Construction Operations Building Information Exchange (COBie)

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Learning Objectives

- Understand the purpose and scope of COBie in the building lifecycle
- Identify common tools and formats used to manage or export COBie data
- Interpret basic COBie spreadsheets and their data components
- Apply COBie concepts in a project scenario
- Relate COBie to broader standards such as Industry Foundation Classes (IFCs), and National BIM Standard in the United States

Outline

- Overview
- COBie Spreadsheets
- Methods to Generate COBie Data
- Good Practices
- Summary

What is COBie?

- COBie stands for **C**onstruction to **O**perations **B**uilding **i**nformation **e**xchange.
- It is a standard that specifies how to capture and deliver data related to the maintainable facility assets in a standardized digital format.
- COBie is part of the U.S. National BIM Standard (NBIMS-US), curated and maintained by The National Institute of Building Sciences.
- The latest version is COBie Version 3 and it is included in NBIMS-US Version 4.
- Construction to Operation means a handover, which happens at the end of new construction, renovation, or the change of facility ownership or management.
- COBie has been typically used for buildings, but it can be used for infrastructure projects as well.

Why COBie?

- Capture and deliver data related to the managed facility asset in **standardized digital format**
  - Replace the paper-based document exchanges with a digital format
  - Replace proprietary formats with an open and standardized format
- Enable the information of reuse across different project participants and life-cycle stages
- Eliminate the wasted effort associated with the production of paper documents (e.g., a large volume of Operations and Maintenance Manuals)
- Reduce the cost and improve the quality of construction handover

Maintainable Facility Assets

The items that the facility owner will manage in computerized operation & maintenance systems:

- Spaces
- Architectural assets (e.g., doors and windows)
- HVAC system assets (e.g., chillers, boilers, and air-handling units)
- Plumbing system assets (e.g., plumbing fixtures and valves)
- Fire suppression system assets (e.g., fire extinguishers and pumps)
- Electrical system assets (e.g., lighting fixtures, distribution panels, and switchgears)
- Other product and equipment

It is up to the owner to specify the list of maintainable facility assets!

COBie Format

Format	Referred Standard
STEP physical file format	ISO/IEC 10303-21:2016
ifcXML format	ISO/IEC 10303-28:2007
SpreadsheetML format	ISO/IEC 29500-1:2016
JSON format	ISO/IEC 21778:2017

- These formats are intended for system-to-system exchange of information without user intervention, not for end users. They are used for large projects.
- Spreadsheets are user-readable and workable for small projects.
- There is a mapping relationship between COBie spreadsheet data tables, data fields and other formats. For example:
  - COBie.Zone <==> IfcZone;
  - COBie.Space <==> IfcSpace, IfcExtgernalSpatialElement

COBie Spreadsheets

COBie 19 Data Tables

Table Category	Tables
Overall tables	Facility, Company
Spatial tables	Level, Zone, SpaceType, Space, Coordinate
Asset tables	Type, Component, System, Attribute
Process tables	Instruction, Package, Job, Event, Risk
Support tables	Document, Resource, PickList

- Not all tables are required. The required ones are yellow highlighted.

Data Table Description

Table Name	Description
Facility	High-level information related to the facility represented by a COBie deliverable
Company	Information related to a company this is referred elsewhere in a COBie deliverable
Level	Information related to the vertical levels (e.g., floors) of a facility
Space Type	Different types of spaces (e.g., office, restroom, computer lab)
Space	The breakdown of Levels into rooms or areas of common functions
Zone	The grouping of spaces combined for a common purpose
Coordinate	The simple geometric orientation used to identify a component in a space
Type	Information related to different types of products and equipment (e.g., boiler, door)
Component	Individual instances of product and equipment defined in the Type table
System	The grouping of Components that provide a common function (e.g., HVAC, lighting)

