CRC-CI Project 2007-002-EP

National BIM Guidelines and Case Studies

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Where are we up to:

- This is 'First Draft' of National Guidelines
- Case Studies approximately 25% complete



BIM The INFORMATION part



On the same map

Talking about the same thing

Speaking the same language/ terminology



The interrelationships of information

Who creates it ?

Who else uses it ?

Who amends it ?

Who is responsible for it ?



Product model-based design







Relationships of International Framework of Dictionaries to IDM



Information over Project Life Cycle

Pre-design and planning Phase

Design Phase

Construction Phase

Post – Construction / Operation Phase



Owners View Pre-design and planning Phase

Space planning, program compliance

Software

Affinity Codebook International Facility Composer SketchUp Form Z dRofus



Designers view Design Phase

Space planning, program compliance Architectural Design Structural Analysis and design Building Services analysis and design Urban design Code checking Co-ordination Energy analysis Sustainability assessment Visualization Collaboration

Software - Architecture

ArchiCAD Revit Architecture Bentley Architecture Autodesk ADT

Software - Structural

Tekla Revit Structure Bentley Structural Autodesk ADT Robobat Prosteel 3D Orion 3D Plus



Designers view Design Phase

Space planning, program compliance Architectural Design Structural Analysis and design Building Services analysis and design Code checking Co-ordination Energy analysis Sustainability assessment Visualization Collaboration

Software - Mechanical

DDS - HVAC Revit MEP Bentley Architecture Riuska

Software - Electrical

DDS - Electrical Revit MEP Bentley Electrical



Designers view Design Phase

Space planning, program compliance Architectural Design Structural Analysis and design Building Services analysis and design Code checking Co-ordination 4D construction scheduling 5D Estimating and cost planning, quantity take-off Energy analysis Sustainability assessment Visualization Collaboration

Software - Sustainability

LCADesign

Software - Hydraulic

DDS - Plumbing Revit MEP Bentley Hydraulics

Software – Estimating/QS

Cost X CRC - Estimator

Software – Checking & Co-ordination

Navisworks Solibri CRC – Checker Octaga **Software - Environmental** Ecotect



Constructors View Sub-Constructors View Construction Phase

Code checking Co-ordination 4D construction scheduling 5D Estimating and cost planning, quantity takeoff Pre-fabrication Asset Management/ Operation simulation Visualization Collaboration

Software – 4D, 5D

Navisworks Synchro

CAD Duct



Operators View FM & Operation Phase

Space planning, program compliance Code checking Co-ordination Pre-fabrication Asset Management/ Operation simulation Energy analysis Sustainability assessment

Software - FM

Vizelia Rhyti FM Desktop Archibus Bentley Facilities MAXIMO



Major issues to emerge

-Need for development of common concepts and terminology

- -Model Life Cycle
- -BIM Migration Roadmap
- -Not many completed BIM projects apart from Project Services

-Integration of more cross-discipline project partners from the whole building life cycle:

Owners/ operators, Builders, Sub-contractors, Building product suppliers



Model Life Cycle

- -Variation to current practice
- -Different forms of collaboration
- -New business opportunities
- -New design possibilities
- -Resource implications
- -Based on Building Life Cycle



BIM Migration Roadmap

- -Guidance for industry
- -Conceptual
- -Detailed steps
- -A little or a lot, achievable steps
- -Software specific
- -Data exchanges and linkages



BIM Guidelines Content

- **1. General Introduction**
- 2. Model Creation and Management
- 3. Disciple Modelling
- 4. Model Analysis / Simulations
- 5. Case Studies
- 6. Appendices



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1. General Introduction

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<u>1. General Introduction</u>

- 1.1 Scope
- 1.2 Description of key concepts
- 1.3 Glossary of terms
- 1.4 11 project Phases in Project Life Cycle
- 1.5 RAIA BIM Diagram
- 1.6 BIM Implementation Stages
- 1.7 BIM Information Levels
- 1.8 Classification of Building Information
- 1.9 Role of Model Manager
- 1.10 Business drivers for BIM



