

NRC Publications Archive Archives des publications du CNRC

BIM and the Three Cs Interoperability for Communication, Collaboration and Coordination Dickinson, J. K.

This publication could be one of several versions: author's original, accepted manuscript or the publisher's version. / La version de cette publication peut être l'une des suivantes : la version prépublication de l'auteur, la version acceptée du manuscrit ou la version de l'éditeur.

Publisher's version / Version de l'éditeur:

BIM Workshop, Red River College Applied Research and Commercialization, NSERC [Proceedings], 2011-05-05

NRC Publications Archive Record / Notice des Archives des publications du CNRC : https://nrc-publications.canada.ca/eng/view/object/?id=835e2e41-8a27-4527-b402-7b2cc27ecee7 https://publications-cnrc.canada.ca/fra/voir/objet/?id=835e2e41-8a27-4527-b402-7b2cc27ecee7

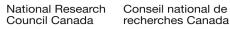
Access and use of this website and the material on it are subject to the Terms and Conditions set forth at https://nrc-publications.canada.ca/eng/copyright READ THESE TERMS AND CONDITIONS CAREFULLY BEFORE USING THIS WEBSITE.

L'accès à ce site Web et l'utilisation de son contenu sont assujettis aux conditions présentées dans le site <u>https://publications-cnrc.canada.ca/fra/droits</u> LISEZ CES CONDITIONS ATTENTIVEMENT AVANT D'UTILISER CE SITE WEB.

Questions? Contact the NRC Publications Archive team at PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca. If you wish to email the authors directly, please see the first page of the publication for their contact information.

Vous avez des questions? Nous pouvons vous aider. Pour communiquer directement avec un auteur, consultez la première page de la revue dans laquelle son article a été publié afin de trouver ses coordonnées. Si vous n'arrivez pas à les repérer, communiquez avec nous à PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca.









Centre for Computer-assisted Construction Technology BIM and the Three Cs Interoperability for Communication, Collaboration and Coordination

John Dickinson, Ph.D., P. Eng.

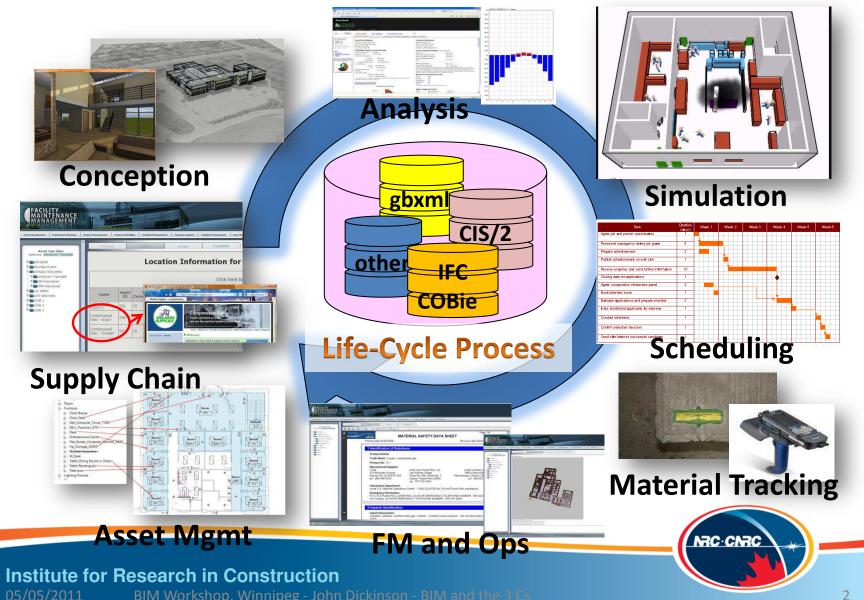
John.Dickinson@nrc.gc.ca

5 May 2011





NRC-CCCT Background



Presentation Outline

Interoperability

- Why care?
- BIM Promise
- Game Changer

Proprietary Formats

- Autodesk
- Others

05/05/2011

Open Specs.