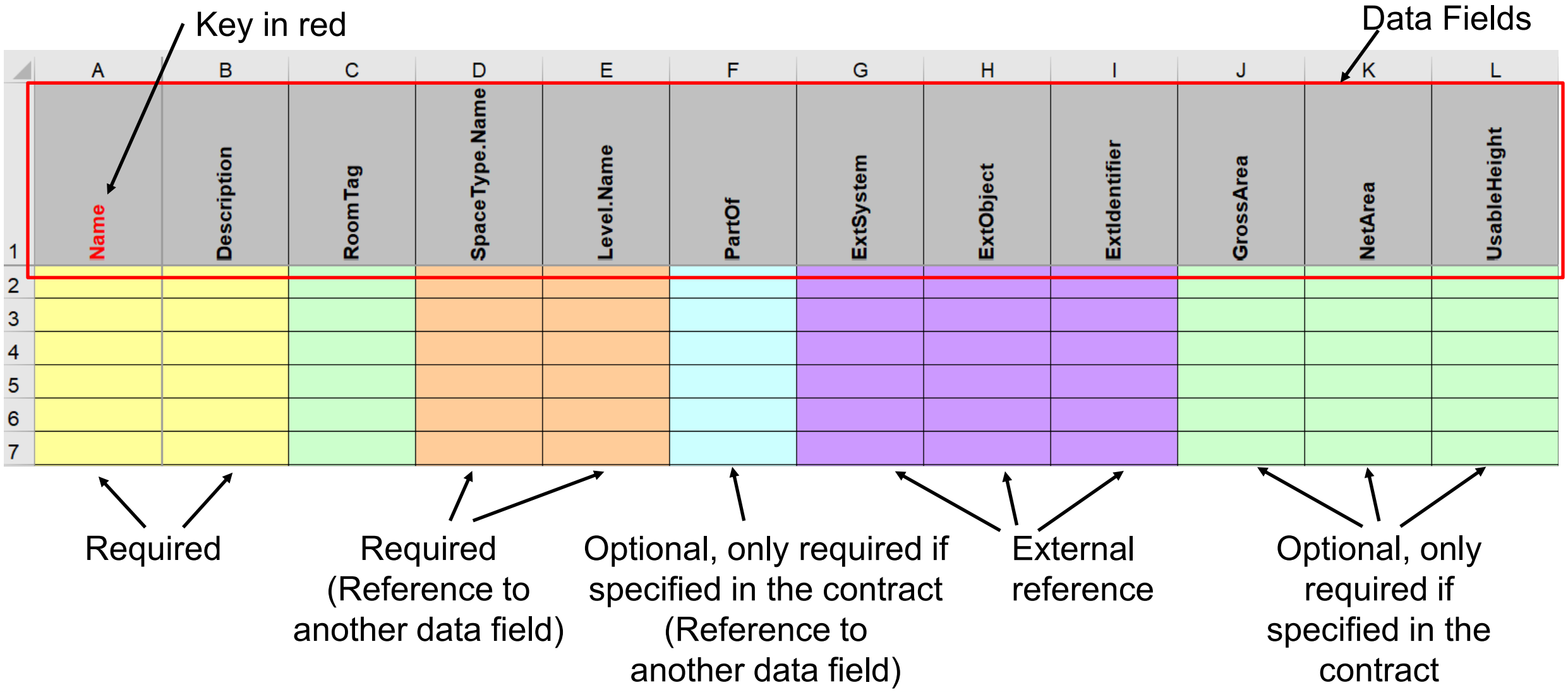
Data Table Description (Cont'd)

Table Name	Description
Attribute	Specific information related to an asset defined elsewhere
Instruction	Instructions related to a COBie deliverable
Package	Information about a legal contract
Job	A piece of work related to operation, maintenance, or troubleshooting a component
Event	A single occurrence of a task as part of a job
Risk	The exchange of business process and exception reporting information
Document	Records about external files
Resource	Tools, materials, and training needs
PickList	Lists of predetermined values for certain data fields

