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BIM and the Three Cs Interoperability for Communication, Collaboration and Coordination
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BIM and the Three Cs Interoperability for Communication, Collaboration and Coordination

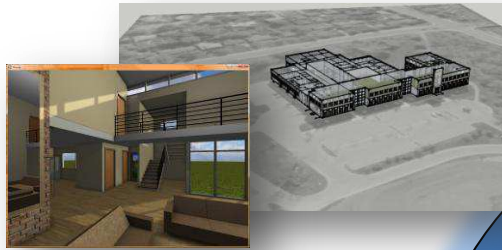**John Dickinson, Ph.D., P. Eng.** **John.Dickinson@nrc.gc.ca**
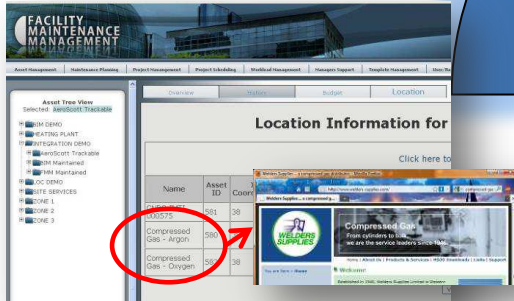
5 May 2011

National Research Council Canada

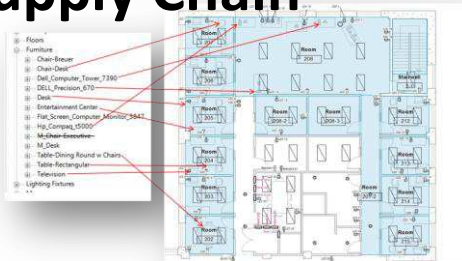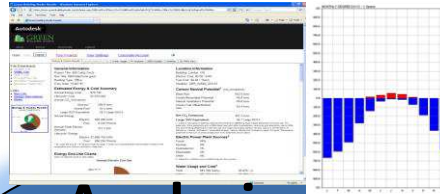Conseil national de recherches Canada

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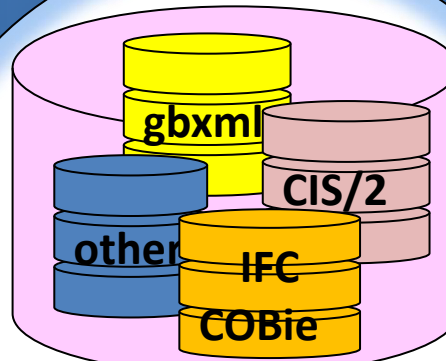
NRC-CCCT Background

Conception

Analysis

Simulation

Supply Chain

Life-Cycle Process

gbxml
CIS/2
other
IFC
COBie
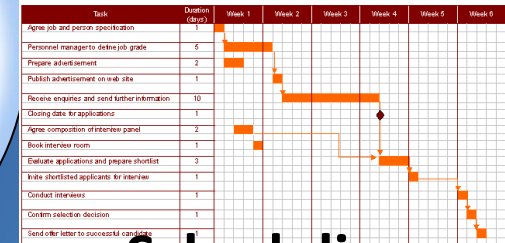
Scheduling
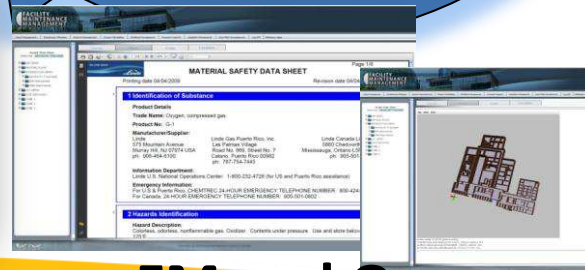
Material Tracking

Asset Mgmt

FM and Ops

Presentation Outline

Interoperability

- Why care?
- BIM Promise
- Game Changer

Proprietary Formats

- Autodesk
- Others

Open Specs.

- IFC
- COBie
- gbXML
- CIS 2.1

3C Technology

- Federated Model Tools
- Model Servers

Interoperability

Why care?

