AUTODESK UNIVERSITY

BU21079

Building Information Modeling to Facilities Information Management and Beyond

Meghan Ruffo, BIM Manager / Carolinas HealthCare System
Thomas Koltoniak, BIM Specialist / Carolinas HealthCare System
Geoffrey Coon, BIM Specialist / Carolinas HealthCare System

Learning Objectives

- Understand the need for owner BIM contract requirements and the resources needed to assist with compliance
- Understand the use of virtual coordination to minimize rework and shorten planned downtime
- Understand use of virtual documentation for regulatory compliance
- Understand the program ROI and cost avoidance in utilizing BIM for FIM

Description

Carolinas HealthCare System will review the strategic implementation of Building Information Modeling (BIM) from project inception to facilities management. The owner team will then explore the benefits of project processes, such as multi-team member collaboration, virtual coordination, and owner BIM standards that help minimize project risk. The owner team will also describe their use of BIM during facilities management, which includes space management, asset management, and virtual documentation. Carolinas HealthCare System will conclude with the BIM program lessons learned and return on investment of their BIM to FIM (Facilities Information Management) implementation.

Your AU Experts

Meghan Ruffo - Meghan is currently managing the Building Information Modeling (BIM) Program for Carolinas HealthCare System. In her role, Meghan has developed BIM Guidelines for project deliverables, stating the requirements needed for design, coordination, and facilities management models. Meghan is a Registered Architect, LEED Accredited Professional, and Revit Architecture Certified Professional.

Thomas Koltoniak - Thomas is a BIM Specialist for Carolinas HealthCare System with 17 years' experience in Architectural design and construction. He provides Facility Revit Modeling, BIM Project Submission Reviews, Project BIM Coordination and Archibus Space Management coordination. Thomas is a Revit Certified Professional.

Geoffrey Coon - Geoffrey is a BIM Specialist and FM Infrastructure Technical Assistant for Carolinas HealthCare System. He provides Facility Revit Modeling, BIM Project Submission Review and BIM Coordination for FM ArcFlash Projects. Geoffrey joined Carolinas HealthCare System with 36 years of experience as an Architect in Healthcare, Senior Living, Commercial and Residential projects.

Carolinas HealthCare System Overview

Carolinas HealthCare System (CHS) is healthcare organization based in Charlotte, North Carolina. The system contains over 900 care locations, more than 7,600 licensed beds, employs nearly 60,000 people, and accounts for almost 12 million patient interactions each year.

The Building Information Modeling (BIM) team is part of the Facilities Management Department (FMG) headquartered in Charlotte. FMG manages a footprint of over 17 million square feet, based primarily in Charlotte, but extends to the Western and Northern Carolina border. FMG includes a variety of services, ranging from site selection and development, construction project management, building maintenance, space planning, property management, building security, and environmental services. The BIM group supports the various FMG teams by maintaining accurate building documentation, which includes both the physical layout of the space and systems, as well as the data associated with building elements

The Value of BIM for Owners

As a building owner, Carolinas HealthCare System views Building Information Modeling as a resource to make more informed decisions during the building lifecycle. The enterprise implementation of BIM is seen as combining both technology and process improvements in order to reduce risk, improve facility design and construction, and most importantly provide a better patient care environment.

Pilot Project

Carolinas HealthCare System was introduced to BIM with a project that completed in 2009, CMC-Lincoln. The contractor created the BIM model for coordination prior to construction. The project was a design assist delivery, where the general contractor and key trade partners were brought on to the project early in order to help complete project documentation. This combined effort (BIM and collaboration) resulted in substantial cost savings and reduction in project schedule. Overall the project realized more that $2 million in savings from reduced errors and omissions, and opened 4 months early. More information on this project can be found here:
http://usa.autodesk.com/adsk/accelerate better design

CMC-LINCOLN HOSPITAL – THE FIRST BIM PROJECT FOR CHS, COMPLETED IN 2009

Contract Development and Compliance Checking

The foundation of the BIM program at CHS has been the establishment of BIM deliverable requirements. Establishing project expectations together with model and data use and intentions has initiated the success of going from project BIM to Facilities Information Management.

Contract Development

The development of BIM requirements has been a continual process, where standards and deliverables are tested on projects in collaboration with consultants, contractors, and FMG team members. After CMC-Lincoln, a BIM deliverable guideline was developed in early 2010. These guidelines were piloted on several projects, ranging from a new rehabilitation hospital, acute care renovations, and even medical office upfits. This process continued throughout 2010 and 2011, and by mid-2012 contract requirements were issued with the FMG AIA master agreements (annual agreements with Architects, Engineers, and Contractors) that mandated a BIM deliverable for all projects. The contracts are based on a heavily modified AIA E202 and contain 3 sub-exhibits, a BIM Execution Plan, Formatting Requirements, and Content Requirements.

BIM Execution Plan

The BIM Execution Plan or BEP, is the project specific document outlining project team members, model access and exchange procedures, coordination schedules and goals, and element ownership and development detail. The model element table lists each element and ownership responsibility/detail by phase. This ensures that expectations are established at project inception in order to avoid confusion and scope gaps near project completion.

ARCHITECTURAL								
Item	Details	CSI UniFormat #	Level of Development					
			DDs	Author	CDs	Author	Const.	Author
Exterior Wall Systems		B2010	300	WMBA	300	WMBA	300	WMBA
Interior Walls/ Partition Types		C1010	300	WMBA	300	WMBA	300	WMBA
Fire Rated Walls		C1010	300	WMBA	300	WMBA	300	WMBA
Equipment (Kitchen, Medical, Other)		E1040	300	WMBA	300	WMBA	300	WMBA
Ceilings		C1070	300	WMBA	300	WMBA	300	WMBA
Stairs/ Elevators/ Escalators	Vendor Drawings for Elevators will be provided.	B1080	300	WMBA	300	WMBA	300	WMBA
Doors and Door Frames		C1030	300	WMBA	300	WMBA	300	WMBA
Windows, Glazing, and Curtain Wall		B2020	300	WMBA	300	WMBA	300	WMBA
Millwork and Casework		E2010	300	WMBA	300	WMBA	300	WMBA
Roofing	Insulation, sloping, access, and details will be provided by WMBA.	B1020	300	WMBA	300	WMBA	300	WMBA
Furniture	WMBA Interiors	E2010	300	WMBA	300	WMBA	300	WMBA
Soft Goods	WMBA Interiors	E2020	300	WMBA	300	WMBA	300	WMBA
Artwork	WMBA Interiors	E2020	300	WMBA	300	WMBA	300	WMBA
Finishes	WMBA Interiors	C2010	300	WMBA	300	WMBA	300	WMBA
Ceiling Finishes		C2010	300	WMBA	300	WMBA	300	WMBA

EXAMPLE OF MODEL ELEMENT TABLE

Formatting Requirements

This exhibit contains the requirements for model formatting, including naming conventions for Revit files, families, and digital drawings, as well as required templates and content expected in each model type. Consistent formatting is needed in order to maintain file size, avoid element duplication, and incorporate project changes into master facilities management models.

