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ICSC2015

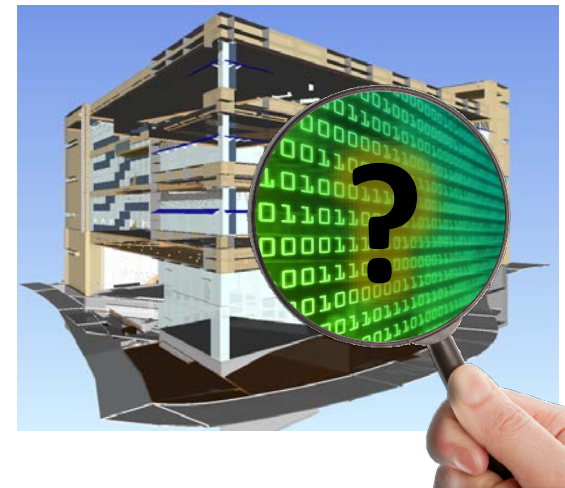
June 10, 2015

# REVIEW OF BIM QUALITY ASSESSMENT APPROACHES FOR FACILITY MANAGEMENT

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# Motivation

- BIM for FM
  - Creating intelligent FM systems out of BIM
- Project handover is essential in information lifecycle
- Deliverables (incl. BIM) must include required information pieces for FM
- Assessing the information quality (IQ) of BIM from FM perspective



# Motivation

- Motivation case study: The Centre for Interactive Research on Sustainability (CIRS)
- Creating FM information system based on delivered BIM → IQ issues
- Challenges:
  - “What” are the typical IQ issues?
  - “Which” IQ characteristics are relevant?
  - “How” to assess these BIM-IQ characteristics?



# Approach

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- Categorization of IQ issues
  - Determining FM and BIM perspectives
  - Creating an analysis framework
- Identification of BIM-IQ characteristics
- Analysis of related literature and assessment approaches



# Determining FM and BIM perspectives

- Interviews, observations and literature review
- Analysis of O&M workflow
- Three key terms for creating intelligent FM information systems:
  - Assets
  - MEP systems
  - Spaces
- BIM perspectives:
  - Entity level
  - Model level
  - User level



# BIM-IQ Analysis Framework for FM

	BIM-IQ Perspectives					
FM Cat.	Entity Level			Model Level		User Level
Asset	Incomplete Assets	Inaccurate Values for Asset Attributes	Inaccurate Asset Placement	Compliance with BIM Standards	Model Clashes	Understandability of Information
MEP Systems	Incomplete MEP Systems	Inaccurate Values for System Definitions	Inaccurate Spatial Allocation of MEP Systems			
Space	Incomplete Spaces	Inaccurate Values for Space Definitions	Inaccurate Space Placement			
Issue Type Categories:	Information Incompleteness	Value Inaccuracy	Spatial Inaccuracy	Model Incompatibility	Uncoordinated Information	Incomprehensible Information



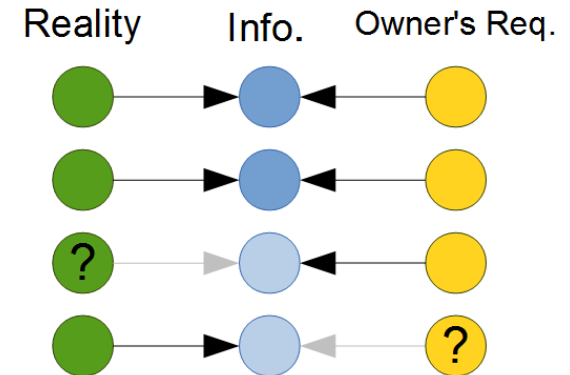
# Information Incompleteness

- Existence of “necessary” information
- 2 types of benchmark
- Challenges:

## 1. What should be checked?

- Assets with central roles in system
- Assets which need frequent maintenance
- Assets that can be remotely monitored and controlled

## 2. How to assess?



# Information Incompleteness

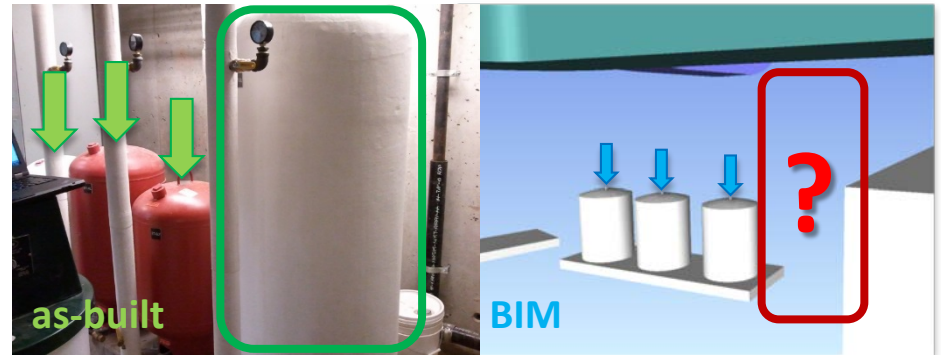
## ■ How to assess?