- IFC
- COBie
- gbXML
- CIS 2.1
- 3C Technology
 - Federated Model Tools
 - Model Servers



Institute for Research in Construction

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 C

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



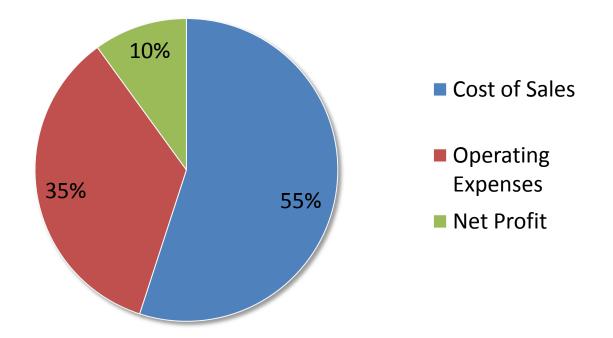
Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 C

Profitability in Construction

% Total Revenue

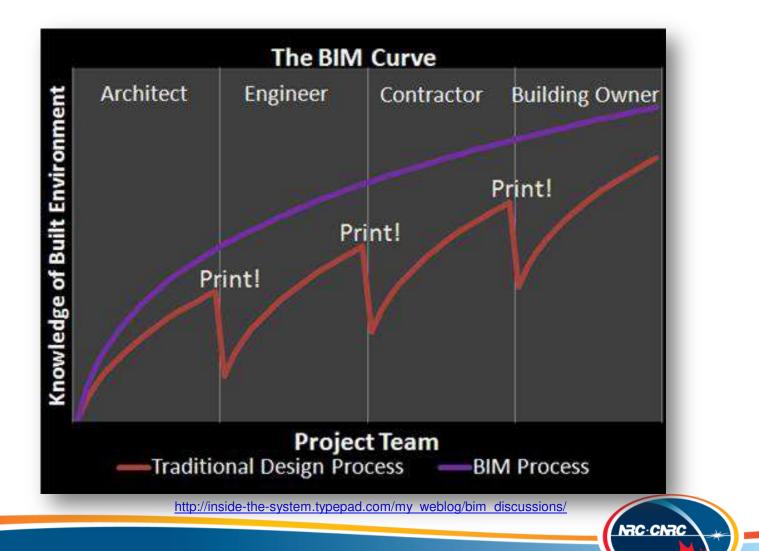


Statistics Canada 2008: Small and Medium Construction Firms (<\$5M)

http://www.ic.gc.ca/cis-sic/cis-sic.nsf/IDE/cis-sic23bece.html



The Promise: Interoperability



Institute for Research in Construction

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 C

BIM Definition (Noun)

http://www.buildingsmartalliance.org/index.php/nbims/about/

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

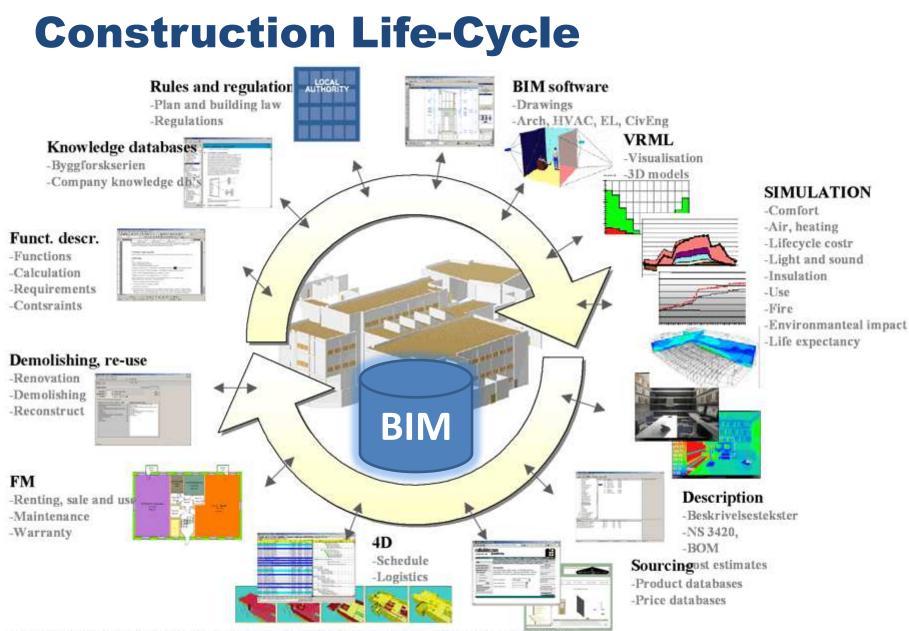




Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 Cs



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

05/05/2011 BIM Workshop, Winnipeg - John Dintips//www.potheledins/project-information-owners.442302-79297.html

