CSI Formats and Building Information Modeling

Federal Facilities Council
Government/Industry Forum
October 31, 2006

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The Construction Specifications Institute
North American Information Standards

Phases
- Pre-project Planning
- Preliminary Design
- Design
- Bidding
- Procurement
- Construction
- Operations

Processes
- Conceptual Design, Cost Planning
- Detailed Design, Specification, Product search, selection
- Cost estimate
- Bid packages, price discovery
- Purchasing, Scheduling, Change mgmt
- Asset modeling, Facility mgmt.

Information Standards
- UniFormat
- MasterFormat
- OmniClass
- National CAD Standard
- Uniform Facility Guide Specs
- Industry Foundation Classes (ifc)
- Open Geospatial Consortium (OGC)
- Open Standards Consortium for Real Estate (OSCRE)
- National BIM Standard

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UniFormat
Elemental Classification System

A  Substructure
   A10 Foundations  Level 2
      A1010 Standard Foundations  Level 3
         A1010.XX Wall Foundations  Level 4
            A1010.XX Column Foundations  Level 5

B  Shell

C  Interiors

D  Services

E  Equipment and Furnishings

F  Special Construction and Demolition

G  Building Sitework

Z  General
Work Results by Element

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strip footing, load 3.9 KLF soil cap, 3 KSF, 24&quot; wide x 8&quot; deep, plain</td>
<td>0.099</td>
<td>B.C.Y.</td>
</tr>
<tr>
<td>Excavating, trench or continuous footing, common earth, 3/8 C.Y. tractor</td>
<td>2.000</td>
<td>S.F.</td>
</tr>
<tr>
<td>loader/backhoe, 1' to 4'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavating, trench, common earth, vibrator plate, trim sides and bottom</td>
<td>1.340</td>
<td>SFCA</td>
</tr>
<tr>
<td>for concrete pours, excl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.P. concrete forms, footing, continuous wall, plywood, 4 use, includes</td>
<td>1.000</td>
<td>L.F.</td>
</tr>
<tr>
<td>erecting, bracing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I.P. concrete forms, footing, keyway, tapered wood, 2&quot; x 6&quot;, 4 use,</td>
<td>1.000</td>
<td>Lb.</td>
</tr>
<tr>
<td>includes erecting, bracing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforcing steel, in place, footings, #4 to #7, A615, grade 60, incl</td>
<td>1.000</td>
<td>Ea.</td>
</tr>
<tr>
<td>access. Labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforcing steel, in place, dowels, deformed, 2' long, #4, A615, grade</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Structural concrete, ready mix</strong>, normal weight, 3000 psi, includes</td>
<td>0.050</td>
<td>C.Y.</td>
</tr>
<tr>
<td>material only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural concrete, placing, continuous footing, shallow, direct chute,</td>
<td>0.050</td>
<td>C.Y.</td>
</tr>
<tr>
<td>includes vibrating, exc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete finishing, floors, monolithic, screed and bull float (darby)</td>
<td>2.000</td>
<td>S.F.</td>
</tr>
<tr>
<td>finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backfill, trench, 6&quot; to 12&quot; lifts, dozer backfilling, compaction with</td>
<td>0.049</td>
<td>E.C.Y.</td>
</tr>
<tr>
<td>vibrating roller</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: RS Means CostWorks
MasterFormat
Work Results Classification System
50 Divisions