#	Used Term	General Discussion Topic	Assessment / Assurance	Used Method	Reference	Domain
1	Completeness	Required BIM objects and properties	Assurance	Checklist	(GSA 2011)	AEC
2	Completeness	Value of Information for Facilities Management	Assessment	–	(Kasprzak et al.)	AEC
3	Included Info.	Quality Assurance	Assurance	–	(Kulusjärvi 2012)	AEC
4	Missing Objects	Correctness	Assessment	Survey	(Berard 2012)	AEC
5	Accuracy	Data and Process Requirements	Assurance	Checklist	(Becerik-Gerber et al. 2011)	AEC
6	Data Richness	Minimum BIM	Assurance	–	(National Institute of Building Sciences 2007)	AEC
7	Detailed and Comprehensive	Quality of Laser-Scanned Data	Assessment	Photo Analysis	(Tang et al. 2011)	AEC
8	Completeness	Data Quality	–	–	(Olson 2002)	CS
9	Completeness	Quality of Raw Data	–	–	(Assaf and Senart 2012)	CS
10	Completeness	Data Quality Dimensions	–	–	(Wand and Wang 1996)	CS



# Information Incompleteness

- Existence of entities / objects
- Visual check
  - Walkthroughs
  - Laser-Scanning
- Information takeoff
  - Querying the model
  - Export: COBie, etc.



# Information Incompleteness of MEP Systems

Is every asset assigned to an MEP system?

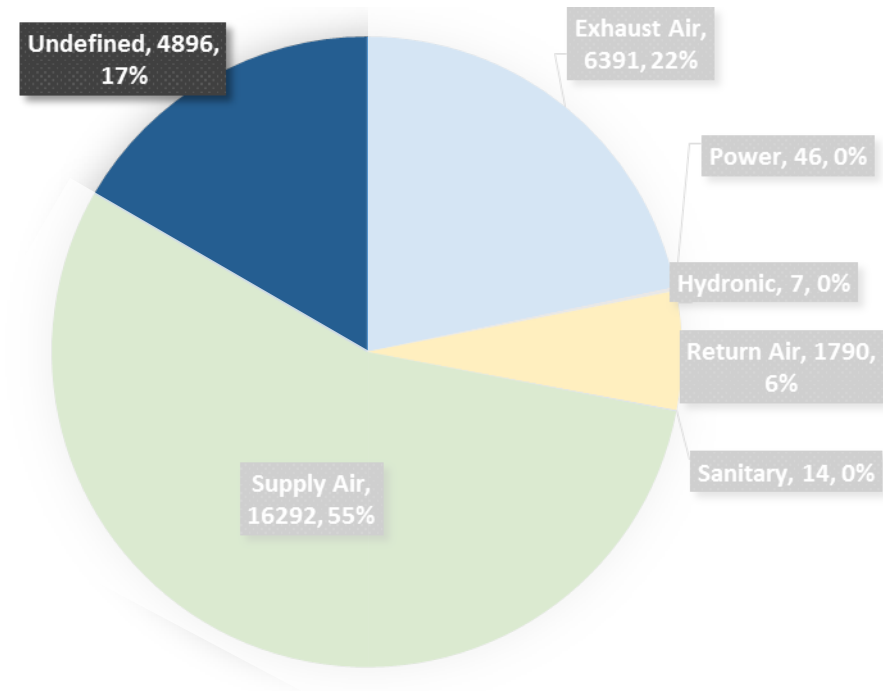
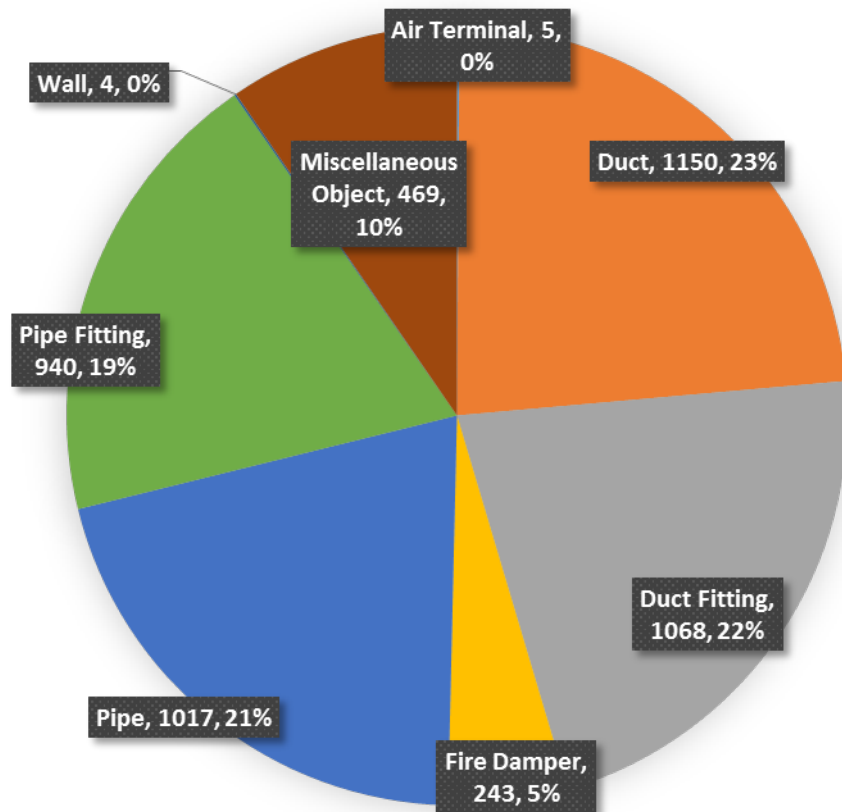
Assigned Assets to an MEP System

#	Used Term	General Discussion Topic	Assessment / Assurance	Used Method	Reference	Domain
1	–	Required BIM objects and properties	Assurance	Checklist	(GSA 2011)	AEC
2	–	System BIM	Assurance	Checklist	(Kulusjärvi 2012)	AEC
3	–	MEP Quality Assurance	Assurance	Checklist	(SBICA 2013)	AEC
4	–	MEPF Specifications	Assurance	Checklist	(USC 2012)	AEC
5	–	–	Assurance	COBie	(BIM Task Group 2012)	AEC