BIM Promise

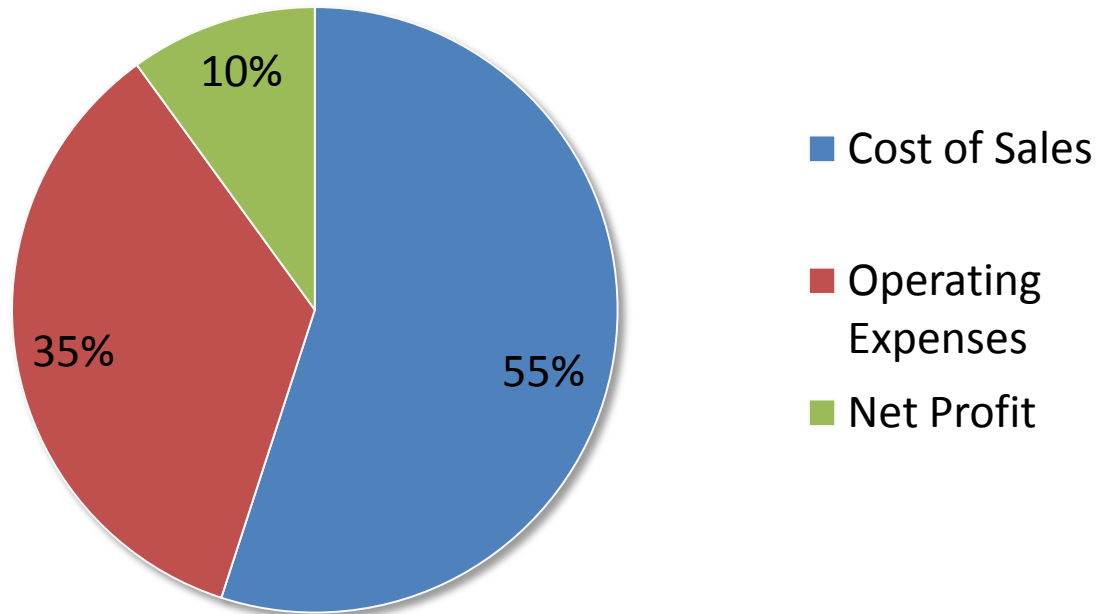Game Changer

Why Care?
Lost Money

2004 NIST report
(Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry)

- $15.8B/y lost due to poor interoperability
  - 1-2% industry's revenue

- 2/3 during operations and maintenance phase

http://www.bfrl.nist.gov/oae/publications/gcrs/04867.pdf

Profitability in Construction

% Total Revenue

- ■ Cost of Sales
- ■ Operating Expenses
- ■ Net Profit

55%   35%   10%

Statistics Canada 2008: Small and Medium Construction Firms (<$5M)
http://www.ic.gc.ca/cis-sic/cis-sic.nsf/IDE/cis-sic23bece.html