Content Requirements

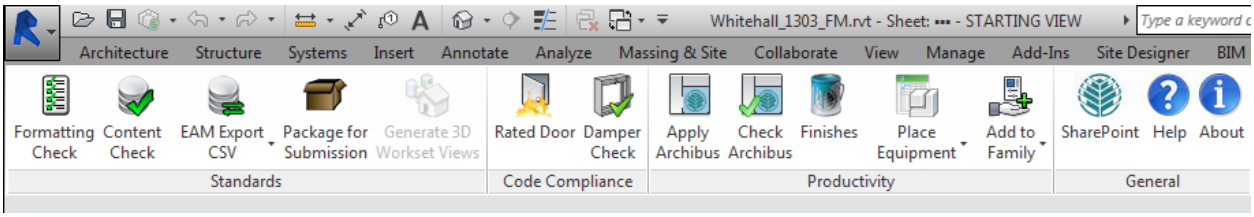
The required content development at each phase is listed in this exhibit. It gives a minimum level of overall model development by discipline and phase. The exhibit also lists the required information or shared parameters completion needed prior to the conclusion of each milestone deliverable.

The BIM contract requirements define what BIM means to Carolinas HealthCare System. The requirements state that information, along with 3D documentation, are required and that the model is intended for use in design, construction, maintenance, and future renovations. Clearly defined deliverable formats are listed that include Revit and Navisworks in their native file formats.

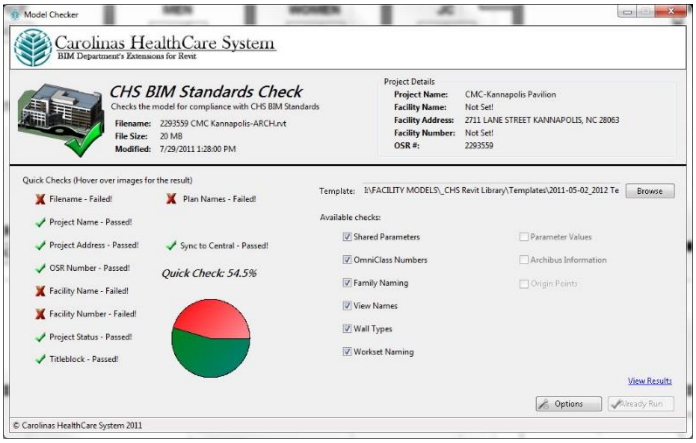
Resources to Assist with Compliance

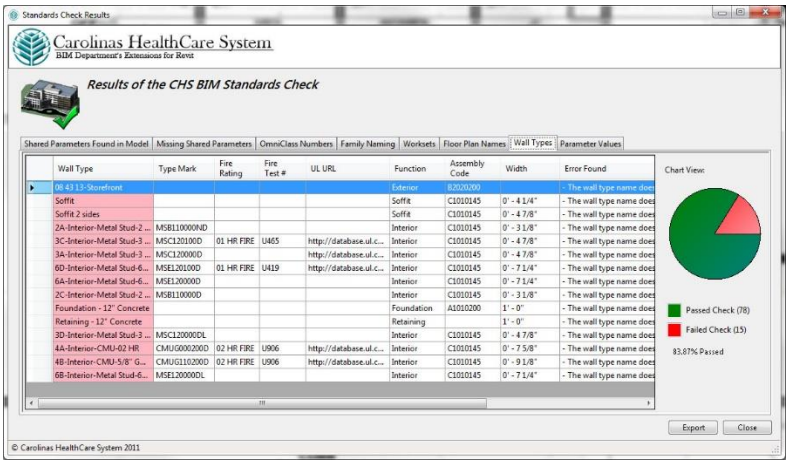
While having contract requirements is a necessary foundation in BIM to FIM, supplemental elements (Revit templates, family libraries, and add-ins) aid in contract compliance. CHS has created Revit templates for architectural, mechanical/electrical/plumbing, and structural disciplines. These templates contain view templates, title blocks, and shared parameters that ensure consistent formatting and translate written concepts to tangible formats that most team members are utilizing. Along with the templates, a family library is available on a SharePoint site for all consultants. Most of the families on the site are consistently used on projects or are items that are not readily available from manufactures, such as medical equipment.

CHS has developed a series of Revit add-ins that assist consultants with model compliance. These add-ins are divided into three categories – standards, code checks, and productivity enhancements. The standards section includes the format check, content check, EAM data export/import, and a package for submission tool. The intent is for the consultant to run these tools prior to submission in order to validate naming conventions, data format and data completion. The code checks are quick scans for door and damper ratings in fire rated walls. These were developed to catch common errors that may result in change orders or construction rework. The productivity enhancement assists consultants with data entry (finish standards can be selected and auto-input into rooms) and coordinating owner provided equipment which can be imported into the model via a spreadsheet.

