Figure 1: Project Greenfield, Phase I (as pictured in this aerial rendering) demonstrates that a COBie-based building information exchange can be successfully implemented across a broad range of facility types.

COBie, from Design to Operations

By Kristine K. Fallon, FAIA; George R. Farish II, LEED AP BD+C; and Danielle Gran

FMC Technologies, Inc. (FMCTI), a global provider of equipment and services to the energy industry, recently implemented the Construction to Operations Building information exchange (COBie) for Phase I of Project Greenfield, a mixed-use corporate campus consisting of approximately 1.7 million square feet of Class A improvements on a 72-acre site in Houston. COBie is an information exchange specification for the life-cycle capture and delivery of facility information. Eight record COBie files were generated and imported into FMCTI's integrated workplace management system (IWMS) prior to substantial completion, allowing the facilities management (FM) team to query 1,600-plus spaces, 1,200-plus equipment standards, 14,000-plus components, 31,000 jobs (preventive maintenance tasks), 28,000 spare parts, 5,000 resources (tools) and 8,700-plus operations and maintenance (O&M) documents on the first day of operations. Since a six-story office building, several industrial buildings with multiple floors of embedded office space, a climate-controlled warehouse, a parking garage, a central plant and significant site infrastructure comprise the FMCTI campus *(see "Figure 1," above)*, Project Greenfield demonstrates that a COBie-based building information exchange can be successfully implemented in the private sector on a large scale across a broad range of facility types.

In this case, the timely delivery of COBie data sets required active engagement by key project stakeholders over a two-year period and a shared commitment to overcome hurdles, particularly in the areas of change management and data management. In the spirit of continuous industry improvement and knowledge sharing, this article offers some key takeaways for members of the extended architecture, engineering, construction, owner and operator (AECOO) community.

Defining COBie Equipment Information Requirements

Ideally, a building owner has a clear definition of what information he/she wants to capture about the various types of building equipment. Some federal agencies have required contractors to complete equipment data templates for years. In those agencies, a facilities manager reviews construction drawings toward the end of design and determines which equipment data templates will be required.

Most building owners, however, do not define their building data handover requirements, even if they have an IWMS or computerized maintenance management system (CMMS) in place. For any owner contemplating a major project—and in order to derive the maximum value from the building information created during design and construction—defining the COBie deliverable requirements before building modeling begins is critical. COBie deliverables almost invariably require manipulation of building information modeling (BIM) object libraries in order to export all required data properly. Project teams need to do quite a bit of rework on the models if they are not provided with the owner's building information requirements in advance.

Key questions are:

- What information is required for operations and maintenance?
- Which design and construction project team members produce this information?
- When during the project should the information be captured?

What Information Is Required?

The most basic approach is to capture data exclusively for equipment that requires maintenance. Similarly, a fundamental approach only captures the minimum required

