook

From the BIM Handbook

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5.0 Executive Summary

BIM is a paradigm change.
BIM redistributes the distribution of effort, placing more emphasis on conceptual design.

While there are clear benefits for the fabricators to employ 3D parametric modeling and interoperability for use in automation and other productivity benefits, the direct benefits to design are more difficult to quantify. However, BIM integration with analyses and simulation, and improving the quality of design, especially in its early stages, provides value to owners equivalent or even greater than any savings in construction costs; design qualities long lasting, offering benefits over the life of a building.

From the BIM Handbook

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5.2 Scope of Design Services

The traditional contract for architectural services suggests a payment schedule (and thus the distribution of effort) to be 15% for schematic design, 30% for design development, and 55% for construction documents. /this latter effort will decrease/

p. 156
We can also see from the diversity of contributors to this book that the main challenge to adopting BIM technology is getting all parties of a design project to agree on new methods of working, and for documenting and communicating their work.

From the BIM Handbook

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5.3.1 Concept Design and Preliminary Analyses

- Quick 3D sketching - *Google SketchUp*
- Larger more geometrically complex projects - *form-Z*
- Layout according to a building program - *Facility Composer*, *Trelligence*
- Energy, lighting - *EcoTect*, *IES*, *Green Building Studio*,
- Cost assessment - Dprofiler

Unfortunately, no one of these programs provides the broad spectrum of functionalities needed for general concept design, and smooth interoperability between these tools is not yet a reality.

Our additions
- dRofus http://www.drofus.no/

From the BIM Handbook

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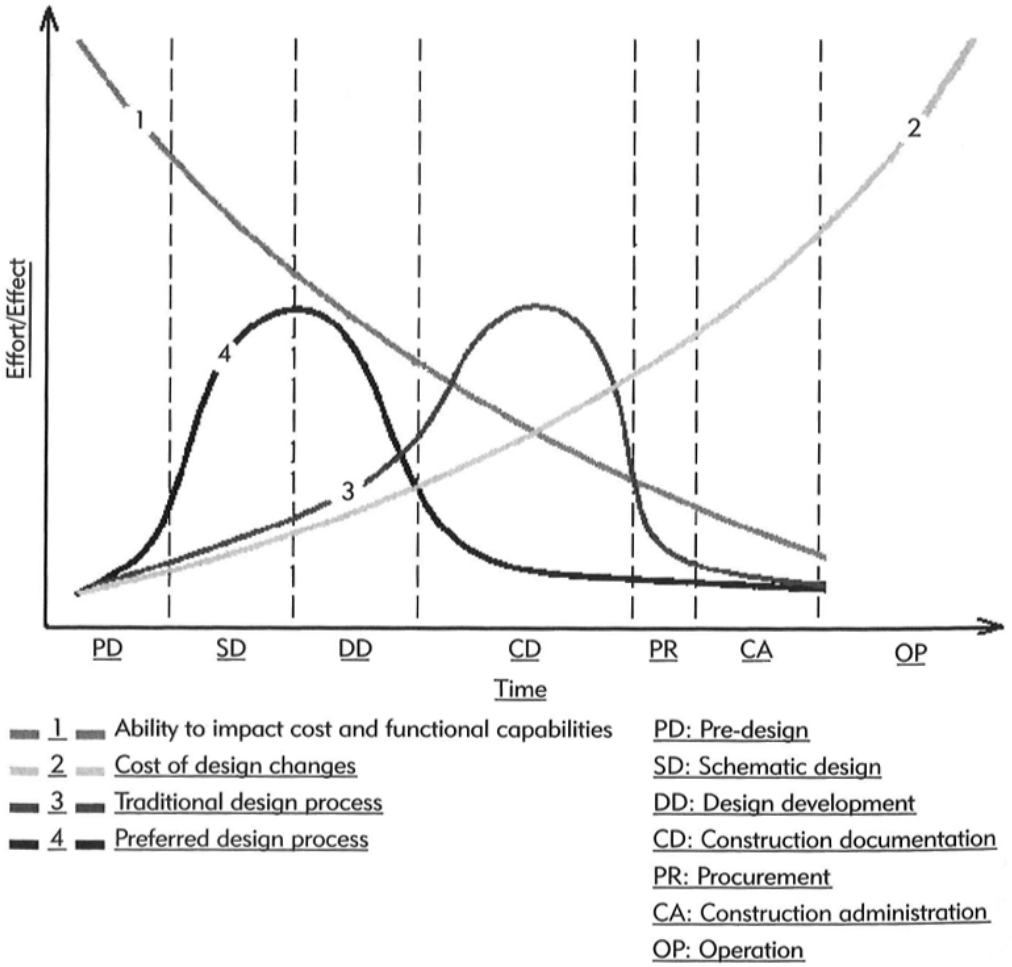
Figure 5-1 Value added, cost of changes and current compensatikon distribution for design services (CURT 2007).



