



Aalto University  
School of Engineering

**Building Information Modeling  
Digital Design & Construction  
Summer School**

Dates: 7th-15th June, 2016  
Venue: Aalto University, Otaniemi

# Building Information Modeling and use of in Facility Management

2D/3D Models, Data Management, Maintenance, Analytics..

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# Outline

What does Facility Management (FM) covers in project lifecycle?

What are the information requirements for FM?

COBie (Constructions Operations Building Information Exchange) standard

Is BIM sufficient for FM? What can it provide for FM or COBie?

Evaluation of COBie in terms of usability

Linked and Graph Data modeling examples for FM

VisuaLynk Demonstration for COBie dataset



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# Background

**Istanbul Kultur University** - Civil Engineering (2004-2009)



ISTANBUL KÜLTÜR UNIVERSITY

**Illinois Institute of Technology**, Chicago

Construction Engineering and Management (2009-2011)

**Effects of BIM on Construction Management Practices**

 Armour College of Engineering  
ILLINOIS INSTITUTE OF TECHNOLOGY

## Mall of Istanbul Project

Technical Office and Site Engineering (2+ Years)

**Tendering, Purchase, Scheduling, Budget, Quality Control**

 MALL OF  
İSTANBUL  
TÜRKİYE'NİN ALIŞVERİŞ MERKEZİ  
THE SHOPPING MALL  
THE RESIDENCE  
THE OFFICE  
THE HOTEL (Proje Aşamasında)

## Aalto University - Civil Engineering

Information Technologies in Construction (2013 - ??)

**BIM-based Facility Management,**

**Internet of Things**

**Semantic Web**

**Software Development**

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## Definitions for Facility Management

**Facilities Management** as the practice of coordinating the physical **workplace** with people and work of an **organisation**.

**Facilities Management** as a management process, which includes analytical and systematic approaches used to determine and deliver the agreed levels of **service** activities that are required to **manage, operate,** maintain and support a facility.

**Facilities Management** as the practice of coordinating the physical workplace with people and work of an **organisation**

**Facilities Management** as the discipline of planning, designing, constructing and **managing** space, in every type of structure, from office building to process plant