Data Tables and Data Fields

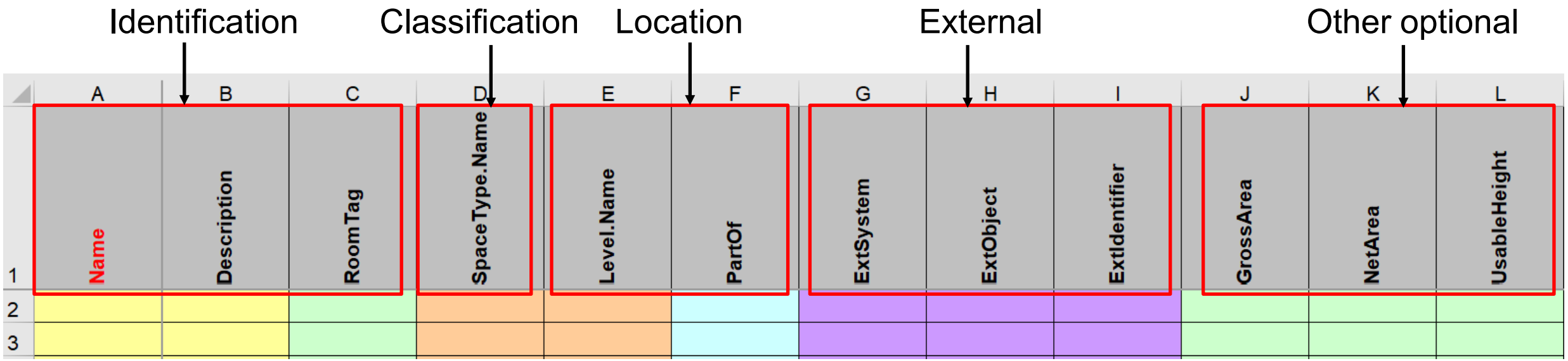
- Each table has a standardized set of predefined data fields, which are color coded to distinguish their status:
  - Always required, new input (yellow)
  - Always required, reference to another data field in the same table or other tables (orange)
  - Required only if specified in the contract, new input (green)
  - Required only if specified in the contract, reference to another data field in the same table or other tables (blue)
  - External reference to computer software (purple)
- Each table usually has a key to distinguish data records (rows). The key can be unique (which is usually “Name”, the first data column) for most tables but it can be a compound key (i.e., the combination of “Name” and other data columns).
  - Key is not used for the Instruction and PickList tables.

Example: The Space Data Table



Data Fields Organization

- Identification: data fields used to identify an asset
- Classification: data fields used to classify an asset
- Location: data fields related to an asset's location
- External: data fields populated by external software



External Reference

The following three data fields are used in all data tables except Instruction and PickLists:

- **ExtSystem**: The name of software generating the record
- **ExtObject**: The name of the data object in software that holds the data in the given record
- **ExtIdentifier**: The unique ID generated by software

Example:

COBie Data	ExtSystem	ExtObject	ExtIdentifier
COBie.Space.1A10	Autodesk Revit 2014, Build: 20131024_2115(x64)	Autodesk.Revit.DB.Architecture.Room	3dde7303-5414-4af6-b96b-591f33d44ad6-0006224a
COBie.Component.HVAC Ducts_851986	Autodesk Revit 2014, Build: 20131024_2115(x64)	Autodesk.Revit.DB.Mechanical.Duct	4ec17585-c36e-4cc3-8301-61df48a06d7e-000d0012

Data Fields and Records

- It is **NOT** permitted to create new custom data fields in COBie tables.
- The same data field name may be used by multiple tables. Use the nomenclature **DataTable.DataField** to refer to a specific data filed on a specific table. For example, the **Name** data field on the **Space** table would be represented as **Space.Name** or **COBie.Space.Name**.
- The **Facility** table must have only one data record. ➔ One COBie file per each facility.
- Other tables can have as many data records as needed (Excel has a limit of 1 million rows).

Data Field Values

- Data types
  - Text: ASCII printable characters (maximum 255)
  - Real number
  - Date
  - URL
- Data fields should not be left blank. If the information is not available, use n/a for text fields and 0 for real number fields.
- Some data fields must be populated with pre-determined values. The lists of pre-determined values are defined in the **PickLists** table.
- Some data fields require a comma separated list of values. This happens when an aggregation relationship exists. For example, the table **Zone** has a data field Space.Name used to indicate possible multiple spaces in each zone.