From the BIM Handbook

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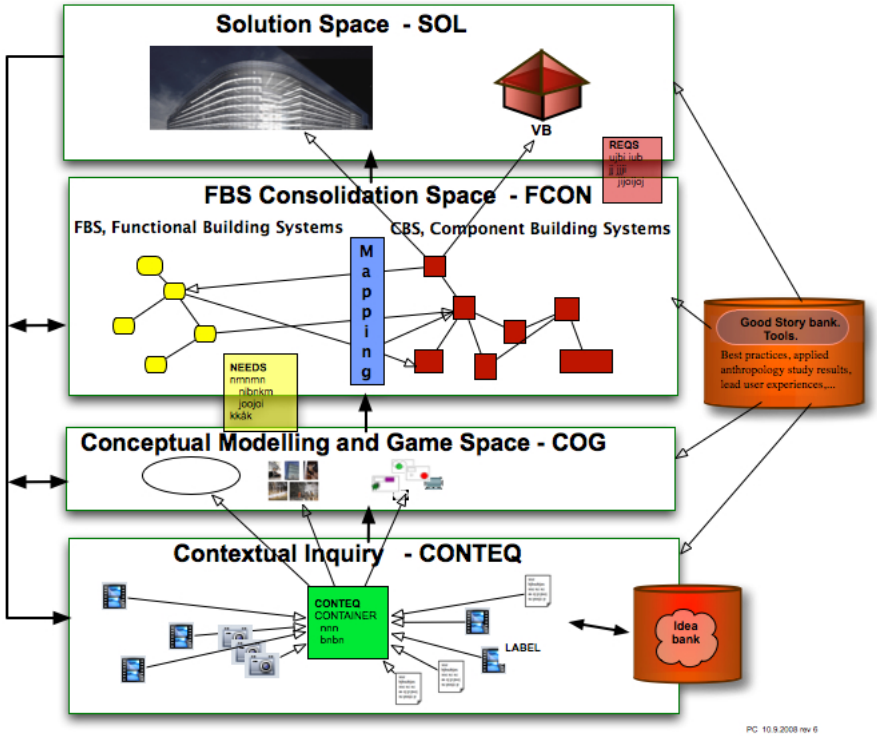
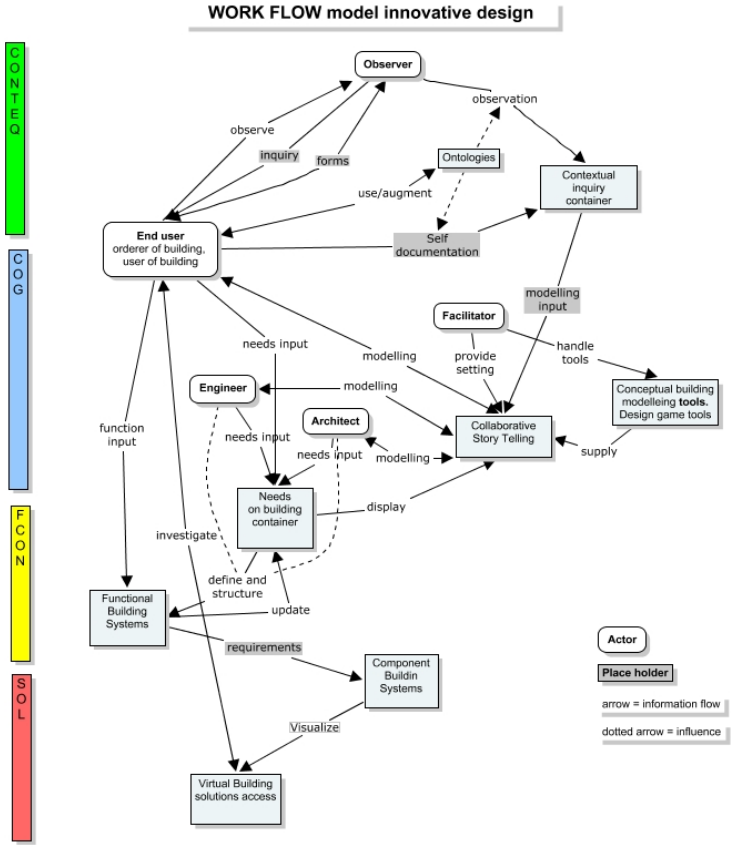
Table 5-2 Concept design applications and the exchange formats they support.