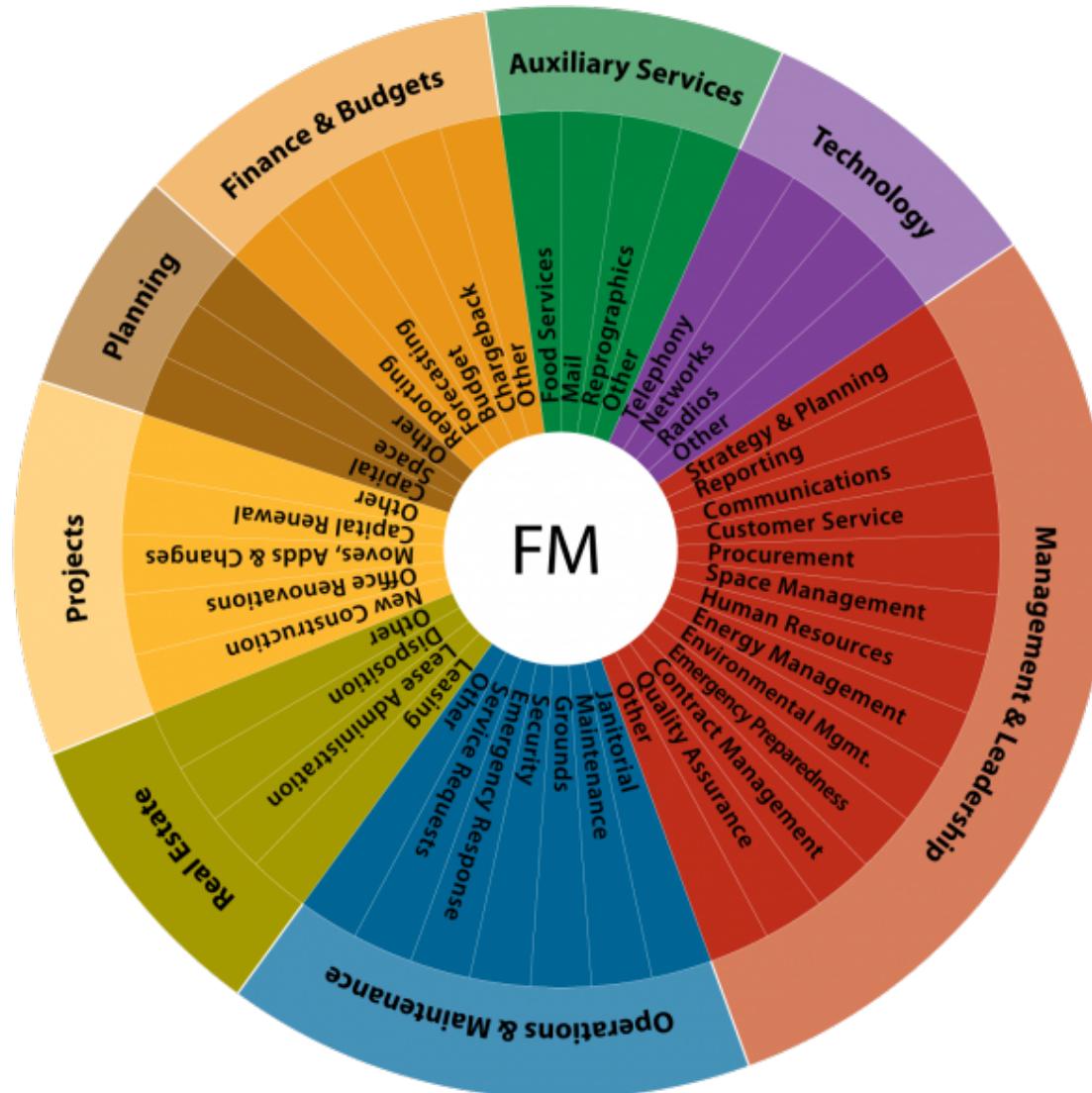
## Definitions for Facility Management

### Almost each definition in literature



FM is an umbrella term which brings together a wide range of issues of a facility for the benefits of the organisations achieving efficiency and effectiveness at an optimal combination of cost, quality and time

## What does Facility Management (FM) covers in project lifecycle?



What are the information requirements for FM?

## Which information do you need?

Owners

Operations

Facility Managers

Technicians

Quality Inspectors

Service Providers

**Give me everything !!**

## What are the information requirements for FM?



What are the information requirements for FM?

**Information requirements should be carefully defined**

**Defined Information should be clearly categorised**

**Categorized information should easily be used**

## What are the information requirements for FM?

**Information requirements should be carefully defined**

**Associations, Unions, Organizations.. and their Standardisation efforts**

The development has started with NIBS FM and Operations Committee with an extensive review of literature and industry focusing on two aspects:

**Determine** the useful minimum of

Information Requirements

Responsible Actors

Lifecycle Phases

**Define** the data exchange standards to

Eliminate the inefficiencies

**Lifecycle** phases were evaluated for

Business Cases

Data Handover Plans

Implementation with Software

## What are the information requirements for FM?

**Information requirements should be carefully defined**

**Associations, Unions, Organizations.. and their Standardisation efforts**

**Association** efforts played a vital role

**MIMOSA**- Machinery Information Management Open Systems Alliance published

Open Systems Architecture for

Enterprise Application Integration (OSA-EAI)

Condition-Based Maintenance (OSA-CBM)

Describes how to integrate asset information and how to transfer to the related system

**IAI** - International Alliance for Interoperability (buildingSMART)

**IFC**- Industry Foundation Classes open-source framework for exchange of facility information

Describes the majority of Component, System, Ownership, Process of digital facility

## What are the information requirements for FM?

**Information requirements should be carefully defined**

**Associations, Unions, Organizations.. and their Standardisation efforts**

**Practices of Public Sector**

**NAVFAC- US Naval Facilities Engineering Command eOMSI - Operations and Maintenance Support Information**

An Information Package includes key information produced during design, construction and commissioning of a facility

<p>Facility Information</p> <p>Primary Systems Information</p> <p>Product Data</p> <p>Delivered in a <b>Spreadsheet File</b></p>
--