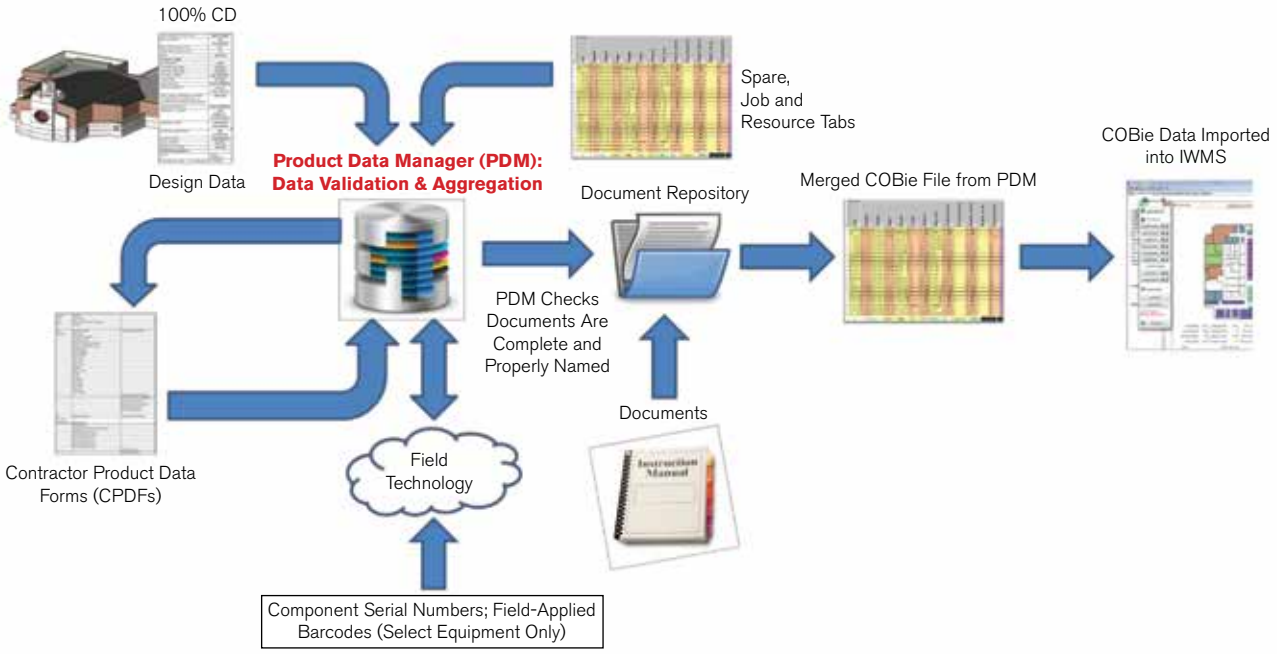

Figure 2: In this illustration, the Product Data Manager validates and aggregates data from many sources and produces the record COBie files for data handover for Project Greenfield.

data fields on the COBie contact, facility, floor, space, type and component data tables. In the standard COBie Excel template (download from **www.nibs.org/?page=bsa_cobiemm**), these columns are colored yellow and orange. In addition, the Document tab relates electronic document files to each equipment type (e.g., O&M manuals, warranties, asset photos, training videos), while the Spare tab captures spare parts data.

Life-safety equipment, such as fire extinguishers, is an important category of equipment to track with COBie as it requires periodic inspection or testing. Building owners should know the location and quantity of such assets to support both the scheduling and tracking of inspections and testing.

Another consideration in defining the scope of required information is that the owner may outsource the provisioning and/or maintenance of some assets to third parties, such as furniture installers, food-service operators, etc. These assets may appear in the design models but may not need to be included in a COBie dataset if they are not going to be tracked and maintained in the owner's IWMS.

Who Produces the Information?

If there is a problem with a piece of equipment, most facility managers want to determine if the equipment is performing to the manufacturer's specifications. Typically, this equipment performance information (e.g., capacity, flow rate, etc.) is provided as part of the product submittals from trade contractors. In these instances, information can be captured as a COBie document related to each equipment type, or as additional type information, and recorded on the COBie Attribute tab.

Many owners also want to know whether the supplied equipment meets the design specifications. This requires capturing design data from the architect/engineer equipment schedules and, possibly, from the design specifications.

Additionally, special, owner-supplied equipment may be included in a project. In the case of Project Greenfield, this included industrial process equipment.

When Should Information Be Captured?

Design intent data should be captured during the construction documents (CD) phase of design, and updated after any addenda or alternates are accepted following procurement. Final COBie Type information is best captured during the product submittals process early in construction. Submittals approved by the design team confirm manufacturer names, model numbers and performance characteristics of any equipment. Component data—serial numbers, barcodes, installed dates, etc.—should be captured once the equipment is in place.

For Project Greenfield, the general contractor was required to record Job, Resource and Spare COBie data for all required equipment types so that FMCTI's IWMS could be populated with preventive maintenance procedures, special tools required and spare parts. This necessary manual entry from O&M manuals and parts lists was received during the last few months of construction.