# Information Incompleteness of MEP Systems

Analysis of the system assignments in the Pharmacy building



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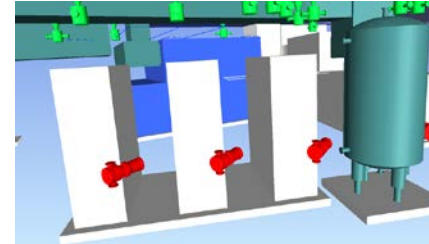
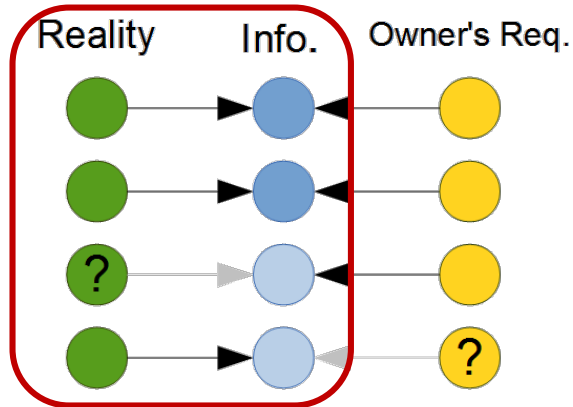
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# Inaccurate Values for Attributes

#	Used Term	General Discussion Topic	Assessment / Assurance	Used Method	Reference	Domain
1	Accuracy	Compliance and Submittals	–	–	(GSA 2011)	AEC
2	Accuracy	Value of Information for Facilities Management	Assessment	–	(Kasprzak et al.)	AEC
3	Unambiguity and Level of Detail	Precision	Assessment	Survey	(Berard 2012)	AEC
4	Accuracy	Quality Assurance	Assurance	Checklist	(SBICA 2013)	AEC
5	Accuracy	Data and Process Requirements	Assurance	Checklist	(Becerik-Gerber et al. 2011)	AEC
6	Accuracy	Minimum BIM	Assurance	–	(National Institute of Building Sciences 2007)	AEC
7	Accuracy	BIM Performance	Assessment	Quantity Takeoff	(Du et al. 2014)	AEC
8	Correctness	Quality Assurance	Assurance	–	(Kulusjärvi 2012)	AEC
9	Accuracy	Quality of Raw Data	–	–	(Assaf and Senart 2012)	CS
10	Accuracy	Data Quality	–	–	(Olson 2002)	CS
11	Accuracy and Precision	Data Quality Dimensions	–	–	(Wand and Wang 1996)	CS



# Inaccurate Values for Attributes



Type Properties

Family: Box-generic Load...

Type: Heat Pump - EW540 Duplicate... Rename...

Type Parameters

Parameter	Value
<b>Identity Data</b>	
Type Comments	MAN
Assembly Code	
<b>Keywords</b>	
Model	
Manufacturer	Siemens
URL	

MODEL: **RWXW360R3PE3NNSB**

S/N: 100602393

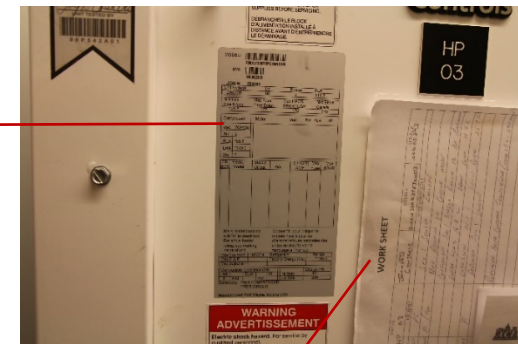
JOB #: 084992

Unit Voltage	Hz	Phase	FLA
208/230	60	3	111.5

Minimum Circuit Amp	Max Fuse Time Delay	Max HACR BRKR (USA)	Max BRKR Canada
125.5	175	175	175

Compressor	Motor	Vac	PH	FLA	HP
Vac	208/230				
PH	3				
RLA	*55.8				
LRA	*340.0				
Qty	2				

CK	Heater Model	Supply Circuit



WORK SHEET

UNIT I.D. HP 03

MECHANIC PS

PS / Tim

MAKE **JOHNSON** CONTROLS

MODEL # RWXW360R3PE3NNSB

SERIAL # 100602393

WORK CARRIED OUT

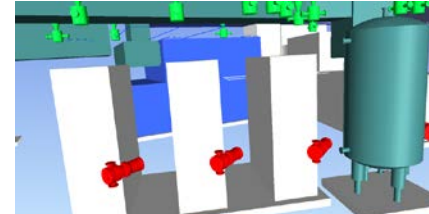
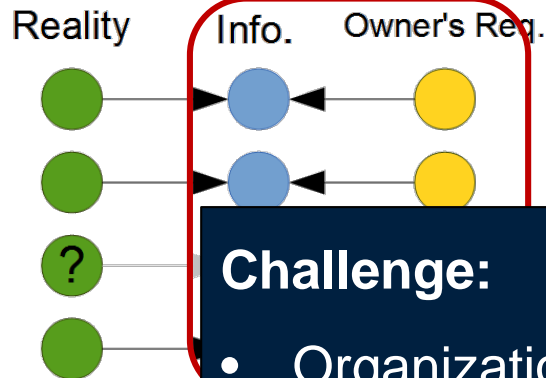
Unit 1 Sensor Failure