The Promise: Interoperability

The BIM Curve

Institute for Research in Construction
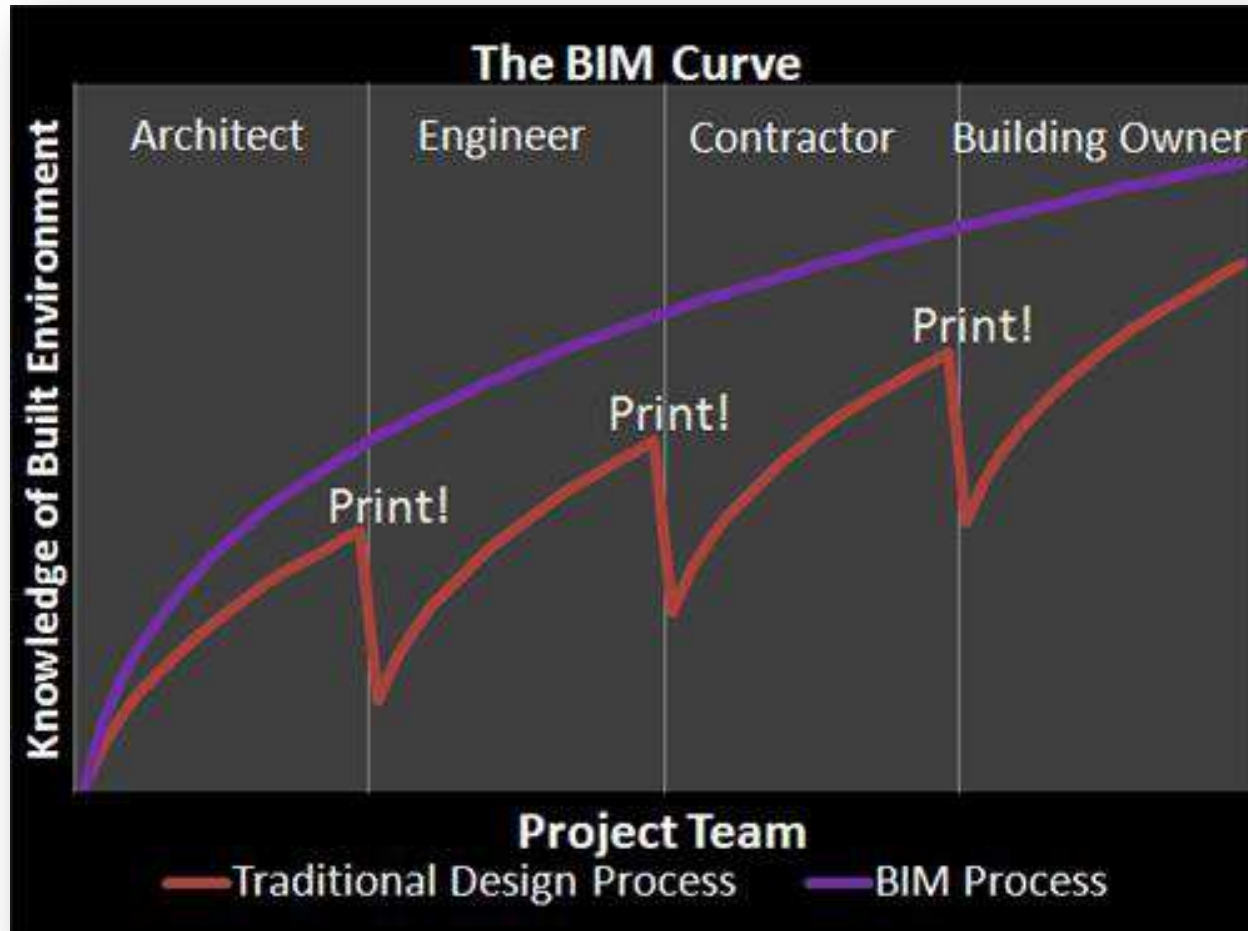
BIM Definition (Noun)

A Building Information Model (BIM) is:

- a <u>digital</u> representation of <u>physical and functional</u> characteristics and <u>relationships</u>

