Cost Estimating and BIM Techniques for Effective Application

Session - S506

Ecobuild Fall 2008

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Today's Presenters

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Today's Presentation

- Introduction
- Definitions, background and what's driving the move to BIM
- Key BIM concepts and benefits
- BIM and BIM related Software
- Integrating BIM and cost estimating and project management
- Project examples
  Estimating
  Scheduling
  Constructability
- Discussion

Background

- BIM is a complicated and developing subject
- Connecting BIM to estimating and project management appears to be rather simple – ***it isn't***
- Today's presentation and discussion will focus on procedures, methodology and business processes
- Technology is important but it is (or should be) a follower not a leader

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Defining Building Information Modeling (BIM)

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Per NIBS

- *A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward.*

Why is BIM different from business as usual?

- BIM represents the shift away from analog/paper processes to digital processes for design, construction and operation.
- It uses model-based technology linked to an integrated project database.
- BIM means actually improving the process and not just doing the same things in a new way
- BIM is not just the electronic transfer of two dimensional documents; *it is an intelligent, parametric, object oriented model-based approach.*

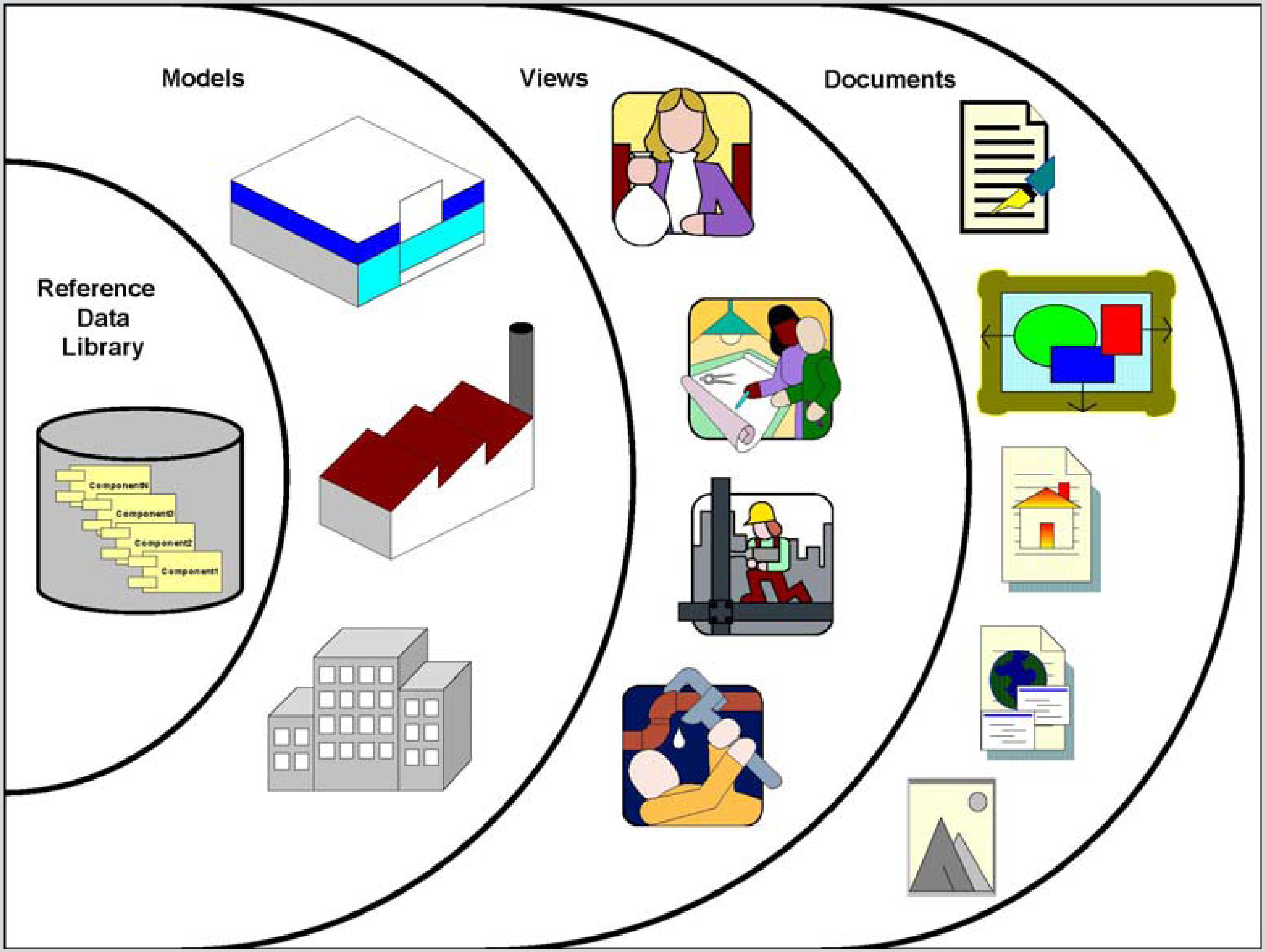
What is driving BIM?