1.2 Description of key concepts

Inter-related concepts

- Information life cycle
- Project life cycle
- Integrated practice
- BIM Information levels
- BIM Implementation Stages
- Technology implications
- Process implications
- Policy implications



1.4 **11 Project Phases in Project Life Cycle**

From Process Protocol in Draft ISO Standard 12006-3

Pre - Design

Construction

Post - Construction

Design

- 0 Portfolio requirements
- 1 Conception of need
- 2 Outline feasibility
- 3 Substantive feasibility
- 4 Outline conceptual design
- 5 Full conceptual design
- 6 Coordinated design (and procurement)
- 7 Production Information
- 8 Construction
- 9 Operation and maintenance
- 10 Disposal



From Process Protocol in Draft ISO Standard 12006-3

























Stage 1B - Intelligent 3D Modelling

Well built

Appropriate BIM tools used for all objects, with correct properties and attributes

Precise geometric sizes and locations

Object properties fully populated with element data

Embedded or linked information in consistent manner

Traditional views / drawings/documents can be automatically extracted and internally consistent

Extracts possible for quantities

Checked for errors

Correct information per BIM Information Level

Verified quality (Checklist, Model Checker)

Automated 2D Plan, Sections, Elevations, Details, Automated Schedules, Quantities, e-Specifications, 4D Construction Scheduling, 3D Visualizations, Perspectives, Sun studies, Animations

Well managed model for in-house use



Stage 2A - One Way Collaboration

Need to agree on project settings and parameters

Well made model (As above)

Agreement on the following:

Project Standards

File naming

File structure

Model divisions

Co-ordinate system

Building Reference Point

Software/ exchange protocol, eg: dwf, IFC

Model transfer method: File, database, model server

Interoperability

Purpose of exchange

Information: Content, Format, Metadata

BIM Information Level to be exchanged

Verification of being checked (QA) (Checklist, Model Checker)

Expected information that will survive or not get changed by exchange

Notification of errors, conflicts, clashes

Data required 'downstream'

Template file with project specific parameters



Stage 2B - Two Way Collaboration

Need to agree on project settings and parameters

As per One Way Collaboration with addition of:

Common co-ordinate system Common Building reference Point

Model Management:

Merge

Check

Clash detect

Time frame

QA

Interoperable

Definition of Partial rights/access to model

Definition of Partial models



1.7 BIM Levels of Information



BIM Levels of Information, from Danish Standards



Construction process over time



AEC Bytes Article Newsletter #35 17th June 2008 Einhorn Yaffee Prescott Architects/Engineers

Formalized Use of BIM

<u>BIM Level 1</u>: for Space Management tasks. Model includes basic components ie. Walls, floors, and roof, some finishes, spaces with relevant name, occupant, department etc.

<u>BIM Level 2</u>: More information to model, ie. Detailed spaces, details of walls, floors, and roof, complete structural system, details of finishes such as mouldings, all building services including ducts, lights, panels and equipment

<u>BIM Level 3</u>: Information needed for analysis and simulation ie. Thermal properties of components, full details of all building systems

<u>BIM Level 4</u>: Complete model that contains fabrication information that can be used as the contract model for full-fledged collaboration and integrated practice.

http://www.aecbytes.com/newsletter/2008/issue_35.html



AEC Bytes Article Newsletter #35 17th June 2008 Einhorn Yaffee Prescott Architects/Engineers

Levels of **BIM**

1: Formalized use of BIM into Business Strategy

2. Clients can understand level of BIM service the firm is capable of providing and match it with the level of requirements they want

3. Firms have a better understanding of the effort it takes to create different levels of models to:

i. compare it to the value that is being derived and;

ii determine level of compensation that would be appropriate and;

iii. how the compensation should be distributed across different phases of the project

http://www.aecbytes.com/newsletter/2008/issue_35.html



<u>1.8 Classification of Building Information</u>

Need for Product Libraries and well, clear and accepted standards for Building Information

NATSPEC Draft *TECHreport* June 2008 "Information classification systems and the Australian construction industry" recommended complying with ISO Standard 12006-2: Organization of information about Construction Works – Part 2: Framework for Classification of Information