SAMPLE KTR FACILITY DATA FILE							
Each facility component or piece of equipment will be a new row. Refer to Model & Facility Data Matrix for guidance on which fields are applicable to specific components & equipment.							
Position	1 Asset/Item	2 Description	3 Long Description	4 Master System	5 System	6 Sub-System	7 Building Number
Explanation	Identification used by KTR to uniquely identify assets or components in a facility	Primary Asset Name (100 Character Limit) To be completed by KTR	Additional Relevant Information (100 Character Limit) To be completed by KTR	Reference values from Model & Facility Data Matrix tab (SYSTEM)	Reference values from Model & Facility Data Matrix tab (SYSTEM)	Reference values from Model & Facility Data Matrix tab (SUBSYSTEM)	Current Building # in renovation work. Will be provided by GVT for new construction
6	BA220163	FOUNDATIONS, WALL FOOTINGS	A10 - FOUNDATIONS	A101010 - STANDARD FOUNDATIONS	A101010 - STRIP FOOTINGS	V/HY-312	
7	BA220164	FOUNDATIONS, STRUCTURAL SLAB ON GRADE	A10 - FOUNDATIONS	A103020 - PLAIN/REINFORCED	V/HY-312		
8	BA2201641	BASEMENT WALL CONSTRUCTION	A20 - BASEMENT CONSTRUCT	A202010 - CP CONCRETE WALLS	V/HY-312		
9	BA2201642	FLOORING, CONCRETE SLAB, PLATE	B10 - SUPERSTRUCTURE	B101010 - CONCRETE FLOOR CONSTRUCTION	B101010 - CONCRETE BEAM AND COLUMN	V/HY-312	
10	BA2201644	WOOD STRUCTURAL FRAME	B10 - SUPERSTRUCTURE	B103010 - ROOF CONSTRUCTION	B103010 - WOOD DECK AND PAFTER	V/HY-312	
11	BA2201645	STEEL STRUCTURAL FRAME	B10 - SUPERSTRUCTURE	B1020 - ROOF CONSTRUCTION	B102010 - STEEL DECK, BEAMS AND B.	V/HY-312	
12	BA2201645	ROOF CONSTRUCTION, CONCRETE STRUCTURE	B10 - SUPERSTRUCTURE	B1020102 - CP CONCRETE ROOF CONS	V/HY-312		
13	BA2201646	EXTERIOR WALLS, BRICK	B20 - EXTERIOR ENCLOSURE	B201010 - SOLID BRICK - SINGLE V/HY-312			
14	BA2201647	EXTERIOR WALLS, STUCCO	B20 - EXTERIOR ENCLOSURE	B2010104 - STUCCO ADDING V/HY-312			
15	BA2201647	EXTERIOR WALLS, STUCCO	B20 - EXTERIOR ENCLOSURE	B2010105 - STUCCO V/HY-312			
16	BA2201651	EXTERIOR WINDOWS (BA2201536)	B20 - EXTERIOR ENCLOSURE	B2020102 - WOOD WINDOWS	V/HY-312		
17	V/HY-312-01	EXTERIOR WINDOWS, ALUMINUM	B20 - EXTERIOR ENCLOSURE	B2020102 - EXTERIOR GLAZED OPENINGS	B2020105 - ALUMINUM WINDOWS	V/HY-312	
18	BA2201653	DOORS, EXTERIOR METAL DOOR	B20 - EXTERIOR ENCLOSURE	B203010 - EXTERIOR DOORS	B2030101 - METAL DOORS	V/HY-312	
19	BA2201654	ROOF, BULKHEAD	B20 - EXTERIOR ENCLOSURE	B204010 - ROOF, BULKHEAD	B2040101 - BULKHEAD	V/HY-312	
20	BA2201657	INTERIOR PARTITIONS - CMU WALLS	C10 - INTERIOR CONSTRUCTION	C100100 - PARTITION	C1001002 - CONCRETE BLOCK	V/HY-312	
21	BA2201655	INTERIOR PARTITIONS - FRAMED WALLS	C10 - INTERIOR CONSTRUCTION	C1010 - PARTITIONS	C101010 - DRYWALL V/HY-312		
22	BA2201660	DOORS, INTERIOR METAL	C10 - INTERIOR CONSTRUCTION	C1020 - INTERIOR DOORS	C1020114 - METAL DOOR	V/HY-312	
23	BA2201659	DOORS, INTERIOR WOOD	C10 - INTERIOR CONSTRUCTION	C1020 - INTERIOR DOORS	C1020100 - WOOD DOOR/WOOD FRAME	V/HY-312	
24	BA2201661	DOORS, INTERIOR GLAZED	C10 - INTERIOR CONSTRUCTION	C1020 - INTERIOR DOORS	C1020100 - WOOD DOOR/WOOD FRAME	V/HY-312	
25	V/HY-312-02	WALL FINISHES, WALL COVERINGS	C30 - INTERIOR FINISHES	C3010 - WALL FINISHES	C301010 - WALL COVERING	V/HY-312	
26	V/HY-312-03	WALL FINISHES, TILE	C30 - INTERIOR FINISHES	C3020 - WALL FINISHES	C302010 - TILE	V/HY-312	
27	BA2201667	FLOORING, CARPET	C30 - INTERIOR FINISHES	C3020 - FLOORING	C3020101 - CARPET	V/HY-312	
28	BA2201668	FLOORING, RESILIENT	C30 - INTERIOR FINISHES	C3020 - FLOORING	C3020103 - COMPOSITION SHEET	V/HY-312	
29	BA2201669	FLOORING, TILE	C30 - INTERIOR FINISHES	C3020 - FLOORING	C3030101 - VINYL/CEMENT/	V/HY-312	
30	BA2201665	CEILING, CEILINGS, WALL / GYPSUM BOARD	C30 - INTERIOR FINISHES	C3030 - CEILING FINISHES	C3030101 - DRIP/VINYL	V/HY-312	
31	BA2201663	CEILING, TILE	C30 - INTERIOR FINISHES	C3030 - CEILING FINISHES	C3030120 - ACOUSTICAL	V/HY-312	
32	BAN00000355	PASSENGER ELEVATORS	D10 - CONVEYING	D1010 - ELEVATORS AND LIFTS	D101010 - HYDRAULIC ELEVATORS	V/HY-312	

## What are the information requirements for FM?

Information requirements should be carefully defined

**Result ?? Standards and Guidelines**



**GUIDELINES**



## What are the information requirements for FM?

Information requirements should be carefully defined

**Result ?? Standards and Guidelines**



**GUIDELINES**



## What are the information requirements for FM?

Information requirements should be carefully defined

What they suggest ?