- *Owners are (or should be) driving the move to BIM*
- Owners want:
  - Improved delivery of facilities
  - Better value for money spent
  - Better connection within the entire process
  - Increased life cycle focus all the way through and including operations
  - More collaboration and less combativeness

Key BIM Concepts

- BIM is “object oriented” rather than “line” oriented.
- Information is collected into a central repository (one database, many connected databases or a virtual database)
- Information is ideally entered into the model only once.
- “Interoperability” is an important consideration to facilitate computer to computer information
- Stakeholders can insert, extract, update or modify information
- BIM functions over the facility’s complete life cycle
- Ultimately, the actual built facility is collected in the model for facility management

Interoperability



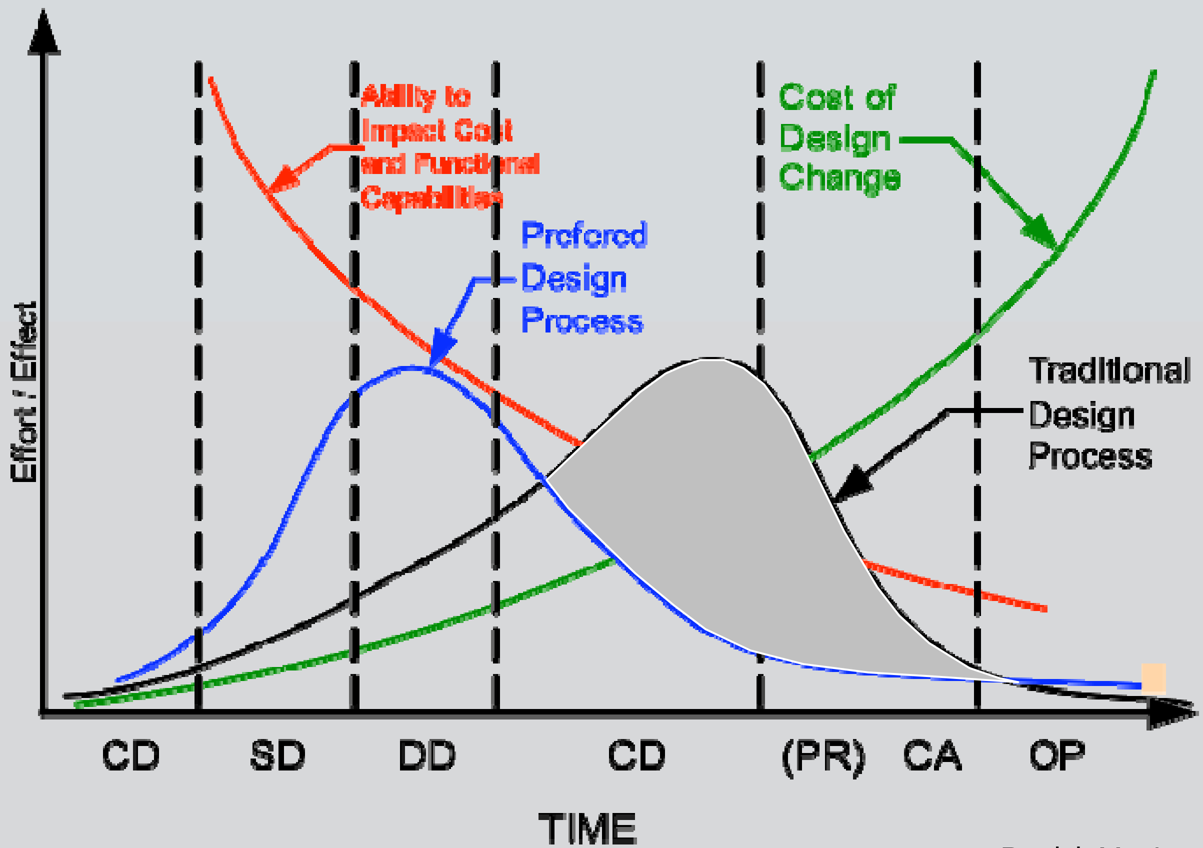
How can BIM improve Cost Estimating and Project Management?

- BIM can transfer information - quantitative, qualitative, dimensional and geospatial
- Potential benefits:
  - Improved accuracy
  - Improved turnaround
  - Design decisions better integrated with cost and schedule information
  - Less wasted & duplicated effort
  - Facilitates true value engineering
  - Provides a more effective source of current and historical project information

It should be easy, right?
Well, not exactly, there are challenges:

- Industry standards will need substantial expansion and improvement
- Estimating is part art and part science
  - BIM can address the science
  - The art is more difficult
- ***Business processes are likely going to change***
  - Cost has often been an afterthought
  - Information pertinent to cost will need gathering and management
  - Responsibilities may change with "Integrated Practice"
  - ***Design decisions will need to be pushed forward in the process***

Business Model – Effect of changing process



Patrick MacLeamy &
US Coast Guard - David Hammond

Standards - Industry Foundations Classes (IFC's)

- IFC's are data elements that provide a taxonomy of the parts of buildings or elements of the process
- They contain relevant information about those parts
- IFC's are used by computer applications to assemble a computer readable models and to exchange information between applications
- This exchange is critical for the long term sustainability of information throughout the facility lifecycle.