This is expected to influence the Guidelines



<u>1.9 The Role of the 'Model Manager'</u>

New jobs emerging – see in outcome of Case Studies " Model Manager" Design Model Manager Design Modeller

Construction Model Manager Construction Modeller

FM Model Manager FM Modeller

"Information Model Manager"



1.10 Business Drivers for BIM Implementation

CRC for Construction Innovation Report to be published soon on website and in summary form in Guidelines



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- **3. Discipline Modelling**
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2. Model Creation and Management

2.1 Modelling Process Overview

2.2 Types of Models or Simulations

2.3 Detailed Modelling Requirements

2.4 Model Management



2.1 Modelling Process Overview

- 1. Modelling
- 2. Visualisations
- 3. Model Checking
- 4. Drawing Production
- 5. Exchange of data
- 6. Simulation



2.2 Types of Models or Simulations required on a project basis

Table of possible models, analyses and simulations



	Potential 3D models for Design, Analysis & Simulation Information Required Use of model dictates model requirements, level of detail and modeling techniques																										
										In	form	atio	n Re	quire	ed												
Use of model dictates model requirements, level of detail and modeling techniques		Information from:														Information to:											
	Owner	Unner Local Authorkies Surveyor Surveyor Survetural Engineer Hydraufo Engineer Landseape Andrikeot Landseape Andrikeot Contraetor Bub-opntraet or Sub-opntraet or												Local Authorities	Surveyar	Aichitect	Structural Engineer	HVAC Engineer	Electrical Engineer	Hydrauf o Engineer	Landspape Anchitect	Contractor	Sub-contract or	Facilities Manager			
Models created																									Γ		
Space planning																									Γ		
Site, urban design context																									Γ		
Site & existing buildings																									Γ		
Architectural model																								\square	Γ		
Structural design model																									Γ		
HVAC design model																									Γ		
Building services design model																									Γ		
Lighting																								\square	Γ		
Electrical																								\square	Γ		
Hydraulics																								\square	Γ		
Interior layouts and design model																								\square	Γ		
Fabrication/ Shop drawings/ models																								\square	Γ		
Road & civil design																								\square	Γ		
Landscaping and external works options																								\square	Γ		
Renovation and refurbishment																								\square			
Facility management model																								\square			
Construction model																									Γ		
																									Ē		



Potential 3D models for Design, Analysis & Simulation															-										
										In	form	atio	n Required												
Use of model dictates model requirements, level of detail and modeling techniques					Info	rmat	ion f	rom:			Information to:														
	Owner	Local Authorities	Survejar	Architect	Structural Engineer	HVAC Engineer	Electrical Engineer	Hydraufic Engineer	Landspape Architect	Contractor	Sub-contract or	Facilities Manager	Owner	Local Authorities	Surveyor	Architect	Structural Engineer	HVAC Engineer	Electrical Engineer	Hydraufic Engineer	Landspape Architect	Contractor	Sub-contract or	Facilities Manager	
Model Analysis / Simulation																									_
Brief development																								\square	
Alternative design options analysis																									
3D visualizations																									
Sun & shadow studies																									
Structural analysis																									
Thermal simulation																									
Sustainability Analysis																									
LCA analysis																									
Model clash detection																									-
Cost planning & control																									
Construction scheduling/ 4D animation																									
Security analysis																									
Code checking and regulatory compliance																									
Acoustic analysis and design																									
Disabled access and egress																									
Fire protection																									
FM, operation, maintenance																									
Automated / linked specifications																									Γ
Heritage documentation & assessment																								\square	
Solar Envelopes																								\square	-
Overshadowing																									Ξ
Daylight Analysis																									Π
Solar Analysis																								-	-
Photovoltaic Collectors																								-	7
																									-



3. Detailed Modelling Requirements

- 1. BIM Information Level required
- 2. Software required
- 3. Exchanges required
- 4. Discipline specific detailed requirements



4. Model Management

BIM Project Setup

Role of Model Manager

Discipline model co-ordinators

Project Modelling Schedule

Project Initiation File and folder structure Modelling Guidelines Exchange Protocols Global Standards Output Conventions Quality Control Risk / Allocation of responsibilities