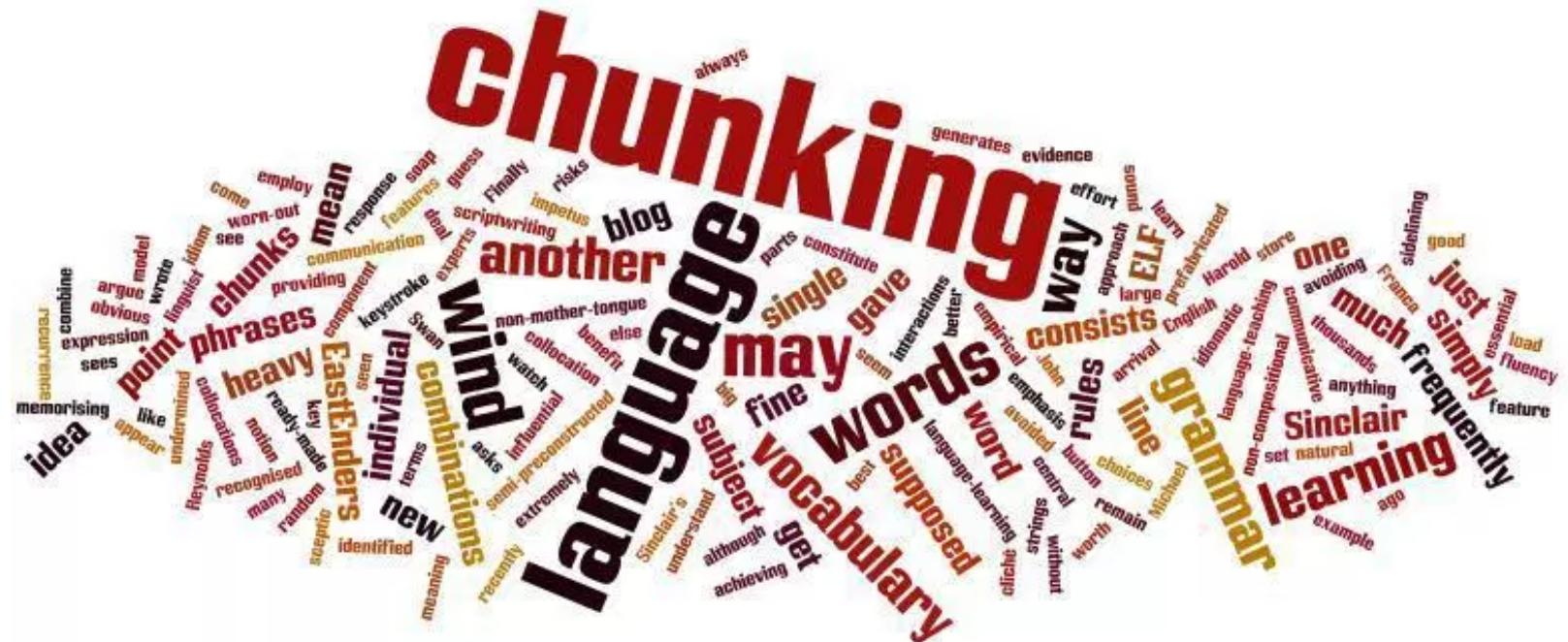
Give me %80-%90 of  
everything !!

Standards should be there, and should be applied but what  
happens when there are many of them on the same topic?

## What are the information requirements for FM?

**Information requirements should be carefully defined**

# The result becomes a big chunk





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## What are the information requirements for FM?

Information requirements should be carefully defined

How did industry try to get rid of this chunk ?

Another Standard :)

## COBie (Construction Operations Building information exchange)

COBie is a **standard** and **data format** for the publication of a **subset of building model** information focused on **delivering building information not geometric modeling**. It is closely associated with **BIM approaches** to design, construction and management of built assets.

The development has started with NIBS FM and Operations Committee with an extensive review of literature and industry focusing on two aspects:

**Determine** the useful minimum of

Information Requirements  
Responsible Actors  
Lifecycle Phases

**Define** the data exchange standards to

Eliminate the inefficiencies

**Lifecycle** phases were evaluated for

Business Cases  
Data Handover Plans  
Implementation with Software

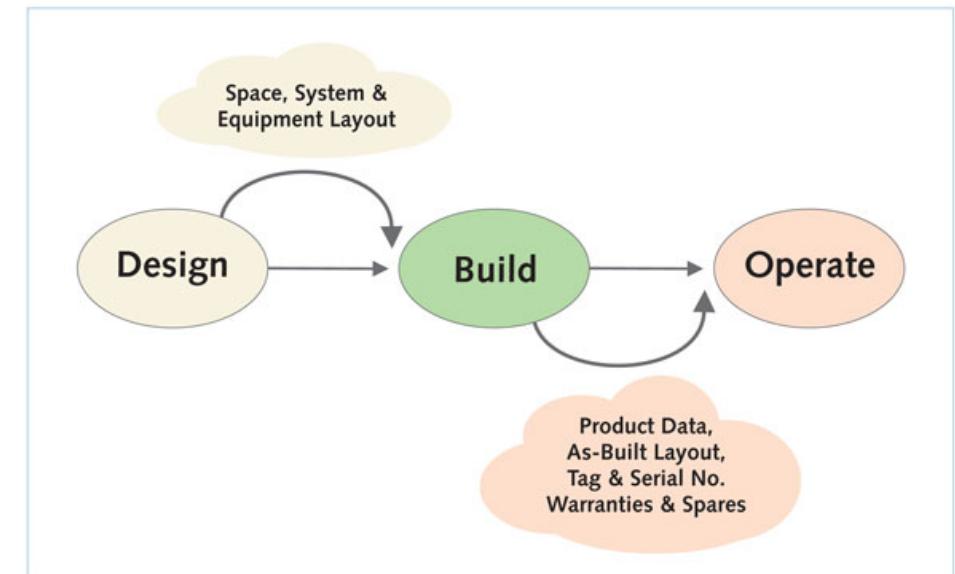
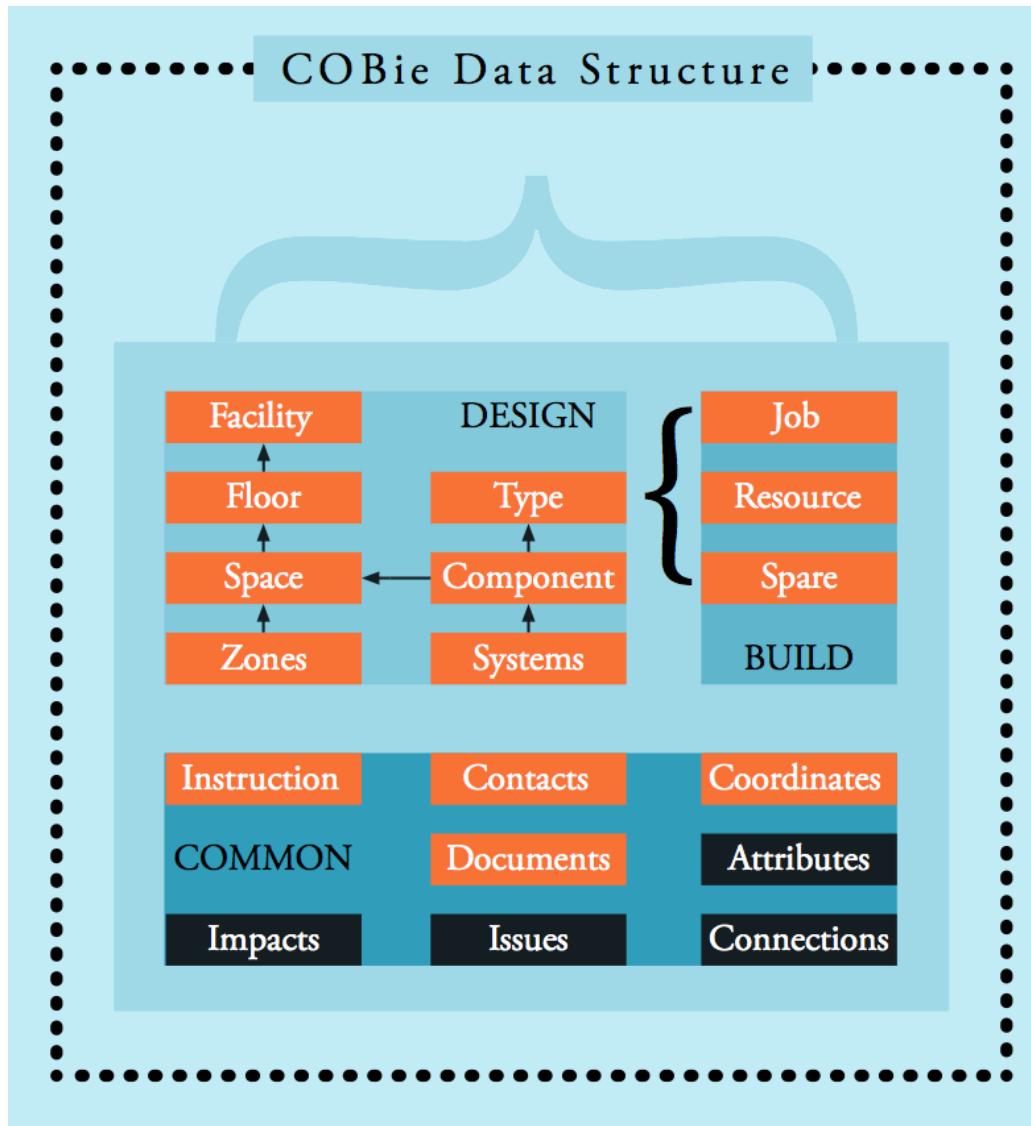
**12** published data exchange standards for process industry were reviewed to identify:

Equipment  
Process  
Systems

Procurement  
Systems  
Operations  
Management

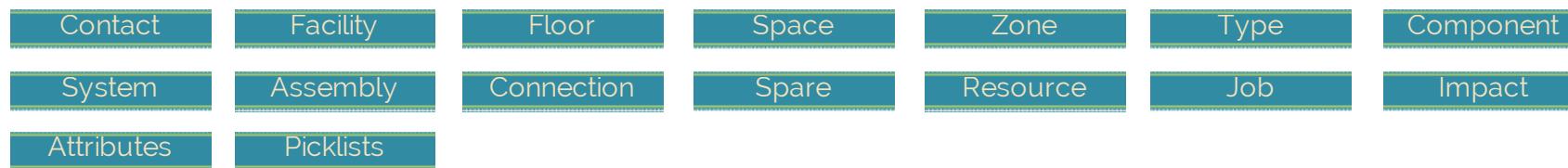
for development of **COBie**

## COBie (Construction Operations Building information exchange)



## COBie (Construction Operations Building information exchange)

Name	CreatedBy	CreatedOn	TypeName	Space	Description	ExtSystem	ExtObject	ExtIdentifier	SerialNumber
2 TFT Monitor:TFT Monitor:TFT Monitor:211812	johnston@brydenwood.c	2012-01-19T12:27:24	TFT Monitor	L0-01A	TFT Monitor:TFT Monitor:TFT Monitor:211812	Autodesk Revit Architecture 20	IfcBuildingElementPro	3c8cy7GE	n/a
3 Mirror:Mirror:Mirror:211825	johnston@brydenwood.c	2012-01-19T12:27:24	Mirror	L0-01A	Mirror:Mirror:Mirror:211825	Autodesk Revit Architecture 20	IfcBuildingElementPro	3c8cy7GE	n/a
4 TFT Monitor:TFT Monitor:TFT Monitor:211790	johnston@brydenwood.c	2012-01-19T12:27:24	TFT Monitor	L0-02B	TFT Monitor:TFT Monitor:TFT Monitor:211790	Autodesk Revit Architecture 20	IfcBuildingElementPro	3c8cy7GE	n/a
5 Mirror:Mirror:Mirror:211826	johnston@brydenwood.c	2012-01-19T12:27:24	Mirror	L0-02B	Mirror:Mirror:Mirror:211826	Autodesk Revit Architecture 20	IfcBuildingElementPro	3c8cy7GE	n/a
6 Generic Int DD:1810 x 2110mm:1810 x 2100mm:211798	johnston@brydenwood.c	2012-01-19T12:27:24	1810 x 2110mm	L0-C01	Generic Int DD:1810 x 2100mm:1810 x 2110mm:211798	Autodesk Revit Architecture 20	IfcDoor	3c8cy7GE	n/a
7 Generic Int D Cell Door:790 x 2110mm:3:211813	johnston@brydenwood.c	2012-01-19T12:27:24	790 x 2110mm 3	L0-02B	Generic Int D Cell Door:790 x 2110mm:3:790 x 2110mm:3:211813	Autodesk Revit Architecture 20	IfcDoor	3c8cy7GE	n/a
8 Generic Int D Cell Door:790 x 2110mm:3:211813	johnston@brydenwood.c	2012-01-19T12:27:24	790 x 2110mm 3	L0-01A	Generic Int D Cell Door:790 x 2110mm:3:790 x 2110mm:3:211813	Autodesk Revit Architecture 20	IfcDoor	3c8cy7GE	n/a
9 Plumbing SVP 1:Plumbing SVP 1:211824	johnston@brydenwood.c	2012-01-19T12:27:24	Plumbing SVP 1	L0-C01	Plumbing SVP 1:Plumbing SVP 1:211824	Autodesk Revit Architecture 20	IfcFlowTerminal	3c8cy7GE	n/a
10 WC Pan:510 x 510mm:510 x 510mm:211788	johnston@brydenwood.c	2012-01-19T12:27:24	WC Pan 510 x 510mm	L0-01A	WC Pan:510 x 510mm:510 x 510mm:211788	Autodesk Revit Architecture 20	IfcFlowTerminal	3c8cy7GE	n/a
11 Wallgate ALS180 Basin:470w x 300d x 470h x 300d:211813	johnston@brydenwood.c	2012-01-19T12:27:24	Wallgate ALS180 Basin 470w x 300d x 470h x 300d:211813	L0-02A	Wallgate ALS180 Basin:470w x 300d x 470h x 300d:211813	Autodesk Revit Architecture 20	IfcFlowTerminal	3c8cy7GE	n/a
12 WC Pan:510 x 510mm:2:510 x 510mm:2:211807	johnston@brydenwood.c	2012-01-19T12:27:24	WC Pan 510 x 510mm	L0-02B	WC Pan:510 x 510mm:2:510 x 510mm:2:211807	Autodesk Revit Architecture 20	IfcFlowTerminal	3c8cy7GE	n/a
13 Wallgate ALS180 Basin:470w x 300d x 470h x 300d:211805	johnston@brydenwood.c	2012-01-19T12:27:24	Wallgate ALS180 Basin 470w x 300d x 470h x 300d:211805	L0-02B	Wallgate ALS180 Basin:470w x 300d x 470h x 300d:211805	Autodesk Revit Architecture 20	IfcFlowTerminal	3c8cy7GE	n/a
14 Cell Bed Family:Cell Bed family:Cell Bed family:211786	johnston@brydenwood.c	2012-01-19T12:27:24	Cell Bed family	L0-01A	Cell Bed Family:Cell Bed family:Cell Bed family:211786	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
15 Cell Desk:Desk Whitewood:Desk Whitewood:211787	johnston@brydenwood.c	2012-01-19T12:27:24	Desk Whitewood	L0-01A	Cell Desk:Desk Whitewood:Desk Whitewood:211787	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
16 Cell Locker:Cell Locker:Cell Locker:211789	johnston@brydenwood.c	2012-01-19T12:27:24	Cell Locker	L0-01A	Cell Locker:Cell Locker:Cell Locker:211789	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
17 Safer Seat:Safer Seat:Safer Seat:211791	johnston@brydenwood.c	2012-01-19T12:27:24	Safer Seat	L0-01A	Safer Seat:Safer Seat:Safer Seat:211791	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
18 Safer Seat:Safer Seat:Safer Seat:211803	johnston@brydenwood.c	2012-01-19T12:27:24	Safer Seat	L0-02B	Safer Seat:Safer Seat:Safer Seat:211803	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
19 Cell Bed Family:Cell Bed family:Cell Bed family:211804	johnston@brydenwood.c	2012-01-19T12:27:24	Cell Bed family	L0-02B	Cell Bed Family:Cell Bed family:Cell Bed family:211804	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
20 Cell Desk:Desk Whitewood:Desk Whitewood:211805	johnston@brydenwood.c	2012-01-19T12:27:24	Desk Whitewood	L0-02B	Cell Desk:Desk Whitewood:Desk Whitewood:211805	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
21 Cell Locker:Cell Locker:Cell Locker:211806	johnston@brydenwood.c	2012-01-19T12:27:24	Cell Locker	L0-02B	Cell Locker:Cell Locker:Cell Locker:211806	Autodesk Revit Architecture 20	IfcFurnishingElement	3c8cy7GE	n/a
22 Basic Wall:Generic Ext - 150mm:211792	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-01A, L0-02B	Basic Wall:Generic Ext - 150mm:211792	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
23 Basic Wall:Generic Ext - 150mm:211793	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-01A, L0-02B	Basic Wall:Generic Ext - 150mm:211793	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
24 Basic Wall:Generic Ext - 150mm:211794	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-01A, L0-02B	Basic Wall:Generic Ext - 150mm:211794	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
25 Basic Wall:Generic Ext - 150mm:211795	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-01A, L0-02B	Basic Wall:Generic Ext - 150mm:211795	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
26 Basic Wall:Generic Ext - 150mm:211796	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-02B	Basic Wall:Generic Ext - 150mm:211796	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
27 Basic Wall:Generic Ext - 150mm:211797	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-02B	Basic Wall:Generic Ext - 150mm:211797	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
28 Basic Wall:Generic Ext - 150mm:211799	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-01A	Basic Wall:Generic Ext - 150mm:211799	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
29 Basic Wall:Generic Ext - 80mm:211800	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 80mm	L0-01A	Basic Wall:Generic Ext - 80mm:211800	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
30 Basic Wall:Generic Ext - 80mm:211801	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 80mm	L0-02B	Basic Wall:Generic Ext - 80mm:211801	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
31 Basic Wall:Generic Ext - 80mm:211802	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 80mm	L0-02B	Basic Wall:Generic Ext - 80mm:211802	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
32 Basic Wall:Generic Ext - 340mm:2:211809	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 340mm	L0-01A, L0-02B	Basic Wall:Generic Ext - 340mm:2:211809	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
33 Basic Wall:Generic Ext - 150mm:211829	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-01A	Basic Wall:Generic Ext - 150mm:211829	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a
34 Basic Wall:Generic Ext - 150mm:211830	johnston@brydenwood.c	2012-01-19T12:27:24	Basic Wall:Generic Ext - 150mm	L0-02B	Basic Wall:Generic Ext - 150mm:211830	Autodesk Revit Architecture 20	IfcWallStandardCase	3c8cy7GE	n/a