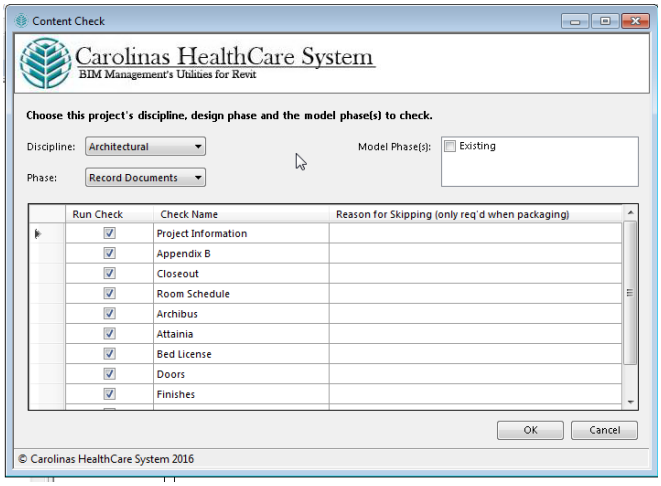


EXAMPLE OF CHS REVIT UTILITIES

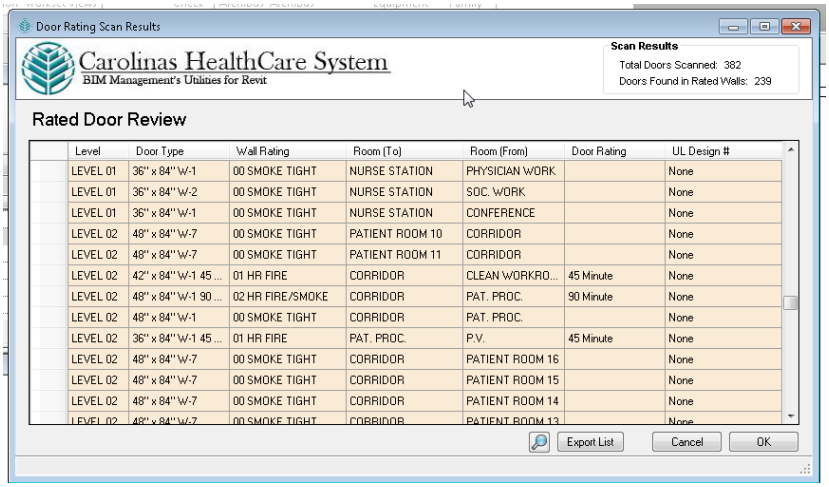




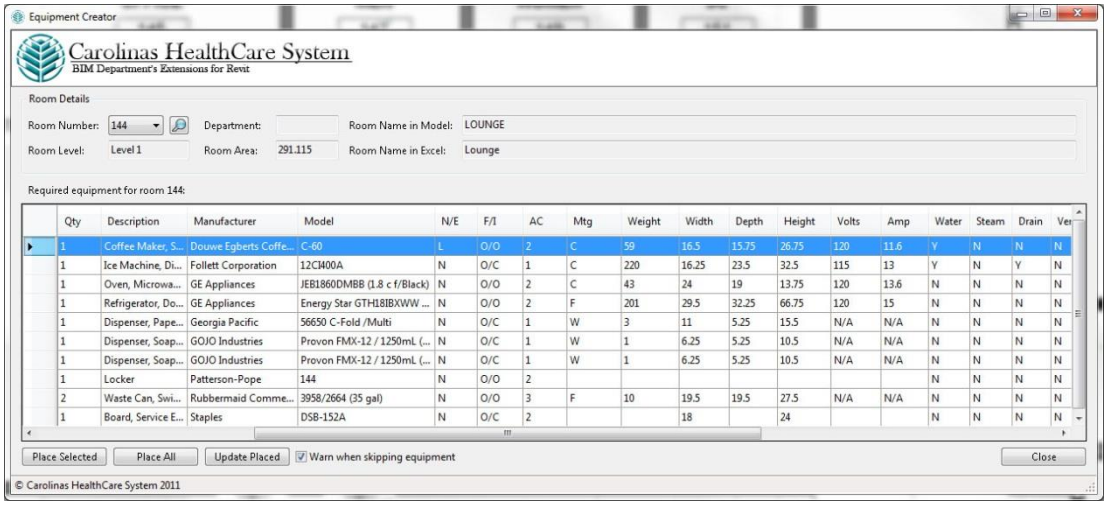
FORMAT CHECK

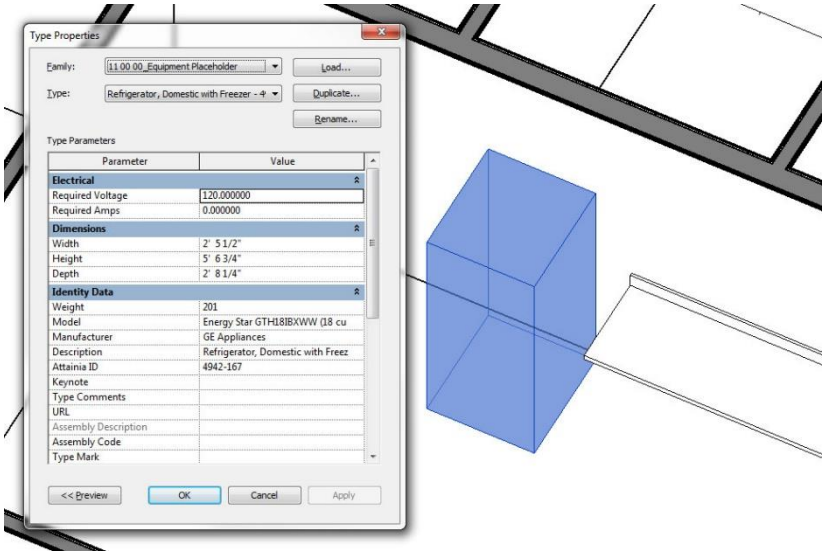


CONTENT CHECK



RATED DOOR CHECK





OWNER PROVIDED EQUIPMENT PLACEMENT AND COORDINATION

Submission Review and Scoring

BIM submissions are required at every milestone phase completion. The BIM team reviews each submission for contract compliance. This ensures all required models and documentation are formatted correctly and that the deliverable is complete. Checking early design submissions such as schematic and construction documents maintains consistent formatting throughout the project and helps eliminate surprises or delayed submissions at project completion. Each team member and the overall team are scored on the submission and that score is reported to FMG leadership to show team member BIM competency. It helps eliminate subjectivity in evaluating a consultant's BIM proficiency.

Carolinas HealthCare System

CARE WITHOUT COMPROMISE

Project Name:	CMC-NE CAC Renovation
OSR #:	2760424
Facility Name:	Clinical Services
Facility Number:	0799
CHS Project Manager:	Gigi Berg
Submission Phase:	Construction Documents
Submission Date:	6/10/2015
Submitted By:	WMBA
Project Contact:	Tracie Sansavera
Project Type:	Revit
Project Scope:	1422.59
Reviewed By:	Meghan Ruffo
Review Date:	6/16/2015

Discipline	Firm	Score
Architectural	WMBA	6
MEP	Caveo	5
Structural		N/A
Interior		N/A
Fire Protection		N/A
Civil		N/A

Team Drawing Review Score (0 - 6): 5.5

Resubmission Required: No

Resubmit By: N/A

Revit Content Checks

Pass?	Check	Details	Comments
Yes	Model includes all applicable Appendix B information and this information matches what is shown on the Appendix B sheet.	The project information (Manage Tab > Project Information) parameters must include all applicable Appendix B information.	
Yes	Submission includes all applicable Archibus and department information.	This is required for all projects. Department information (Department Number, Department Name & Business Unit) should come from the end user. Use the 'Apply Archibus' and 'Check Archibus' CHS Revit Utilities to enter and then check this information; it should not be entered manually.	
Yes	Rated walls correctly are setup and display wall ratings per CHS Standards	Wall fire ratings must follow the convention set in the CHS template filters (01 HR FIRE, 01 HR FIRE/SMOKE, etc). This ensures all ratings will display correctly per DHSR standards in CHS Barrier Management Plans.	
Yes	Project Scope Area Plan is setup and shows the current project scope. This value must also match what is entered into the eForm.	Using the 'Project Scope' area type in Revit, create an area plan for each level in your project and outline the entire scope. This is required for all projects since this number is used by CHS for reporting.	
Yes	Room finishes have been applied to rooms using the correct shared parameters	Room finishes must be applied to room elements in Revit and finishes must be applied to the CHS Shared Parameters setup in the CHS Revit template.	
Yes	Room numbers follow CHS standards	Reference the CHS Room Numbering / Naming Process	
Yes	Submission meets all Project Phase Deliverable requirements found in the CHS BIM Protocol Exhibit	Reference the Project Phase Deliverable requirements found in the CHS BIM Protocol Exhibit	
Yes	Submission meets all Model Requirements found in the CHS BIM Protocol Exhibit	Reference the Model Requirements found in the CHS BIM Protocol Exhibit	