- a <u>lifecycle</u> information <u>collection</u> point

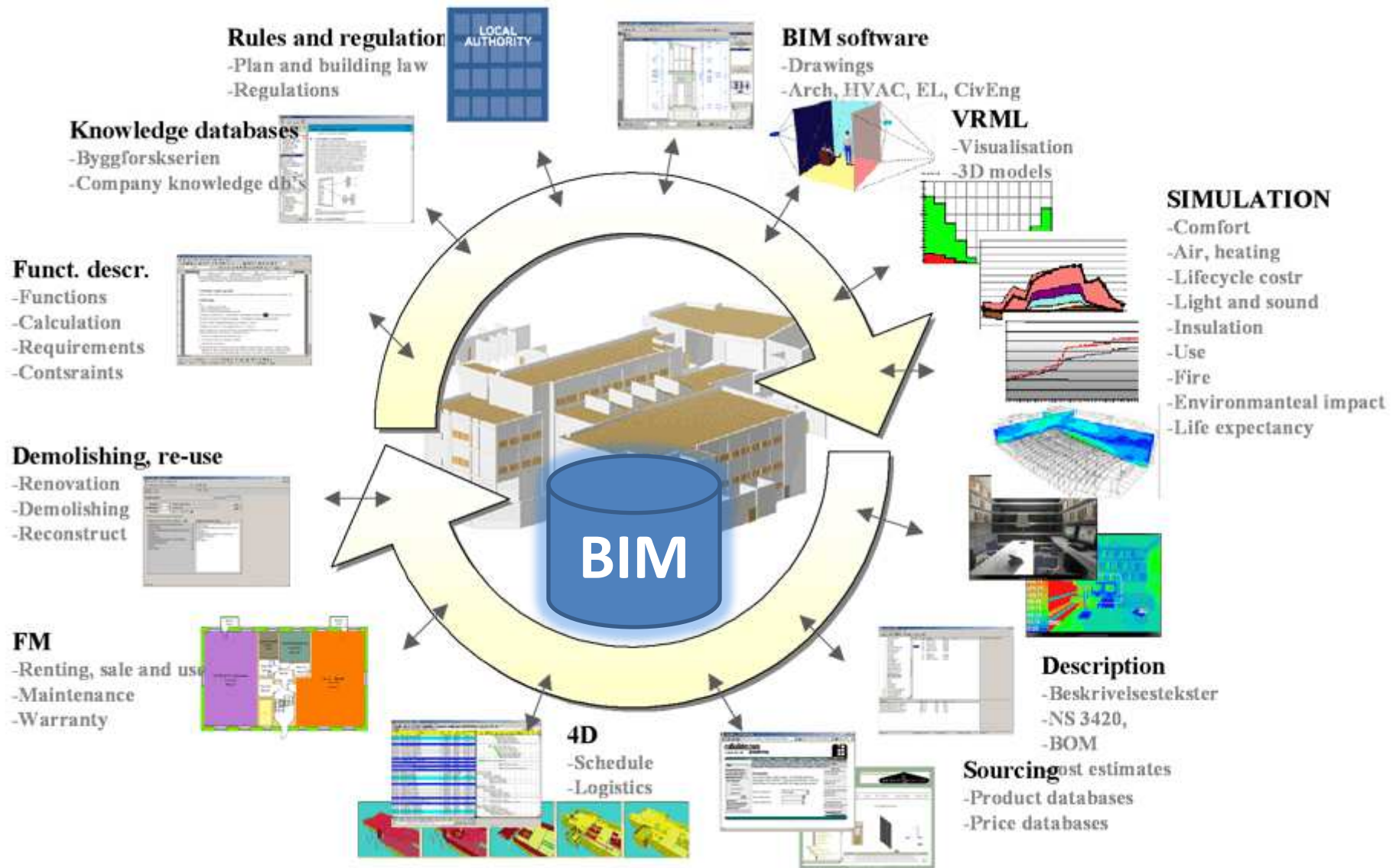- for <u>collaboration</u> by different stakeholders at different phases

- focused on <u>saving resources</u>
  - time, money, materials

- founded on <u>open standards</u> for interoperability

Construction Life-Cycle

Rules and regulation LOCAL AUTHORITY
-Plan and building law
-Regulations

BIM software
-Drawings
-Arch, HVAC, EL, CivEng

Knowledge databases
-Byggforskserien
-Company knowledge db's

VRML
-Visualisation
-3D models

SIMULATION
-Comfort
-Air, heating
-Lifecycle costr
-Light and sound
-Insulation
-Use
-Fire
-Environmanteal impact
-Life expectancy

Funct. descr.
-Functions
-Calculation
-Requirements
-Contsraints

Demolishing, re-use
-Renovation
-Demolishing
-Reconstruct

BIM

Description
-Beskrivelsestekster
-NS 3420,
-BOM

FM
-Renting, sale and use
-Maintenance
-Warranty

4D
-Schedule
-Logistics

Sourcing -ost estimates
-Product databases
-Price databases

Pictures from: Selvaagbygg, DDS, Byggforsk, NBLN University of California, CIFE Stanford, Pythagoras and Oluf Granlund Yo.