	Import formats							Export formats						
Application	**3DS**	**DWG**	**DXF**	**VRML**	**IGES**	**SAT**	**Others**	**3DS**	**DWG**	**DXF**	**VRML**	**IGES**	**SAT**	**Others**
Massing and Sketching														
SketchUp	•	•	•					•	•	•	•			obj, Epix
form·Z	•	•	•	•	•		act, obj, rib, w3d, stp, stl, 3dmf	•	•	•	•	•	•	act, Epix, ArtL, obj, rib, w3d, stp, stl, 3dm
Rhino	•	•	•		•		obj, stp, stl, 3dm	•	•	•	•	•	•	3dm, stp, obj, x_t, stl, xgl
Maxon	•		•	•			direct3d, stl, cct	•		•	•			direct 3d, stl, cct
Space Planning														
MS Visio		•	•				wmf, xls							xls
Vectorworks	•	•	•	•	•	•						•	•	stl, epix
Facility Composer					•		IFC, stp					•		IFC, stp
Trelligence									•	•				gml, csv
Environmental Analysis														
IES		•	•				dgn, gbXML, Revit®							Revit®
Ecotect			•				IFC			•	•			
GreenBuilding Studio		•					rvt, dgn, XML				•			

The VIC Method

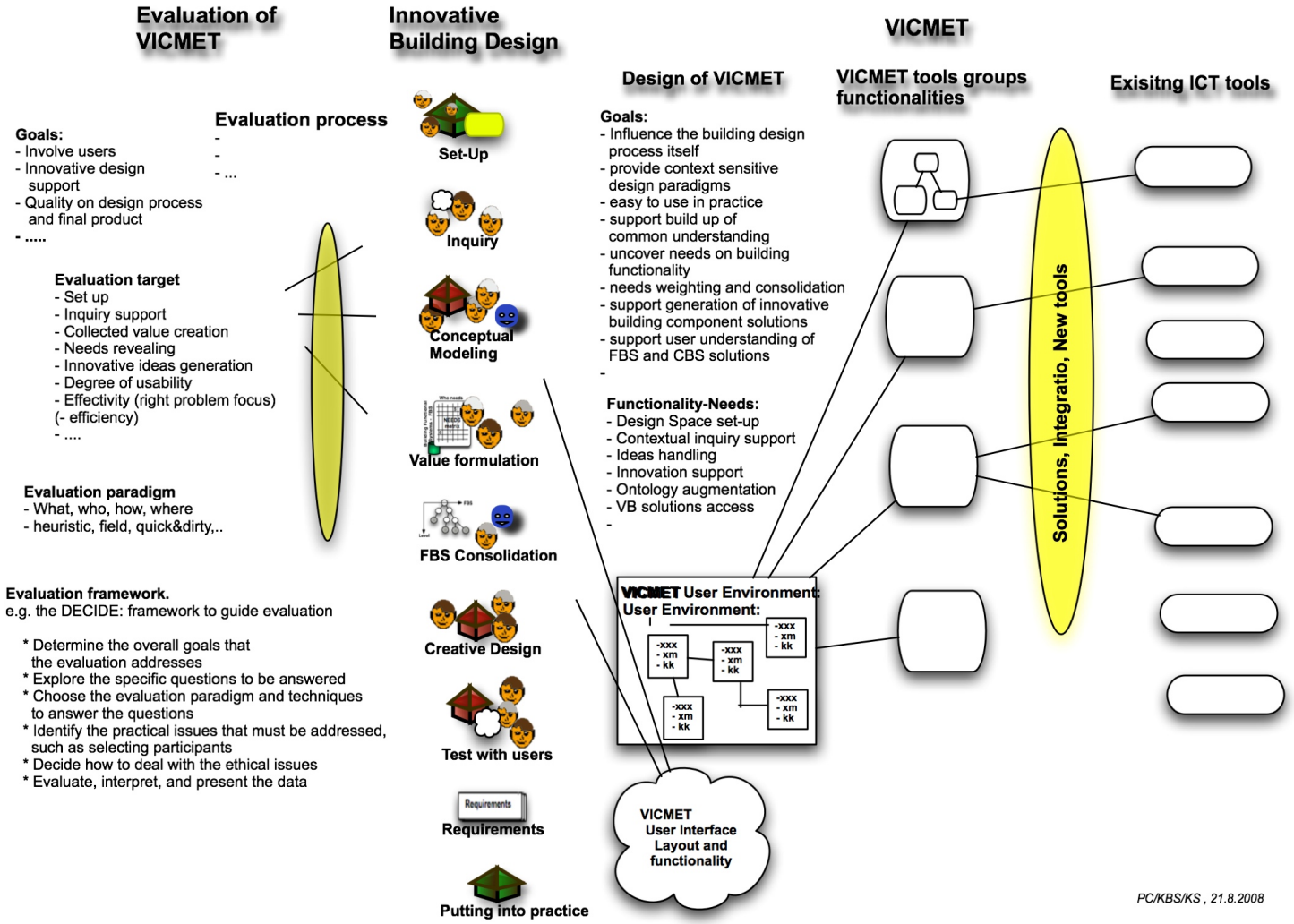


The main working spaces in the VICMET supporting creative and innovative building design.
From (Christiansson et.al. 2009a)



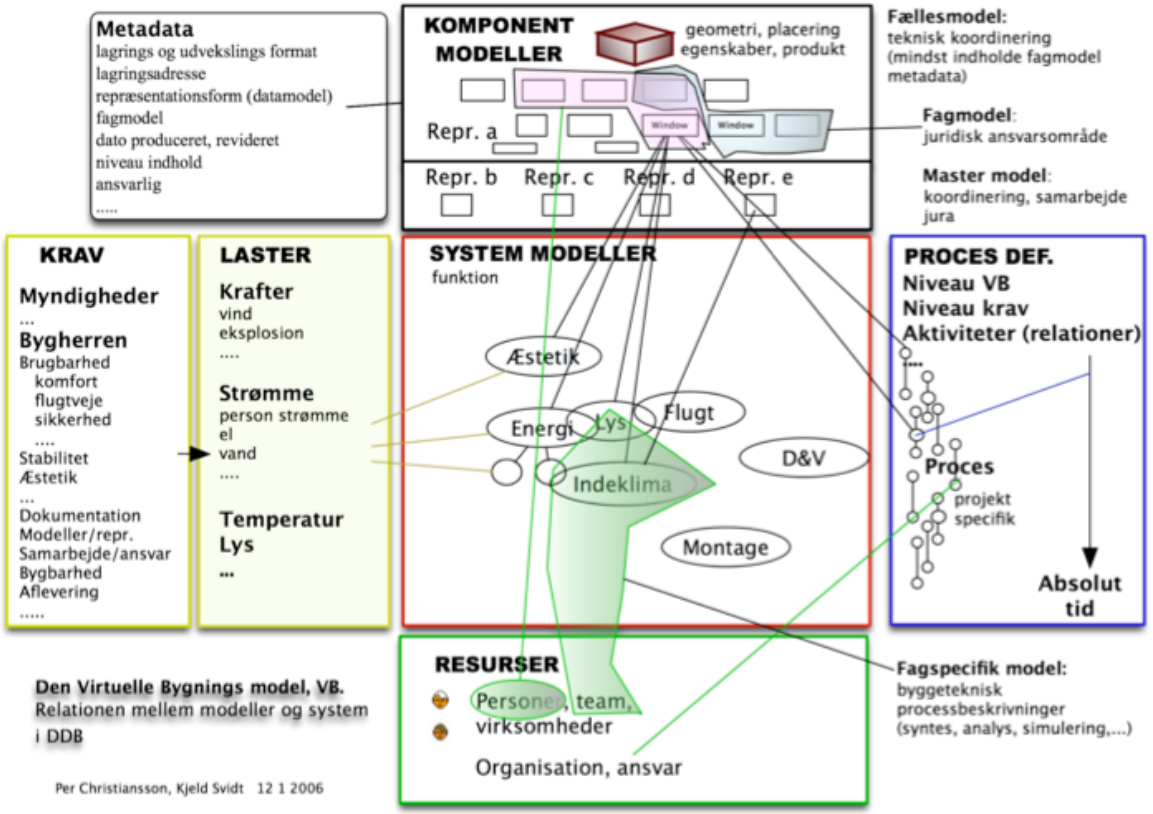
An early work flow model of the VICMET with references to the SOL Solution Space (SOL), FBS (Functional Building Systems) Consolidation Space (FCON), Conceptual Modeling and Game Space (COG), and Contextual Inquiry Space (CONTEQ). From (Christiansson et.al. 2009a)