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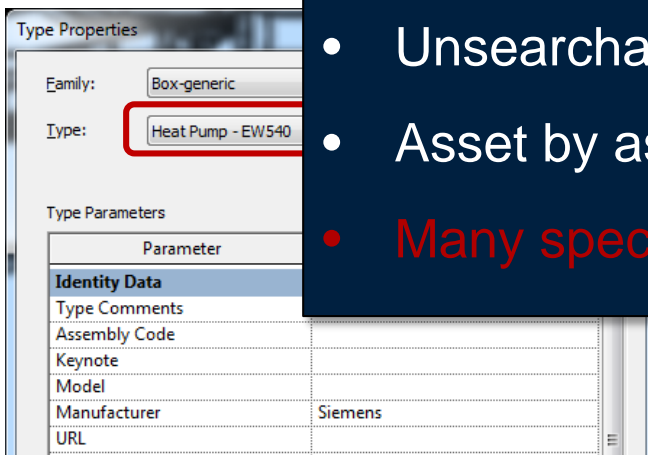
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# Inaccurate Values for Attributes



## Challenge:

- Organization of documents  
(7125 pages, 374 PDFs, 14 folders for CIRS)
- Unsearchable documents
- Asset by asset check is required
- Many specs are part of the name or type



Qty	Description
3	JCI/WaterFurnace Water Source Heat Pump Chillers for geothermal applications Qty 2 Size 540 units, Electrical: 575/3/60v HP-1, HP-2 Qty 1 Size 360 unit Electrical: 1 x 208/3/60v HP-3 Refrigerant: R410A

Page 27

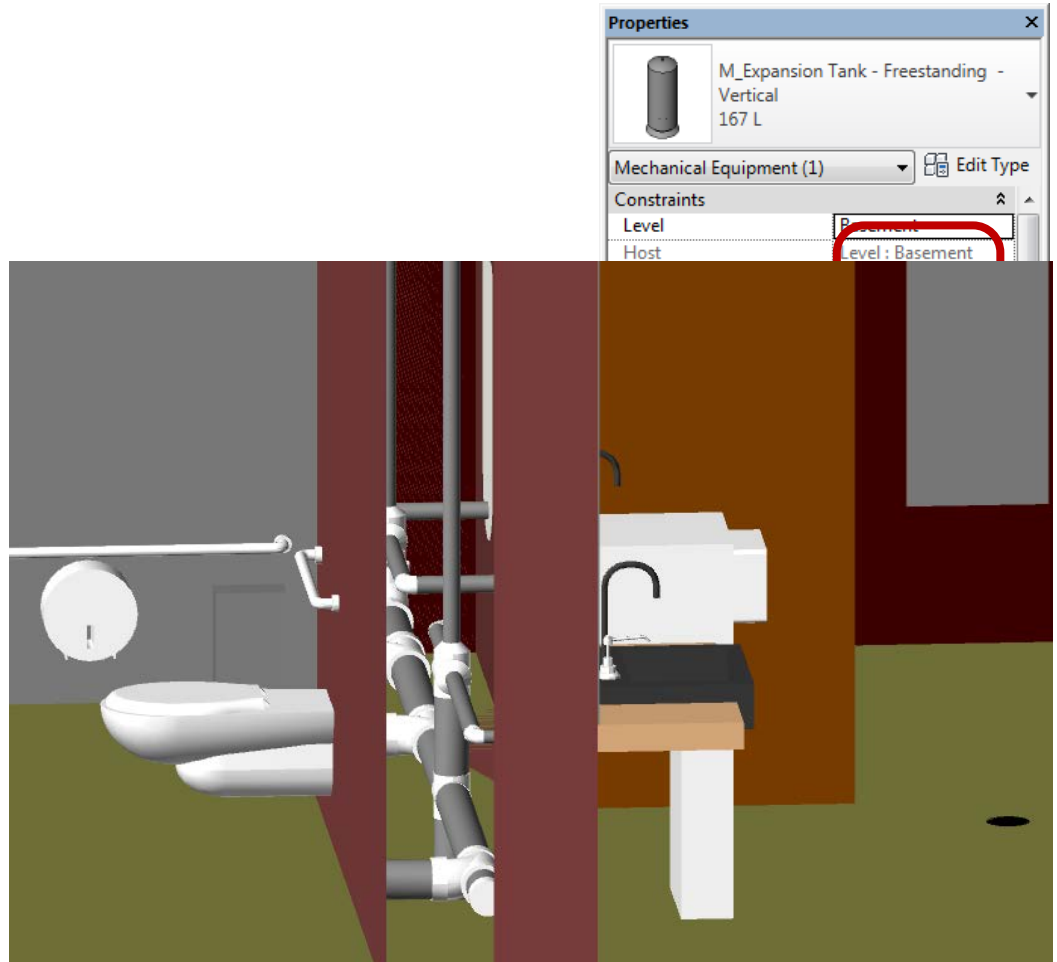


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# Categorization of BIM-IQ Issues for FM