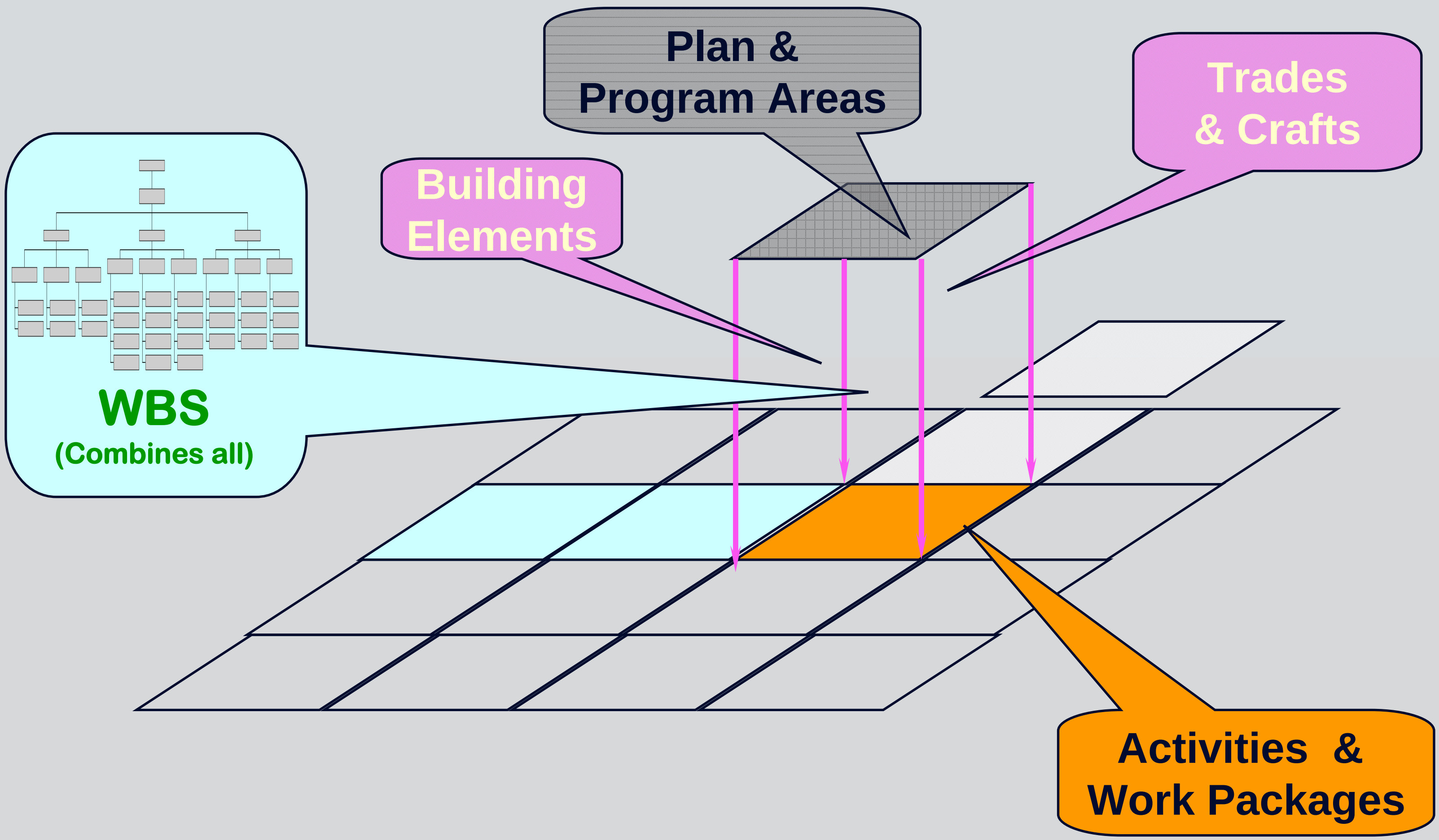
Building standards

- IFC's define computer to computer standards
- Comprehensive building standards are needed:
  - To facilitate definition of building objects and elements
  - To promote communication
  - Standard method of measurement
  - And – the industry needs to use the common standards or confusion may result
    - For example – If Concrete Block is the entry in the model – CMU won't work to retrieve it.

Building standards - continued

- The Construction Specifications Institute (CSI) promotes OmniCLASS to classify objects – it contains:
  - UNIFORMAT (Building Systems) and
  - MASTERFORMAT (Trades and Crafts) tables
- Standards efforts are underway

Work Breakdown Structures



Standards - Proposed Cost Related Metadata
(Courtesy BuildingSMART Alliance)

- Level 10 – “Rule of thumb”
- Level 9 – Historically based on similar facilities
- Level 8 – Based on Uniformat level 2 Model
- Level 7 – Based on Uniformat level 3+ Model
- Level 6 – Schematic Design – MasterFormat based
- Level 5 – Detailed design estimate – book priced
- Level 4 – Detailed design estimate - validated
- Level 3 – Price based on QTO from model
- Level 2 – Price based on quotes from suppliers
- Level 1 – Exact cost based on installed price