VICMET to support creativee/innovative early building design



From (Christiansson et.al. 2009a)

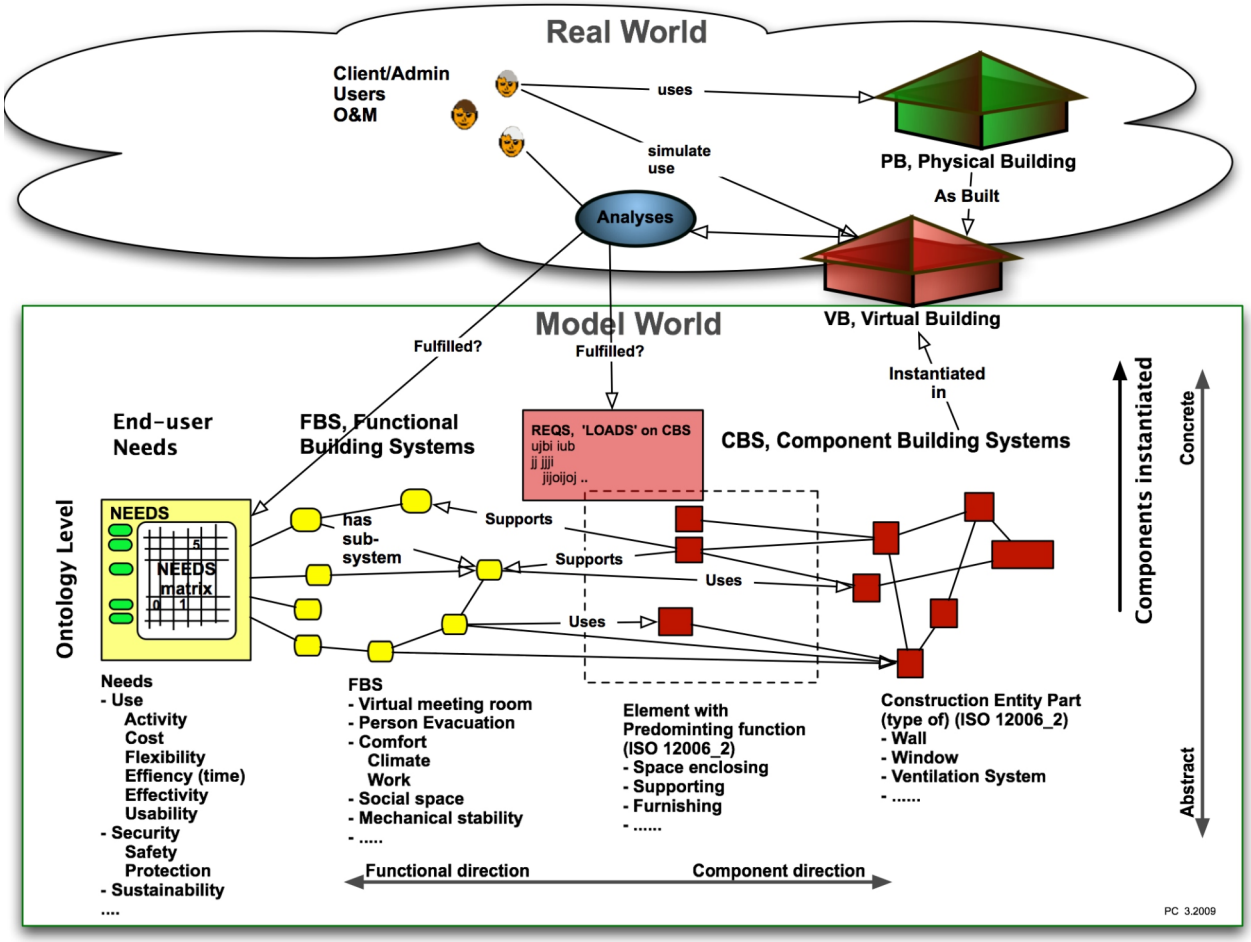
Funktionssystem - komponentsystem



figur 5 Relationerne mellem krav til bygningen, systemmodeller (fagspecifike) og komponentmodellen (bygningsdeler). Fra (Christiansson & Svidt, 2006a)

