BIM: going beyond the design suite

Dickinson, John

https://doi.org/10.4224/21243245

NRC · CONSTRUCTION

BIM:
Going Beyond the Design Suite

Construct Canada 2012

John Dickinson, Ph.D., P.Eng.
John.Dickinson@nrc.gc.ca

National Research Council Canada | Conseil national de recherches Canada | Canada

Outline

BIM Execution Plan

- Illustrated BIM Evolution:
  - Specification and Bidding
  - Fabrication
  - Construction
  - Operation
- Conclusion

NRC·CNRC

Speaker

John Dickinson Ph.D., P.Eng.

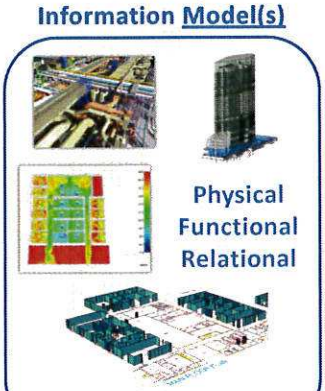
- Bachelors Engineering, Queen's University
- Masters Scientific Computation, Waterloo
- Doctorate Mechanical Engineering, UWO

- 9 years in manufacturing – modelling, simulation, integration
- 5 years in construction – as-builts, BIM, integration

NRC·CNRC

BIM Refresher

Building Information Model(s)



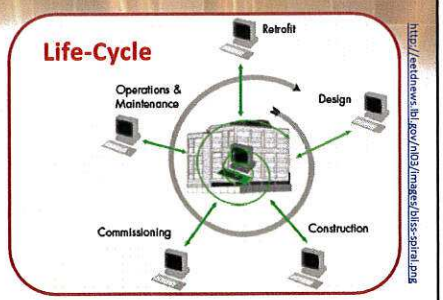
Physical
Functional
Relational

Semantic & Digital
Open Standards

Create
Use
Maintain
Models

Building Information Modelling

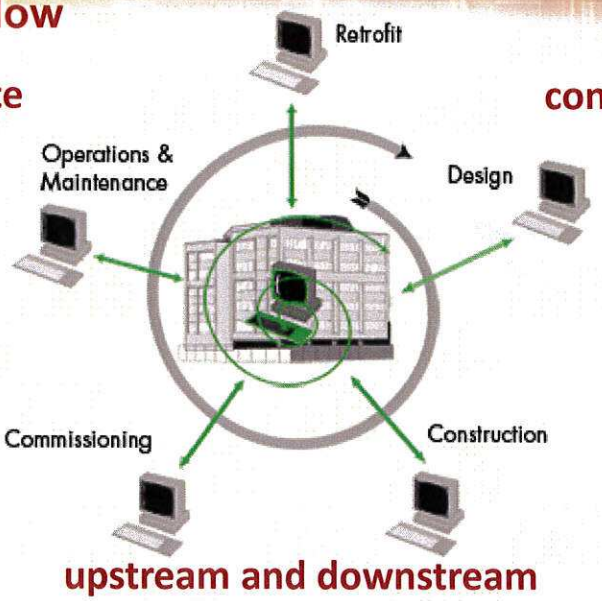
Life-Cycle



http://eetdnews.lbl.gov/n103/images/bliss-spiral.png

Communication & Coordination

BIM Flow



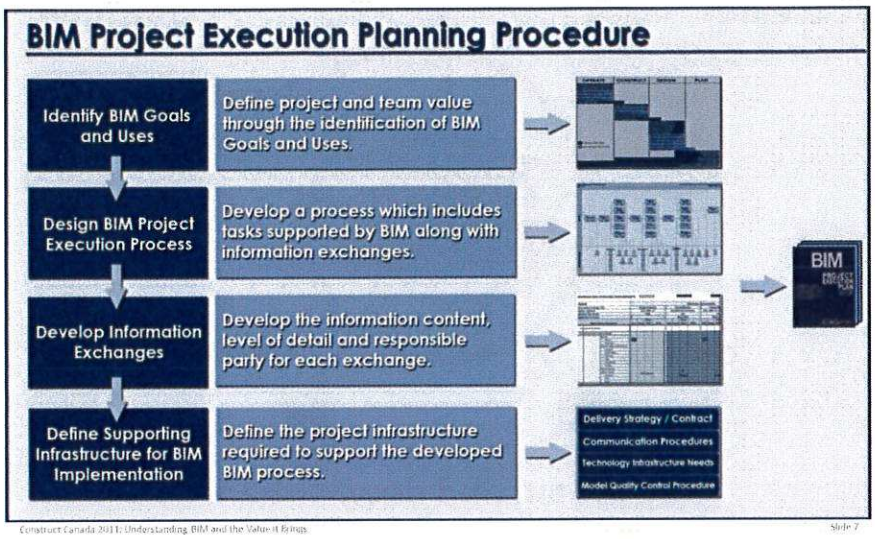
BIM Execution Plan or Project eXecution Plan (PxP)

- Manages Expectations ↔ Supports Use

1. Project Scope / Information	2. Why: Define BIM Goals and Objectives	3. Who, When, What: Design the BIM Process	4. How: Establish Supporting Infrastructure	5. Success: Develop Key Indicators
• Name • Location • Description • Schedule • Participants / Roles	• Clash free → Coord. Model • LEED certification → Specs Model • FMM → As-built Model	• Data Flow • Level of Detail • Level of Development • Who Responsible • Schedule	• Software • Data Exchange • Naming • Tracking • Communicate	• Metrics • Measure and Monitor vs. Goals • Process adherence

NRC·CNRC

Penn State PxP V2.1 referenced in NBIMS-US V2



NRC·CNRC

BIM Evolution Illustrated

- Specification and Bidding
- Fabrication
- Construction
- Operation

Specification and Bidding

- Starts in Design
- But **relevant** to whole Team / Supply Chain / Project
- Converting owner **expectations into reality**

Traditional Process

Owner
- Functional requirements

Designer
- Recommends "designed" elements (drawings)

Specifier
- Spec book: descriptive, administrative, installation
- Manual link to drawings