- Entity level:
  - Incompleteness
  - Value Inaccuracy
  - Spatial Inaccuracy

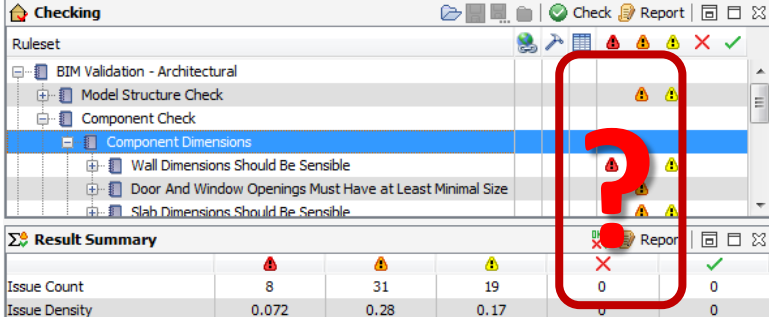




# Categorization of BIM-IQ Issues for FM

## ■ Model level:

- Standards' Incompatibility
- Uncoordinated Model
- Inconsistency

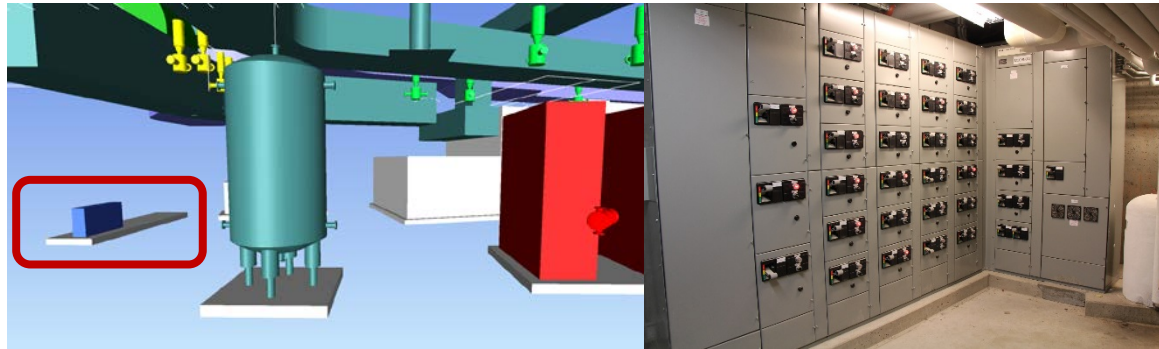


The screenshot shows a 'Checking' window with a 'Ruleset' list and a 'Result Summary' table. A red box highlights a rule with a large red question mark icon.

	Warning	Error	Info	Pass	Fail
Issue Count	8	31	19	0	0
Issue Density	0.072	0.28	0.17	0	0

## ■ User level

- Incomprehensibility
- Inaccessibility





# Conclusion

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- Categorization of IQ issues
  - FM key terms and BIM perspectives
- Identification of BIM-IQ characteristics
- AEC lit. address these issues:
  - Very generic
  - More quality “assurance” than quality “assessment”
  - Issues related to the model semantic have a great research potential
  - Ambiguity in issue identification
  - Concrete assessment approaches are missing





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# Information Incompleteness

- Existence of attributes
  - Using predefined lists
  - For example for an asset:
    - Name
    - location
    - Category / System
    - Manufacturer
    - Model
    - Serial number



Manage Assets

Save Cancel

Asset Image

Images Available for Asset Select an image attachment

Parent Asset Please Select...

Item Name \* AHU-01

Item Description AHU-01

Quantity 1.00

Asset Status Operating

Asset Category \* HVAC

Asset Subcategory Air Handling Unit

Asset Make \* Hunt Air

Asset Model \* IFT-1-2

Serial Number \* S015874-01

Asset Location \*  
1131 SERC  
1151 BC HYDRO  
THEATRE  
MECHANICAL - AHU and PUMPS  
0242



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# Information Accuracy

#	Used Term	General Discussion Topic	Assessment / Assurance	Used Method	Reference	Domain
1	Accuracy	Compliance and Submittals	–	–	(GSA 2011)	AEC
2	Accuracy	Value of Information for Facilities Management	Assessment	–	(Kasprzak et al.)	AEC
3	Unambiguity and Level of Detail	Precision	Assessment	Survey	(Berard 2012)	AEC
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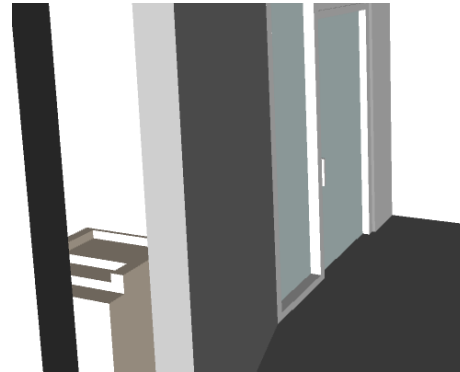
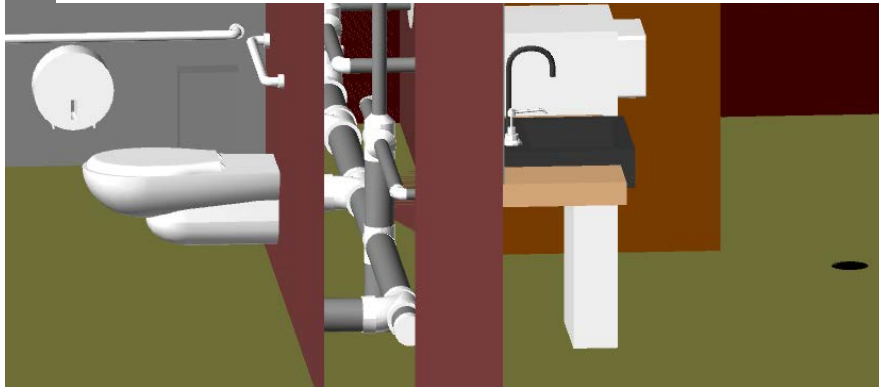
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# Spatial Inaccuracy: Asset- Space Issues



- Where is an asset?
- Inaccurate Asset Placement

#	Used Term	General Discussion Topic	Assessment / Assurance	Used Method	Reference	Domain
1	Spatial relationship	Visual Analytics for FM	–	–	(Asen et al. 2012)	AEC
2	–	Quality Assurance	Assurance	Checklist	(SBCA 2013)	AEC
3	Spatial BIM	BIM Requirements	Assurance	Checklist	(Kulusjärvi 2012)	AEC