Fra (Christiansson & Svidt, 2006)

FBS - CBS



Formalization of the building design process. References are made to (ISO 12006-2, 1001). From (Christiansson & Svidt & Sørensen 2009b)

From the BIM Handbook

p.167-

5.3.2 Building Systems Design and Analyses/Simulation

An effective interface between a BIM authoring tool and an analysis/simulation application involves at least three aspects:

(1) Assignment of specific attributes and relations in the BIM authoring tool consistent with those required for the analysis
(2) …. The analytical model that is abstracted from the physical BIM model will be different for each type of analysis
(3) A mutually supported exchange format for data transfers.

Almost all existing building analysis software tools require extensive preprocessing of the model geometry, defining material properties and applying loads.

In Denmark we use the term “fagmodeller” for a model within a certain field of responsibility. Often analysis/simulation specific models/properties are added in to the fagmodeller.

It is likely that that a suite of preparation tools for performing detailed analyses will emerge embedded within future versions of primary BIM design tools.

From the BIM Handbook

Table 5-3 p.170

Table 5-3 Some of the common analysis/simulation applications and their exchange capabilities.

		Import Formats					Export Formats					
	Application	CIS/2	IFC	DXF/SDNF		SAT	gbXML	CIS/2	IFC	DXF	SDNF	Direct Links
Structural Analysis	SAP200,ETABS	•	•					•	•			Revit® Structures
	STAAD-Pro	•						•				Tekla Structures, Bentley
	RISA			•						•	•	Revit® Structures
	GT-STRUDL	•			•			•				
	RAM							•		•	•	Revit® Structures
	Robobat	•	•									Revit® Structures
Energy Analysis	DOE-2											
	EnergyPlus		•				•		•	•		Ecotect
	Apache			•								IES
	ESP-r			•						•		Ecotect
Mechanical Equipment Simulation	TRNSYS											
	Carrier E20-II											
Lighting Analysis/ Simulation	Radiance			•			•					ArchiCAD®
Acoustic Analysis	Ease			•								
	Odeon			•								
Air Flow/CFD	Flovent			•		•						
	Fluent											
	MicroFlo											IES
Building Function Analysis	EDM Model Checker		•									
	Solibri		•									

From the BIM Handbook

p.173-

5.3.2 Building Systems Design and Analyses/Simulation
- Collaboration

A sharable building model in a neutral format, such as VRML, IFC, DWF or Adobe3D, is easy to generate, compact for easy transmission, allows mark-ups and revisions, and enables collaboration via Web conferences.

We will go deeper in collaboration software in other courses.

From the BIM Handbook

p.180-

5.3.3 Construction-Level Building Models

Designers can approach the development of a construction-level model in at least two different ways:

(1) As a traditionally conceived, the building model a detailed design expressing the intent of the designer and the client. In this view the contractors are expected to develop their own independent construction model and documents.
(2) As a partial detailed model to be further detailed for use in all aspects of construction, planning, and fabrication. In this view, the design model is the starting point for elaboration by the construction team.

p. 183
We believe that BIM tools provide strong advantages for design-build contractual arrangements for building systems and that the use of construction detail level models - where design models are used for fabrication detailing - will become more prevalent due to cost and time savings.

p. 184
Numerous applications are available to facilitate operations within or in concert with the primary BIM design tools used by an A/E firm or consultant. A representative example is shown in Table 5-4, which contains a list of mechanical and HVAC, electrical, piping, elevators and trip analyses and site planning applications.

From the BIM Handbook

Table 5-4 p.184

Plus
- MagiCad http://www.progman.fi/
- CADvent http://www.cadvent.dk/
- MEP-version of major CAD-systems

Table 5-4 Building system layout applications.