Bidders
- Select products
- Requirements **manually** checked for approval

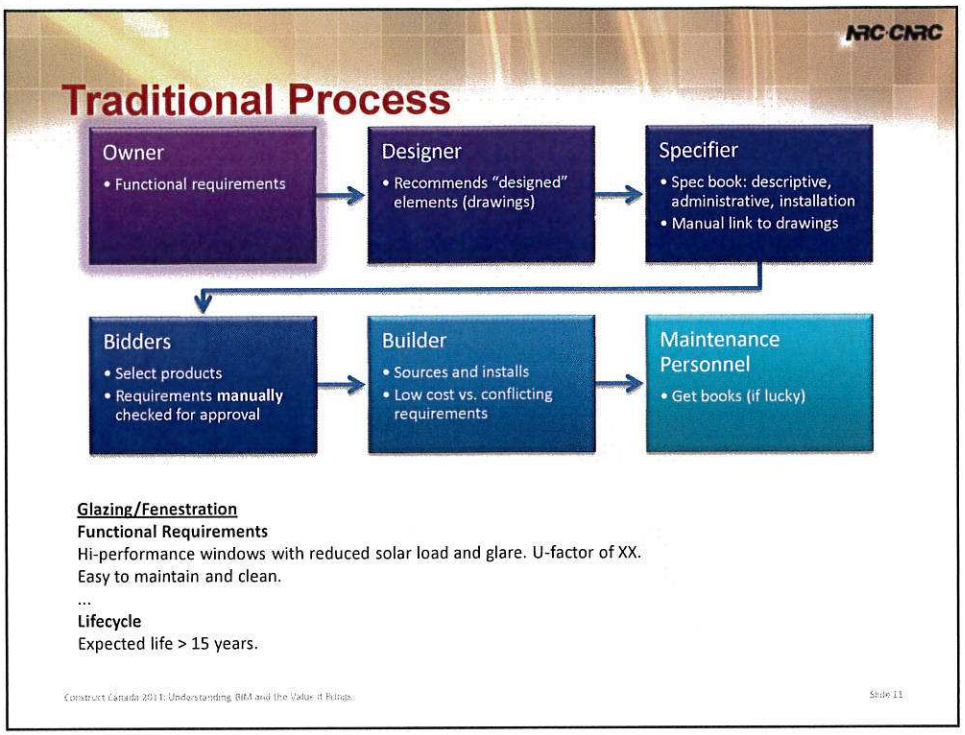
Builder
- Sources and installs
- Low cost vs. conflicting requirements

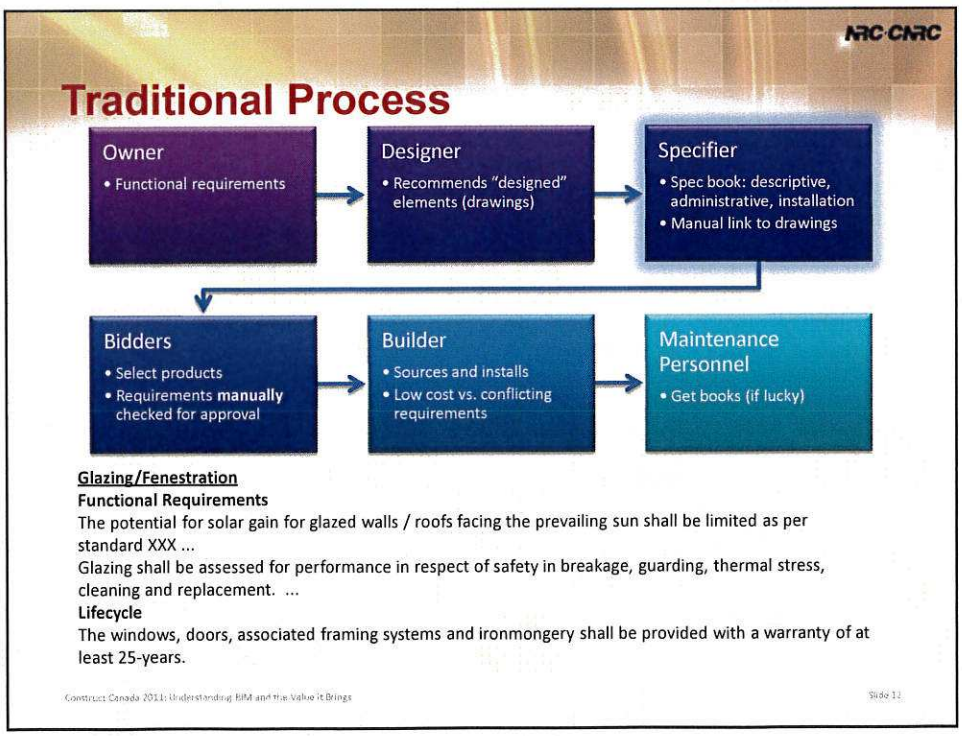
Maintenance Personnel
- Get books (if lucky)

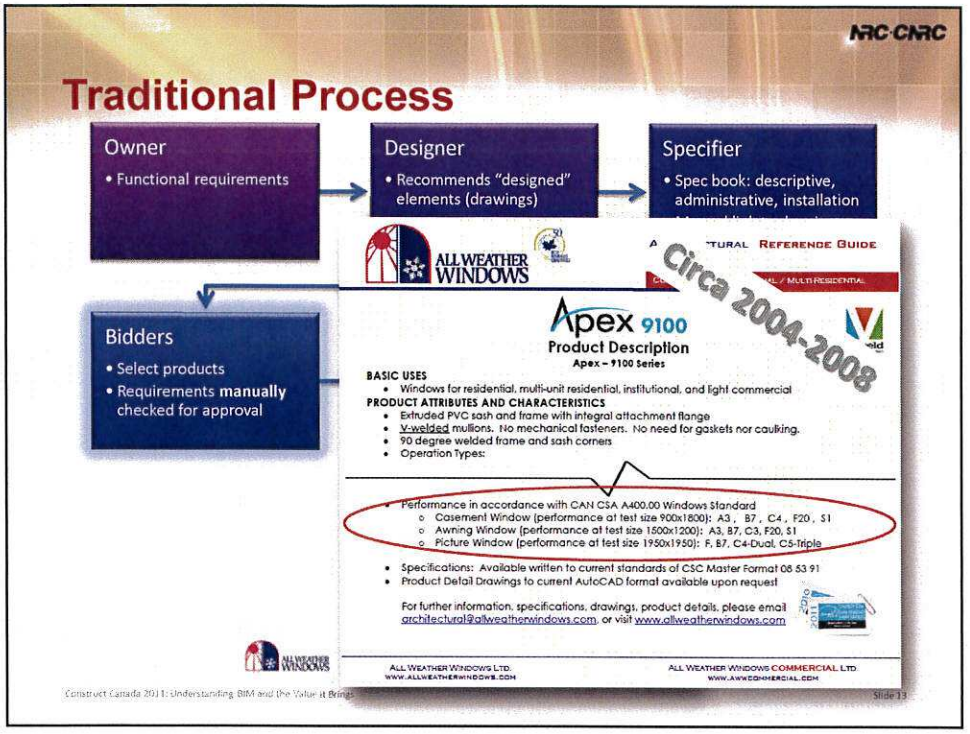
Walk through using windows as the example

