

**Information Delivery Manual (IDM)**  
**for**  
**Quantity Takeoff for Cost Estimating**

Version: 1.0 -- 30-May-11

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## 1 Process Model

### Name                    OGC/bSa – Quantity Take-Off at Concept Design Phase

Change Log		
5-Jan-09	Initial creation of version 0.01, draft for internal review	Tom Wiggins
4-Feb-09	Edits creating version 0.02	Tom Wiggins
11-Feb-09	Edits creating version 0.03	Tom Wiggins
18-Feb-09	Edits for version 0.5 - adding 'ER QTO to Design' to the process diagram, expanding table for 'ER Design to QTO'	Richard See
23-Feb-09	Edits for version 0.6 -- expanded ER tables significantly	Richard See
19-Aug-09	Final changes for version 1.0	Richard See

### 1.1 Overview

Quantity Take-Off is a precursor to completing a cost estimate to determine whether the design meets the project budget. In the early design (conceptual) design phase, quantities used for estimating are building or elemental level quantities as more detailed design information is not available. For example, the conceptual phase allows:

- walls and slabs by area,
- windows by count by size,
- spaces by area,
- structural system by facility area,
- heating system by facility area,
- cooling system by facility area,

The output of the quantity take-off may be the result of a report produced by the cost estimating application, which shows quantities. Other than a valid IFC file for use by cost estimating applications, the QTO process does not produce any output.

#### 1.1.1 Cyclical Design

The process of outputting a quantity take-off is cyclical to match the design submittal requirements. It supports the cost estimating requirements to verify that the project design is within the established budget. The quantity take-off will have increasing complexity as the design progresses from early concept through final design.

##### 1.1.1.1 Conceptual

This is the analysis work undertaken during the programming and concept design stage of the project. It is about providing advice on the potential construction cost of a building to other design roles and the client. The aim of this analysis is to determine the feasibility of concepts in an capital cost context. Conceptual analysis may be undertaken in the absence of detailed geometric information about the building layout, though frequently general spatial layout is included during this stage. Assumptions typically must be made at this stage, maintaining consistent assumptions between the options being evaluated allows for evaluation of relative cost performance.