Building System	Application
Mechanical & HVAC	Carrier E20-II HVAC System Design Bentley Building Mechanical Systems Vectorworks Architect ADT Building Systems Autodesk Revit® Systems
Electrical	Bentley Building Electrical Vectorworks Architect Autodesk Revit® Systems
Piping	Vectorworks Architect ProCAD 3D Smart Quickpen Pipedesigner 3D Autodesk Revit® Systems
Elevators/Escalators	Elevate 6.0
Site Planning	Autodesk Civil 3D Bentley PowerCivil Eagle Point's Landscape & Irrigation Design
Structural	Tekla Structures Autodesk Revit® Structures Bentley Structural

From the BIM Handbook

p.187-

5.3.4 Design-Construction Integration

The historical separation of design from construction did not exist in medieval times and only appeared in the Renaissance. Throughout long periods of history, the separation was minimized through the development of close working relationship between construction craftsmen, who in their later years would work ‘white collar jobs’ as draftsmen in the offices of architects. But in late years, that link has weakened. Draftsmen are chiefly junior architects and the communication between fields craftsmen and the design office has atrophied. In its place, an adversarial relationship has arisen, largely due to the risks associated with liabilities when serious problems arise.

From the BIM Handbook

p.189-

5.3.5 Design Review

Evolution of the design model to the fabrication model inevitably involves additions and changes. These changes must be reviewed by the design team to verify that the design intent has not been lost. Two kinds of reviews are required: (1) replacement of one piece of equipment or manufactured piece with another, which may have different shape and connections (we assume that the specification review and acceptance is handled separately); (2) that the geometry or placement of manufactured and made-to-order pieces are consistent with the placement and geometry of all other components.

In the new process (figure 5-14), upfront collaboration between designer and fabricator allows system products to be selected early, so that layout can be done once in a consistent manner.

From the BIM Handbook

p. 189-190

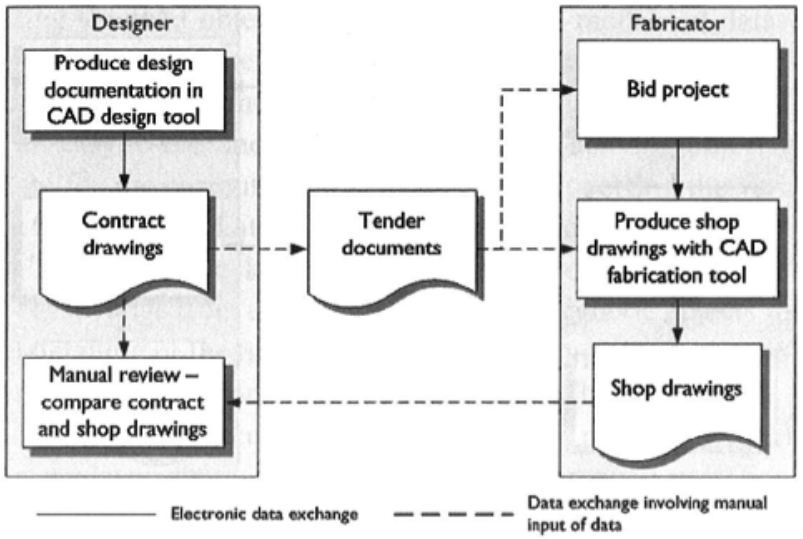
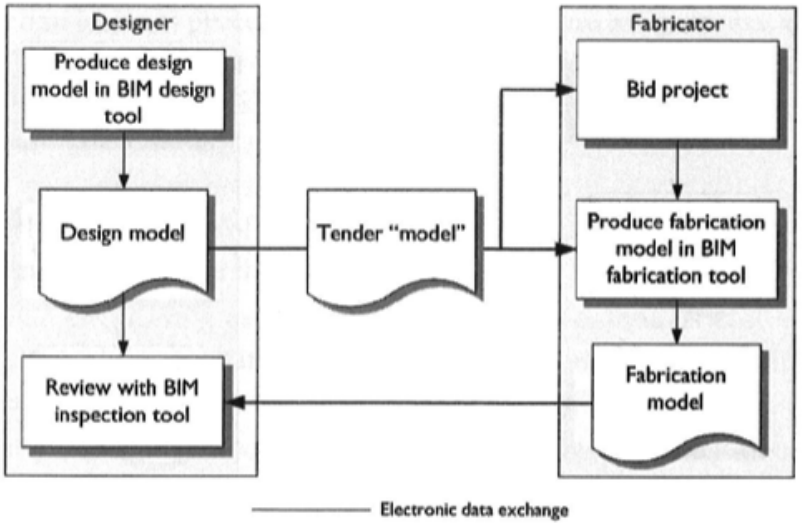


FIGURE 5-13
Traditional design review process, including alternative equipment selection.