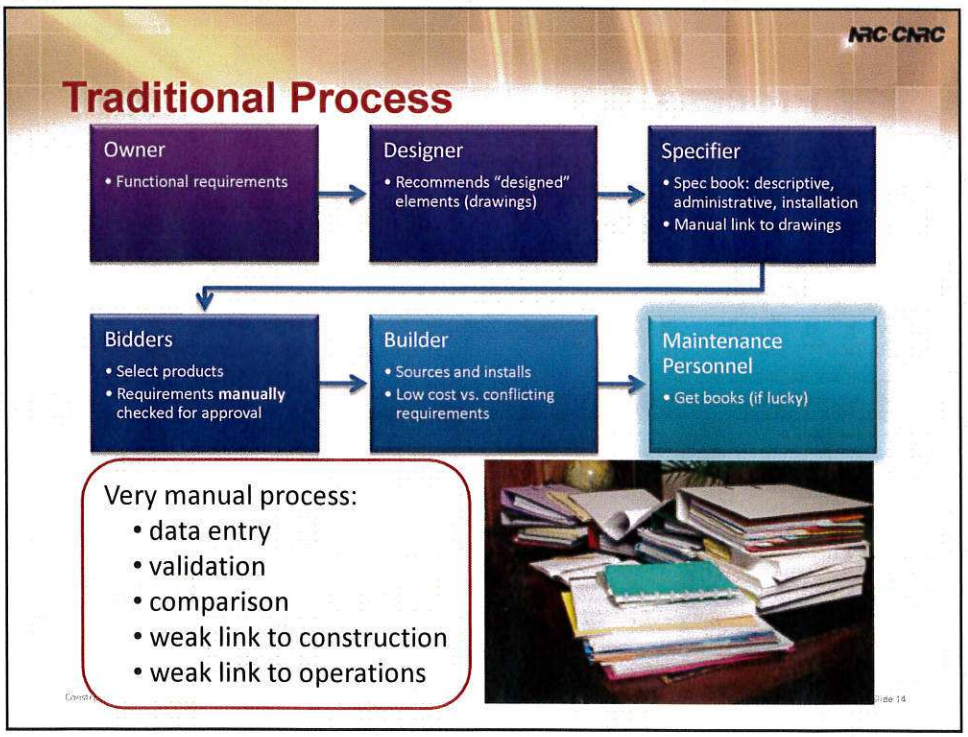
Process breakdown courtesy of David Watson of Digicon Information Inc.

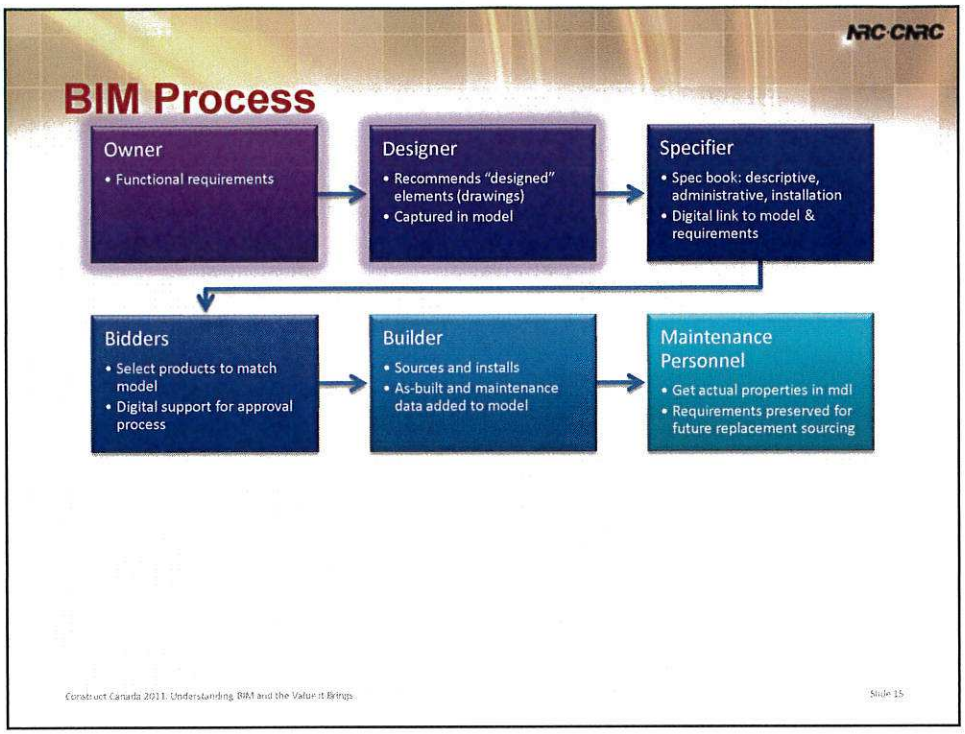
Images and document samples courtesy of All Weather Windows Ltd.