4. Model Management

BIM Project Management

Checking Models

Merging Models

Clash-Detection

Co-ordination

Identify and document conflicts

Define and document solutions

Backup / archive model files



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3. Discipline Modelling

- 3.1 Planning / Pre-Design
- 3.2 Architectural Design
- 3.3 Surveying/ GIS
- 3.4 Civil & Site Design
- 3.5 Structural Design, Steel, Curtain Walling, Concrete Production Models
- 3.6 HVAC Design, Fabrication Production Models
- 3.7 Electrical Design, Security, Telecommunications
- 3.8 Hydraulic Design, Fire Services
- 3.9 Landscape Design
- 3.10 Interior Design
- **3.11 Construction Models**
- 3.12 Facility Management models



Automated Specification Writing:

Geometric objects with attached data

As object inserted into 3D model, information fields are populated with relevant data for specification

Specification can be edited as necessary

Requires:

Accurate geometry

Relevant and reliable technical data

Ideally Non-propriety objects

Objects sourced from Product manufacturers with up-to-date reliable data

Eg. www.e-specs.com/



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4. Model Analysis / Simulations

4.1 Quantity take-off

- 4.2 Visualizations
- 4.3 MEP analyses
- 4.4 Sustainability LCA analysis
- 4.5 Construction Scheduling
- 4.6 Facilities management





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4.1 Quantity take-off



4.2 Visualisations

Perspectives/ 3D views General Assembly drawings Details Renderings Photo-realistic views



Brisbane City Hall, Brisbane City Council



4.3 MEP analyses

ECOTECT- Information Requirements for Analysis and Export IES

4.4 Sustainability

LCA analysis

4.5 Construction

4D & 5D Construction animation

4.6 Facilities Management

Eg. Sydney Opera House example



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5. Case Studies

- 5.1 Brisbane City Hall, Brisbane, QLD
- 5.2 Willawong Bus Depot, Willawong, QLD
- 5.3 Design Parameters
- 5.4 Joint Contact Centre, QLD
- 5.5 Northlakes Police Station, Northlakes, QLD
- 5.6 Queensland State Archives, Runcorn, QLD
- 5.7 400 George Street, Brisbane, QLD
- 5.8 Sea Water Chamber SOH, Sydney, NSW
- 5.9 1 Bligh Street, Sydney, NSW
- 5.10 King Street Wharf, Sydney, NSW
- 5.11 Westfield Centre, Parramatta, NSW
- 5.12 Chifley Square, Sydney, NSW
- 5.13 Rectangular Pitch Stadium, Melbourne, VIC
- 5.14 Possible other projects



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						4/07/2008
	NC	RTHL	AK	ES PO	LICE S	
Discipline	Software	Ver	IEC	Discipline	Manager	
GIS/Survey	Soltware	Vel	" 0	Discipline	Manager	Feedback:
Pre-Design						Benefits:
Architectural	ArchiCAD	11		Douglas	SEETO	
Structural	Tekla	13 SR4				Probleme
HVAC	DDS	6.4				Froblems.
	Riuska	4 4 10				
Electrical	Revit MEP	2008				Other comments
Estimating/Cost control	Cost X	3.0				
Lydraulic		6.4				
Engliting Management	000	0.4				
Medel Checker	Colibri					
Clean Detection	JUIDII					
Clash Detection						
Model Server	150	5.0				
Sustainability	IES	5.8				
Construction Scheduling						
Landscape						
Interiors						
CNC						
Model Viewer	DDS IFC Viewer					
Civil	12D					
SITE/GIS MODEL ARC	HITECTURAL MOD	DEL STR	UCTU RUCTI	RAL MODEL JRAL ANALY	MEP MODE	L CONSTRUCTION SCHEDULING CIVIL EQUIPMENT SCHEDULE MAINTENANCE SCHEDULE ED ANALYSIS ENERGY ANALYSIS SUSTAINABILITY ANALYSIS COSTING ANALY- FM ANALYSIS
PLANNING PRE-DESIG	ON CONCEPT D	ESIGN	KETC	H DESIGN	SCHEMATIC	DESIGN DETAILED DESIGN CONSTRUCTION DOCUMENTS TENDER AS-BUILT FM / OPERATION