http://www.jotne.com/project-information-owners.442302-79297.html

Potential for Game Changer

- Avoid late changes
  - Miss-understandings, miss-communications, unforeseen consequences
- Better solutions
  - No missed-opportunities, multi-disciplinary approaches, mutual understanding and consensus

  - Less errors/clashes,
  - Correct materials/tools/people at correct time,
  - Offsite work, prefab assemblies

Communication
Collaboration
Coordination
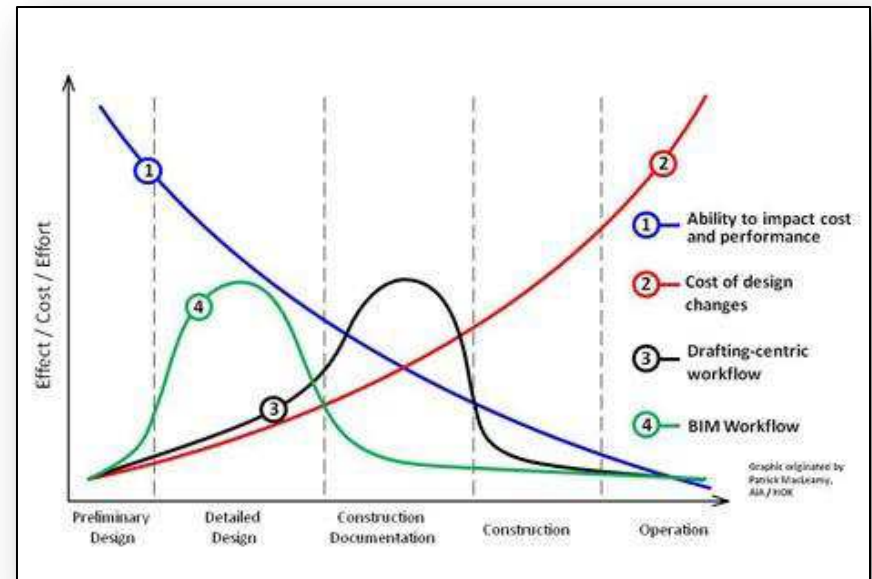
http://www.cenews.com/magazine-article-cenews.com-october-2008-what_does_bim_mean_for_civil_engineers_-6098.html

Proprietary Formats

Autodesk

Others

Proprietary BIM Formats – Autodesk

Autodesk®

DWG – 18 different formats (2009), none publicly documented, RealDWG library licensable, limited metadata – not BIM

DXF – published and maintained, 2D, limited 3D

DWF – lightweight – one way – not BIM

RVT – highly proprietary – BIM

NWD – single file Navisworks

NWF – links – proprietary

Proprietary BIM Formats – Others

PLN – Graphisoft ArchiCAD
– claimed first BIM format (1987)