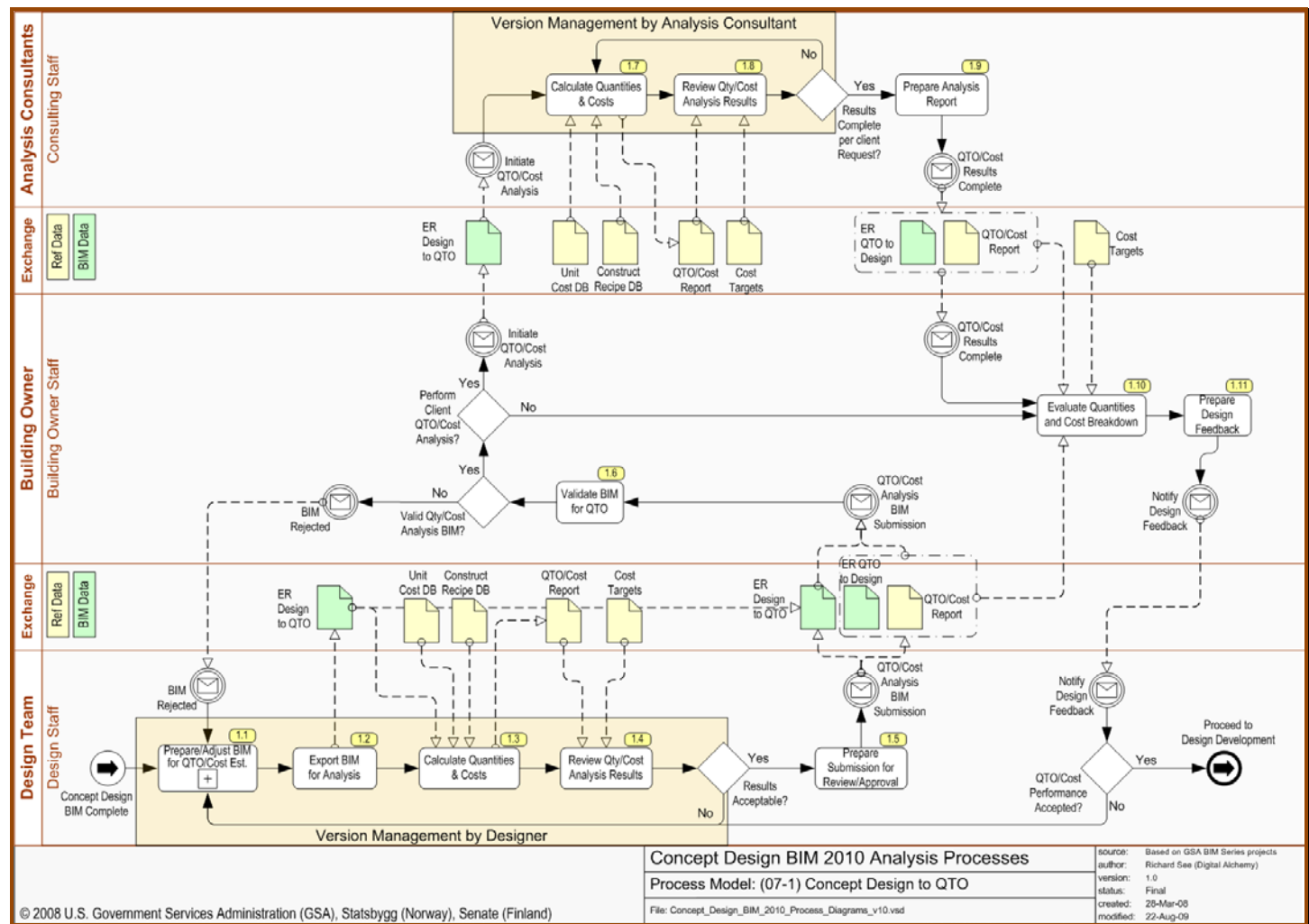
### 1.1.1.2 Detailed

This is the analysis work undertaken during the schematic, design development and construction document stages of the project and assumes the availability of geometric and building system information for the design. The overall process is the same at each stage of work, the difference being simply about the extent of the information available and the level of certainty that can be applied to the information. These factors impact the analysis methods used, which may range from relatively simple area and elemental quantities at the earlier design stages to detailed quantity take-off at the later design stages.

Within this process map, the conceptual design phase of the project is shown.

## 1.2 Specification of Process

### 1.2.1 Concept Design Phase Quantity Take-Off



### 1.2.1.1 Concept Design BIM Complete

Type	Initial Concept BIM
Documentation	<p>It is assumed at this point the architect has defined a building concept design complete with all the required building elements and space objects. This design provides a proposed building layout including functional and non-functional space configuration and placement of other geometric elements.</p> <p>Non-functional spaces such as technical spaces, circulation spaces, shafts, etc. must be defined by a space object and not left as unidentifiable voids surrounded by geometry.</p> <p>Spaces that represent multi-story spaces such as atria and vertical distribution routes such as shafts, stairways and elevator shafts should be represented as distinct spaces at each level of the building that are related to each other vertically (either via an opening in a slab or an element located at the opening for e.g. safety purposes).</p> <p>The Concept Design BIM should include:</p> <ul style="list-style-type: none"> <li>○ the site and building location</li> <li>○ the building orientation including its relationship to true north</li> <li>○ the site and building elevation above a reference datum</li> <li>○ the building story information</li> <li>○ 3D geometry of adjacent buildings</li> <li>○ 3D geometry of the building, including walls (exterior/interior), curtain walls, roofs, floors/slabs, ceilings, windows/skylights, doors, and shading devices</li> <li>○ space objects, including those defined by virtual space boundaries</li> </ul> <p>At the end of this task, the following exchange requirements from <b>ER Arch Concept to QTO Inputs</b> should be met: <i>Project, Site, Building, and Building Stories</i>.</p> <p>The following exchange requirements from <b>ER Arch Concept to QTO Inputs</b> should be partially met: <i>Space, Wall, Slab, Opening, Beam, Column, Curtain Wall, Stair Flight, Ramp Flight, Equipment, Plumbing Fixtures, HVAC, Electrical, Hot Water Systems, Cold Water Systems and Vertical Transportation Systems</i>.</p>

### 1.2.1.2 Prepare/Adjust BIM for QTO/Cost Estimate [1.1]

Type	Sub-Process
Documentation	At this point, the Concept Design BIM is passed to the appropriate designer to prepare the BIM for quantity take-off. The designer may still be the architect, any other design consultant or any combination. Details of this sub-process are described in Section 1.2.2.