Tracking design decisions and implications

- Design decisions (and assumptions) have consequences and implications
  - An object (assembly) has components
  - Components may be interconnected
  - Dimensions are interconnected
  - Components affect overall object

- A true BIM will track and coordinate these issues
  - As an object changes all referenced components must also change
  - Conflicts may arise –
  - Example – *an electrical box in a 6” wall – the wall is changed to 4” – the box must also change*

What can using BIM do?
Potential reduction/reinvestment of time spent

	Potential Improvement
Scoping, phasing and scheduling	30 - 60%
Quantity survey	50 - 75%
Unit prices	10 - 20%
Extensions and documentation	5 - 10%
General conditions, OH&P	3 - 5%
Escalation and contingencies	?
Market assessment	?
Review and checking	3 - 5%
Overall	over 50%

What are the larger benefits?

- Improved cost management
  - Money spent more wisely
  - Less reworking due to overruns
  - Overall time can reduce
- Better communication
  - Less wasted effort
  - Reduced conflict

The "Estimator" versus the "Cost Manager"

- Today's approach largely confines the estimator to react to design decisions
- Cost management is a much broader and interactive role
  - As an estimator
  - As a CM at Risk
- Influence of BIM?
  - If all we do is extract an dump information, the process won't really improve
  - The cost manager should be an integrated team member
  - Provide ongoing and "live" cost advice

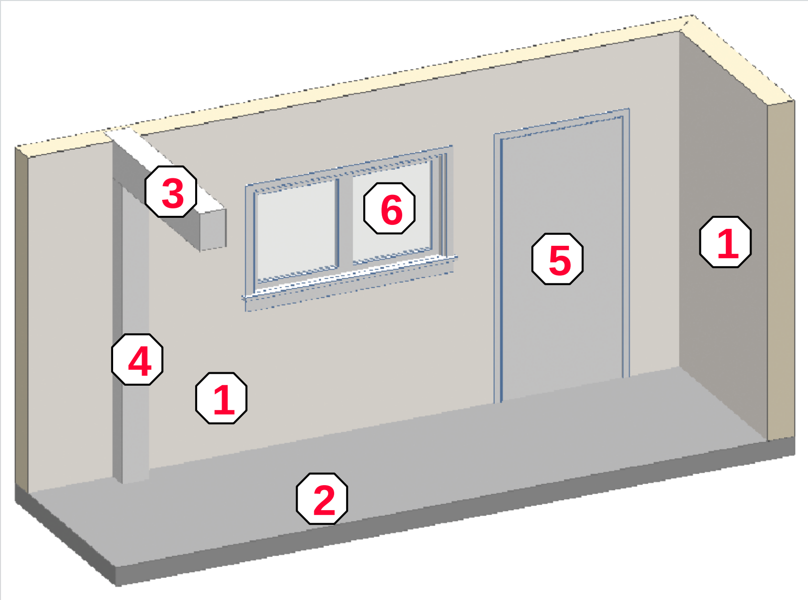
Working with BIM

It's all centered on "objects"

- **The objects have "attributes"**
- **These attributes include**:
  - **<u>Function</u>** - What purpose is the object serving
  - **<u>Materials</u>** - What material or materials make up the object
  - **<u>Installation</u>** - What methods are used to install or construct the object
  - **<u>Location</u>** - Where in the building is the object located.
  - **<u>Dimensions/Properties</u>** - Physical dimensions and properties of the object.
  - **<u>Quantity</u>** - How many of the objects exist within the building - likewise how much of the materials making up the objects are used.
  - **<u>Quality/Performance</u>** - What the qualitative properties of the object including physical form, appearance, capacity, etc.

What an “object” might consist of:

(Credit to Richard See, Digital Alchemy)



1. Wall
2. Slab
3. Beam
4. Column
5. Door
6. Window

How the process works with BIM

- Design work is more collaborative
- Decisions tend to be pushed forward in the process
- Work tends to proceed more “as needed” rather than on rigid phases
- Phase deliverables are “views” and “reports” off the model rather than hard milestones
- Costing efforts tend to be more detailed from increased input and expanded assumptions
- Review efforts should focus more on the decisions and assumptions that drove the estimate rather than just on the resulting estimate itself
- Calendar time to produce an estimate should reduce because efforts should overlap more rather than being sequential

What about all the information that typically isn't included in traditional documents?