PickLists

The **PickLists** table specifies the acceptable values for certain data fields in other tables. These data fields and associated tables include the following:

Attribute.Category	Job.Category	Table
Company.Category	Job.Status	Type.AssetType
Coordinate.Category	Level.Category	Type.Category
Coordinate.TableName	Package.Category	Zone.Category
Document.ApprovedBy	Risk.Category	Introduction.AreaUnit
Document.Category	Resource.Category	Introduction.CurrencyUnit
Document.Stage	Risk.Consequence	Introduction.DurationUnit
Event.Category	Risk.Likelihood	Introduction.LinearUnit
Facility.Category	SpaceType.Category	Introduction.VolumeUnit
Facility.Type	System.Category	Introduction.WeightUnit

PickLists Examples

- Values are pre-determined by the COBie Standard. For example, the Attribute.Category defines the following values: Approved, As Built, Exact Requirement, Maximum Requirement, Minimum Requirement, Requirement, Submitted.
- Values refer to the categories defined by a construction classification system, e.g., OmniClass. OmniClass tables can be used in the following data fields:

COBie Data Field	OmniClass Table
Company.Category	Table 34
Facility.Category	Table 11
Package.Category	Table 22
SpaceType.Category	Table 13
System.Category	Table 21
Type.Category	Table 23

OmniClass: https://www.csiresources.org/standards/omniclass/standards-omniclass-about

Exercise

For the information listed below for a piece of HVAC equipment, identify which **COBie Table** and **COBie Data Field** it would typically belong to.

- The manufacturer
- The serial number
- The date when the HVAC equipment was installed
- A link to the PDF manual for the HVAC equipment
- The room where the HVAC equipment is located
- The name of the company responsible for the equipment warrenty

Methods to Generate COBie Data

Typical Methods

- Manually entry using spreadsheets
- Export from BIM software
- Middleware or COBie conversion tools
- Data Extraction from Computer-Aided Facilities Management Systems

Manual Entry Using Spreadsheets

- Directly filling out the COBie template in Excel
- Use case: small projects, BIM models are not available or post-construction handover data
- Manual entry using data from design drawings, equipment schedules, and as-built documents
- Example equipment schedule:

VARIABLE AIR VOLUME TERMINAL BOX SCHEDULE

SYMBOL	MANUF	MODEL	SIZE		MINIMUM AIR FLOW (CFM)	MAXIMUM AIR FLOW (CFM)	HEATING AIR FLOW (CFM)	LEAVING AIR TEMPERATURE (°F)	AIRSIDE PRESSURE DROP (INCHES WG)	HEATING COIL							CONTROL VALVE		NC LEVEL		ACCESSORIES/REMARKS
			UNIT	OUTLET						FLUID	TOTAL CAPACITY (MBTUH)	ROWS	FLOW (GPM)	EWT (°F)	LWT (°F)	WPD (FT H20)	2-WAY/ 3-WAY	CV	RADIATED	DISCHARGE	
3820-HVAC-VAV-100	KRUEGER	LMHS	16	24x18	1100	2400	1100	91.9	0.40	HOT WATER	43.5	2	8.3	140	129.0	2.87	3-WAY	5.63	21	17	120V/24VAC TRANSFORMER, BACNET INTERFACE
3820-HVAC-VAV-102	KRUEGER	LMHS	14	20x17.5	600	1200	900	90.3	0.17	HOT WATER	34.0	2	4.4	140	123.9	2.56	2-WAY	2.98	13	13	120V/24VAC TRANSFORMER, BACNET INTERFACE
3820-HVAC-VAV-104	KRUEGER	LMHS	07	12x10	100	200	200	99.4	0.05	HOT WATER	9.5	2	2.1	140	130.7	1.04	2-WAY	1.42	14	19	120V/24VAC TRANSFORMER, BACNET INTERFACE