# Served Spaces by an Asset or a System

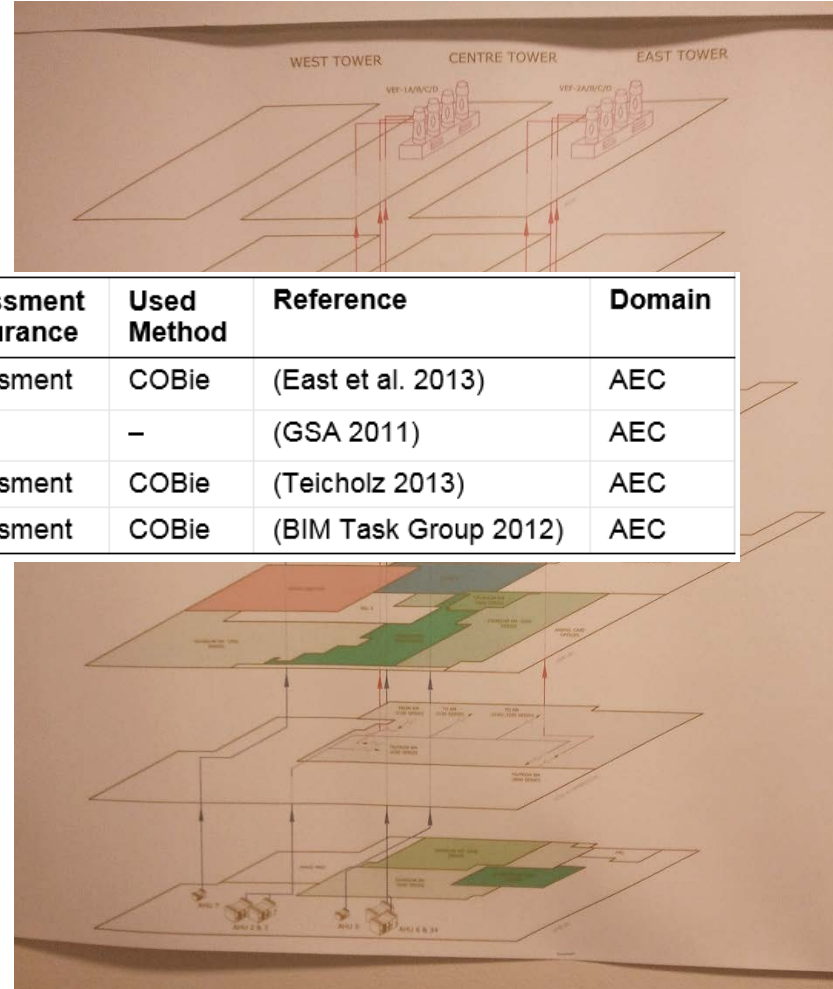


## ■ Challenges:

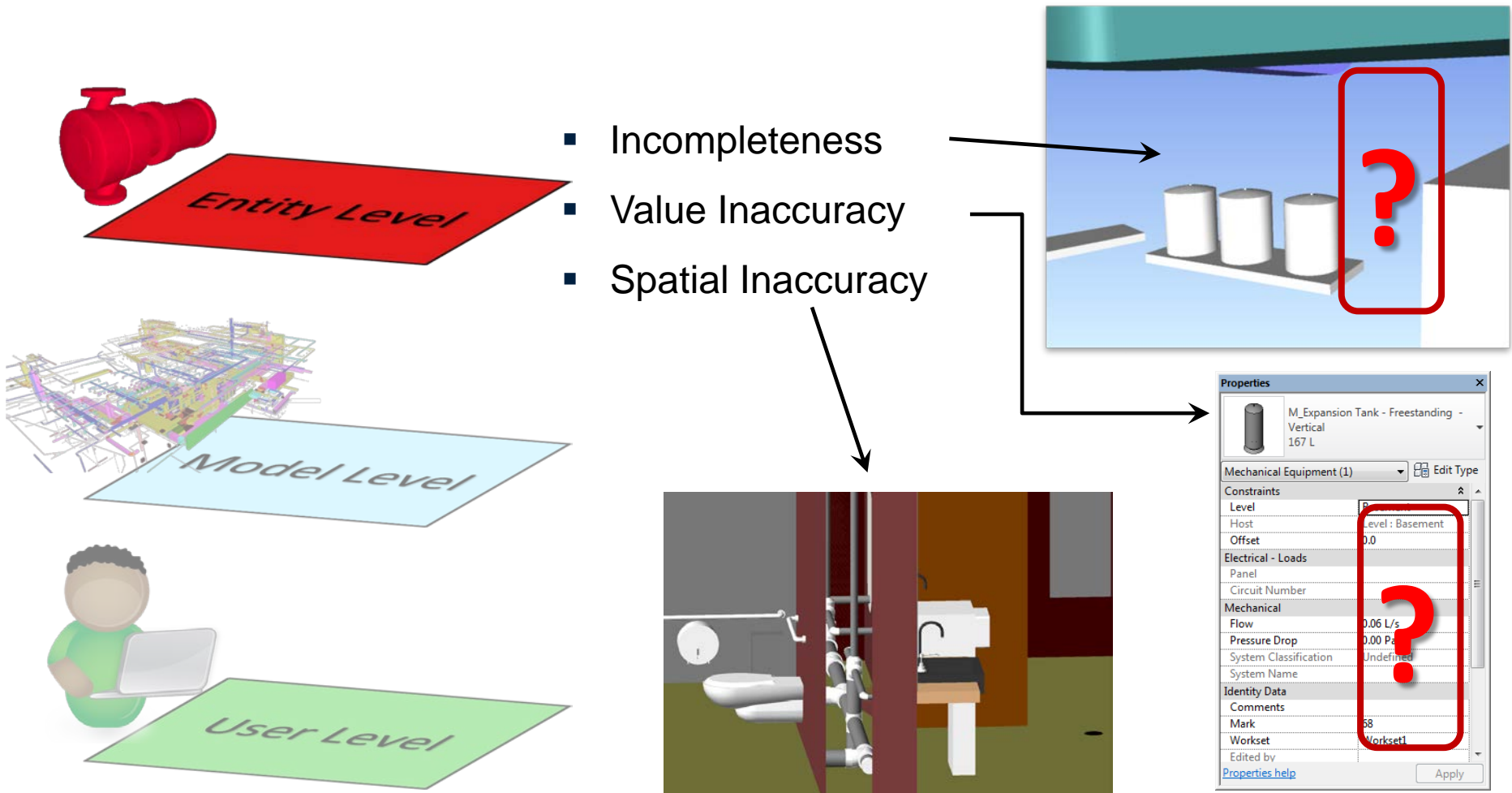
### ■ No direct asset-space connection

#	Used Term	General Discussion Topic	Assessment / Assurance	Used Method	Reference	Domain
1	Served zones	FM Handover Model	Assessment	COBie	(East et al. 2013)	AEC