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6.1 References and resources

6.2 Software listing

6.3 Discipline information requirements

6.4 BIM Objects Data requirements

These to be updated on a regular basis



6.1 References and resources

Books

Web sites

Research papers

Conference presentations and papers



6.1 References and resources

	↓ v	
Article Title	Web site	Comment
FIATECH / NIST		
NISTIR 7417 General Buildings Information Handover Guide: Principles,		Very good and
Metholodogy and Case Studies	http://www.facilityinformationcouncil.org/bim/pdfs/nistir_7417.pdf	comprehensive
Capital Facilities Information Handover Guide. Part 1.	http://www.fire.nist.gov/bfrlpubs/build06/PDF/b06016.pdf	
Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities		
Industry	http://www.bfrl.nist.gov/oae/publications/gcrs/04867.pdf	
Data Standards Clearinghouse	http://www.fiatech.org/projects/idim/dscdata.htm	
FIATECH Capital Projects Technology Roadmap	http://www.fiatech.org/pdfs/projects/fiatech_ectp_mapping.pdf	
IAI/ buildingSMART		
Industry Foundation Classes - Release 2x IFC Technical Guide	http://www.iai-international.org/Model/documentation/IFC_2x_Technical_Guide.pdf	
Collaboration, Integrated Information, and the Project Lifecycle in Building	http://www.leanconstruction.org/files/Forum_Meetings/Design_Forum_4-	
Design, Construction and Operation	1Jun06/doc/CurtCollaboration.pdf	
IAI Information Delivery Manual	http://www.iai.no/idm/index.html	
	http://idm.buildingsmart.no/confluence/display/IDM/Home	
GSA		
	http://www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8195&channelPage=	
GSA 3D-4D Building Information Modeling	%252Fep%252Fchannel%252FgsaOverview.jsp&channelld=-18161	
PM4D Final Report CIFE Technical Report Number 143	http://www.stanford.edu/group/4D/download/PM4D_Final_Report.pdf	
	http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/GSA_BIM_Guide_v0_60-	
3D-4D-BIM Overview	Series01 Overview 05-14-07 R2C-a3-I 0Z5RDZ-i34K-pR.pdf	
	http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/BIM_Guide_Series_02_	
Spatial Program Validation	v0.96 R2C-a3-I 0Z5RDZ-i34K-pR.pdf	
	http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/GSA_BIM_02_Appendix	
Spatial Program Validation Appendix	v09_R2C-a3-I_0Z5RDZ-i34K-pR.pdf	
· · · · · · · · · · · · · · · · · · ·		
AIA		
Ontinizing the Construction Process: An Implementation Strategy	http://www.aia.org/SiteOhiects/files/in_ontimizingconstructionprocess.pdf	