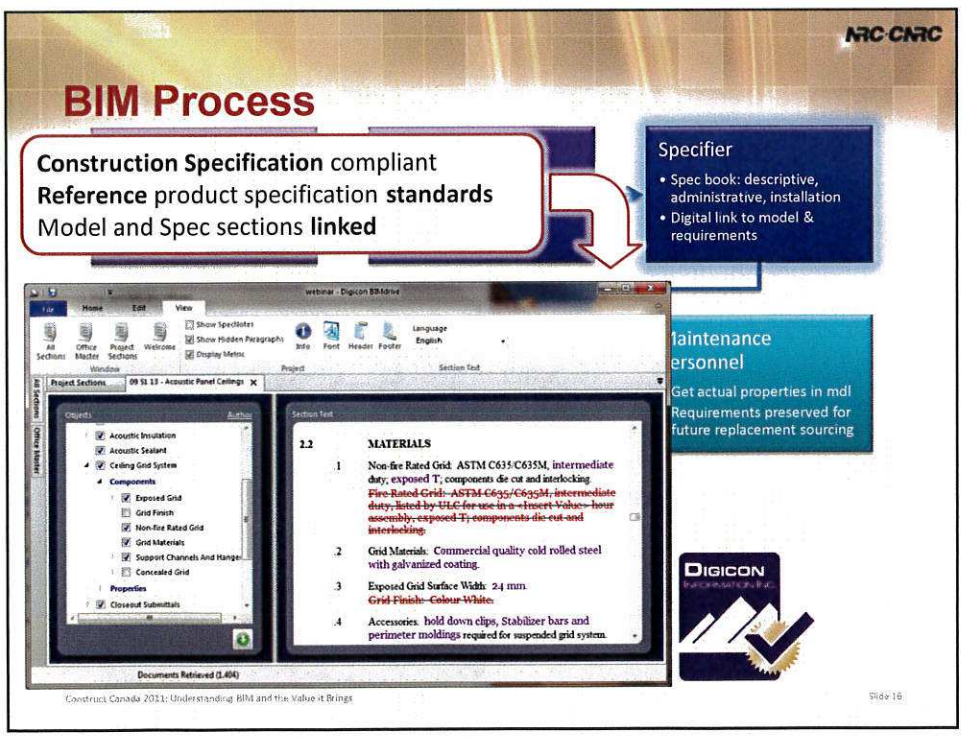

NRC·CNRC
Traditional Process
Owner
• Functional requirements
Designer
• Recommends "designed" elements (drawings)
Specifier
• Spec book: descriptive, administrative, installation
• Manual link to drawings
Bidders
• Select products
• Requirements manually checked for approval
Builder
• Sources and installs
• Low cost vs. conflicting requirements
Maintenance Personnel
• Get books (if lucky)
Glazing/Fenestration
Functional Requirements
Hi-performance windows with reduced solar load and glare. U-factor of XX.
Easy to maintain and clean.
...
Lifecycle
Expected life > 15 years.
Construct Canada 2011: Understanding BIM and the Value it Brings
Slide 11

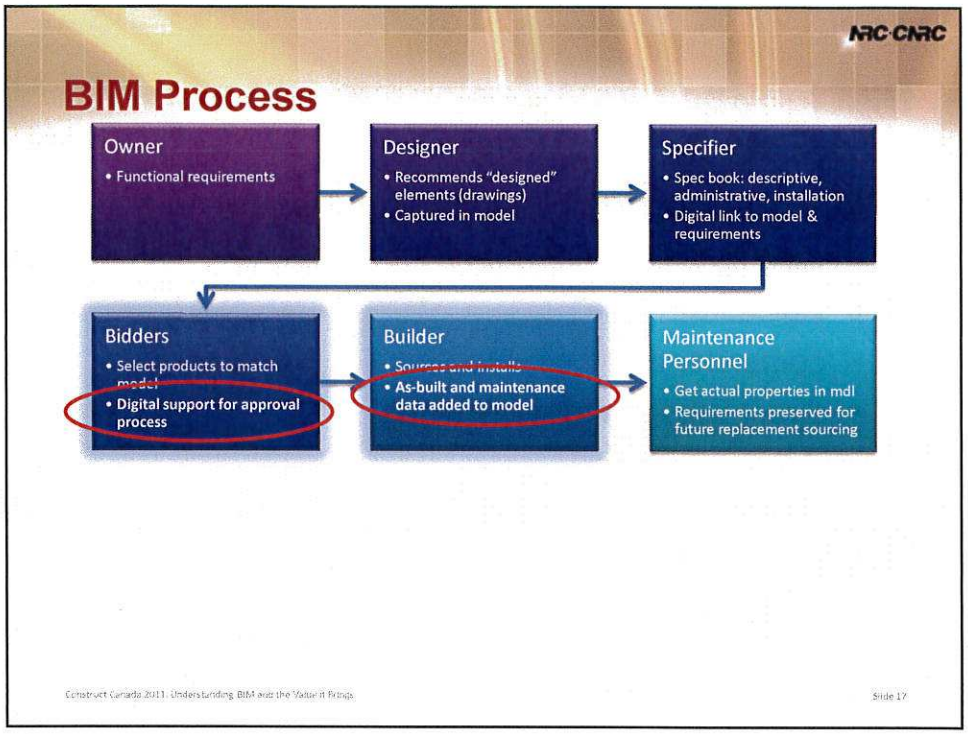

NRC·CNRC
Traditional Process
Owner
• Functional requirements
Designer
• Recommends "designed" elements (drawings)
Specifier
• Spec book: descriptive, administrative, installation
• Manual link to drawings
Bidders
• Select products
• Requirements manually checked for approval
Builder
• Sources and installs
• Low cost vs. conflicting requirements
Maintenance Personnel
• Get books (if lucky)
Glazing/Fenestration
Functional Requirements
The potential for solar gain for glazed walls / roofs facing the prevailing sun shall be limited as per standard XXX ...
Glazing shall be assessed for performance in respect of safety in breakage, guarding, thermal stress, cleaning and replacement. ...
Lifecycle
The windows, doors, associated framing systems and ironmongery shall be provided with a warranty of at least 25-years.
Construct Canada 2011: Understanding BIM and the Value it Brings
Slide 11