TYPICAL SUBMISSION SCORECARD

Design and Construction

As stated earlier, the foundation for BIM has been in project and construction management with the development of BIM contract requirements. However, it was the technology and collaboration seen together that initiated the development of the CHS BIM program.

Project Type Specifics

One of the early lessons learned when rolling out the CHS BIM requirements has been the understanding of how to adjust requirements by project type. BIM for CHS cannot be a one-size –fits all approach due to the variances in project type (new construction, renovation) and project size. FMG manages everything from new hospital construction to small-scale general office renovation. There has also been the added challenge of working in existing facilities without any existing BIM models. In order to address these issues, the BIM team developed documentation that lists project type and expectations, as well as reasons for these requirements. This has been a useful document in communicating with consultants and internal FMG team members.

Aesthetics Only (Furniture and Finishes)	Provide finish information in Revit Room object. Room objects can be created from lines on top of CAD files or from an existing 3D model	CHS created tool that allows designed to auto-populate fields (manufacturer and model #) which reduces input time by designer Information is embedded into model and is linked to report on SharePoint for all CHS team members to access	Finish information not located in consistent place – sometimes on drawings and sometimes in the specifications. Finding manufacture and model in this way is time consuming and does not allow us to easily import into an FM system.
MEP Equipment Replacement	Draw new work in 3D Revit	Existing conditions can be 2D CAD reference files, but new work – new ductwork or AHU should be modeled in Revit 3D per CHS standards. This allows us to start to build MEP models for future projects and renovation without adding more work to the project. The teams have to draw this anyway – Revit helps with future projects and maintenance.	Teams could draw everything in 2D, but we would never be able to start to build MEP models for future projects or maintenance.
	Populate required parameters for new equipment (Manufacturer, model number, serial number, and link O&M, submittal, & warranty)	New equipment should meet all of the data parameter requirements as this can be exported into our EAM system and used for maintenance. On equipment replacement projects this is typically a handful of elements.	Team could not populate the information and the models would be 3D representations only which is not Building Information Modeling.
CERP	Draw new work in 3D Revit	Existing conditions can be 2D CAD reference files, but new work – new ductwork or AHU should	Teams could draw everything in 2D, but we would never be able

EXAMPLE OF PROJECT TYPE REQUIREMENTS

Collaborative Delivery

CHS has adopted a collaborative delivery approach for large projects due to the benefits realized on the initial pilot project. Most large-scale projects utilize a design assist approach where the general contractor is selected at the start of the project along with the design team. Once the project models and documentation reach schematic design, key trade partners are engaged to help finish documentation and assist with constructability issues while the design is being finalized. The goal of this type of collaboration is to have a completed construction document set, as well as shop drawings at the end of the design phase.

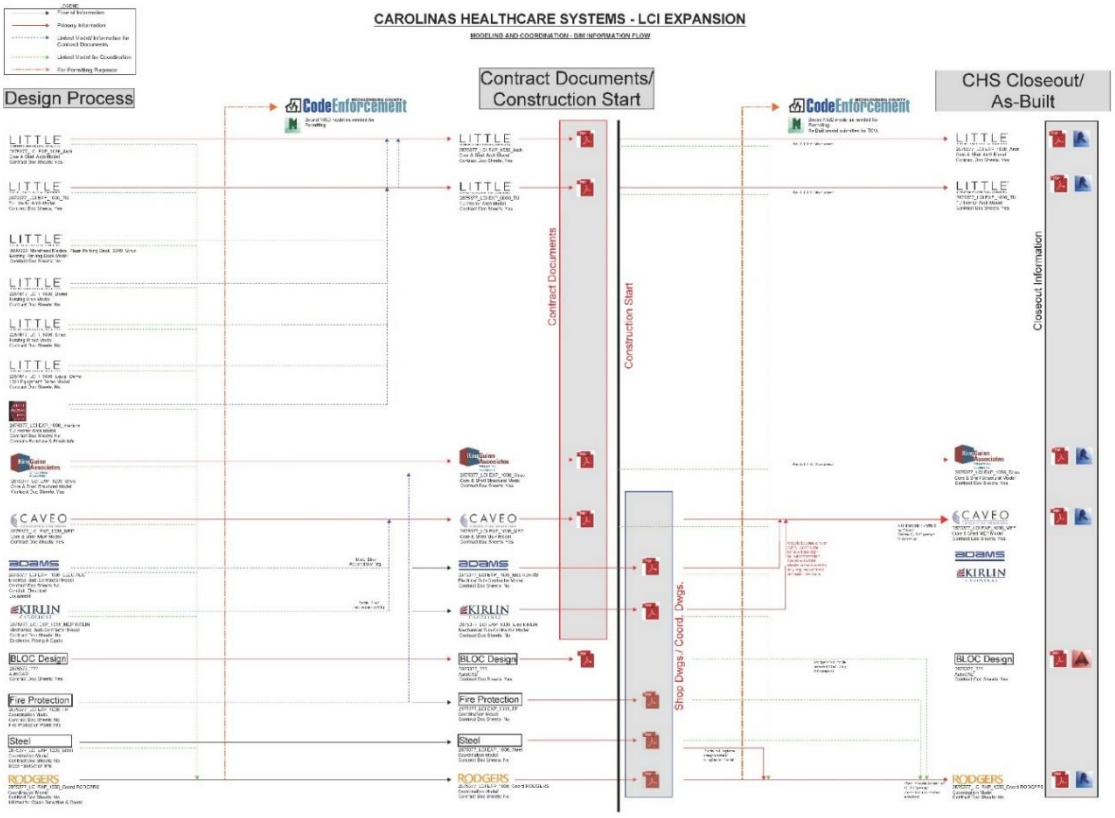
There have been several challenges with this type of project delivery. In past projects, teams had a tendency to fall back on traditional roles and processes. For examples, design teams may work on something then hand-off to the trade partner without any previous interaction –

teams were working in silos. In order to address this, co-location was used to provide more interaction. However, co-location created its own set of challenges. Technology infrastructure, physical space needs, and time management became an issue. The transfer of files using weekly uploads and weekly meetings were still not creating the collaborative environment envisioned by CHS.