2	Served area	BIM for FM	–	–	(GSA 2011)	AEC
3	Zoning	COBie.Zone	Assessment	COBie	(Teicholz 2013)	AEC
4	–	Operation and Maintenance Information	Assessment	COBie	(BIM Task Group 2012)	AEC

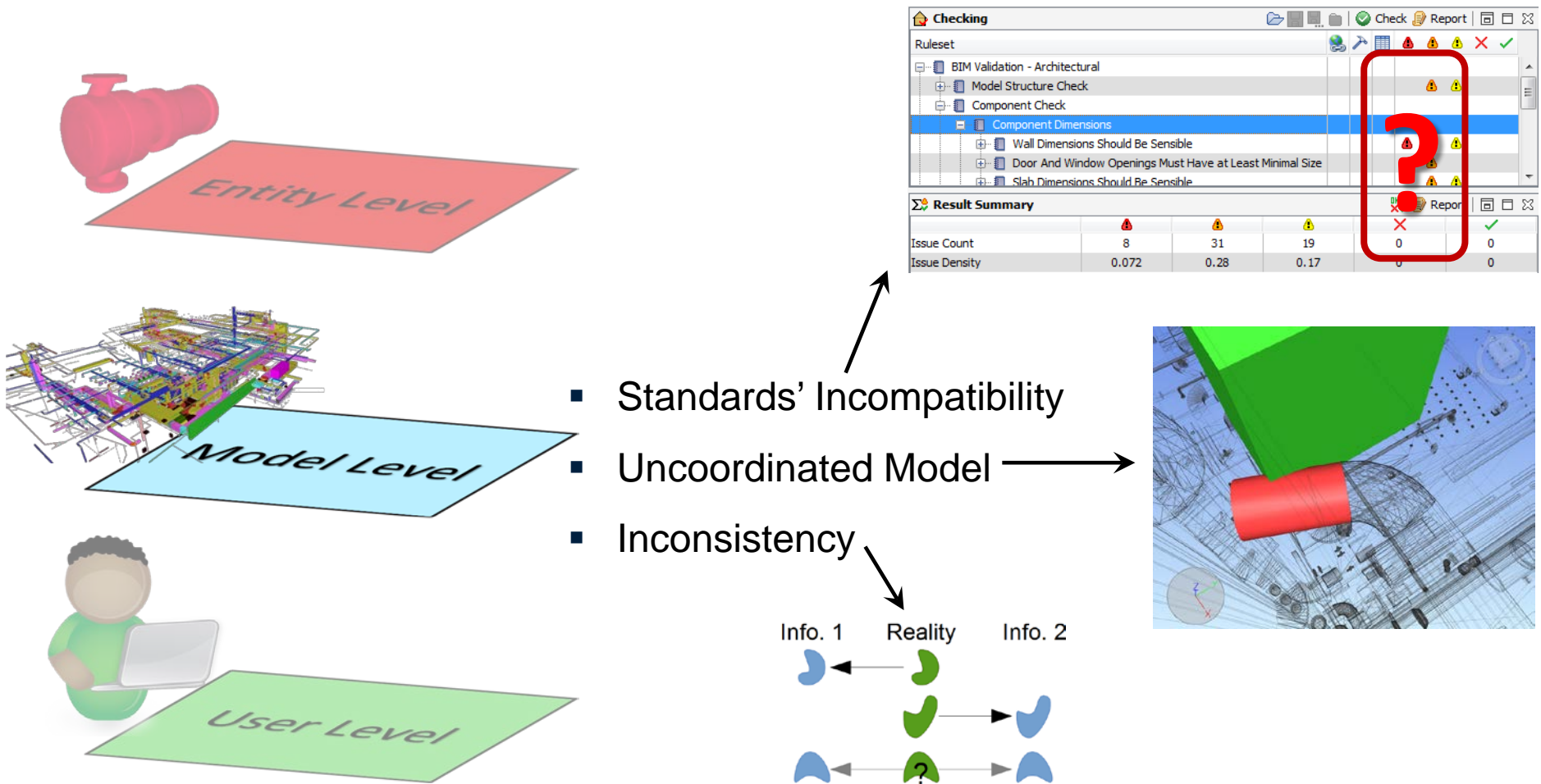
### ■ Identification of systems that connect the asset and served space