- Means and methods
- Work scheduling
- Work process steps
  - Excavation
  - Formwork
  - Falsework
  - Staging
  - Materials handling
- Specifics of Diagrammatic and "Performance" items
  - Sprinkler systems
  - Electrical systems routing
  - Hardware

BIM and BIM related Software

- **BIM Systems**
  - Bentley Architecture
  - ArchiCAD
  - Revit Architecture
  - VectorWorks ARCHITECT
- **BIM “Enabler” Systems**
  - NavisWorks
  - Innovaya
  - VICO Constructor
  - Archibus (Facility Management)
- **Estimating Software**
  - Timberline
  - US Cost Success
  - BSD CostLink
  - CATO
  - MC^2

Important note: *BIM models may not interchange between BIM software packages and estimating software is not necessarily BIM compatible*

Static assembly example– Brick Veneer/Wood Stud Backup

Courtesy Reed Construction Data

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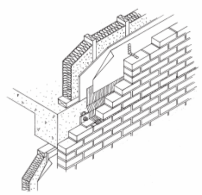
B20 Exterior Enclosure

B2010 Exterior Walls



Exterior brick veneer/stud backup walls are defined in the following terms: type of brick and studs, stud spacing and bond. All systems include a back-up wall, a control joint every 20', a brick shelf every 12' of height, ties to the backup and the necessary dampproofing, flashing and insulation.

System Components	QUANTITY	UNIT	COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
SYSTEM B2010 129 1100					
STANDARD BRICK VENEER, 2"X4" STUD BACKUP @ 16"O.C., RUNNING BOND					
Standard brick wall, 4" thick, running bond	1.000	S.F.	5.95	9.90	15.85
Wash smooth brick	1.000	S.F.	.04	.85	.89
Joint backer rod	.100	L.F.		.10	.10
Sealant	.100	L.F.	.02	.26	.28
Wall ties, corrugated, 7/8" x 7", 22 gauge	.003	Ea.	.02	.14	.16
Shelf angle	1.000	Lb.	.93	.87	1.80
Wood stud partition, backup, 2" x 4" @ 16" O.C.	1.000	S.F.	.41	.95	1.36
Sheathing, plywood, CDX, 1/2"	1.000	S.F.	.57	.68	1.25
Building paper, asphalt felt, 15 lb.	1.000	S.F.	.05	.13	.18
Fiberglass insulation, batts, 3-1/2" thick paper backing	1.000	S.F.	.61	.35	.96
Flashing, copper, paperbacked	.100	S.F.	.10	.31	.41
TOTAL			8.70	14.54	23.24

B2010 129 Brick Veneer/Wood Stud Backup

	FACE BRICK	STUD BACKUP	STUD SPACING (IN.)	BOND		COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
1100	Standard	2x4-wood	16	running		8.70	14.55	23.25
1120				common		10	16.40	26.40
1140				Flemish		10.95	19.15	30.10
1160				English		12.10	20	32.10
1400		2x6-wood	16	running		8.95	14.65	23.60
1420				common		10.25	16.50	26.75
1440				Flemish		11.20	19.25	30.45
1460				English		12.35	20.50	32.85
1500			24	running		8.75	14.40	23.15
1520				common		10.05	16.25	26.30
1540				Flemish		11	19	30
1560				English		12.15	20	32.15
1700	Glazed	2x4-wood	16	running		12.40	15	27.40
1720				common		14.50	17.05	31.55
1740				Flemish		15.90	20	35.90
1760				English		17.65	21.50	39.15

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B20 Exterior Enclosure

B2010 Exterior Walls

B2010 129 Brick Veneer/Wood Stud Backup

	FACE BRICK	STUD BACKUP	STUD SPACING (IN.)	BOND		COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
2000	Glazed	2x6-wood	16	running		12.65	15.10	27.75
2020				common		14.75	17.15	31.90
2040				Flemish		16.15	20.50	36.65
2060				English		17.90	21.50	39.40
2100			24	running		12.45	14.85	27.30
2120				common		14.55	16.90	31.45
2140				Flemish		15.95	20	35.95
2160				English		17.70	21	38.70
2300	Engineer	2x4-wood	16	running		6.80	13	19.80
2320				common		7.75	14.55	22.30
2340				Flemish		8.40	17.05	25.45
2360				English		9.20	17.85	27.05
2600		2x6-wood	16	running		7.05	13.10	20.15
2620				common		7.95	14.65	22.60
2640				Flemish		8.65	17.15	25.80
2660				English		9.45	17.95	27.40
2700			24	running		6.90	12.85	19.75
2720				common		7.80	14.40	22.20
2740				Flemish		8.45	16.90	25.35
2760				English		9.25	17.70	26.95
2900	Roman	2x4-wood	16	running		8.80	13.35	22.15
2920				common		10.15	15	25.15
2940				Flemish		11.05	17.45	28.50
2960				English		12.30	18.70	31
3200		2x6-wood	16	running		9.05	13.45	22.50
3220				common		10.40	15.10	25.50
3240				Flemish		11.30	17.45	28.75
3260				English		12.55	18.80	31.35
3300			24	running		8.85	13.20	22.05
3320				common		10.20	14.85	25.05
3340				Flemish		11.10	17.30	28.40
3360				English		12.35	18.55	30.90
3500	Norman	2x4-wood	16	running		7.80	11.45	19.25
3520				common		8.95	12.70	21.65
3540				Flemish		18.20	14.75	32.95
3560				English		10.75	15.50	26.25
3800		2x6-wood	16	running		8.05	11.55	19.60
3820				common		9.20	12.80	22
3840				Flemish		17.90	14.25	32.15
3860				English		11	15.60	26.60
3900			24	running		7.85	11.30	19.15
3920				common		9	12.55	21.55
3940				Flemish		18.25	14.60	32.85
3960				English		10.80	15.35	26.15
4100	Norwegian	2x4-wood	16	running		6.70	10.45	17.15
4120				common		7.60	11.55	19.15
4140				Flemish		8.20	13.35	21.55
4160				English		9	13.90	22.90
4400		2x6-wood	16	running		6.90	10.55	17.45
4420				common		7.85	11.65	19.50
4440				Flemish		8.45	13.45	21.90
4460				English		9.25	14	23.25