CHS started exploring cloud hosting on the next round of collaborative delivery projects in order to address the file sharing and interactive environment. A third party provided a cloud with virtual desktops for all team members. Only team members using Revit could access the cloud; a secondary digital documentation site was still needed. The overall experience was better than past projects, however issues with initial cloud ramp up, creation of a VPN, and software licensing became concerns.

CHS has recently moved to using Collaborate for Revit in order to address the past third party cloud concerns. There are 5 projects using this tool with over 100 total Revit users. The projects are still in design and construction and the new tool evaluation will be done once a project is complete.

Throughout the technology explorations on collaborative delivery projects, the management of model and data workflow has been critical. Unlike a design bid build delivery there is not a clear handoff and the BIM Execution Plan has needed to be more detailed in order to account for this more dynamic interaction. Tracking the BIM development beyond the standard model element table has been necessary. Teams have developed additional workflow graphics which add another level of element breakdown in order to accurately establish roles and responsibilities between all team members.



EXAMPLE OF BIM WORKFLOW

Partnership with local Code Enforcement

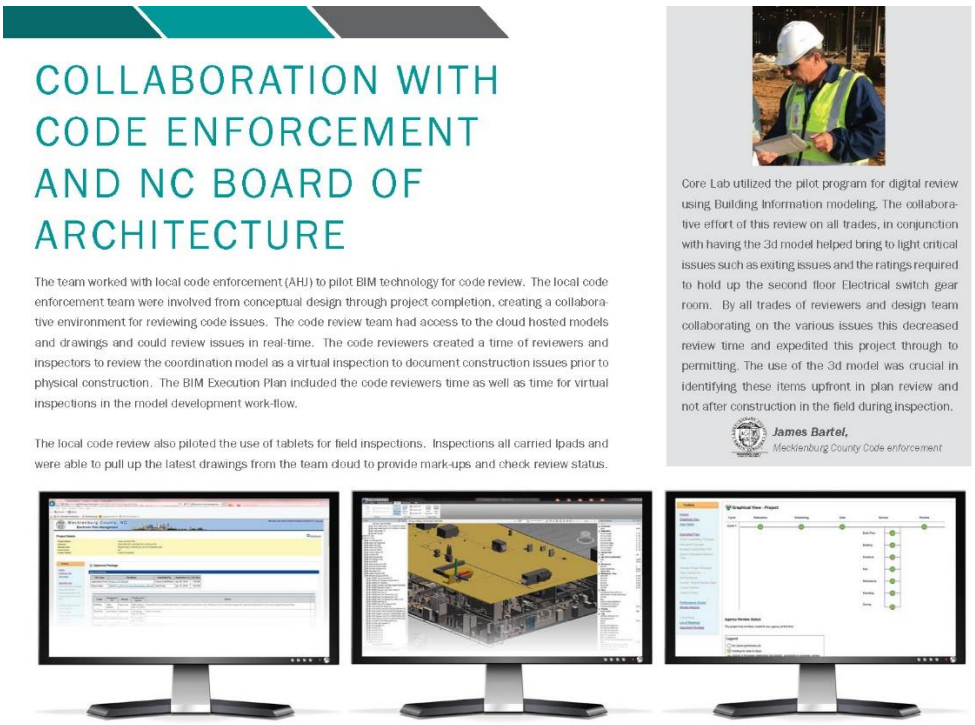
Technology and team member regression have been challenges faced with collaborative delivery. A third challenge has been the concern of licensure and digital signing and sealing of documents while working on a collaborative delivery project. CHS has worked with local code enforcement, Mecklenburg County, to review these concerns along with piloting BIM code review. Mecklenburg County has taken the initiative to test BIM code review and participate in the collaborative design approach along with the design team and trade partners. The county was engaged in early interactive reviews and walkthroughs of models and even tested virtual inspection using Navisworks models prior to construction. CHS along with the county sought to address the use of BIM code review in the NC Building code, the NC Board of Architects, and the NC Board of Examiners for Engineers & Surveyors. A code provision was made in the NC building code and both boards issued guidelines for BIM and IPD collaboration.

More information can be found at these links:

http://www.ncdoi.com/OSFM/Engineering_and_Codests

http://www.ncbels.org/Policies/SigningandSealing(BIM-IPD)ProjectsGuidelines.pdf

http://www.ncbarch.org/wp-content/uploads/2015/10/FINAL_2015-0911_NCBA_BIMIPD_Statement.pdf



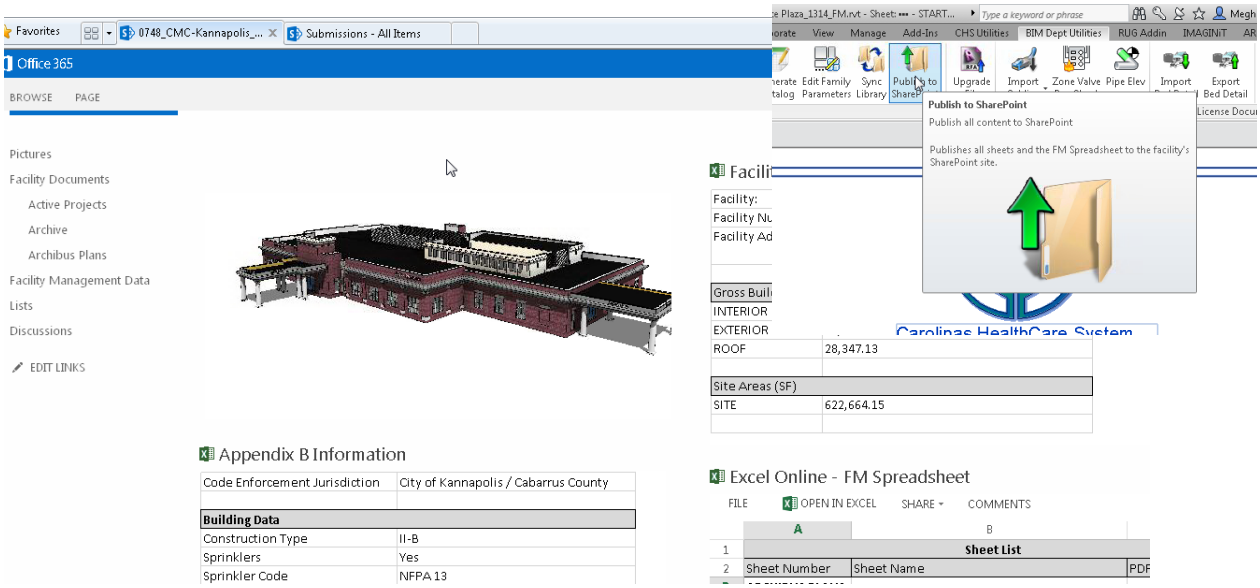
Facilities Information Management

While project and construction management has been the foundation of the BIM program, the downstream uses of BIM for facilities information management has impacted a large section of the facilities management group. The information captured during the project has been leveraged to aid various groups in the management of facilities. The three main data flows from the BIM models has been to a virtual documentation site or virtual plan room, the space management system, and the enterprise asset management system or EAM.