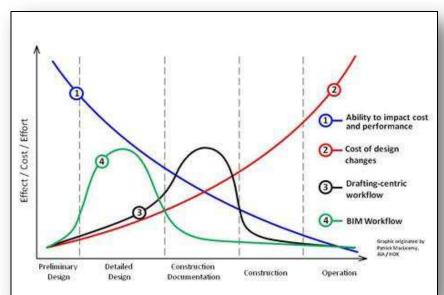
Potential for Game Changer

- Avoid late changes
 - Miss-understandings, misscommunications, 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



Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 Cs

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

- GRAPHISOFT
- 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





Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 Cs

Open (International) Specifications

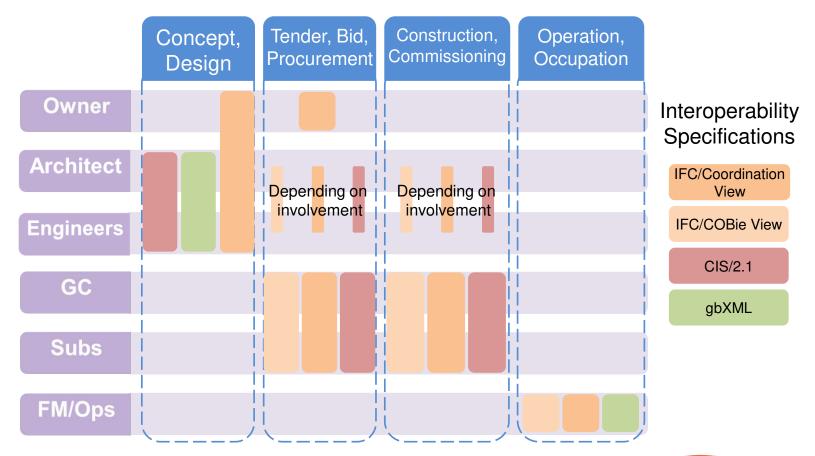
IFC COBie gbXML **CIS/2.1**



Institute for Research in Construction

05/05/2011

Specification's Relevance in Design-Bid-Build





Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 C

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:

05/05/2011

- 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), ...

Institute for Research in Construction

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 C

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" \leftarrow 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



Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 Cs

IFC vs. COBie 2 Example

|--|

#60=

#61=IFC

File Edit View Insert Format Help

D 🛎 🖬 🕘 🛕 🔺 🐇 🖻 🛍 🗠 🦉

- IFCRELDEFINESBYPROPERTIES('240vmOsfrEDf6pv6A6C9NR',#2,\$,\$,(#50),#70); OCALPLACEMENT (#47, #71); GRE_MTES('3kQGEO5CvBWxbKj5J12eKX',#42,\$,\$,#51,(#72,#73,#74,#75,#76,#77,#78,#79)); BYPROPERTIES ('39 CywK993LeGCxMKmVNFt', #2, \$, \$, (#51), #80);
 - MENT(#47,#81);
 - DINSPATIALSTRUCTURE('3DnOiZyvrF8wx_XG421Xfz',#42,\$,\$,(#82),#51);
 - [S('3]TF06d\$bAq9Mcq1BAiFaE',#42,\$,\$,#52,(#83,#84,#85,#86,#87,#88,#89,#90));
- #62=IFCRE PROPERTIES('2WwQlllqnEHAKb18VVa357',#2,\$,\$,(#52),#91);
- #63=IFCL_CALPLACEMENT(#47,#92);
- #64=IFCRELCONTAINEDINSPATIALSTRUCTURE('3c10QahbL9DqqbjECZsXdd',#42,\$,\$, (#93),#52); #65=IFCRELDEFINESBYPROPERTIES('1KYc7vgFHA5ezt9tXzY4TR',#2,\$,\$,(#53),#94);
- #66=IFCLOCALPLACEMENT(#47,#95);
- #67=IFCCARTESIANPOINT((0.,0.,0.));
- #68=IFCDIRECTION((0.,0.,1.)); #69=IFCDIRECTION((1.,0.,0.));
- #70=IFCELEMENTQUANTITY('3hP JW0rjFCAc0A #71=IFCAXIS2PLACEMENT3D(#98,#99,#100); #72=IFCSPACE('10rGsxVsjFQRyUbPRTfio1',#42 #73=IFCSPACE('02x9qDEpXAjgmxgRilfOWJ',#42 #74=IFCSPACE('2q17\$01zjC9x9TFYrOm9vg',#42, #75=IFCSPACE('1DRNfcw4jC6QSpJ95H41CU',#42,'EG-104
- #76=IFCSPACE('2fufa2CPH5M914qbIA5AdW',#42,'EG-201 #77=IFCSPACE('30Lu9rWwr2ZhgmbRIOOxAG',#42,'EG-202 #78=IFCSPACE('0yVNcdNcj6TheBMgV\$Q3b0',#42,'EG-203 #79=IFCSPACE('2bc7LNaLjAWfq7n5bBQSh3',#42,'EG-204 #80=IFCELEMENTQUANTITY('20ICd9LkD6CfGt0QsXxqBG',# #81=IFCAXIS2PLACEMENT3D (#135, #136, #137); #82=IFCBUILDINGELEMENTPROXY('2KgRevgTT8oAYY3uJXyf) #83=IFCSPACE('3izD5nyc1A00zXeb QE7nb',#42,'0G1-200 #84=IFCSPACE('324NzePkD8aQw1n\$\$oTVF_',#42,'OG1-10) #85=IFCSPACE('300eWXgOX3ZxkAC7ZoY5PG',#42,'0G1-10 #86=IFCSPACE('3A_K1MZMzFbeaR1DIOVpCu',#42,'0G1-10' #87=IFCSPACE('3L6fACDAPCJAUPVffY1UZD',#42,'OG1-10