DGN – Bentley MicroStation – BIM
– supports OpenDGN with software library

VWX – Nemetscheck Vectorworks – BIM

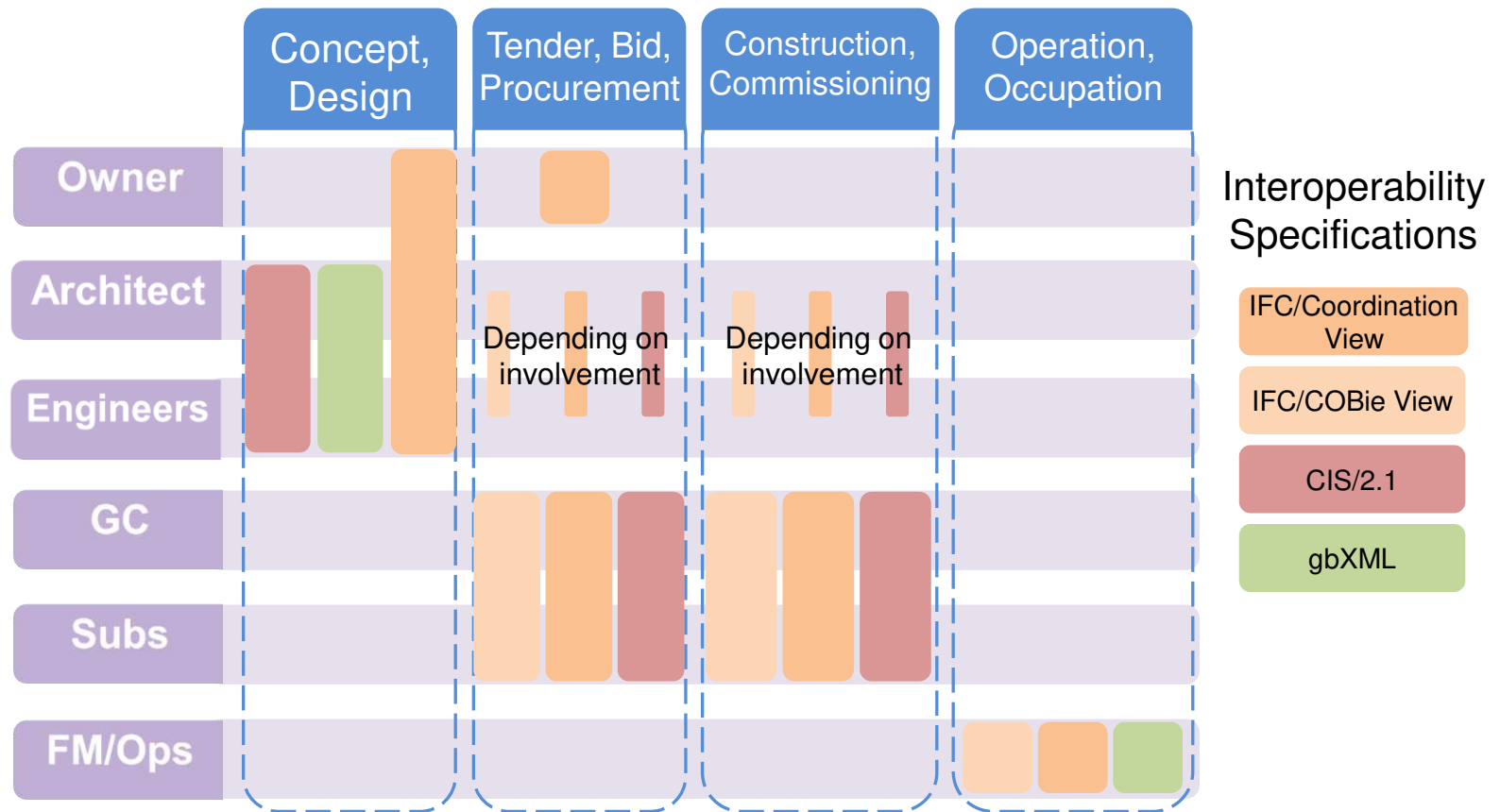3D PDF – one way transfer – not BIM

Open (International) Specifications

IFC

COBie

gbXML

CIS/2.1

Specification's Relevance in Design-Bid-Build

IFC: Industry Foundation Classes

- Closest to ISO/IS certification

- Currently ISO/PAS 16739

- .ifc files – heavily uses STEP (ISO 10303)

- Fairly comprehensive: building elements, spaces, ...

- Certification 2.0 program for implementations of stable version IFC2x3

- IFC2x4 final release 2Q – plan IS by Q3

IFC Continued

- Interrelated **Objects** with globally unique identifiers
- Database compatible – tracking/control modifications
- Model View Definitions – legal subsets of data

Two common IFC2x3 Model View Definitions:

- Coordination View – design & construction
- Basic FM Hand Over – construction & operator

IFC Adopters

- Finland (Senate) 2007,
  Norway (Statsbygg) 2007,
  Denmark (DEACA) 2009,
  Singapore 1997 permits, ...
- USA:
  - GSA (2007+) major projects spatial BIM (IFC2x2)
  - Universities (Penn State, Arizona State, Emory University Atlanta, ...)
  - U.S. Army, NASA
- Canada: Alberta, B.C., Montreal (city), ...

IFC Coordination View

When: Design through Hand Over, Retrofits

What: Coordination, Clashes, Planning, Material,...