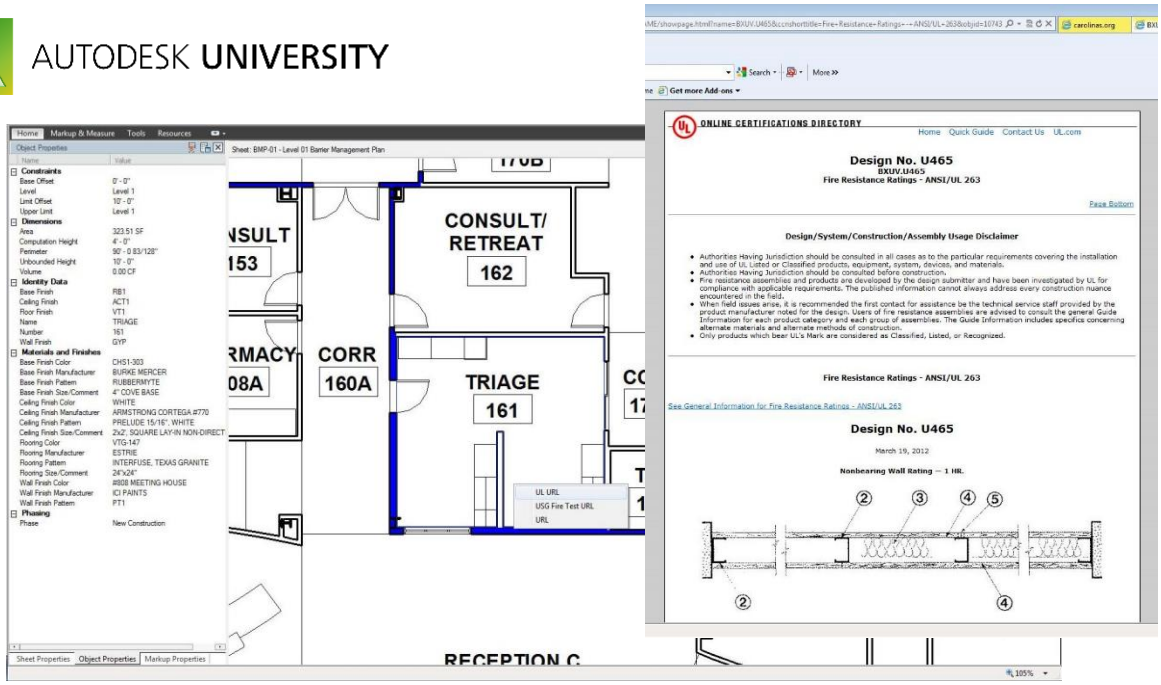
Virtual Documentation

The Revit models contain the digital representation of the building in 3D along with the data needed for management. Asking all FMG team member to work in Revit is not a feasible solution, however conveying the information to a large audience was needed. A virtual plan room was developed in order to distribute Revit information to all FMG team members. The virtual plan room is a 365 Microsoft SharePoint site. The information in the model is exported to SharePoint via floor plan views, 3D views, and data extractions. Each CHS facility site was created with a dashboard of information and drawings for that facility. The dashboard shows the building area, code information, and a finish schedule – all of which can be exported to excel. Since the Revit model is linked to these sites, changes that are made in Revit – both floor plan/3D views and data are auto-published to SharePoint, ensuring all users are working from current information.

Archiving historical building information and having that available to FM team members was also needed. These same facility sites that link to the Revit models also host drawings (some dating back to 1930) as well as the O&M manuals, submittals, and warranty information.



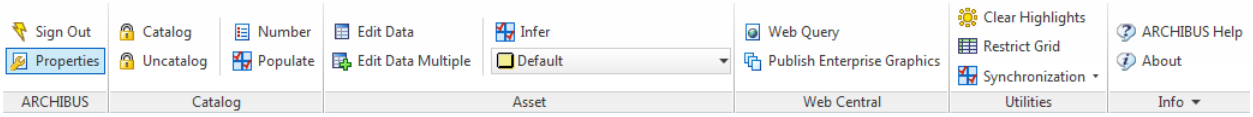
EXAMPLE OF FACILITY SITE DASHBOARD AND REVIT LINK



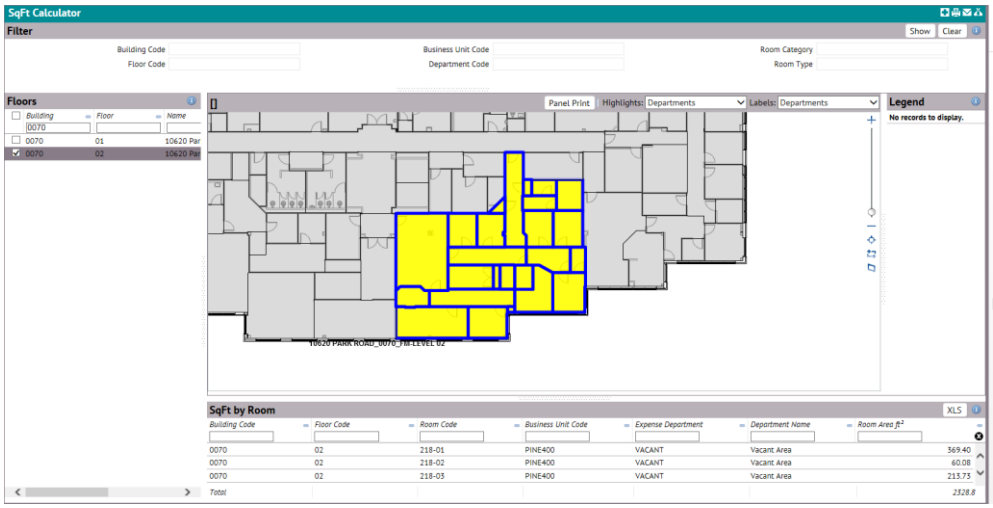
EXAMPLE OF REVIT EXPORTED VIEWS ON SHAREPOINT

Space Management

One of the first BIM to FIM system integrations was the connection with the CHS space management system. CHS uses Archibus for space management and lease management. Archibus has an off the shelf add-in that creates a bi-directional integration with a Revit model. Room and area data are published to Archibus for enterprise square footage reporting. The physical backgrounds are also linked to the database, so that users can view interactive drawings in a web browser. Data such as department ownership and employee locations are published from Revit when a building or project is completed. However, the data is updated in the database and is synced back to Revit on a weekly basis.