A spreadsheet with 20 workbooks and 100s / 1000s rows of data



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## COBie (Construction Operations Building information exchange)

**Let's have a look how COBie looks like and  
what it includes**

## Is BIM sufficient for FM? What can it provide for FM or COBie?

COBie is a solution **X**

COBie is BIM-based solution **XX**

**COBie is a standard**

**COBie is a information structure/framework**

**BIM is a useful modeling platform and also information source**

**But it is generally design and construction oriented**

**FM domain requires more than design and construction data  
which BIM cannot provide.**

## Is BIM sufficient for FM? What can it provide for FM or COBie?

BIM software applications are good sources for in COBie handover

But they are not only information sources

Can BIM software (Revit, ArchiCAD, etc.) provide work order data ?

Can BIM software (Revit, ArchiCAD, etc.) provide maintenance schedule ?

If BIM means only software, No!

BIM is not only software, it is a built environment ecosystem/platform

## Evaluation of COBie in terms of USABILITY

- COBie can be delivered and represented in 3 different formats:



**XML, Extensible Markup Language**



**STEP, IFC file format**



**SpreadsheetML, (MS Excel)**



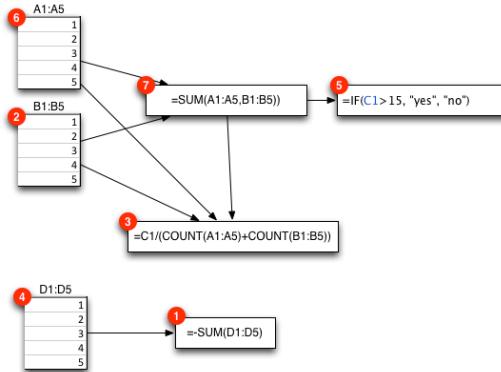
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## Evaluation of COBie in terms of USABILITY

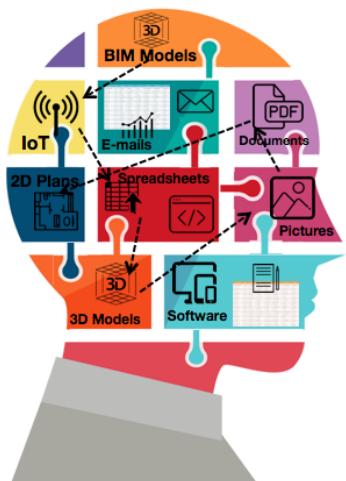
**What's difficult/challenging with COBie  
Spreadsheet?**

## Evaluation of COBie in terms of USABILITY



Navigation is **difficult** in the large spreadsheets like COBie

End-users can **get lost** during searching dependent data in large spreadsheets.