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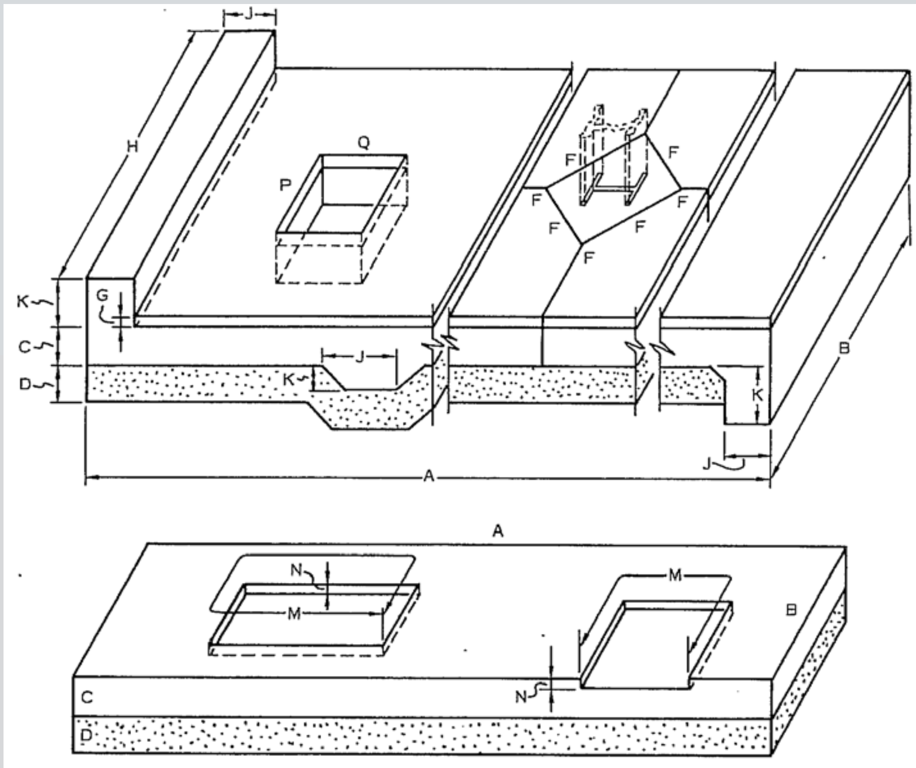
"Intelligent" Assembly example– Slab on Grade

Dimensional Information



A = Slab Length
B = Slab Width
C = Slab Thickness
D = Insulating Fill Thickness
E = Slab Reinforcing Allowance
F = Joint Length
G = Topping Thickness
H = Thickened Slab/Integral Curb Length
J = Thickened Slab/Integral Curb Width
K = Thickened Slab/Integral Curb Height
L = Thickened Slab/Int Curb Reinforcing
M = Depressed Slab Perimeter
N = Depression Depth
P = Slab Block - Out Length
Q = Slab Block-Out - Width

“Intelligent” Assembly example– Slab on Grade

Quality and Means/Methods Decisions

High Level Decisions

Type of Facility
- Office/Admin
- Warehouse
- Light Manufacturing
- Heavy Manufacturing
- Laboratory
- Hospital

Uniform Floor Loading
- 100 PSF
- 200 PSF
- 500 PSF
- 800 PSF
- 1500 PSF

Type of Traffic
- Foot Only
- Pnuematic Tires
- Solid Rubber Tires
- Steel Wheels

Detailed Decisions

Fine Grade & Vapor Barrier
- None
- Fine Grade Only
- Fine Grade & Vapor Barrier
- Fine Grade, VB & Termite Treatment

Insulating Fill
- None
- Sand
- Gravel
- Crushed Stone
- Lean Concrete

Concrete Placing
- Direct Pour
- Crane & Bucket
- Pump
- Carts
- Conveyor

Concrete Quality
- 2000 PSI
- 3000 PSI
- 5000 PSI

Concrete Curing
- None
- Liquid Membrane
- Plastic Sheeting
- Electrical Heated Pad
- Vacuum

Slab Reinforcing
- None
- WWF
- Structural Slab

Control Joints
- None
- Sawcut & Seal
- Premoulded Expansion Joint
- Tooled

Concrete Topping
- None
- Regular Weight 1"
- Regular Weight 2"
- Lightweight 1"
- Lightweight 2"
- Iron Oxide 3/4"
- Spark Resistant 1/2"
- Granolithic HD 1"

Slab Finishes
- None
- Screed
- Steel Trowel
- Steel Trowel HD
- Textured Finish
- Acid Etch
- Steel Trowel & Metalic Hardener
- Steel Trowel & Surface Colorant

Thickened Slab / Integral Curb
- None
- Thickened Slab
- Integral Curb

Benefits of "Intelligent" assemblies versus static assemblies

- Static assemblies require many combinations and permutations
  - Still may not match up one on one
  - Choice may be adequate for pricing but not match object attributes
- Intelligent assemblies allow cost data to match object information
  - Could be by Facility Type at early stage
  - Detail can be added as appropriate
  - Assumptions can be made and tracked
  - Conflicts and inconsistencies can be checked
  - Combinations and permutations handled by inputs and decisions

What needs to be done to integrate BIM, estimating and project management?