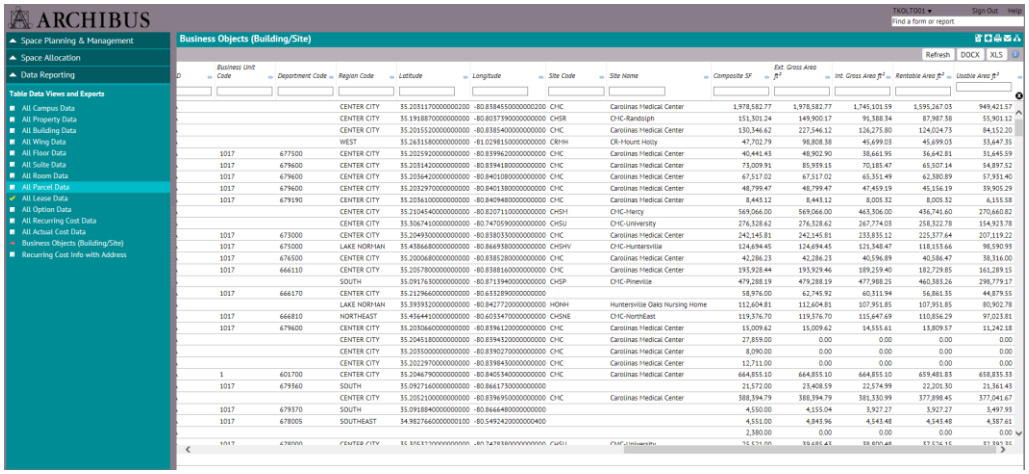


ARCHIBUS REVIT INTERFACE



INTERACTIVE WEB BASED DRAWINGS

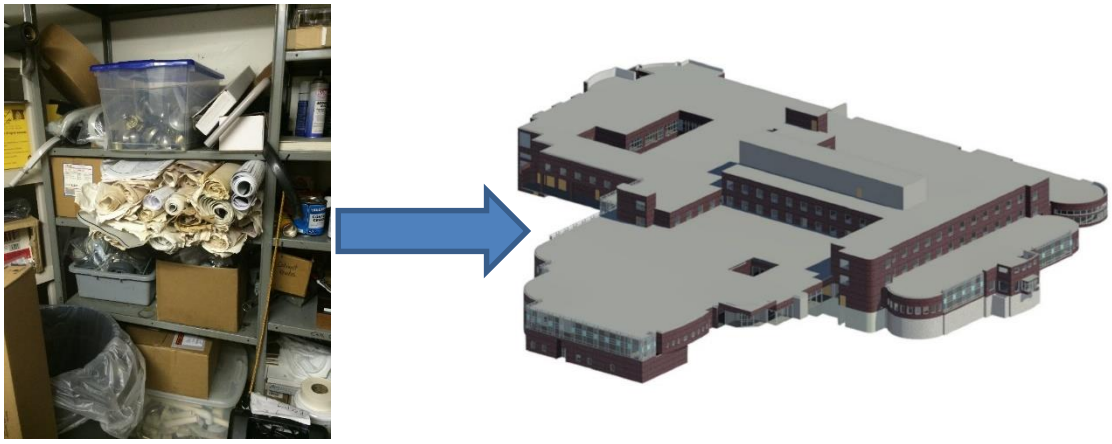
Data linked into Archibus from Revit is used for space management as well as reporting for other CHS departments. Maintaining accurate department square footage is required for Medicare and Medicaid reporting.



DATA REPORTING IN ARCHIBUS

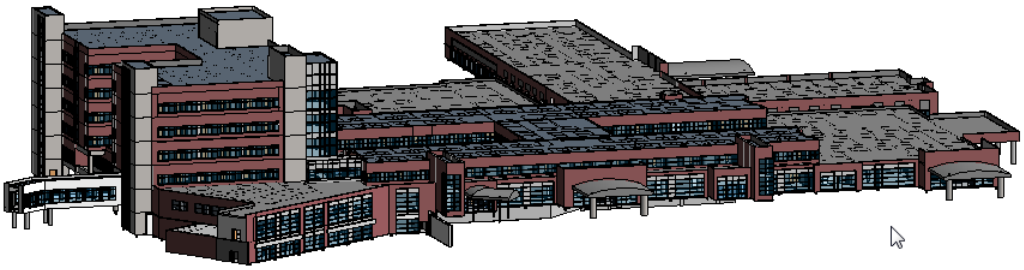
Existing Facilities

Connecting new projects to the system was a first step in establishing the BIM space management process. The challenge remained in bringing existing facilities that had either CAD drawings or no drawings into Archibus. The need for Medicare and Medicaid reporting as well as better management of employee locations and department layouts required the existing facilities to be added to the system. CAD was the initial program chosen to document these facilities, however the pilot Archibus integration with Revit had shown that creating Revit models and linking those to Archibus was twice as fast as tracing objects in CAD. The early studies also showed that models following the CHS BIM standards reduced the Archibus project data transfer time from 40 hours to 1 hour. These metrics enforced the decision to convert over 15.8 million square feet to Revit and link to Archibus. There is currently one facility remaining to be converted in the 17 million square feet primary enterprise.