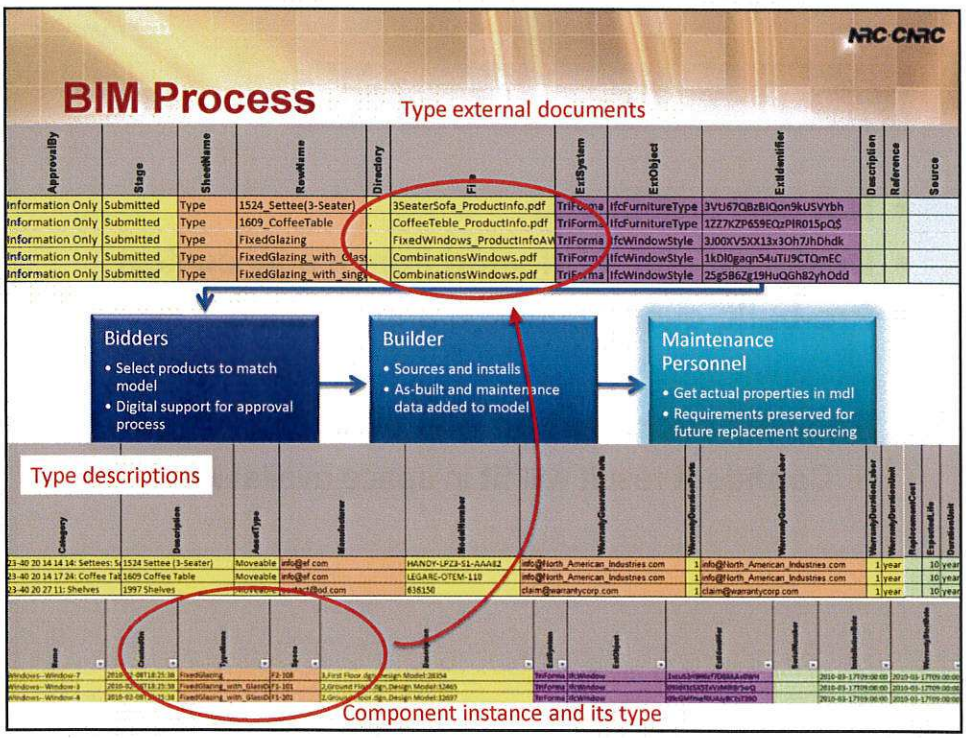

NRC·CNRC
Traditional Process
Owner
• Functional requirements
Designer
• Recommends "designed" elements (drawings)
Specifier
• Spec book: descriptive, administrative, installation
Bidders
• Select products
• Requirements manually checked for approval
ALL WEATHER WINDOWS
Circa 2004-2008
Apex 9100
Product Description
Apex – 9100 Series
BASIC USES
• Windows for residential, multi-unit residential, institutional, and light commercial
PRODUCT ATTRIBUTES AND CHARACTERISTICS
• Extruded PVC sash and frame with integral attachment flange
• V-welded mullions. No mechanical fasteners. No need for gaskets nor caulking.
• 90 degree welded frame and sash corners
• Operation Types:
• Performance in accordance with CAN CSA A400.00 Windows Standard
o Casement Window (performance at test size 900x1800): A3, B7, C4, F20, S1
o Awning Window (performance at test size 1500x1200): A3, B7, C3, F20, S1
o Picture Window (performance at test size 1950x1950): F, B7, C4-Dual, C5-Triple
• Specifications: Available written to current standards of CSC Master Format 08 53 91
• Product Detail Drawings to current AutoCAD format available upon request
For further information, specifications, drawings, product details, please email architectural@allweatherwindows.com, or visit www.allweatherwindows.com
ALL WEATHER WINDOWS LTD.
WWW.ALLWEATHERWINDOWS.COM
ALL WEATHER WINDOWS COMMERCIAL LTD.
WWW.AWWCOMMERCIAL.COM
Construct Canada 2011: Understanding BIM and the Value it Brings
Slide 13


NRC·CNRC
Traditional Process
Owner
• Functional requirements
Designer
• Recommends "designed" elements (drawings)
Specifier
• Spec book: descriptive, administrative, installation
• Manual link to drawings
Bidders
• Select products
• Requirements manually checked for approval
Builder
• Sources and installs
• Low cost vs. conflicting requirements
Maintenance Personnel
• Get books (if lucky)
Very manual process:
• data entry
• validation
• comparison
• weak link to construction
• weak link to operations
Slide 14


NRC·CNRC
BIM Process
Owner
• Functional requirements
Designer
• Recommends "designed" elements (drawings)
• Captured in model
Specifier
• Spec book: descriptive, administrative, installation
• Digital link to model & requirements
Bidders
• Select products to match model
• Digital support for approval process
Builder
• Sources and installs
• As-built and maintenance data added to model
Maintenance Personnel
• Get actual properties in mdl
• Requirements preserved for future replacement sourcing
Construct Canada 2011: Understanding BIM and the Value it Brings
Slide 15


NRC·CNRC
BIM Process
Construction Specification compliant
Reference product specification standards
Model and Spec sections linked
Specifier
• Spec book: descriptive, administrative, installation
• Digital link to model & requirements
aintenance
ersonnel
Get actual properties in mdl
Requirements preserved for
future replacement sourcing
2.2 MATERIALS
.1 Non-fire Rated Grid: ASTM C635/C635M, intermediate duty; exposed T, components die cut and interlocking.
~~Fire Rated Grid: ASTM C635/C635M, intermediate duty, listed by ULC for use in a <Insert Value> hour assembly; exposed T; components die cut and interlocking.~~
.2 Grid Materials: Commercial quality cold rolled steel with galvanized coating.
.3 Exposed Grid Surface Width: 24 mm.
~~Grid Finish: Colour White.~~
.4 Accessories: hold down clips, Stabilizer bars and perimeter moldings required for suspended grid system.
DIGICON
Construct Canada 2011: Understanding BIM and the Value it Brings
Slide 16


NRC·CNRC
BIM Process
Owner
• Functional requirements
Designer
• Recommends "designed" elements (drawings)
• Captured in model
Specifier
• Spec book: descriptive, administrative, installation
• Digital link to model & requirements
Bidders
• Select products to match model
• Digital support for approval process
Builder
• Sources and installs
• As-built and maintenance data added to model
Maintenance Personnel
• Get actual properties in mdl
• Requirements preserved for future replacement sourcing
Construct Canada 2011: Understanding BIM and the Value it Brings
Slide 17


NRC·CNRC
BIM Process
Type external documents
ApprovalBy
Stage
SheetName
RowName
Directory
File
ExtSystem
ExtObject
ExtIdentifier
Description
Reference
Source
Information Only Submitted Type 1524_Settee(3-Seater) 3SeaterSofa_ProductInfo.pdf TriForma IfcFurnitureType 3VtJ67QBzBIQon9kUSVYbh
Information Only Submitted Type 1609_CoffeeTable CoffeeTeble_ProductInfo.pdf TriForma IfcFurnitureType 1ZZ7KZP659EQzPIR015pQ5
Information Only Submitted Type FixedGlazing FixedWindows_ProductInfoAW TriForma IfcWindowStyle 3J00XV5XX13x3Oh7JhDhdk
Information Only Submitted Type FixedGlazing_with_Glass CombinationsWindows.pdf TriForma IfcWindowStyle 1kDl0gaqn54uTIJ9CTQmEC
Information Only Submitted Type FixedGlazing_with_single CombinationsWindows.pdf TriForma IfcWindowStyle 2Sg5B6Zg19HuQGh82yhOdd
Bidders
• Select products to match model
• Digital support for approval process
Builder
• Sources and installs
• As-built and maintenance data added to model
Maintenance Personnel
• Get actual properties in mdl
• Requirements preserved for future replacement sourcing
Type descriptions
Category
Description
AssetType
Manufacturer
ModelNumber
WarrantyGuarantorParts
WarrantyDurationParts
WarrantyGuarantorLabor
WarrantyDurationLabor
ReplicationCost
ExpectedLife
DurationUnit
23-40 20 14 14 14: Settees: S 1524 Settee (3-Seater) Moveable info@ef.com HANDY-LPZ3-S1-AAA82 info@North_American_Industries.com 1 info@North_American_Industries.com 1 year 10 year
23-40 20 14 17 24: Coffee Tal 1609 Coffee Table Moveable info@ef.com LEGARE-OTEM-110 info@North_American_Industries.com 1 info@North_American_Industries.com 1 year 10 year
23-40 20 27 11: Shelves 1997 Shelves claim@warrantycorp.com 636158 claim@warrantycorp.com 1 claim@warrantycorp.com 1 year 10 year
Name
CreationDate
TypeName
Space
Description
ExtSystem
ExtObject
ExtIdentifier
ElementNumber
ObjectType
WarrantyStartDate
Windows - Window-7 2010-03-08T18:25:38 FixedGlazing F2-108 3,First Floor design Design Model:28354 TriForma IfcWindow 2010-03-17T09:00:00 2010-03-17T09:00:00
Windows - Window-3 2010-02-09T18:25:38 FixedGlazing_with_Glass:DF1-101 2,Ground Floor design Design Model:12465 TriForma IfcWindow 2010-03-17T09:00:00 2010-03-17T09:00:00
Windows - Window-4 2010-02-09T18:25:38 FixedGlazing_with_Glass:DF1-201 2,Ground Floor design Design Model:12697 TriForma IfcWindow 2010-03-17T09:00:00 2010-03-17T09:00:00
Component instance and its type