### 1.2.1.3 Export BIM for Analysis [1.2]

Type	Task
Documentation	Once the BIM has been prepared for quantity take-off and validated in Task 1.1, it is exported to IFC for quantity take-off. At this point, all the required exchange requirements in <b>ER Arch Concept to QTO Inputs</b> have been met.

**1.2.1.4 Calculate Quantities & Costs [1.3]**

Type	Task
Documentation	The designer is now almost ready to perform a quantity take-off in preparation for preparing the cost estimate. The actual cost estimating task is outside the scope of this Manual. The estimating application may use reference data such as Unit Cost Database and Construction Recipe Database to prepare the cost estimate.

**1.2.1.5 Review Quantity/Cost Analysis Results [1.4]**

Type	Task
Documentation	<p>As the actual cost estimating task is outside the scope of this Manual, so is the review of a cost analysis. At this point, all the exchange requirements of the <b>ER Arch Concept to QTO</b> should be met. The results may be evaluated directly from the QTO/Cost Review Report prepared by a cost estimating application, or the results may be checked using a BIM model checker using the IFC file with the results written back to it.</p> <p>However, if a quantity/cost analysis is performed, the results of the quantity/cost analysis are obtained and evaluated against any cost targets that may exist. If the targets are not achieved, then the designer must go back to Task 1.1 and make further modifications to the building geometry, constructions, or some other building design variable. If the targets are achieved, the designer can move forward to Task 1.5.</p> <p>It is frequently the situation where the designer is evaluating a given design not just against its costs, but also against other performance targets such as energy performance, circulation efficiency, etc. If a design meets the cost targets, but falls short of energy performance targets, for example, and vice versa, then the design can be “failed” and designer will have to further iterate on the building design by returning to Task 1.1.</p>

**1.2.1.6 Prepare Submission for Review/Approval [1.5]**

Type	Task
Documentation	<p>Once the designer is satisfied with a design, they will prepare a submission package for client review/approval.</p> <p>The designer may insert URLs in the IFC BIM for the quantity and cost reports referencing the documents created in the quantity/cost analysis.</p>

**1.2.1.7 Validate BIM for QTO [1.6]**

Type	Task
Documentation	After receipt of the IFC BIM complete with <b>ER Arch Concept to QTO Inputs</b> and <b>Quantity/Cost Report</b> (not in the scope of this Manual), the client will use a data validation tool to verify that the BIM meets the requirement of the MVD.

**1.2.1.8 Calculate Quantities & Costs [1.7]**

Type	Task
Documentation	As the actual cost estimating task is outside the scope of this Manual, so is the

	Calculate Quantities & Costs task. The client may use internal staff or hire an outside consultant to verify the designer's quantity/cost results. The estimating application may use reference data such as Unit Cost Database and Construction Recipe Database to prepare the cost estimate.
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### 1.2.1.9 Review Quantity/Cost Analysis Results [1.8]

Type	Task
Documentation	The results of the client quantity/cost analysis are obtained and evaluated. The results are reviewed to ensure accuracy and integrity.

### 1.2.1.10 Prepare Analysis Report [1.9]

Type	Task
Documentation	Once the client quantity/cost analysis results are verified and approved, an analysis report is prepared comparing the results of the client analysis with those of the designer.  The client or consultants may insert URLs in the IFC BIM for the quantity and cost reports referencing the documents created in the quantity/cost analysis.