- Understand and follow standards
- Develop and expand “intelligent” assemblies
- Develop protocol to manage design decisions and connections to estimate
  - Designers define “design intent”
  - Constructors interpret “design intent” and define specific means and methods
  - Estimators and schedulers must rationalize both to produce an accurate and effective estimates and schedules
- *The design process will likely change – be prepared*

Important Considerations

- Estimates, specifications and to some degree schedules will almost always have advanced information versus the design
  - Assumptions exceed information
  - Project information can be “synthesized” through parametric modeling and the use of historical projects
  - These assumptions should be managed and tracked
- The design process should react and that may mean:
  - Extra work up front
  - “Broken” design
  - Different processes
  - Changes in fee structure

BIM Demonstrations

- **Navisworks Manage 2009 for Management**
- **Innovaya Quantity Take Off for estimating take offs**

Scheduling Lessons

- Visualization for planning and monitoring
- Improves collaboration by creating a better understanding for parties that would normally not comment on the schedule
- Need highly skilled schedulers

Estimating Lessons

- Sets the ground for Real-Time estimates as budgets change
- Improves accuracy
- Requires more highly skilled estimators who:
  - Understand the complete process
  - Have the ability to translate design intent into the estimate
  - And ultimately into construction
- Estimating considerations not directly reflected in the model:
  - Formwork
  - Drywall installed at 8’ high compared to 18’ high
  - Performance specifications

Constructability Lessons

- Early clash identification to significantly reduce changes during construction and help keep schedule on track
- Requires collaboration, coordination and teamwork
- Great tool, but has to be used within bounds of what is reasonable
- Many clashes not consequential
- Encourages continuous model interaction

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Clash Resolution – Example 1

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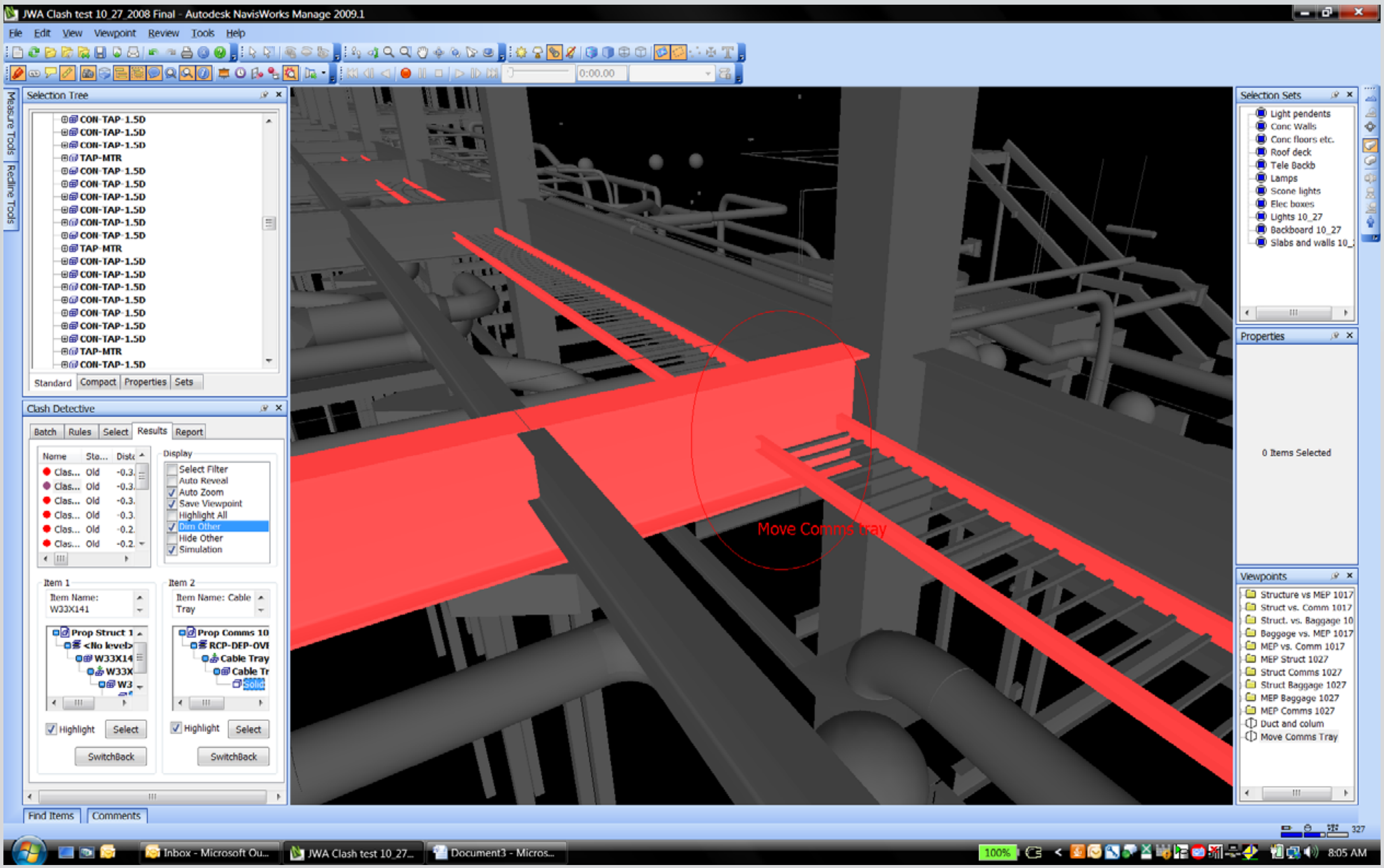