NRC·CNRC

BIM for Specifications and Bidding

- Very digital and continuous process:
  - data transfer – not re-entry
  - validation
  - completeness
  - direct link from requirements:
    - ➢through specs
    - ➢to construction
    - ➢to operations

NRC·CNRC

Fabrication

- **Not** craft built **in situ**
- **Designed and fabricated** from model context
- **Pre-built**, quality checked and installed

- Requires **coordination** with other disciplines
  - **Confident** result will **fit** in space available

NRC·CNRC

Fabrication Example

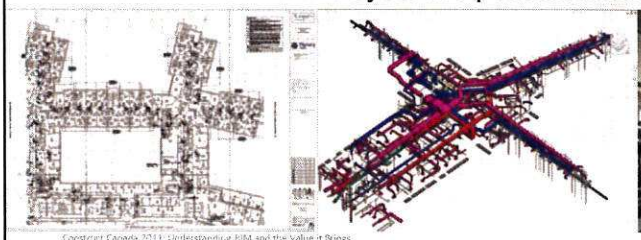
- St. Joseph's Healthcare West 5th Campus, Hamilton, Ont.
- 855,000 ft² & $380 million (construction costs)
- Design Build Finance Maintain (DBFM), PCL – D & C
- 680 trades and support staff on site

NRC·CNRC

HVAC Pre-Fabrication

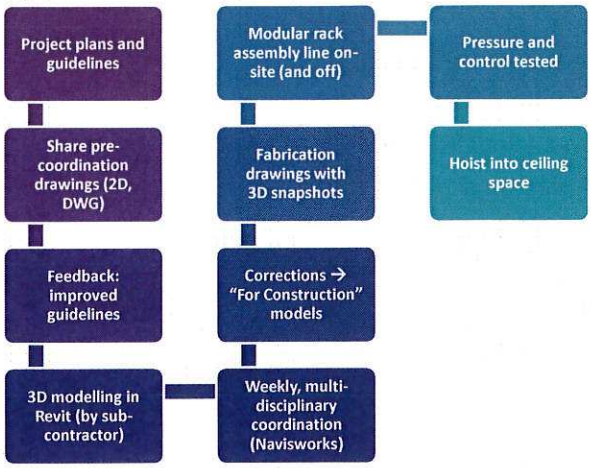
All figures courtesy of Comstock

- HVAC by Comstock Canada Ltd.
- **Goal** of complete modular construction
  - On-site, floor level, rack assembly lines
  - Completed and tested on the ground
  - Installation with hydraulic jacks
- Mechanical room systems prefabricated off-site from mdl



