Construction Classification Criticality
– Architecture, Engineering, Construction, Facilities Management, & Life-cycle Management of the Built Environment

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Building classification systems are an essential tool in achieving measurable productivity across the Architecture, Engineering, Construction, Operations, and Owner (AECOO) domains and life-cycle management of the built environment in general.

It is impossible engage in collaborative and productive processes among AECOO participants without a common understanding of terms, definitions, and relationships.

The myriad of requirements, specifications, documents, data types, inter-relationships, and dependencies encountered throughout the life-cycle of built structures would be better understood and managed if based upon common terms, definitions, and data structures. The convergence of information pertaining to all aspects of a physical assets life-cycle is best called a physical asset model.

The competencies required for physical asset modeling should NOT be confused with those of 3-dimensional (3D) visualization, which is merely one of several methods of representing and working with previously disparate information.

Physical asset modeling and models include and require multiple competencies, industries, business processes, data formats, classification structures and layers, and technologies.

Standardized classification, is needed in order to organize and share physical asset information, processes and requirements (physical, functional, economic, environment…) across multiple competencies, team members, asset users, and oversight groups.

Classification enables information to be used for multiple purposes, individually and generically, such as determining initial and final scopes of work (SOW), cost estimating, capital planning and deferred maintenance management, space utilization, life-safety/security, levels of compliance, and mission dependencies.

Examples AECOO classification systems and data architectures include Omniclass, Uniformat, Masterformat, COBie, and Uniclass.

With properly designed, flexible, and comprehensive architectures, classification systems should enable the location, representation, manipulation, and use of the same object and/or process and/or cost for differing criteria/purposes.

Key Words: Classification systems, Taxonomy, asset model, asset modeling, collaboration, lean construction, integrated project delivery, IPD, job order contracting, JOC, BIM, OmniClass, MasterFormat, UniFormat, Uniclass, building information management, building information models, building information modeling.

Introduction

The evolution, use, and value of AECOO classification systems requires and is dependent upon common terms, definitions, and robust flexible data architectures.

First, some basics.

- Classification is the process of putting things into orderly groups based on similar characteristics.
- Taxonomy, originally the science of describing, naming, and classifying organisms, has now expanded beyond organisms.

- Hierarchy is a ranking system and generally includes attributes such as form, structure, etc. The most common form of hierarchical classification system the following one applied to organisms.
    - Kingdom
    - Phylum
    - Class
    - Order
    - Family
    - Genus
    - Species
    - Varieties
- Systematics, another attribute/relationship-based layer, is a system that organizes the tremendous diversity of organisms into a phylogenetic (inferred evolutionary relationships among various biological species or other entities) tree. Additionally, Cladistics is a system of taxonomy that reconstructs phylogenies by inferring relationships based on similarities. Unique characteristics found in a particular group of organisms, called derived traits or derived characters, are used.
- Technology provides the following structures:
    - Data Model: A concept or set of concepts used to describe the structure of a database, associated constraints.
        - Categories of data models:
            - Conceptual (high-level, semantic) data models: Concepts that are close to the way many users perceive data. (Also be called entity-based or object-based data models.)
            - Physical (low-level, internal) data models: concepts that describe details of how data is stored in the computer.
            - Implementation (representational) data models: Concepts that fall between the above two, balancing user views with some computer storage details.
    - Database Schema: A description of a database, including descriptions of the database structure and associated constraints. Change is generally in frequent. Conceptual schema describes the structure and constraints for the whole database for a community of users. Dependent upon a conceptual or implementation data model. External schemas describe the various user views, and generally uses the same data model as the conceptual level. Mappings among schema levels are transform requests and data. References are made to external schema, and are mapped within the database to the internal schema for execution.
    - Database Instance: The actual data stored in a database at a particular moment in time. Also called database state/occurrence.
    - Valid State: A state that satisfies the structure and constraints of the database. Change occurs with each database update.
    - Data Dictionary: A set of terms, descriptions, and application program descriptions (as required), that is used to assist in the preservation, storage, and updating of all information/applications, usage standards, etc. The data dictionary can be multi-level. For example an “active” data dictionary used by programmers, and a “passive” data dictionary used by users.

The convergence of “traditional” and “technology” classification represents a major opportunity and a major challenge to the AECOO community. The opportunities are listed below. The formidable challenge is equivalent to the cultural barriers and significant change management associated with LEAN collaborative construction delivery methods (Integrated Project Delivery – IPD, Job Order Contracting). AECOO participants and oversight groups, especially Owners, must demand consistent classification of information.