FIGURE 5-14
A model-based design review of fabrication models.



From the BIM Handbook

p.192

5.4 Building Elements Library and Portals
5.4.2 Portals

The Google 3D Warehouse is a public repository for SketchUp content. This service could force a re-thinking of the library metaphor given the tools, technologies, and business opportunities it provides.

For example, McGraw Hill Sweets has begun experimenting with 3D Warehouse by creating a McGraw Hill Sweet's group and placing Sweets-certified manufacturer BEM /Building Element Models …. doors, windows…/ models in SketchUp formats in the Warehouse. This Google distributed service technology for storage and search, combined with Sweets domain model, is an example of new business opportunities enabled by technology.

In addition to table 5.5, see also:
http://www.digitaleprodukter.dk/

From the BIM Handbook

p.197, 198

5.5 Consideration in Adoption for Design Practice
5.5.1 BIM Justification

BIM design productivity Benefits
One way to directly assess the production benefits of a technology such as BIM is according to the reduction of errors. These are easily tracked by the number of Request for Information (RFIs) and Change Orders (Cos) on a project. These will always include a component based based on the client's change of mind or changes in internal conditions. However, changes based on internal consistency and correctness can be distinguished and their numbers on different projects collected. These indicate an important benefit of BIM and have been reported in several of the case studies in Chapter 9.

p.199
Research into the productivity gain for producing structural engineering drawings with rebar detailing has yielded gains between 21% and 59% dependent on size, complexity, and receptiveness of the structures.

p.200
It also should should be recognized that a single BIM tool is not necessarily ideal. Some firms decide not to limit themselves to a single model generation tools, but rather to support multiple BIM products, recognizing that some tools have non-overlapping benefits.

From the BIM Handbook

p.200

5.5.2 Training and Deployment

Early project should focus on the basic skills needed for modeling buildings and producing drawings, including incrementally compiling object libraries and getting the basics down before undertaking more advanced integration efforts.

…..

An important note of caution during the early phase of IM adoption is to avoid providing too much model detail too soon.

….

A reconsideration of the level of detail provided to the consultants and collaborators has also been found to be worthwhile. These parties can be brought into discussions earlier or later, depending on their roles.

….

Architects represent only one component of an overall design team. Collaboration requires a number of engineering, mechanical, or other specialty consultants.

….

Data exchange methods must be worked out on a company-to-company basis. Model-based coordination using web conferencing is a straightforward and very effective means of managing projects.

From the BIM Handbook

p.202

5.6 New and Changed Staffing within Design Firms

The greatest challenge in implementing new design technologies is the intellectual transition in getting senior design team leaders to adopt new practices.
….

Among several potentially effective ways to address this challenge:

- Team partners with young BIM-savvy design staff who can integrate the partner's knowledge with the new technology.
- Provide one-to-one training one day a week or on a similar schedule
- Host a charette /intense period of design activity/ for design teams that includes training for partners in a relaxed location.

Similar transition issues exist with other senior staff, such as project managers and similar methods may be used to facilitate their transition.
…
A second major challenge in any design firm will be the changed composition of staff respect to skills.
….
Details, material selections, and layouts only need to be defined once and can be propagated to all drawings where they will be eventually visible. As a result, the number of junior staff members working on construction documentation will be reduced.

From the BIM Handbook

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5.6 New and Changed Staffing within Design Firms CONT!

Although the need for entry-level architects is reduced, drawing cleanup, model detailing, and integration and coordination of multiple building subsystems will continue as important and valuable tasks.

…
As design firms adopt BIM, they will need to assign responsibility for the two much-expanded roles that will be crucial to their success:

1) System Integrator […exchange methods, libraries, templates,…]
2) Model Manager ….. The model manager determines the policies to be followed for establishing read-and-update privileges, for merging consultant's work and other data into master model, and for managing model consistency across versions.

REFERENCES

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Christiansson P, Svidt K, Sørensen B (2009b) Future integrated design environments, Journal of Information Technology in Construction (ITcon), Vol. 14, Special Issue Next Generation Construction IT: Technology Foresight, Future Studies, Roadmapping, and Scenario Planning, pg. 445-460, http://www.itcon.org/2009/29

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http://it.civil.aau.dk