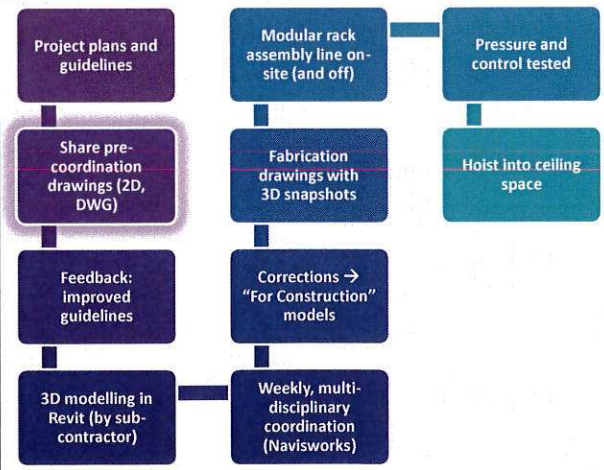
NRC·CNRC

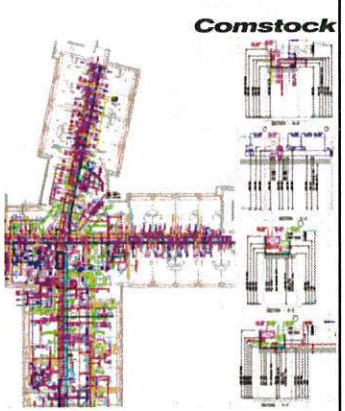
Process Followed



NRC·CNRC

Process Followed

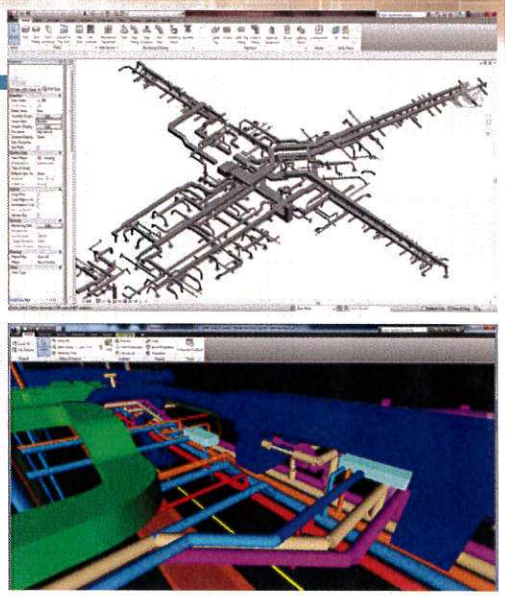




2D Rack Layout Pre-Coord. DWG

Process Followed

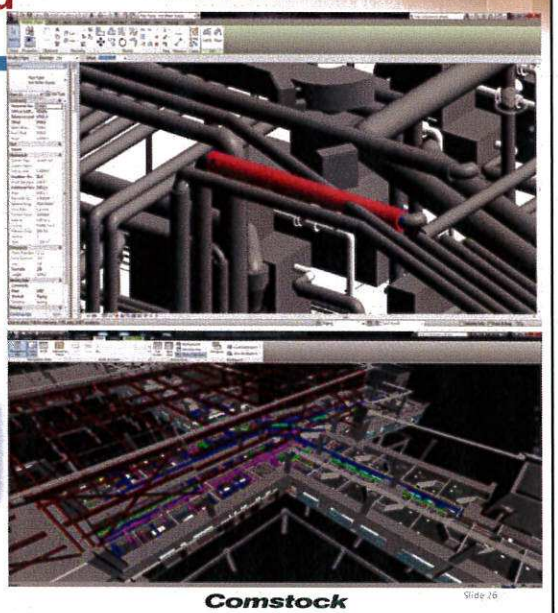
- Project plans and guidelines
- Share pre-coordination drawings (2D, DWG)
- Feedback: improved guidelines
- 3D modelling in Revit (by sub-contractor)
- Weekly, multi-disciplinary coordination (Navisworks)
- Corrections → "For Construction" models
- Fabrication drawings with 3D snapshots
- Modular rack assembly line on-site (and off)



Comstock

Process Followed

- Project plans and guidelines
- Share pre-coordination drawings (2D, DWG)
- Feedback: improved guidelines
- 3D modelling in Revit (by sub-contractor)
- Weekly, multi-disciplinary coordination (Navisworks)
- Corrections → "For Construction" models
- Fabrication drawings with 3D snapshots
- Modular rack assembly line on-site (and off)



Comstock

Process Followed

NRC·CNRC

Project plans and guidelines

Share pre-coordination drawings (2D, DWG)

Feedback: improved guidelines

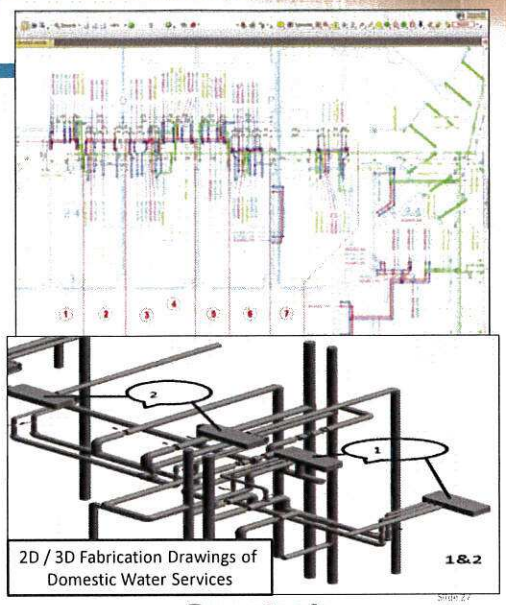
3D modelling in Revit (by sub-contractor)

Weekly, multi-disciplinary coordination (Navisworks)

Corrections → "For Construction" models

Fabrication drawings with 3D snapshots

Modular rack assembly line on-site (and off)



2D / 3D Fabrication Drawings of Domestic Water Services

Comstock

Process Followed

NRC·CNRC

Project plans and guidelines

Share pre-coordination drawings (2D, DWG)

Modular rack assembly line on-site (and off)

Fabrication drawings with 3D snapshots

Pressure and control tested

Hoist into ceiling space

Comstock

Connecting Sections and Testing

NRC·CNRC

Process Followed

Project plans and guidelines

Share pre-coordination drawings (2D, DWG)

Modular rack assembly line on-site (and off)

Fabrication drawings with 3D snapshots

Pressure and control tested

Hoist into ceiling space

Benefits:

- Time efficiencies
- Safety
- Quality

Comstock

Model and On-Site View of C Block Level 2

NRC·CNRC

Construction

Coordination

- 3D coordination → minimum expectation
- Number of GOOD free viewers (& paid options):
  - Tekla BIMSight (IFC, DWG, DGN)
  - AutoDesk Navisworks Freedom (NWD, DWF)
  - Solibri Model Checker (IFC), ...
- **Export models** – federated view, clash detect
- Communicate & collaborate

NRC·CNRC

Coordination Example

- Low level 3D design with trade 3D fabrication

NRC·CNRC

Scheduling Example – EllisDon

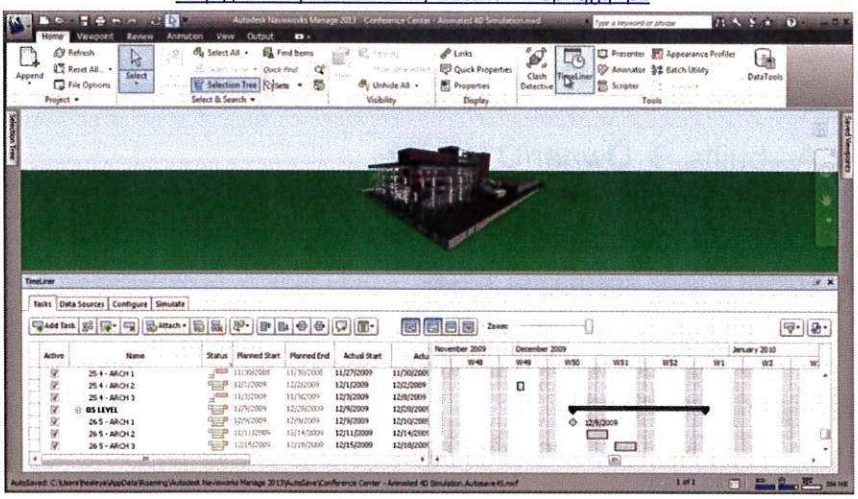
- Scheduling a bit **more complicated**
- Created at beginning, reviewed throughout
- Predominantly Navisworks linked to MS Project / Primavera

- EllisDon schedule:
  - Built backwards **from subs needs**
  - Initially macro scale, **iteratively refined**
  - **Not** developed to individual **component level** – could be
- Subs vet schedules at each level
- Last stage reviewed on-site
- **Benefits**: Faster review by foremen & less errors