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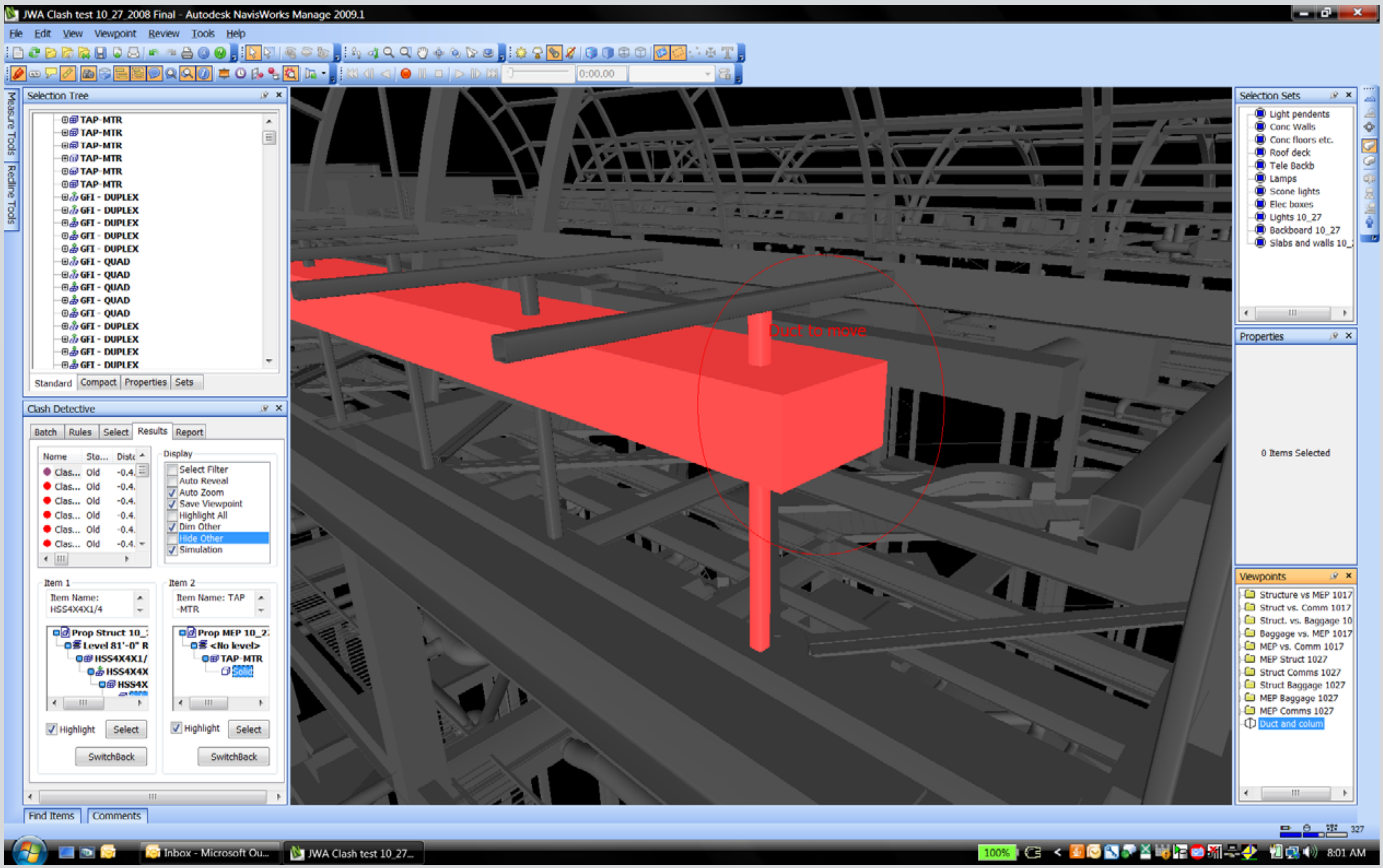
Clash Resolution – Example 2



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