The objectives and benefits of robust and flexible classification across the AECOO domain include:

- All users be able to access, understand, and work with the same data.
- A single user’s view is immune to changes made in other views.
- Users should not need to know the technical classification details, and/or information storage details.
- Information storage structures should be able to be changed without affecting users’ views.
- Internal structure of information/database should be unaffected by changes to physical aspects of storage.
- Conceptual structure changes to information/database should not affect all users.
- Information/data independence is preserved. Logical Data Independence is the capacity to change the conceptual schema without also changing the external schemas and associated application programs. Physical Data Independence allows for changing the internal schema without having to change the conceptual schema. Creating/changing “mappings” between schema preserves/support data independence. The higher-level schemas themselves are unchanged. Hence, the application programs need not be changed since they refer to the external schemas. Within object-oriented environments the user/programmer specifies what data to retrieve than how to retrieve/represent it. This is extremely powerful relative to

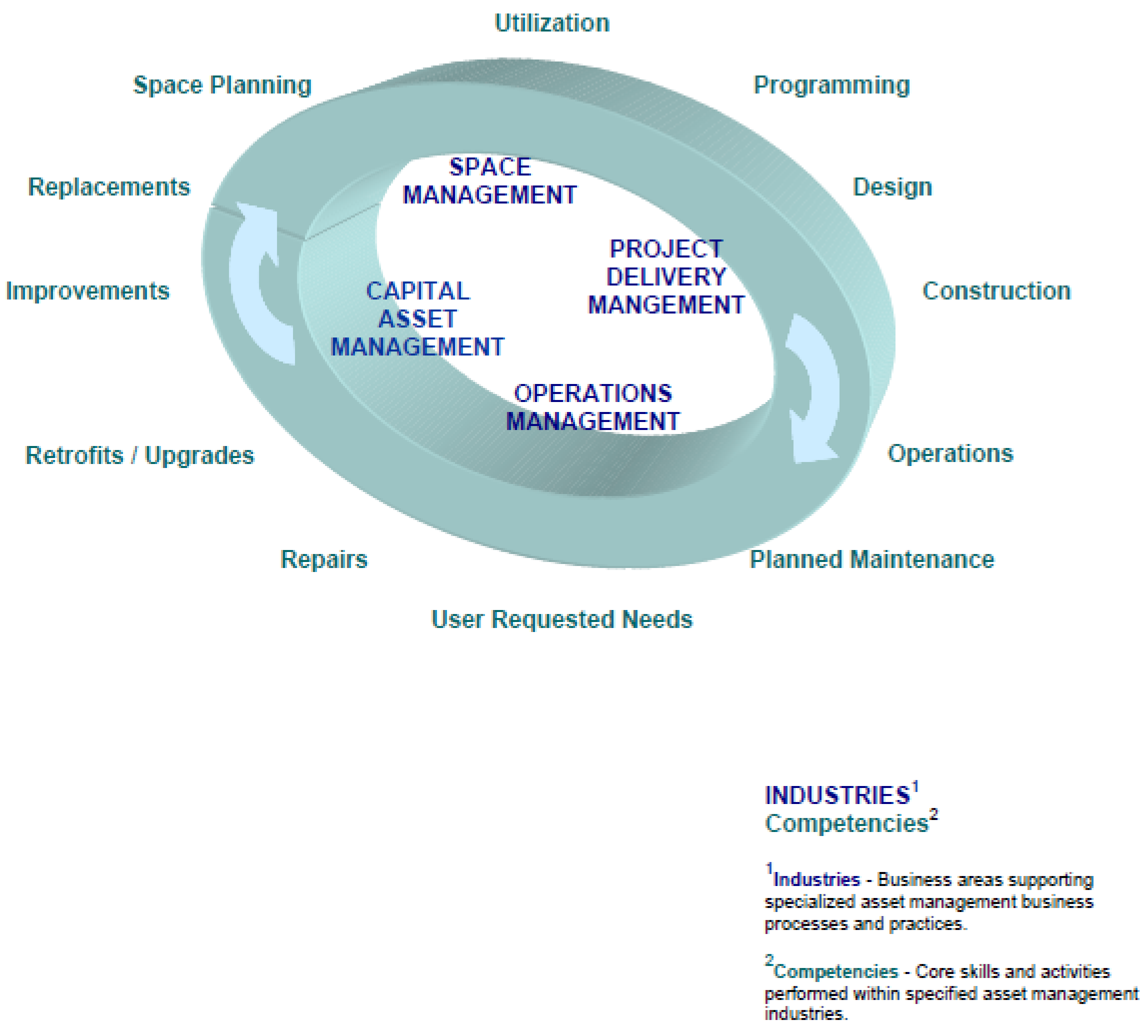
maintaining and improving classification.