NRC·CNRC

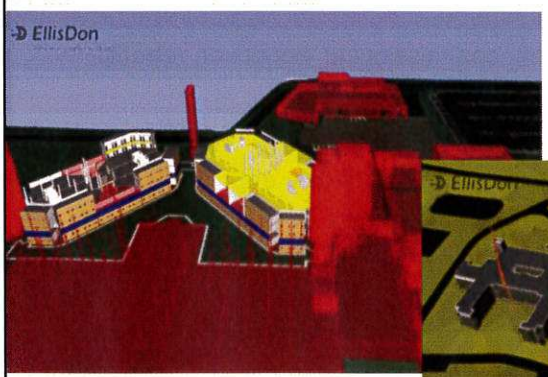
Linking Model Elements to Schedule

http://www.youtube.com/watch?v=DSpfIqgq4pE



NRC·CNRC

EllisDon Videos



Erection plan for prefab concrete
Stand-alone test of erection sequencing

Waypoint Mental Health
Consultant design models linked to EllisDon Project schedule

NRC·CNRC

Operation

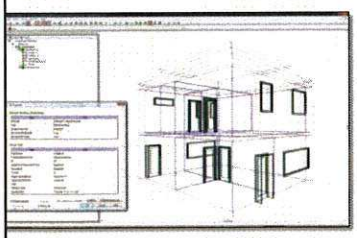
FM Handover

- Goal: **No data loss or redundant entry!**
- As-builts → Owner/Operator
  - Makes, models, warrantees, locations, systems, ...
- Proprietary solutions exist:
  - Autodesk, Bentley, ArchiCad to
  - Ecodomus, ArtrA, Maximo...
- Open Standards:
  - IFC FM Handover MVD and COBie

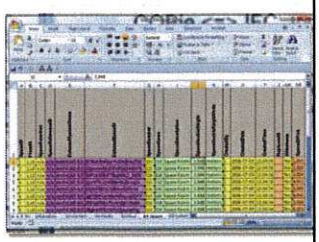
NRC·CNRC

IFC Facility Management Handover COBie
(Construction Operations Building information exchange)

When: procurement, construction, commissioning, handover, retrofits
What: MEP, equipment lists, warranties, spaces, etc.
Who: sub-contractors, facilities managers, operators
Pros: easy to use, growing support (US Army, NASA, etc.)
Limitations: not graphical, support still growing



buildingSMART
International Alliance for Interoperability



CBSA Facility – COBie Edmonton Airports

BIM – Canadian Border Services Agency Facility

- Common use facility for CBSA and Edmonton Airports (EA) needs.
- **Value approach: non revenue generating**
- No added design costs from BIM

- **BIM**: Architects & MEP, Construction Mgmt
- **Architect** used marked up BIM model from CM (redline) to create **as-built** model

NRC·CNRC

Commissioning (Cx)

- Commissioning done in traditional way by CM
- Audited by a third party

- **Parallel Cx test by EA Engineering Dept.**
  - Export return air units (RTU-xxx) **BIM → COBie**
  - Import as-designed into Electronic Cx Tool (**ECT**)
  - Do commissioning
  - Export rich design and Cx data **into Maximo**

NRC·CNRC

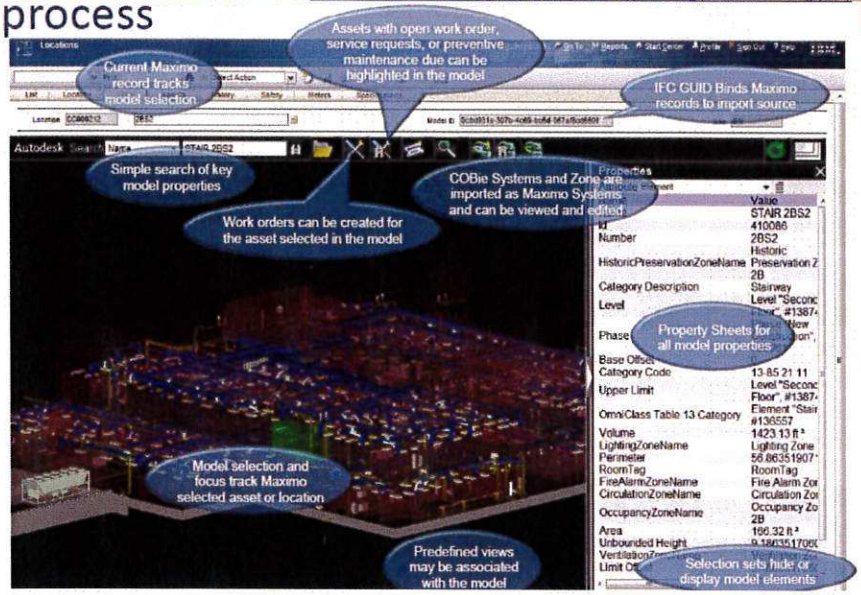
Electronic Commissioning Tool (ECT)

- Many pre-built, airport specific, Cx checks
- Database backend
- **Owner has care and control of the information**
  - Audit Cx progress – entered data
  - Correlates design, drawings and installed data
  - Rules require approval for design/dwg changes

NRC·CNRC

IBM Maximo process

http://buildingsmartalliance.org/index.php/newsevents/proceedings/cobie2011challenge/ibm/



NRC·CNRC

Test Results

- Project is ongoing
- Past issues: manual entry by maintenance clerk
  - Data **fidelity**
  - **Incomplete** or **inaccurate** equipment lists
  - Assets do not get entered at all
- Current issues:
  - Database schema required for **COBie to ECT**
  - Needed expertise for schema – but reusable
  - Difficulty relating ECT's database to Maximo

NRC·CNRC

Conclusion

BIM very useful beyond the Design Stages

Technology and Standards easing hurdles

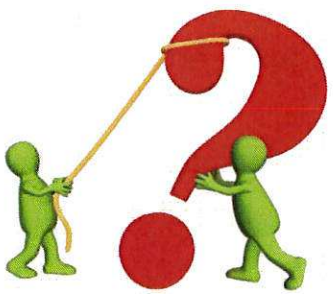
Active use in Canada

- Design
- Specification & Bidding
- Coordination
- Handover

Recipe for Success → Have a BIM Execution Plan (PxP)

NRC·CNRC

NRC · CONSTRUCTION



John.Dickinson.PEng@gmail.com
John.Dickinson@nrc.gc.ca

National Research Council Canada | Conseil national de recherches Canada | Canada