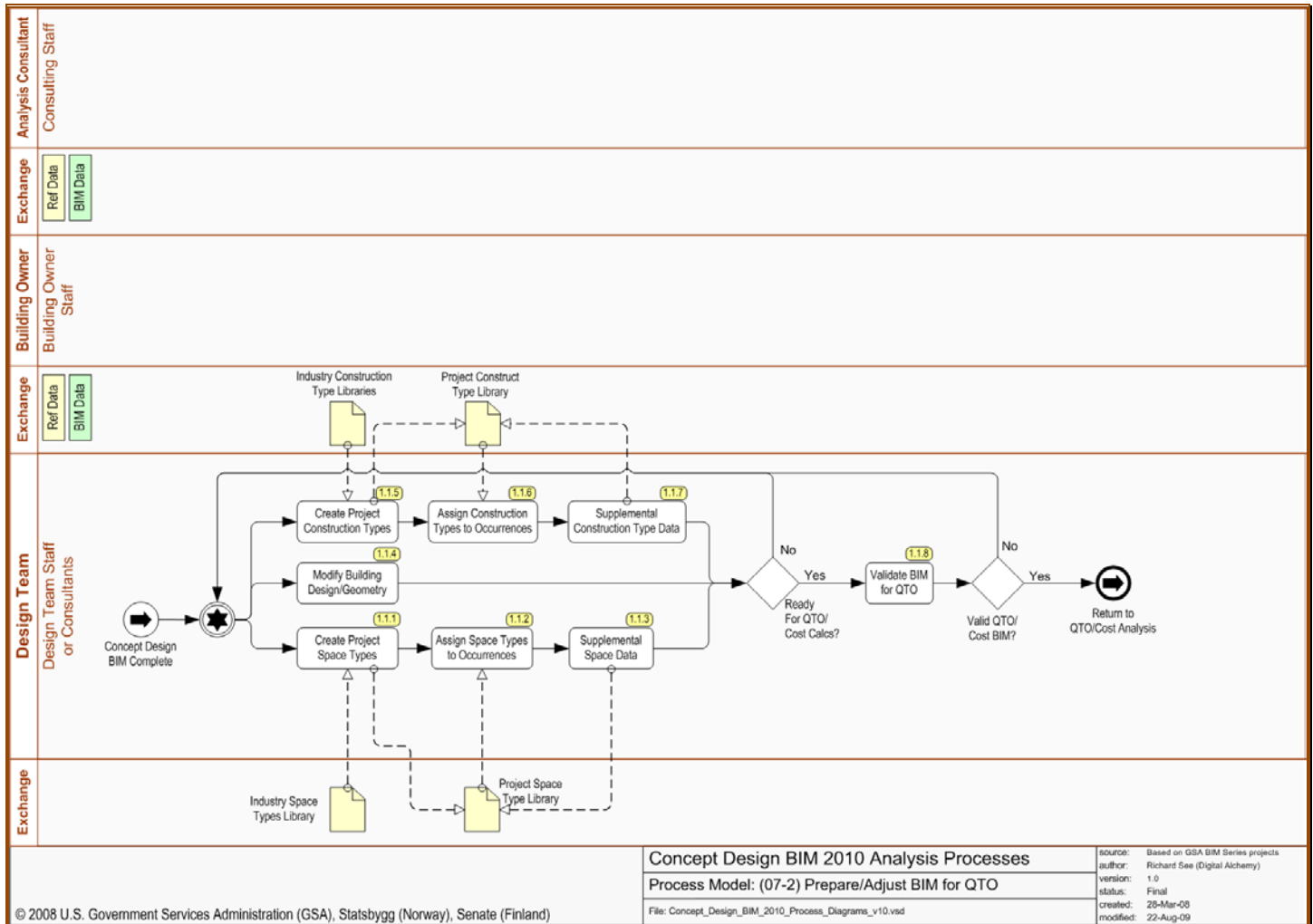
### 1.2.1.11 Evaluate Quantities and Cost Breakdown [1.10]

Type	Task
Documentation	The client will evaluate the analysis report submitted by their internal staff or consultant. Costs will be evaluated against the cost targets, resulting in a "go/no go" decision for the design.

### 1.2.1.12 Prepare Design Feedback [1.11]

Type	Task
Documentation	The client will document the resulting quantities and cost analysis (which may or may not include an independent quantities and cost analysis for comparison/validation), and recommendations for the design team. The design feedback package will be delivered back to the designer, and will include either an approval or rejection of the design originally submitted to the client by the designer.

1.2.2 Prepare/Adjust BIM for Quantity Take-Off





### 1.2.2.1 Create Project Space Types [1.1.1]

Type	Task
Documentation	<p>This process considers that an industry space type data library exists from which a project specific space type library can be derived. The industry space type library may be accessed from a server over the web or from directly within the BIM-authoring application. The project specific space type library contains only definitions of those space types that can be used on the project of concern.</p> <p><u>Ensure Valid Space Utilization Zones</u></p> <p>Where Space Utilization Zones are not otherwise available through the building information model, they need to be created for quantity take-off purposes.</p> <p>When defining the Space Utilization Zones, the following information is required:</p> <ul style="list-style-type: none"> <li>○ Relating space (the space which the boundary is to define for the building element)</li> <li>○ Related building element (the building element to which the space is related)</li> <li>○ Connection geometry (the form of the space boundary geometry; surface geometry should be used by preference to give the 2D topographical boundary and this should be for both horizontal and vertical boundaries.</li> <li>○ Physical or virtual boundary</li> <li>○ Internal or external space</li> </ul>