Construction Classification Systems

Classification systems are required in order to support asset life-cycle modeling and management and associated efficient LEAN collaborative construction delivery methods.

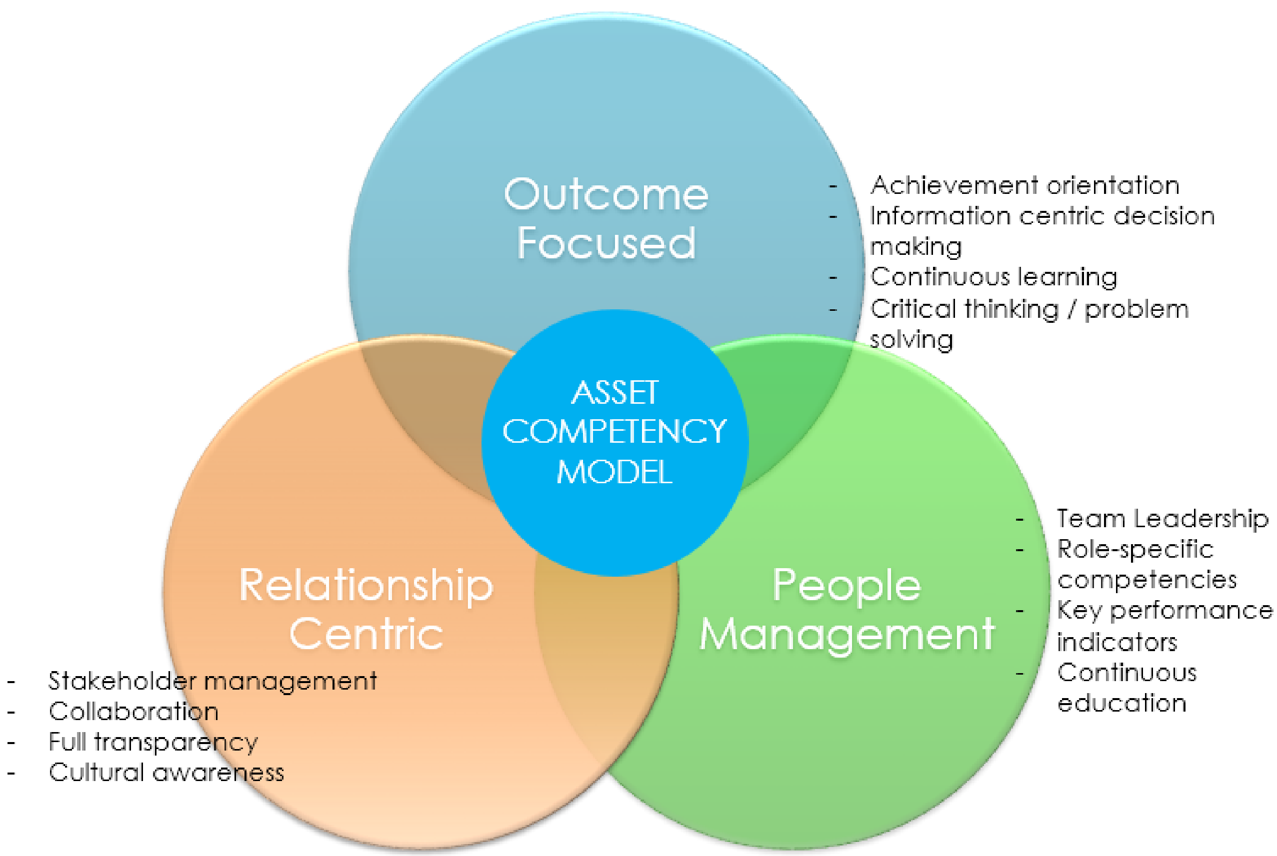
Asset life-cycle modeling and management, also referred to an asset total cost of ownership management involves the convergence and interdependence of multiple competencies, domains, and technologies as represented in the below graphic.