MasterFormat is organized to integrate the Life-Cycle of the Facility

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October 2006

<table>
<thead>
<tr>
<th>Division Numbers and Titles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procurement and Contracting Requirement Group:</strong></td>
</tr>
<tr>
<td>Div. 00 Procurement and Contracting Requirements</td>
</tr>
<tr>
<td><strong>Specification Group:</strong></td>
</tr>
<tr>
<td>General Requirements Subgroup:</td>
</tr>
<tr>
<td>Div. 01 General Requirements</td>
</tr>
<tr>
<td>Facilities Construction Subgroup:</td>
</tr>
<tr>
<td>Div. 02 Existing Conditions</td>
</tr>
<tr>
<td>Div. 03 Concrete</td>
</tr>
<tr>
<td>Div. 04 Masonry</td>
</tr>
<tr>
<td>Div. 05 Metals</td>
</tr>
<tr>
<td>Div. 06 Wood, Plastics, and Components</td>
</tr>
<tr>
<td>Div. 07 Thermal and Moisture Protection</td>
</tr>
<tr>
<td>Div. 08 Openings</td>
</tr>
<tr>
<td>Div. 09 Finishes</td>
</tr>
<tr>
<td>Div. 10 Specialties</td>
</tr>
<tr>
<td>Div. 11 Equipment</td>
</tr>
<tr>
<td>Div. 12 Furnishings</td>
</tr>
<tr>
<td>Div. 13 Special Construction</td>
</tr>
<tr>
<td>Div. 14 Conveying Equipment</td>
</tr>
<tr>
<td>Div. 15 – 19 Reserved for Future Expansion</td>
</tr>
<tr>
<td><strong>Facility Services Subgroup:</strong></td>
</tr>
<tr>
<td>Div. 20 Reserved for Future Expansion</td>
</tr>
<tr>
<td>Div. 21 Fire Suppression</td>
</tr>
<tr>
<td>Div. 22 Plumbing</td>
</tr>
<tr>
<td>Div. 23 HVAC</td>
</tr>
<tr>
<td>Div. 25 Integrated Automation</td>
</tr>
<tr>
<td>Div. 26 Electrical</td>
</tr>
<tr>
<td>Div. 27 Communications</td>
</tr>
<tr>
<td>Div. 28 Electronic Safety and security.</td>
</tr>
<tr>
<td><strong>Site and Infrastructure:</strong></td>
</tr>
<tr>
<td>Div. 30 - 39 Reserved for Future Expansion</td>
</tr>
<tr>
<td><strong>Process Equipment Subgroup:</strong></td>
</tr>
<tr>
<td>Div. 40 Process Integration</td>
</tr>
<tr>
<td>Div. 41 Material Processing and handling</td>
</tr>
<tr>
<td>Div. 43 - 49</td>
</tr>
</tbody>
</table>
Why Revise *MasterFormat*?
SectionFormat

Provides a uniform approach to organizing specification text contained in a Project Manual

PART 1 GENERAL
- SUMMARY
- REFERENCES
- DEFINITIONS
- SYSTEM DESCRIPTION
- SUBMITTALS
- QUALITY ASSURANCE
- DELIVERY, STORAGE, AND HANDLING
- PROJECT/SITE* CONDITIONS
- SEQUENCING
- SCHEDULING
- WARRANTY
- SYSTEM STARTUP
- OWNER’S INSTRUCTIONS
- COMMISSIONING
- MAINTENANCE

PART 2 PRODUCTS
- MANUFACTURERS EXISTING PRODUCTS
- MANUFACTURED UNITS
- EQUIPMENT
- COMPONENTS
- ACCESSORIES
- MIXES
- FABRICATION
- FINISHES
- SOURCE QUALITY CONTROL

PART 3 EXECUTION
- INSTALLERS EXAMINATION
- PREPARATION
- ERECTION
- INSTALLATION
- APPLICATION
- CONSTRUCTION
- REPAIR/RESTORATION RE-INSTALLATION
- FIELD QUALITY CONTROL
- ADJUSTING
- CLEANING
- DEMONSTRATION
- PROTECTION
- SCHEDULES

Properties

Materials

Products
Need – Bi-directional Information Flow and Cross-referencing

Various documents share same information structures, however, information generated in each document cannot directly be transferred to another application or cross-referenced.

Source: Georgia Institute of Technology
Dr. Charles Eastman, Elif Yagmur-Kilimci

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OmniClass – Classification System for the Built Environment

**WorkGroup 1:**
11 Construction Entities by Function
12 Construction Entities by Form
13 Spaces by Function
14 Spaces by Form

**WorkGroup 2:**
21 Elements - UniFormat
22 Work Results – MasterFormat 04
23 Products

**WorkGroup 3:**
31 Phases
32 Services
33 Disciplines
34 Organizational Roles
35 Tools
36 Information

**WorkGroup 4:**
41 Materials
49 Properties
Relation of **MasterFormat** and **UniFormat** to OmniClass
Industry Foundation Classes

- Set of internationally standardized construction industry object definitions
- Basis – integration of objects across project life cycle using a single model
- IFC stores object data – geometry, 3D dimensions, location, relationships, properties
- IFC and OmniClass intersect in Elements and Properties Table

International Open Standard = IFC model
**IfcElement**: Generalization of all components that make up an AEC product.

**IfcBuildingElement**: The building element comprises all elements that are primarily part of the construction of a building, i.e., its structural and space separating system.