111	451	368	80	46	83	74	29	10	340	301	336	299	317	6,889	4,193	4,932	3,688	1,536	2,44	
439	164	94	54	91	85	40	78	73	232	371	431	411	481	182	198	181	180	184	180	
235	166	172	10	30	62	49	32	31	480	491	467	420	454	182	198	181	180	184	180	
4.433	896	2.132	2.390	3,850	2,175	1,389	2,823	3,528	2,189	2,482	2,179	2,050	2,288	1,920	1,748	2,387	2,939	1,989	2,288	
1.870	2,845	1.001	1.870	2,845	1.001	1.870	2,845	1.001	1.870	2,845	1.001	1.870	2,845	1.001	1.870	2,845	1.001	1.870	2,845	
2.427	1.133	1.308	2.427	1.133	1.308	2.427	1.133	1.308	2.427	1.133	1.308	2.427	1.133	2.427	1.133	2.427	1.133	2.427	1.133	
2.424	2.697	1.710	2.424	1.844	1.725	2.424	2.697	1.710	2.424	1.844	1.725	2.424	2.697	1.710	2.424	1.844	1.725	2.424	2.697	
1.692	1.903	1.442	1.692	1.903	1.442	1.692	1.903	1.442	1.692	1.903	1.442	1.692	1.903	1.442	1.692	1.903	1.442	1.692	1.903	
1.199	2.032	1.198	1.199	2.032	1.198	2.453	1.199	2.032	1.198	2.453	1.199	2.032	1.198	2.453	1.199	2.032	1.198	2.453	1.199	
35	290	92	35	290	92	286	430	158	35	290	92	286	430	158	35	290	92	286	430	
74	243	277	74	243	277	324	249	175	74	243	277	324	249	175	74	243	277	324	249	
194	301	175	194	301	175	354	301	175	194	301	175	354	301	175	194	301	175	354	301	
17	3,809	2,432	17	3,809	2,432	1,988	6,303	545	17	3,809	2,432	1,988	6,303	545	17	3,809	2,432	1,988	6,303	545
35	299	158	35	299	158	324	301	175	35	299	158	324	301	175	35	299	158	324	301	175

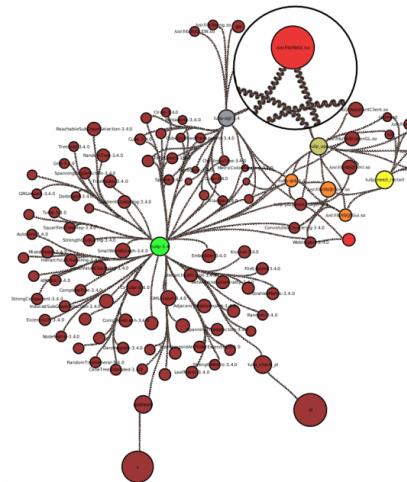
**High cognitive load** due to serially shifting among thousands of data and workbooks.

# Evaluation of COBie in terms of USABILITY



**Finding specific data entity/sets among workbooks is an iterative process.**

The **dependencies** among data entities are **invisible**. It becomes difficult to understand the entire structure of COBie spreadsheet



Spreadsheets usually contain **text and numbers** only

## Enhancement of COBie Data Structure in Usability Perspective

The **primary objective** of this research is to outline the issues which make COBie data less accessible and usable by users, including inexperienced personnel, who would likely have difficulties in understanding the existing representation of COBie data.

### Design Thinking steps:

Understand, Define, Ideate, Prototype



To keep the problem definition discrete and simple and ideate solution:

**As a user, I ..... , I need to/have to .....**

## Enhancement of COBie Data Structure in Usability Perspective

### As a user,

- *lose my focus while navigating among workbooks. I need a platform in which navigation is easier (interactive).*
- *have difficulty to see the dependent information within workbooks. I need to explicitly see the dependencies of a specific COBie data.*
- *am having difficulty to process COBie data within different workbooks. I need to see all the relevant COBie data and dependencies at an easy and abstract level.*
- *have difficulty in understanding the semantic links among different COBie entities. I need to see my search results in a simplified format.*
- *cannot search a specific data based on its dependencies. I need to be able to find the specific COBie data based on its dependencies.*
- *want to access a specific data entity and its dependencies. I need the functionality that does not force me to navigate repetitively.*
- *want to select the COBie data entity with the 3D BIM model and see selected entity's dependencies. I need a platform in which BIM model and COBie data is mapped with each other*
- *may have duplications when I enter COBie data manually. I need a platform that warns me for duplications and prevents multiple data entries automatically.*

## Enhancement of COBie Data Structure

### VisualCOBie, baby steps of VisuaLynk platform

- Interactive and bi-directional integration with 2D/3D models, direct access data from models
- Explicitly represented relationships/dependencies between the data entities/sets
- Visually represented information instead of pure text and numbers
- Dependency-based dynamic search and query
- Prevents duplication in multiple data entries during handover phase
- Query tracking with dynamically updated natural language results
- Dynamic CRUD (create, read, update, delete) operations on COBie data



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## Enhancement of COBie Data Structure

VisualCOBie, baby steps of VisuaLynk platform

Let's see how COBie looks like in VisuaLynk now

[www.visualynk.com](http://www.visualynk.com)



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## Tomorrow's Challenge !!

**Let's model your profession's data structure.**

Each domain and profession is unique. How do you relate the information entities in your domain? Let's model it !!

Please visit the following site and start to model

<http://www.apcjones.com/arrows/>