However, once a product has been approved, the contractor should capture this data promptly—even better would be if such information is supplied in COBie format by the equipment manufacturer.

In addition, Division 1 contract language required very specific deliverables that tied the release of subcontractor retainage to COBie data delivery. Division 1 also required adherence to a COBie execution plan (CEP)—a variant of a BIM execution plan—focusing on data. Key CEP topics included:

- Roles and responsibilities.
- Naming conventions and content.

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- Required equipment classes.
- Appendices with detailed attribute requirements for spaces and equipment types.

This document established detailed naming conventions for Spaces, Types, Components and Documents, as well as the field or parameter names for all attributes. This allowed for detailed COBie deliverable validation and resulted in numerous unanticipated benefits. Although the need for rigorous naming conventions often is debated, the Project Greenfield experience proved that naming conventions are extremely valuable.

A preliminary CEP should be drafted early in the project during programming and concept development, and should convey information about COBie roles, responsibilities, naming conventions and a high-level schedule of asset categories to be catalogued. Because all equipment types are not known until very late in the CD phase, the CEP should be treated as a flexible, living document that is updated periodically to reflect the increasing level of facility model development.

Teams who commit to COBie deliverables must adjust workflows and traditional project management responsibilities to enable a balanced focus on both design/geometry and data management. Agile teams willing to embrace such changes in the era of BIM and "big data" will improve their technical skillsets and position themselves to win future business.

Climbing the COBie Learning Curve

Trammell Crow Company (TCC) served as the development manager for Project Greenfield, overseeing a broad scope of work, including site due diligence, design, construction and commissioning. During design development, TCC and FMCTI jointly concluded that the campus FM team would realize significant long-term operating efficiencies by adopting the COBie standard. They set a goal to collect, validate and load meaningful datasets into a to-be-procured IWMS prior to occupancy.

While many of the project architects and engineers had prior experience working on capital projects of similar scale and complexity to Project Greenfield, virtually none had experience submitting design schedules for downstream use by an IWMS. The prospect of introducing an unfamiliar and seemingly complex process in the middle of a fast-paced design schedule raised concerns about the "COBie learning curve" and its potential impact on schedule and cost.

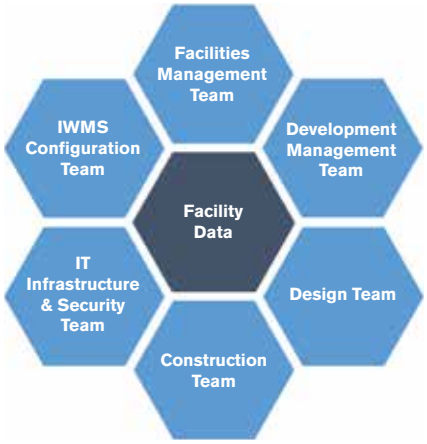

Figure 3: Bringing together a broad range of internal teams (such as those at FMCTI) helps identify how facility data standards and collection efforts can be utilized beyond the domain of an FM team.

To mitigate these risks, TCC engaged Kristine Fallon Associates (KFA) to serve as the project's COBie consultant. KFA's key deliverables included: (1) defining Division 1 COBie requirements; (2) validating COBie design and construction data; and (3) generating record COBie files. Within a relatively short period, KFA developed a consensus-based CEP, which allowed the AECOO team to better gauge the effort required to produce project-specific COBie design deliverables.

The Project Greenfield general contractor (GC) initially expressed some reservations about incorporating COBie deliverables into its construction contract. The GC felt that few subcontractors in the market were familiar with COBie and speculated that subcontractors might pad their bids to address the COBie learning curve. After multiple discussions, the team suggested that a draft copy of the CEP be issued to relevant subs in advance of pre-bid meetings. The draft copy would set clear expectations. Because subs were thoroughly briefed on COBie submittal requirements before the start of competitive bidding, virtually no subcontractor submitted a bid with a COBie premium.