Who: Owner, AEC, Subs, Operator

Pros: Free viewers, broad support

Limitations: Fabrication Steel & MEP, LOD, scheduling, …

IFC Facility Management Handover

Scope: "Handover from planning and design applications and construction and commissioning software to CAFM and CMMS applications" ← building life-cycle link

Specific subset of IFC – an MVD – .ifc file

Construction-Operations Building Information Exchange (COBie)

COBie 2.3 (Jan 2011) defines a two-way mapping to a multi-sheet spreadsheet

- No special/expensive software to edit/read
- Contractors add data as systems installed/commissioned
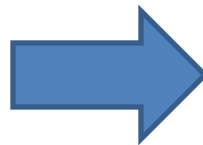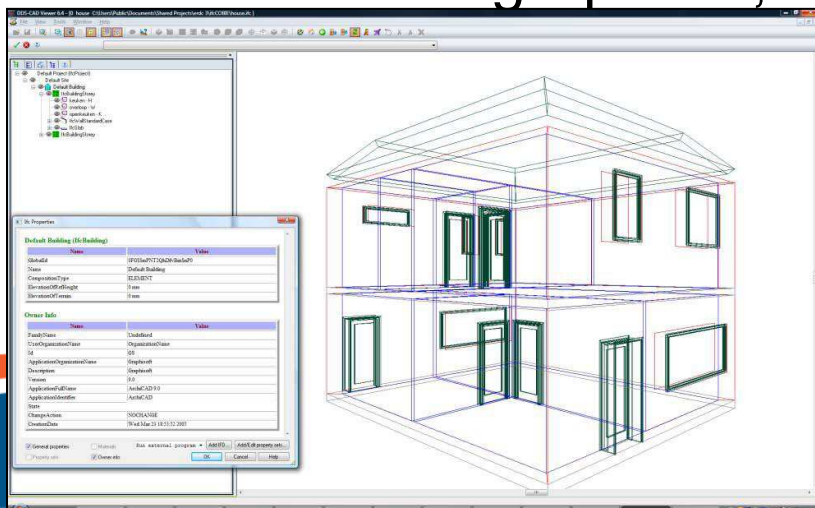
IFC vs. COBie 2 Example
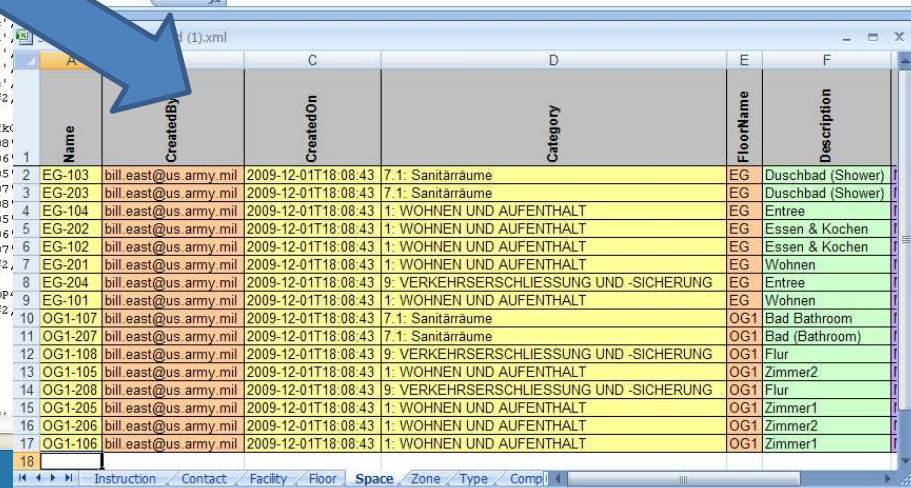
IFC Hand Over / COBie