### 1.2.2.2 Assign Space Types to Occurrences [1.2.3]

Type	Task
Documentation	<p>Once the project space type library has been created, the designer may assign the space types to space occurrences, making a connection between the space occurrence and the type of space to which it conforms.</p>

### 1.2.2.3 Supplemental Space Data [1.1.4]

Type	Task
Documentation	<p>This task deals with individual spaces that may not be defined fully within the project space type library, or not defined to the designer's satisfaction. Initial data may be taken from a library template, but is then updated (or added) for the particular space being dealt with. Upon completion, information about this space may be saved back to the project space type library for future application.</p> <p>At the end of this task, the following exchange requirements from <b>ER Arch Concept to QTO Inputs</b> should be met: <i>Project, Site, Building, Building Stories, Spaces</i>.</p> <p>The following exchange requirements from <b>ER Arch Concept to QTO Inputs</b> should be met partially: <i>Beam, Column, Stair Flight, Ramp Flight, Equipment, Plumbing Fixtures, HVAC, Electrical, Hot Water Systems, Cold Water Systems and Vertical Transportation Systems</i>.</p>

**1.2.2.4 Modify Building Design/Geometry [1.1.4]**

Type	Task
Documentation	<p>In this step, the designer makes any necessary modifications to the building geometry or any other building design parameter other than those addressed by project construction or space types.</p> <p>At the end of this task, the following exchange requirements from <b>ER Arch Concept to QTO Inputs</b> should be met: <i>Project, Site, Site, Building, Building Stories, and Spaces</i>.</p> <p>The following exchange requirements from <b>ER Arch Concept to QTO Inputs</b> should be met partially: <i>Space, Beam, Column, Stair Flight, Ramp Flight, Equipment, Plumbing Fixtures, HVAC, Electrical, Hot Water Systems, Cold Water Systems and Vertical Transportation Systems</i>.</p>

**1.2.2.5 Create Project Construction Types [1.1.5]**

Type	Task
Documentation	<p>This process considers that an industry construction type data library exists from which a project specific construction type library can be derived. The construction type selected for a building element impacts the capital cost of the project. The industry construction type library may come from a variety of sources. The industry construction type library may be accessed from a server over the web or from directly within the BIM-authoring application. The project specific construction type library contains only definitions of those construction types that can be used on the project of concern.</p> <p>A single construction object may have one, two, three, or more construction types assigned to it based on the needs of the client.</p> <p>The default assumptions based on the project construction type is meant to be a starting point only, and the values may be modified prior to running the simulation.</p>

**1.2.2.6 Assign Construction Types to Occurrences [1.1.6]**

Type	Task
Documentation	<p>Once the project space type library has been created, the designer may assign the construction types to building element occurrences, making a connection between the building element occurrence and the type of construction to which it conforms.</p>

**1.2.2.7 Supplemental Construction Type Data [1.1.7]**

Type	Task
Documentation	<p>This task deals with individual constructions that may not be defined fully within the project construction type library, or not defined to the designer's satisfaction. Initial data may be taken from a library template but is then updated (or added) for the particular space being dealt with. Upon completion, information about this construction may be saved back to the project construction type library for future application.</p> <p>At the end of this task, the following exchange requirements from <b>ER Arch Concept</b></p>

	<p><b>to QTO Inputs</b> should be met: <i>Project, Site, Building, Building Stories, Spaces, Beam, Column, Stair Flight, Ramp Flight, Equipment, Plumbing Fixtures, HVAC, Electrical, Hot Water Systems, Cold Water Systems and Vertical Transportation Systems.</i></p>
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### 1.2.2.8 Validate BIM for QTO [1.1.8]

Type	Task
Documentation	After geometry, construction type, space type, and any other modifications to the building are made, the BIM is ready to be validated for quantity and cost analysis. Validation will take place by exporting an IFC file and using a model checker to ensure the MVD requirements have been met.