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6.2 Software listing

Data Exchanges						
GIS/ Survey						
Space planning	Vectorworks Fundamentals	SketchUP	Trelligence Affinity	Facility Composer	FormZ	Codebook International
Pre-design - Design	GSA - ArchiCAD	GSA - Revit				
Design						
Architectural - Architectural	ArchiCAD - Re∨it	Revit - Bentley	Bentley - ArchiCAD	Autodesk ADT		
Architectural - Structural	ArchiCAD - Re∨it Structure	Revit- Revit Structure	ArchiCAD - Tekla	Re∨it - Tekla	Bentley Structure	
Structural - Structural	Re∨it Structure - Tekla					
Structural Analysis	Robobat	Prosteel 3D				
Architectural - Environmental Analysis	ArchiCAD - Ecotect	Revit - Ecotect	Re∨it - IES	ArchiCAD - IES		
Architectural - Mechanical	ArchiCAD - DDS HVAC	Revit - DDS HVAC	Revit - Revit MEP	ArchiCAD - Re∨it MEP	Riuska	Bentley Mechanical
Architectural - Electrical	ArchiCAD - DDS Electrical	Revit - DDS Electrical	Revit - Revit MEP	ArchiCAD - Revit MEP		Bentley Electrical
Architectural - Hydraulic/ Plumbing	ArchiCAD - DDS Plumbing	Revit - DDS Plumbing	Revit - Revit MEP	ArchiCAD - Revit MEP		
Architectural - FM	Vizelia	FM Desktop		Rambyg	Ryti	Bentley Facilities
Architectural - Costing	ArchiCAD - Cost X	Revit - Cost X	ArchiCAD - CRC Estimator	Re∨it - CRC Estimator		
Code Checker						
Specification						
Landscaping	ArchiCAD Landscaping					
Model Checker / Viewer	ArchiCAD - Solibri	Revit - Solibri	ArchiCAD - Navisworks	Re∨it - Navisworks	DDS IFC Viewer	Octaga
Model Viewer						
Visualization	Simurban	Form-Z	VIZ			
Sustainability	ArchiCAD - Ecotect	Revit - Ecotect	ArchiCAD - LCADesign	Re∨it - LCADesign	ArchiCAD - IES	Revit - IES
4D Construction Scheduling	ArchiCAD - A3D	Revit - A3D	ArchiCAD - Navisworks	Re∨it - Navisworks	Constructor	
External works						
Civil	<u>12D</u>					
Fabrication						
Model Servers						
	Spearpoint (NZ) Fire					
Fire	Simulator					
Interiors						
Product Libraries	BIM World	Omniclass	Natspec?			



6.3 Discipline information requirements

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Architecture																			Τ
		IC	PD) SD	DD) C	DC	N	РС										Т
Required from:	ltem									Hydraulics	Sewer lines								Т
Civil Engineers	Platforms										Access covers								Т
	Roadways										Associated services								T
	Parking										Building drainage								T
	Ground levels										Hot water service								T
	Cut and fill										Downpipe positions								
	Site drainage										Vents								T
											Solar collectors								Τ
Mechanical Engineers	Plant layout outlines										Sprinklers								T
	Vents										Services ducting								T
	Exhausts																		T
	Intakes									Landscape	Paths								Τ
	Plant										Planting beds								Τ
	Ductwork										Furniture								T
	Air ducts										Existing trees								T
	Air returns																		T
										Structural									T
	Ducting									Engineers	Pads								
	Intakes										Piers								Τ
	Plant profile outline										Columns								T
	Ductwork										Joints								T
	Penetrations										Setdowns								Τ
											Access laddes								
Data	Cables										Structural steel details								
	Penetrations																		Τ
										Office Interiors	Furniture layouts								Τ
Electrical Engineers	Cables										Built-in furniture								
	External lighting										Lighting								
	Distribution points on the site plan										Bulkheads on the ceiling plan								Τ
	Distribution points on the floor plan										Bulkheads on the sections								
	Penetrations										Furniture elevations								
	Electrical symbols on the floor plan																		
	Light fittings																		Τ
												IC	PD	SD	DD	CD	CN	PC	
	Electrical symbols on the ceiling plan																		
	Alarms									QS	Assembly Code								
											Elemental Code								
Fire	External alarm panels																		
	Alarms																		
	Detectors									FM	Fields to populate								



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<u>6. Appendices</u>

6.4 BIM Objects Data requirements

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	Site										
	Space										
	Building Storey										
	Real Property										
	Wall										
	Curtain wall										
	Building										
	Window										
	Skylight										
	Door										
	Opening										
	Recess										
	Slab										
	Roof slab										
	Roof										
	Column										
	Beam										
	Stair										
	Railing										
	Parametric object										
	Non-BIM tools										
	Area object										
	Surface object										
	Mass/volume object										
- 11				 	 						



Where are we up to:

- This 'First Draft' of National Guidelines
- Case Studies approximately 25% complete
- CRC for Construction-Innovation website for updated versions of the Guidelines

www.construction-innovation.info

- Welcome feedback, comments and further discussions
- What have we left out ?
- Want to be on the email list ?
- Want your details available to others on the list ?
- Second round of industry consultations/ presentations in October 2008
- Project to be finalised by December 2008

Information contact: scott.beazley@construction-innovation.info