When: Procurement, Construction, Commissioning, Hand Over, Retrofits

What: MEP, equipment lists, warrantees, coordinates., …

Who: Sub-contractors, FM, Operators

Pros: Growing support, backed by US Army Corp Engineers and NASA, easy to use

Limitations: not graphical, support still growing

COBie Supporters

CIMsteel Integration Standards Release 2 (2003) – CIS/2.1

- Steel Construction Institute (UK)
- Endorsed by the American Institute of Steel Construction (US)
- Design, analysis, detailing and fabrication processes vertically in structural steelwork industry
- Like IFC based on STEP (ISO 10303)
- On-going effort to harmonize with IFC
- Older, established standard
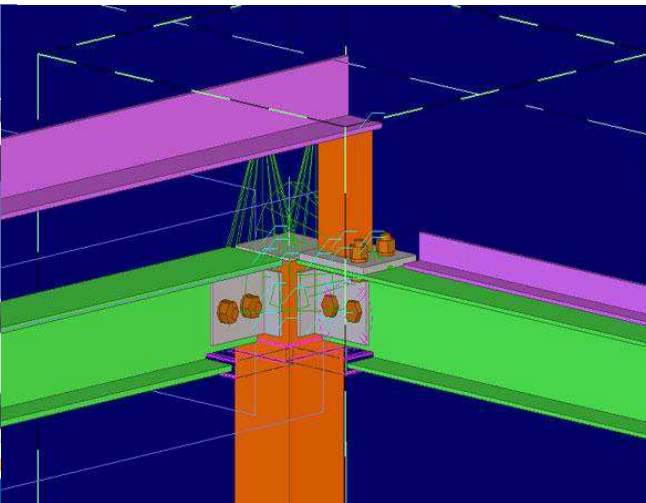
CIS/2.1

When: Entire structural steel design, fab, erection cycle

What: Design, detailing and fabrication data…

Who: Structural steel sector

Pros: Established, comprehensive US standard

Limitations: only for structural steel

gbXML: green building XML

- Initially bridge model to DOE tools
- Mostly for energy and comfort modelling
- Non-profit controlled targeting sustainable building solutions in design, ops and re-cycling

When: Design & Analysis, Operations
What: Space/Zone geometry, systems
Who: Designers, Analysts, FM, Operators
Limitations: Changing rapidly, small scope

gbXML Supporters

- Artifice – DesignWorkshop
- Autodesk – AutoCad, Revit, Green Building Studio, Ecotect
- Bentley – Architecture, Mech. Systems, speedikon, Hevacomp
- Cadsoft – Envisioneer
- Onuma – BIMStorm
- Arup – EnergySave
- blueCape – OpenFOAM
- CADLine – Cymap
- DesignBuilder – v2
- ...

- http://www.gbxml.org/software.php

3C Technology

Federated Model Tools

Model Servers

Some Federated Model Tools

Solibri Model Viewer – .ifc
Tekla BIMsight – .ifc, .ifcxml, .ifczip, .dwg, .dgn, .xml (Tekla Web Viewer files)
Navisworks Freedom – .nwd, 3D .dwf

Vectorworks – .dxf, .dwg, .kml (Google Earth), .3ds, SketchUp
Navisworks – .dxf, .dwg, .dgn, .dwf, .3ds, CIS/2, .ifc
Innovaya – as a plug-in (big three)

Model / File Servers

Support multiple users, multiple tools, multiple locations.
  Database like access & control & backup

Examples:

BIMServer (bimserver.org)

- internal .ifc, merge, revisions, change finder, database like query & filter, open source or commercial

Onuma Model Server (Onuma, BIMStorm)

- .ifc internal, BIMXML plug-in (big three), element level access, cloud

Others

- Autodesk Buzzsaw   Newforma   projects , ...

Summary

Interoperability – Communication, Collaboration & Cooperation

- Shared models – no re-keying
- Impact: fundamental change in the construction sector
- Not yet transparent, automatic or even necessarily straight forward

Open Specifications – real solutions now

- IFC (COBie), gbxml, CIS/2.1 – rapidly growing support and application
- Improving coverage/completeness/consistent support

Pragmatic

- Team using family of tools with common proprietary format
- Federated Model Tools bridge many mixed tool gaps – some are free
- Model servers support broadest three C level interaction

BIM in <u>use</u> and delivering value <u>now</u>

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