## 1.3 Specification of Data Objects

### 1.3.1.1 Library Information for Objects Types

Type	Data Object
Documentation	<p>At the Concept design stage, designers have not modeled many of the building data objects, yet descriptive data provides useful information for preparing a cost estimate.</p> <p><u>Site Object</u></p> <p>The Industry Classification source is UniFormat. See Section 1.3.1.6 Industry Classification Library – UniFormat.</p> <p><u>Building Object</u></p> <p>The functional classification source is OmniClass Table 11 (construction entities by function).</p> <p><u>Building Story Object</u></p> <p>No recognized standard functional classification source is identified. Descriptors used by the model are sufficient.</p> <p>Above grade and below grade are common descriptors.</p> <p><u>Space Object</u></p> <p>See Section 1.3.1.4 - Industry Space Type Library.</p> <p><u>Wall Object</u></p> <p>The Industry Classification source is UniFormat. See Section 1.3.1.6 Industry Classification Library – UniFormat.</p> <p>Each object shall have an indicator for load bearing or non-load bearing.</p> <p>Each object shall have an indicator for fire rating (including not applicable).</p> <p><u>Slab Object</u></p> <p>The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.</p>

Beam Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Column Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Opening Object

It does not require an Industry Classification.

Door Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Each object shall have an indicator for fire rating (including not applicable).

Window Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Each object shall have an indicator for fire rating (including not applicable).

Curtain Wall Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Stair Flight Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Ramp Flight Object

The Industry Classification source is UniFormat. See Section See Section 1.3.1.6 - Industry Classification Library – UniFormat..

Equipment Object

The Industry Classification source is OmniClass table 23, products.

Plumbing Fixtures Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

HVAC System Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Electrical System Object

The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.

Hot Water System Object

	<p>The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.</p> <p><u>Cold Water System Object</u></p> <p>The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.</p> <p><u>Vertical Circulation System Object</u></p> <p>The Industry Classification source is UniFormat. See Section 1.3.1.6 - Industry Classification Library – UniFormat.</p>
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### 1.3.1.2 Industry Construction Type Library

Type	Data Object
Documentation	The industry construction type data library for the Testbed is the BPEA Thread construction type data. The BPEA industry construction type library comes from a variety of sources. The industry construction type library may be accessed from a server over the web or from directly within the BIM-authoring application.

### 1.3.1.3 Project Construction Type Library

Type	Data Object
Documentation	The project construction type data library is derived for the project from the industry construction type library, and reflects any modifications or additions the designer has made to the industry source data.

### 1.3.1.4 Industry Space Type Library

Type	Data Object
Documentation	<p>The industry space type data library identifies space function using OmniClass table 13 (space by function). An optional second classification is by form using the OmniClass table 14 (space by form).</p> <p>The industry space type library may be accessed from a server over the web or from directly within the BIM-authoring application.</p> <p>A single space object may have one, two, three, or more space types assigned to it based on the needs of the building owner and project team. Multiple on-going projects between the GSA, Construction Specification Institute (CSI), the International Code Council (ICC), and others are working to map various naming classifications systems to each other. When this work is complete, consistent and transparent mapping of space names within BIM models will be possible.</p> <p>Spaces may be Interior or Exterior.</p>

### 1.3.1.5 Project Space Type Library

Type	Data Object
Documentation	The project space type data library is derived for the project from the industry space type library, and reflects any modifications or additions the designer has made to the industry source data.