<table>
<thead>
<tr>
<th>IfcElement</th>
<th>IfcBuildingElement</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcBuildingElement</td>
<td>IfcBeam</td>
</tr>
<tr>
<td>IfcDistributionElement</td>
<td>IfcBuildingElementComponent</td>
</tr>
<tr>
<td>IfcElectricalElement</td>
<td>IfcBuildingElementProxy</td>
</tr>
<tr>
<td>IfcElementAssembly</td>
<td>IfcColumn</td>
</tr>
<tr>
<td>IfcEquipmentElement</td>
<td>IfcCovering</td>
</tr>
<tr>
<td>IfcFeatureElement</td>
<td>IfcCurtainWall</td>
</tr>
<tr>
<td>IfcTransportElement</td>
<td>IfcDoor</td>
</tr>
<tr>
<td>IfcVirtualElement</td>
<td>IfcFooting</td>
</tr>
<tr>
<td></td>
<td>IfcMember</td>
</tr>
<tr>
<td></td>
<td>IfcPile</td>
</tr>
<tr>
<td></td>
<td>IfcPlate</td>
</tr>
<tr>
<td></td>
<td>IfcRailing</td>
</tr>
<tr>
<td></td>
<td>IfcRamp</td>
</tr>
<tr>
<td></td>
<td>IfcRampFlight</td>
</tr>
<tr>
<td></td>
<td>IfcRoof</td>
</tr>
<tr>
<td></td>
<td>IfcSlab</td>
</tr>
<tr>
<td></td>
<td>IfcStair</td>
</tr>
<tr>
<td></td>
<td>IfcStairFlight</td>
</tr>
<tr>
<td></td>
<td>IfcWall</td>
</tr>
<tr>
<td></td>
<td>IfcWallStandardCase</td>
</tr>
<tr>
<td></td>
<td>IfcWindow</td>
</tr>
</tbody>
</table>
Building elements - IFC

In IFC functions are defined as properties rather than the basis of their classification.

IfcWall objects

Property Set Attachment
(IfcRelDefinesByProperties)

Property set is attached

Pset_WallCommon

- Is External
- Load Bearing
- Compartmentation
- Extend to structure
- ...

Source: Georgia Institute of Technology
Dr. Charles Eastman, Elif Yagmur-Kilimci
Relation of OmniClass & UniFormat to IfcElements

Currently OmniClass elements (which are very close to UniFormat Elements) represents assemblies rather than individual elements. Thus, some elements in OmniClass correspond to aggregation of a number of elements in IFC such as:

- IfcBeam
- IfcColumn
- IfcSlab
- IfcWall
- IfcCovering
- OmniClass Floor Construction
- OmniClass Roof Construction
- OmniClass Exterior Wall
- OmniClass Bearing Wall
- OmniClass Retaining Wall

- many to many relations

Source: Georgia Institute of Technology
Dr. Charles Eastman, Elif Yagmur-Kilimci
OmniClass elements table – Requirements for incorporating designed elements

Identifying the designed types for elements which represents assemblies might result in infeasible number of designed elements.

Source: Georgia Institute of Technology
Dr. Charles Eastman, Elif Yagmur-Kilimci
Taxonomies

• Taxonomies are hierarchical thesauri – relating broader and narrower concepts and providing terminology alternatives for identifying these concepts
• Taxonomies can help establish a controlled vocabulary
• OmniClass and the IFD provide a basis for establishing a taxonomy
International Framework for Dictionaries (IFD)

- LexiCon
- BARBi
- Other International Thesaurus
- Other International Taxonomy
- International Framework Dictionary (IFD)
- OmniClass
- North American Construction Industry Taxonomy
Point-to-point Communication

Communication is Conveying meaning

Concepts to be communicated
Encoding
Message formed

Communication medium

Message received, decoded, concepts understood
Encoding of a Message

- Semantics
- Syntax
- Content

Meaning - Data model
Format
Instance Data

Concepts to be communicated
Encoding
Message formed

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Agree on Semantics and Syntax

- Participants can communicate using a common language
- Any participant can communicate with any other participant
- Facilitates high performance teams
Goal of Using Standards

Organized, Transparent Information

Planning, Feasibility Analysis

Technical data, Specifications, Drawings, Configurators

Requests for clarification during bid stage

Submittals

RFI/RFQ, Shop drawings, Order entry, Invoice, tracking

Op/maint. manuals Diagnostic data