Storey quantities', \$, \$, (#96, #97));

g Room', \$, #104, #105, 'Living Room', .ELEMENT., .INTERNAL., \$);

H + + Instruction Contact Facility Floor Space Zone Type Comp 4

#73=IFCSPACE(U2x9qDEpxAjgmxgRiltOWJ ,#42		- (* fx				
#74=IFCSPACE('2q17\$01zjC9x9TFYrOm9vg',#42, EG-1.						
#75=IFCSPACE('1DRNfcw4jC6QSpJ95H41CU',#42,'EG-104',						
#76=IFCSPACE('2fufa2CPH5M914qbIA5AdW',#42,'EG-201',	N	d (1).xml				- = X
#77=IFCSPACE('30Lu9rWwr2ZhgmbRIOOxAG',#42,'EG-202',			С	D	E	E
<pre>#78=IFCSPACE('OyVNcdNcj6TheBMgV\$Q3b0',#42,'EG-203',</pre>			C C	U	-	
<pre>#79=IFCSPACE('2bc7LNaLjAWfq7n5bBQSh3',#42,'EG-204',</pre>						
#80=IFCELEMENTQUANTITY('2oICd9LkD6CfGt0QsXxqBG',#2,			5		l e	5
#81=IFCAXIS2PLACEMENT3D(#135,#136,#137);			9	ŝ	ar	E II
#82=IFCBUILDINGELEMENTPROXY('2KgRevgTT8oAYY3uJXyfk(e	1 E	te	5	E	5
#83=IFCSPACE('3izD5nyc1A00zXeb_QE7nb',#42,'0G1-208'	1 Nan	e e	e l	ate	0	8
#84=IFCSPACE('324NzePkD8aQw1n\$\$oTVF_',#42,'OG1-106'		0	U U	Ŭ	ш.	-
#85=IFCSPACE('300eWXgOX3ZxkAC7ZoY5PG',#42,'OG1-105		bill.east@us.army.mil				Duschbad (Shower)
#86=IFCSPACE('3A_K1MZMzFbeaR1DIOVpCu',#42,'OG1-107	3 EG-203	bill.east@us.army.mil	2009-12-01T18:08:43	7.1: Sanitärräume	EG	Duschbad (Shower)
#87=IFCSPACE('3L6fACDAPCJAUPVffY1UZD',#42,'OG1-108'	4 EG-104	bill.east@us.armv.mil	2009-12-01T18:08:43	1: WOHNEN UND AUFENTHALT	EG	Entree
#88=IFCSPACE('10BrLPTTb9YRj_KH\$XxvOV',#42,'OG1-205'	5 EG-202			1: WOHNEN UND AUFENTHALT	EG	Essen & Kochen
<pre>#89=IFCSPACE('0P2PXhgSf7UPJkGwijpEMR',#42,'0G1-206' #90=IFCSPACE('1UiLW17xLFwRSI33AMW4Xt',#42,'0G1-207'</pre>	6 EG-102			1: WOHNEN UND AUFENTHALT	EG	Essen & Kochen
#90=IFCSPRCE('IOILWI'XLFWRSI33ANW4XC',#42,'OGI-207 #91=IFCELEMENTQUANTITY('O4UEifVM94xBjitprlCjmK',#2,				1: WOHNEN UND AUFENTHALT	EG	Wohnen
#91=IFCELEMENIQUENIIII('040EIIUN94x6jicpiicjink',#2, #92=IFCEXIS2PLACEMENT3D(#170,#171,#172);						
#92=IFCBUILDINGELEMENTSD(#170,#171,#172); #93=IFCBUILDINGELEMENTPROXY('Onr&4sCbr800gvF1phtOP4	8 EG-204			9: VERKEHRSERSCHLIESSUNG UND -SICHERUNG	EG	Entree
#94-IFCELEMENTOLINITITY (11 mrgHt DoEdmDUlofDenUid) #2	9 EG-101	bill.east@us.army.mil	2009-12-01T18:08:43	1: WOHNEN UND AUFENTHALT	EG	Wohnen I
<pre>#94=IFCELEMENTQUANTITY('1wrgHtBe54mRWlofD5nUjd',#2, #95=IFCAXIS2PLACEMENT3D(#177,#178,#179);</pre>	10 OG1-107	bill.east@us.army.mil	2009-12-01T18:08:43	7.1: Sanitärräume	OG1	Bad Bathroom
#96=IFCQUANTITYLENGTH('Net Height', \$, \$, 1.25);	11 OG1-207	bill.east@us.army.mil	2009-12-01T18:08:43	7.1: Sanitärräume	OG1	Bad (Bathroom)
<pre>#97=IFCQUANTITYLENGTH('Storey Height', \$, \$, 1.38);</pre>	12 OG1-108	bill east@us army mil	2009-12-01T18-08-43	9: VERKEHRSERSCHLIESSUNG UND -SICHERUNG	OG1	Flur
#98=IFCCARTESIANPOINT((0.,0.,-1.25));				1: WOHNEN UND AUFENTHALT		Zimmer2
#99=IFCDIRECTION((0.,0.,1.));				9: VERKEHRSERSCHLIESSUNG UND -SICHERUNG		Flur
#100=IFCDIRECTION((1.,0.,0.));						
4101-TROBEL LOCIONOTOCOOUD (10-V-VEALDELL				1: WOHNEN UND AUFENTHALT		Zimmer1
				1: WOHNEN UND AUFENTHALT		Zimmer2
For Help, press F1	17 OG1-106	bill.east@us.army.mil	2009-12-01T18:08:43	1: WOHNEN UND AUFENTHALT	OG1	Zimmer1
	18	1				3

Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 Cs

For Help, press F1

IFC Hand Over / COBie

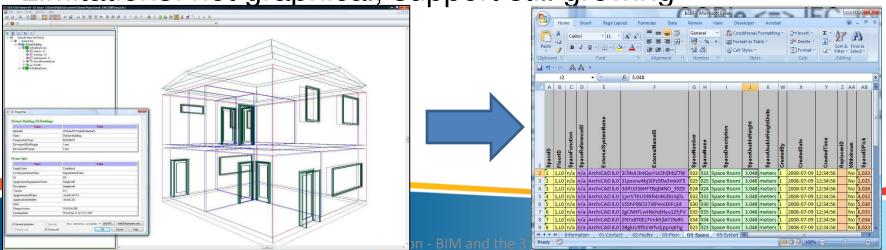
When: Procurement, Construction, Commissioning, Hand Over, Retrofits

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



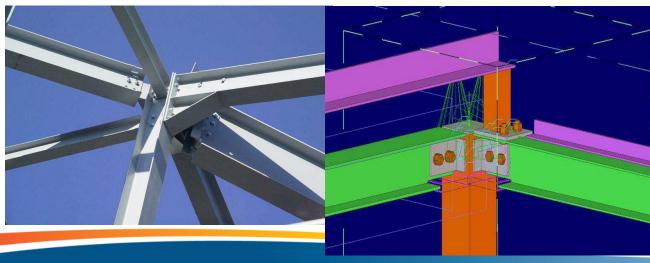


05/05/2011

SCI



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





Institute for Research in Construction 05/05/2011 BIM Workshop, Winnipeg - John Dickinson - BIM and th

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



05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 Cs

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)



Institute for Research in Construction

05/05/2011

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

05/05/2011

 Autodesk^{*} Buzzsaw'





BiMserver





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

05/05/2011

- 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 use and delivering value now





John Dickinson John.Dickinson@nrc.gc.ca +1 (519) 430-7123 National Research Council of Canada Centre for Computer-Assisted Construction Technologies 800 Collip Circle, London, Ontario, N6G-4X8 Canada



Institute for Research in Construction

05/05/2011

BIM Workshop, Winnipeg - John Dickinson - BIM and the 3 C