### 1.3.1.6 Industry Classification Library – UniFormat

Type	Data Object
Documentation	<p>The Industry Classification for many Object Types is UniFormat. At the early design stage, designers will not model objects in sufficient detail or will not model the object. This only permits use of the higher level UniFormat element titles, which does not allow UniFormat to convey designer intent to the estimator.</p> <p>In a one-to-one mapping of modeled object and Industry Classification, some objects not modeled rely on a corresponding Level 2 UniFormat element title: HVAC System Object – D30 Heating, Ventilating and Air Conditioning, Electrical System Object – D50 Electrical, Vertical Circulation Object – D10 Conveying. The Site Object uses the Level 1 element title, G Building Sitework. Other objects, such as Hot Water System and Cold Water System, use Level 3 titles (D2020 Domestic Water Supply).</p> <p>Modeled objects have similar difficulties. Consider the Beam and Column Objects. UniFormat classifies beams and columns as sub-elements of larger building elements of:</p> <ul style="list-style-type: none"> <li>○ B1010 Floor Construction (Level 3) <ul style="list-style-type: none"> <li>○ B1010._ Floor Structural Frame (unnumbered Level 4)</li> </ul> </li> <li>○ B1020 Roof Construction <ul style="list-style-type: none"> <li>○ B2010._ Roof Structural Frame</li> </ul> </li> </ul> <p>There are unnumbered sub-headings for each unnumbered Level 4 heading that for Structural Frame suggest possible material types.</p> <p>UniFormat Elements for an Object Type may be in different major element sections of UniFormat. They may not be at the same level in the UniFormat structure. The Wall Object provides an example of both cases:</p> <ul style="list-style-type: none"> <li>○ A1010._ Wall Foundations has an unnumbered sub-heading of Foundation Walls</li> <li>○ A2020 Basement Walls</li> <li>○ B2010 Exterior Walls</li> <li>○ C1010 Partitions</li> </ul> <p>The ability to use child element titles, a one-to-many relationship, becomes useful as a checklist to convey intent of the designer – especially if accompanied by the ability to include notes as a narrative as well. However, this functionality moves beyond the intent of assigning an Industry Classification to each object.</p>

### 1.3.1.7 Industry Classification Library - OmniClass

Type	Data Object
Documentation	<p>The Industry Classification for some Object Types is various OmniClass tables. Specific tables referenced include:</p> <p>Table 11 Construction Entities by Function.</p> <p>Table 13 Space by Function. See Section 1.3.1.4 Industry Space Type Library.</p> <p>Table 14 Space by Form. See Section 1.3.1.4 Industry Space Type Library.</p>

	Table 23 Products. This table include Equipment in section 23-40 00 00 Equipment and Furnishings. As with UniFormat, only higher level titles area useful at early design.
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### 1.3.2 Exchange Requirement Data Objects

#### 1.3.2.1 ER\_Arch\_Concept\_to\_QTO\_Inputs\_(concept)

Type	Data Object
Name	ER_Arch_Concept_to_QTO_Inputs_(concept)
Documentation	<p>Exchange of complete set of quantity take-off inputs for use in construction cost analysis.</p> <p>For CPD Correlation: NBIMS Section 4. 11 Capability Maturity Dimensions. The table below shows the possible matrix of interaction for the 11 CPD spheres of influence and the 10 project stages for the testbed.</p>

		Capability Maturity Level										
		Customer Sphere	Staffing Sphere	Structure Sphere	Sales Sphere	Development Sphere	Operations Sphere	Finance Sphere	Strategy Sphere	Marketing Sphere	Leadership Sphere	Customer Spere
Project Stage		0	1	2	3	4	5	6	7	8	9	10
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											

## 1.4 Specification of Decision Point Gateways

### 1.4.1 Ready for Quantity/Cost Analysis

Type	Decision Point
Documentation	At this point the <b>designer</b> must decide if <b>all</b> the <b>desired design changes</b> have been made and the model is ready for QTO to support cost analysis. If so, the model is ready for simulation. If not, the designer must further modify the building design.

### 1.4.2 Valid Quantity/Cost Analysis BIM?

Type	Decision Point
Documentation	After deciding that the model is ready for analysis, the designer uses a model checker to ensure that all the input exchange requirements have been met. This step also takes place when the client evaluates the BIM model submitted to them by the designer. If the BIM model meets the requirements set forth by the rule checking sets in the model checker, the BIM is valid. If not, it is invalid.

### 1.4.3 Results Acceptable?

Type	Decision Point
Documentation	The designer evaluates the results of the quantity/cost analysis and compares them to the cost targets for the design. If the design meets the cost targets, as well as any other project performance metrics (such as energy performance), the results are acceptable. If not, the designer must further modify the building design.

### 1.4.4 Perform Client Quantity/Cost Analysis?

Type	Decision Point
Documentation	The client may want to perform an independent quantity/cost analysis to validate the results of the designer's analysis. This independent quantity/cost analysis may be executed by internal staff of the client, or by a consultant.

### 1.4.5 Results Complete per Client Request?

Type	Decision Point
Documentation	The internal staff or consultant that is conducting the independent quantity/cost analysis decides if the results of their analysis are accurate and reliable, and conform to the client's work order.

### 1.4.6 Quantity/Cost Analysis Accepted?

Type	Decision Point
Documentation	The designer reviews the design feedback from the client for design approval or rejection.