Figure 1: Asset Lifecycle Model
for
Total Cost of Ownership Management

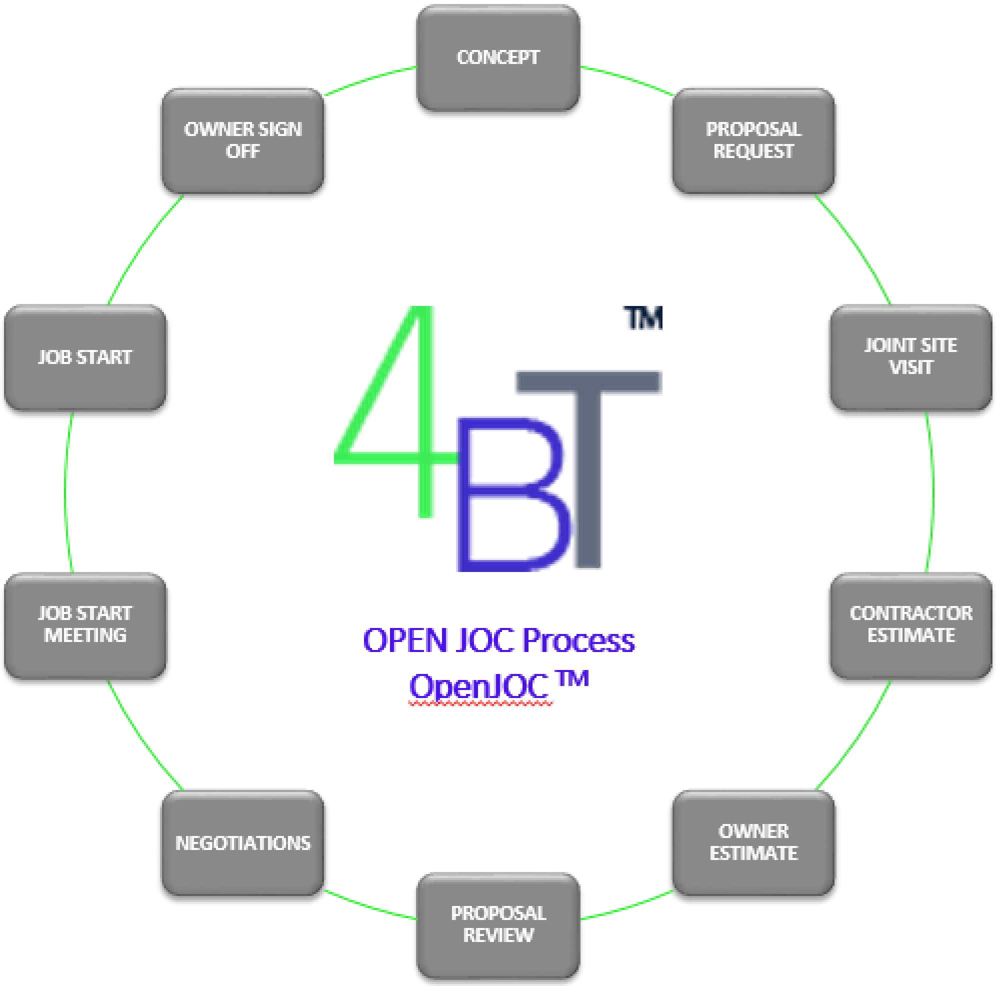


LEAN collaborative construction delivery methods, some of which have been available for decades (Integrated Project Delivery, IPD, for major new construction, and Job Order Contracting, JOC, for renovation, repair, maintenance, sustainability, and minor new construction) enable the efficient execution of projects associated with asset life-cycle modeling and management. The below graphics portray concepts and workflows associated with LEAN collaborative construction delivery.