In a similar fashion to typical BIM coordination meetings (which often focus on geometry and interference resolution), COBie coordination meetings served as essential checkpoints to confirm data was being generated and validated in a timely manner—a key point since the CEP was not published until halfway through the CD phase. Meetings provided a forum for sourcing solutions to a wide range of data-management challenges relating to such issues as parametric modeling, automated asset sequencing and managing variances between construction drawings and submittals. At the end of each call, the team agreed to a two-week, look-ahead schedule with a clearly defined set of deliverables, which proved to be an effective accountability tool.

Since robust and configurable software tools for aggregating, collaborating on, validating and manipulating COBie data are in short supply, KFA provided a configurable tool for Project Greenfield—the Product Data Manager (PDM)—which allowed data aggregation, management and validation at a very detailed level *(see "Figure 2," page 9)*.

Extending the Value of COBie

Some of the more commonly cited benefits of COBie include avoiding costly, yet common project closeout challenges, such as: waiting months for the delivery of handover documents; tracking down incomplete submittals after key construction personnel demobilize; manually entering large volumes of data into a CMMS/IWMS during the early stages of occupancy; and abstracting preventive maintenance procedures, tools and spare parts from O&M manuals. As expected, the implementation of COBie on Project Greenfield enabled FMCTI to avoid these common pitfalls. However, the project team did not fully anticipate the extent to which it would leverage COBie during the facility life cycle, including valuable contributions in four key performance areas: safety, quality, delivery and cost.

TCC also engaged a broad range of internal FMCTI teams in a series of discovery meetings prior to procuring

the IWMS for Project Greenfield—an important aspect of the project's success. The goal of these meetings was to summarize the project's COBie data standards and collection efforts and determine to what extent this data could be utilized outside of the FM team. Representatives from information technology (IT) infrastructure/security, accounting, finance, tax, human resources and communications participated in these meetings, prompting extensive discussions about opportunities to extend internal access to such facility data for the purpose of streamlining cross-departmental business workflows *(see "Figure 3," opposite page)*. These meetings had a significant influence on the scope and sequencing of the IWMS implementation.

In Conclusion

Many findings and recommendations of using COBie for Project Greenfield follow.

Findings

- The owner gains significant benefits from using the COBie approach.
- COBie provides an excellent framework for the delivery of large amounts of data about space and equipment for operations and maintenance use in a machine-readable, standard, structured format.
- This data can be delivered before closeout and loaded quickly into an IWMS, CMMS or facility management system.
- Once turned over, the COBie data benefits a significant number of systems used to operate, maintain, change, monitor, control and account for the facility assets—essentially, breaking down data silos.
- The COBie approach substantially changes common design/construction business processes to capture the COBie data at the source and at the time created, and applies new tools to aggregate, validate and manage that data throughout the project life cycle.
- Despite the process changes, this approach does not require a radical departure from traditional project-delivery approaches or the division of responsibilities between design and construction.
- There is a significant organizational learning curve in transitioning from a document-centric project approach to an information-centric project approach.
- The market lacks project collaboration and COBie data management tools that handle data and associated documents.
- Although many software products have COBie import or export capabilities, the COBie tools generally are not yet robust or well-supported.

Recommendations

- Owner organizations should initiate COBie requirements planning before schematic design.
- Owner organizations should create a CEP template that can be adapted for any project.
- Like successful BIM use, COBie requires execution planning and dedicated management. Both designers and contractors should consider this in planning and staffing projects with COBie requirements.
- Manufacturers should provide procedures for equipment startup, shutdown and maintenance, as well as spare parts lists in COBie format. This information is very valuable to an owner's FM team. This information also is very difficult and time-consuming for the contractors to extract from manuals.
- Software vendors should step-up support for the COBie standard to make it easier to import, export, collaborate on, validate, aggregate and deliver valuable facility data. JNIBS

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