Export from BIM Software

- Export COBie data from BIM authoring tools
- Use case: design or construction models created by BIM tools already contain structured data
- Representative tools: Autodesk Revit, Bentley AECOsim, and ArchiCAD
- Example procedures
  - Bentley AECOsim: https://docs.bentley.com/LiveContent/web/AECOsim%20Building%20Designer%20Help-v5/en/GUID-B0EC9E30-69C6-43FB-AAD8-D4D2FB52DED4.html
  - Autodesk Revit: https://www.youtube.com/playlist?list=PL0RZIBv0pCfsnVaZwY6ENDYqPeftp320I

Middleware or COBie Conversion Tools

- Create COBie data by transforming existing BIM or IFC data via the use of middleware tools
- Use case: existing BIM models are IFC-compliant but not directly COBie-ready
- Representative tools: IfcOpenShell/Ifccobie (https://ifcopenshell.github.io/docs/python/html/ifccobie.html#)

Data Extraction from Computer-Aided Facilities Management (CAFM) Systems

- Create or update COBie data by pulling asset data from CAFM databases and formatting them as COBie
- Use cases: 1) existing buildings where no BIM model is available; 2) retroactive COBie population from long-standing asset records
- Representative CAFM tools that support COBie export: Archibus, Maximo, and Planon
- Example: COBie exporting workflow in Maximo (https://www.ibm.com/docs/en/maximo-eam-saas?topic=data-exporting-from-maximo-asset-management-cobie)

Good Practices

Recommended Good Practices

- Start with the end in mind
  - What information will be needed?
  - When will the data be delivered?
  - Who will deliver and review the content in each COBie deliverable
- Consider a COBie execution plan in contracts

What information will be needed?

- The list of maintainable facility assets
- The list of optional COBie data tables that are needed
- The list of optional COBie data fields that are needed
- The list of properties for each maintainable facility asset. The COBie Guide has the minimum set of information for all different product and equipment.

- ***The information need is not "the more the better".***
- ***Because not all data tables and data fields are required, it is important for the owner to specify what information is necessary for each type of equipment.***

When Will the Information be Provided or Updated?

- Whenever a handover occurs or at a certain project phase
- COBie targets the construction-operation handover but it can be used for intermediate handovers between different project participants (e.g., from designer to constructor)
  - At the end of conceptual design development
  - At the end of design development
  - At the end of construction documentation
  - At the construction-operation handover
  - At fixed intervals during the operating phase

Specify interim COBie deliverables, especially for large projects. The intermediate deliverables (also called "data drops") may not include all the information ultimately required at the construction-operation handover but they are important to ensure data completeness and accuracy.

Who Will Provide the Information?

- Architects: spatial information (spaces, floor) , equipment locations, architectural element schedules (e.g., door and window)
- Engineers: product and equipment schedules
- Contractors: manufacturer, make, model, serial number, installation date, and etc. of installed product and equipment
- Suppliers: data sheets of product and equipment
- Commissioning agents: warranties, spare and parts, maintenance information
- Facility owner: reparation, maintenance, replacement

Summary

- COBie bridges the gap between design/construction and operations/maintenance.
- COBie has a structured format for delivering asset data at project handover.
- The COBie spreadsheet includes 19 tables covering Facility, Floor, Space, Type, Component, System, Jobs, Documents, and more.
- Using COBie can reduce manual data entry, standardize the handover process, and improve asset visibility and operational readiness.

References

- COBie Standard V3. National Institute of Building Sciences. https://nibs.org/nbims/v3/cobie/
- East, B. and Carrasquillo-Mangual, M., 2012. The COBie Guide. https://www.bimpedia.eu/static/nodes/1010/COBie_Guide_-_Public_Release_3.pdf

Further Reading Assignment

- Autodesk COBie Extension for Revit. https://www.youtube.com/playlist?list=PL0RZIBv0pCfsnVaZwY6ENDYqPeftp320IEngineers: product and equipment schedules
- ASHRAE Standard 224-2023: Standard for the Application of Building Information Modeling.
- Kumar, V. and Teo, E.A.L., 2020. Perceived benefits and issues associated with COBie datasheet handling in the construction industry. *Facilities*, 39(5/6), pp.321-349.

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