CUSTOMER CENTRIC CULTURE
Map
customer journey and lifecycle
Refine
operating model to enable customer centricity
Align
technologies and processes to support and drive customer engagement
Engage
executives and leaders
Focus
development around target areas and behaviour change
Integrate
disparate business unit cultures
Transform
culture top to bottom
Measure
change using key metrics
Incorporate
customer feedback into processes and behaviours


ASSET COMPETENCY MODEL
Outcome Focused
- Achievement orientation
- Information centric decision making
- Continuous learning
- Critical thinking / problem solving
People Management
- Team Leadership
- Role-specific competencies
- Key performance indicators
- Continuous education
Relationship Centric
- Stakeholder management
- Collaboration
- Full transparency
- Cultural awareness


OUTCOME-
BASED
GLOBALIZATION OF
OPERATING MODELS
BEST VALUE
STRATEGIC FOCUS
UPON TOTAL COST OF
OWNERSHIP
COLLABORATION
Clearly Defined
Roles,
Responsibilities,
Outcomes
ANALYTICS
STANDARDIZED
INFORMATION &
FACT BASED
DECISION MAKING
Insight vs.
Excessive Control
KEY PEFORMANCE
METRICS – KPIs &
CONTINUOUS TRAINING
OpenJOC™
IPD
LEAN
CONSTRUCTION
DELIVERY



4BuildingTogether

Both asset life-cycle modeling and management and LEAN collaborative construction delivery require robust classification systems. The ability to efficiently communicate across multiple team members and associated areas of expertise and work requires the ability to "translate" and map information via a common structure. Classification provides the generic features required for this activity.

There are multiple considerations when creating a classification system for physical asset life-cycle modeling and management as well as associated construction project delivery.

1. Purpose – A classification system for AECOO domain should provide the foundation for clearly and consistently describing processes, workflows, tools, products, and attributes relevant to multiple uses and contexts.
2. Properties
3. Organizational Framework – Conceptual foundation specific to the AECOO domain.
4. Principles for developing Groupings/Relationships - Direct grouping (also known as enumerated or hierarchical) and faceted groupings are relatively common in the construction sector. Classes are identified through combinations of properties thought direct groupings. An assembly of various components of a nonstructural wall (studs, wallboard, electrical components, etc.) is an example of a direct grouping. In faceted classification multiple sets of attributes can be combined, such to categorize all potential combinations of items, and new objects can easily be created.
5. Taxonomy

The classification purpose determines the taxonomy properties, divisions, subdivisions, and groups. Subdivision criteria include compositional properties and functional properties. Compositional properties include dimensions, shapes, materials, while functional properties include fire rating, load, etc. One or more properties can be used to set up a subdivision or group. Should objects be in multiple classes or groups, they can be characterized by primary, secondary classes, etc.
While some may argue that classification should be "exhaustive and definite", I would counter that flexibility and time (instance) and purpose must be considered. I do not subscribe to the belief that each object must below to only one class.

Omniclass, Uniformat, MasterFormat, & UniClass represent relatively well known and used construction classification systems.

Omniclass

The OmniClass Construction Classification System (OCCS) is an attempt to organize all construction information, and is supported by the Construction Specifications Institute, CSI and Construction Specifications Canada, CSC. MasterFormat and UniFormat are included within Omniclass.

The purpose of OmniClass is to better enable the organization, sorting, and updating planning, design, construction and facility management information for all aspects of a physical asset's life-cycle. Omniclass should provide classification for all products and procedures throughout the life cycle of a physical asset.

OmniClass follows the framework set out the ISO 12006-2 standard. (Ceton, 2011). As noted, tables include MasterFormat for work results table, and UniFormat for elements.

OmniClass is a faceted classification, thus can classify from multiple perspectives. For example, OmniClass uses more than fifteen (15) ISO tables to represent a different facet of construction information. Examples:
Table 21, 22 and 23 - building products.
Table 21 – Elements/UniFormat
Table 22 - Work Results/MasterFormat
Table 23 Products/EPIC

MasterFormat

MasterFormat is also produced by CSI and CSC, and has been used to organize line item construction items for decades. MasterFormat is a hierarchical list of numbers, tasks, products, and associated descriptions. It's divided into "Sections" and arranged in "Levels". There are currently over fifty (50) divisions.

UniFormat

The AIA and GSA initially developed UniFormat. Then ASTM International began developing a standard for classifying building elements, based on UniFormat, and it evolved into UniFormat II. CSI and CSC created the latest version of Uniformat II.

UniFormat is based upon major building systems and assemblies. The systems and assemblies are characterized by function. Uniformat is primarily used for construction cost estimating and building life-cycle modeling UniFormat framework is a hierarchical system including categories and levels.
A: substructure, B: shell, C: interiors, D: services, E: equipment & furnishings, F: special construction & demolition, G: building site work and Z: general.

Uniclass

Uniclass is a faceted classification system including approximately fifteen (15) tables intended for all aspects of the design and construction process. It is organized by two to six digit codes. Work results are included in Uniclass2.