# Categorization of BIM-IQ Issues for FM

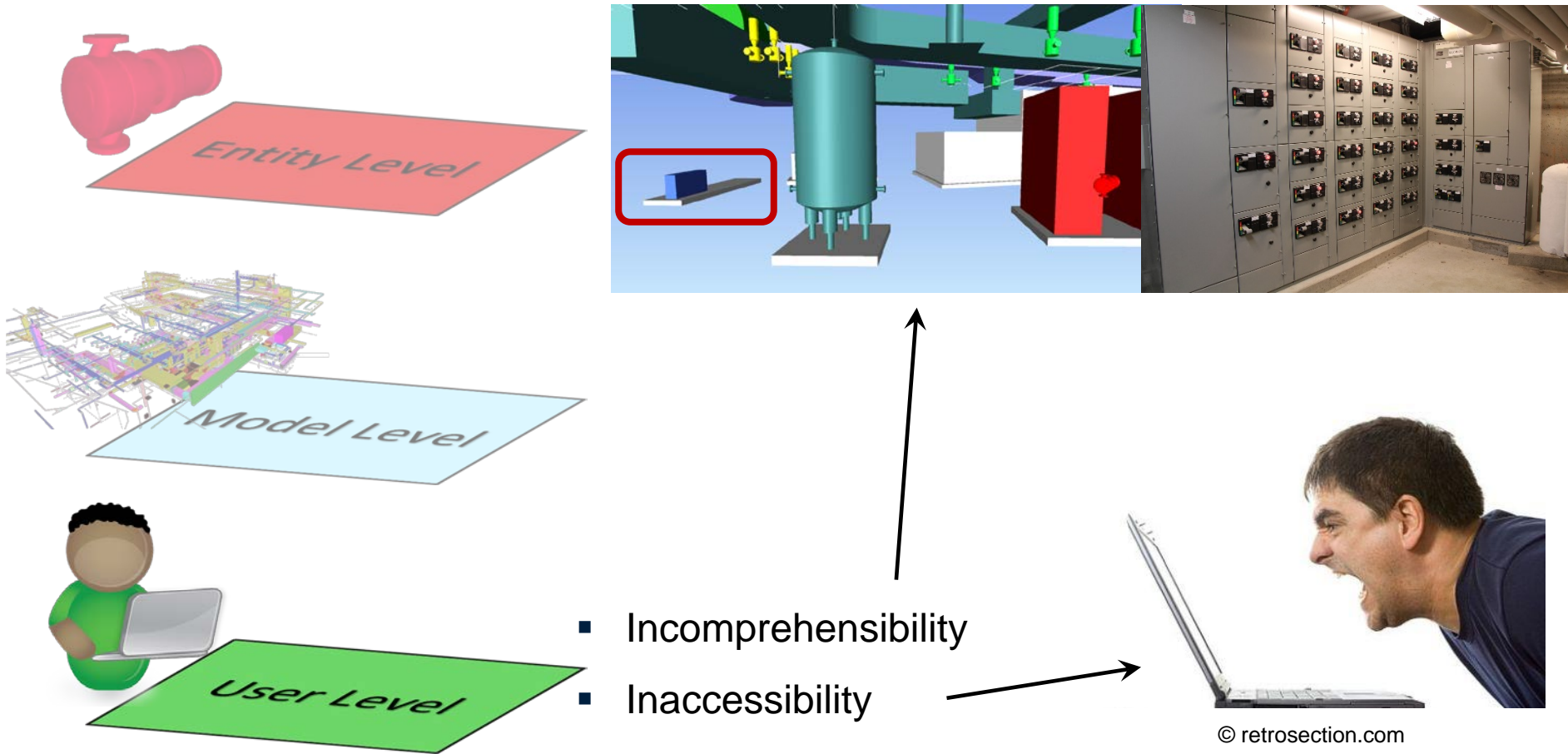


# Categorization of BIM-IQ Issues for FM





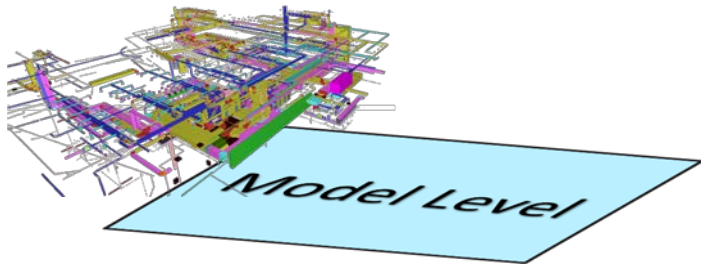
# Categorization of BIM-IQ Issues for FM



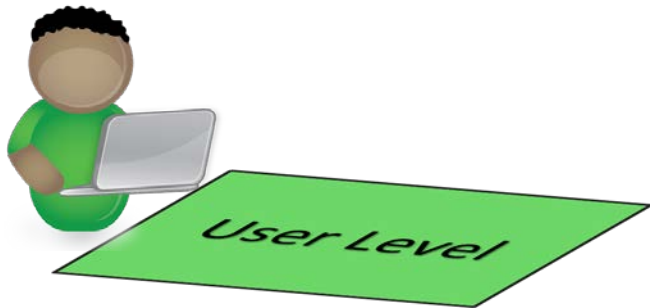
# Categorization of BIM-IQ Issues for FM



- Incompleteness
- Value Inaccuracy
- Spatial Inaccuracy



- Standards' Incompatibility
- Uncoordinated Model
- Inconsistency



- Incomprehensibility
- Inaccessibility

# Inaccurate Values for Asset Attributes



- Many specs are part of the name or type

Information Takeoff			
Takeoff All   ITO All Pumps			
Type	Component	Count	Color
120 GPM Capacities - 10.85 Feet Heads	Object	14	Yellow
74 GPM Capacities - 2.6 Feet Heads	Object	5	Cyan
Heat Pump - EW540	Object	3	Green
Medium	Object	3	Red
Small	Object	2	Orange

Information Takeoff			
Takeoff All   ITO All Pumps			
Type	Component	Count	Color
120 GPM Capacities - 10.85 Feet Heads	Object	14	Yellow
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