CONVERTING EXISTING FACILITIES TO REVIT

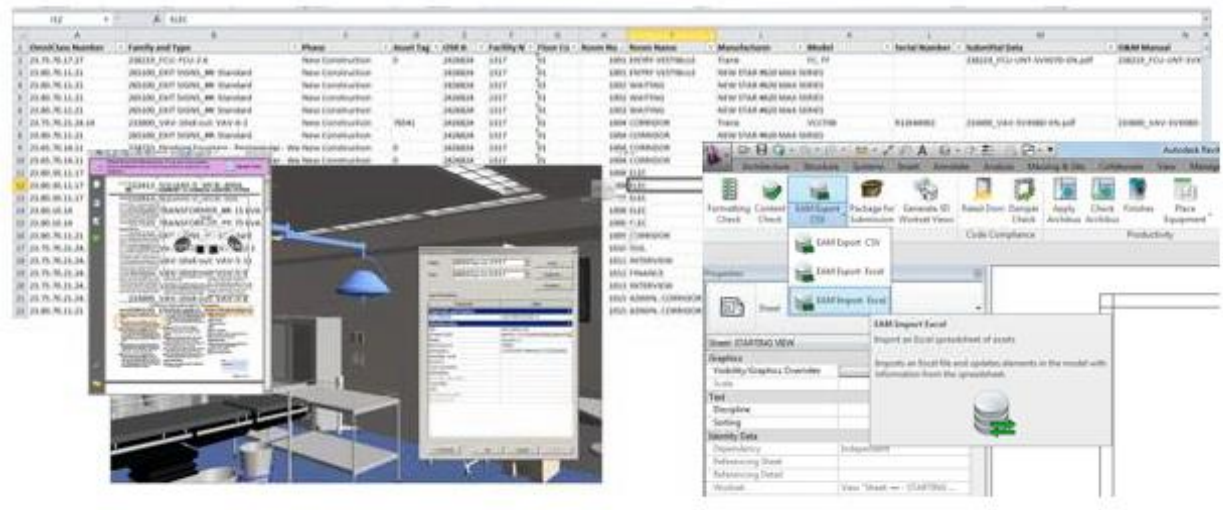
The conversion of existing facilities to Revit was done by the CHS BIM team. In order to do this efficiently the team consisted of experienced Revit users. The details required for space management was also evaluated. The models include only walls, doors, columns, and glazing. The level of detail for these elements was at 300 or construction document level instead of a fabrication level.



LEVEL OF DETAIL EXAMPLE

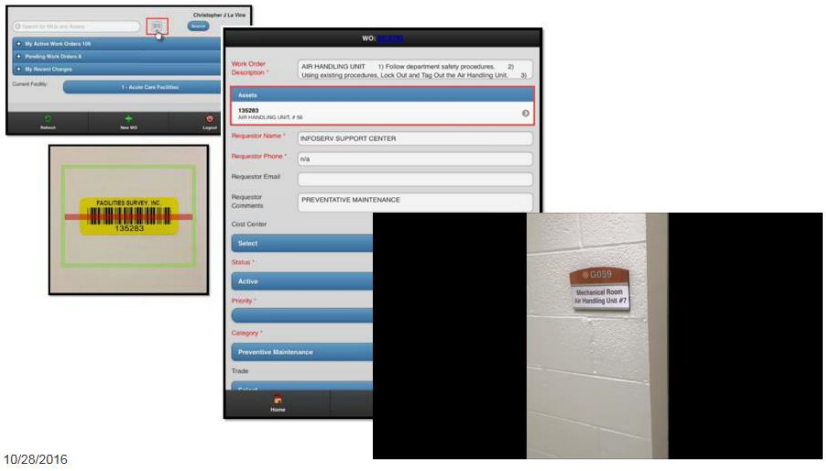
Asset Management

FMG replaced its legacy CMMS system (computerized maintenance management system) in 2013 which created the opportunity to build another BIM to FIM system connection. The new system, Enterprise Asset Management (EAM) from Facilities Survey did not come with an off the shelf integration. The CHS BIM team hired a consultant to build a custom integration that would export the data from Revit to EAM. The BIM team along with the FMG maintenance team reviewed the data needs for EAM. The main elements needed were the Asset tag (barcode), model and manufacturer, serial number, and links to O&M, submittal, and warranty cut sheets. The custom tool scans the model and pulls assets by Omniclass number into an excel export. The data can either be updated in Revit or in the excel export and imported back into Revit. The final report is imported into EAM at project substantial completion. The use of the excel export has simplified the process so that it can be applicable to all projects types from large scale renovation to small general office changes. Capturing the changes and keeping the EAM updated is critical for the plant operations and maintenance team.



REVIT TO EAM EXPORT

Once the data is imported into the EAM, work order and preventive maintenance schedules are established within the program. All of the information is accessible via mobile device by scanning the barcode on the asset and allowing work order and other maintenance work to be completed on a mobile device.

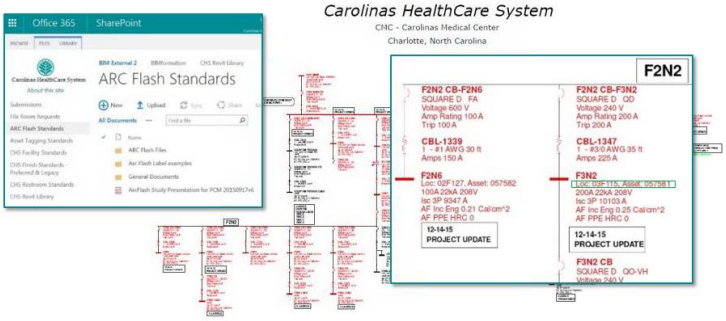


BARCODE AND MOBILE DEVICE INTERFACE

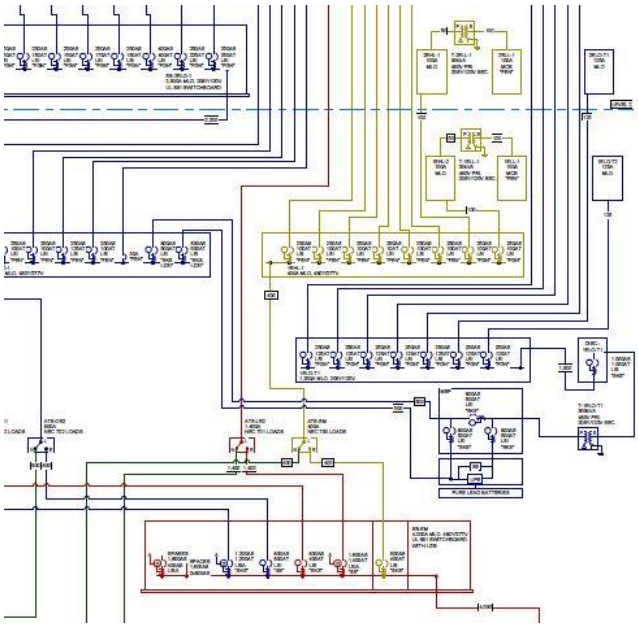
The Revit to EAM data transfer has shown value on the data input side as well as the data collection. Prior to the Revit interface, teams would walk facilities in order to locate equipment and obtain the information needed for maintenance. In one example, a new hospital, this effort took over 640 hours to locate all required equipment and input into the CMMS system. Not only was this a time consuming effort, there was a two month delay in using the system after the building was occupied. With the current Revit process, the 640 hours is reduced to 2-3 hours of data import and schedule assignments, and eliminates the delay of information after occupancy. Current BIM contracts require all asset information prior signing off on substantial completion.

Supplemental Documentation

Transferring data from Revit to Archibus and EAM has shown incredible efficiencies, however additional documentation is needed for full facility maintenance. The BIM team has assisted with the facility ARC Flash and SKM file management as well as facility electrical riser diagrams. The ARC Flash file management employs the SharePoint workflows and updates used for other BIM submissions. The electrical riser diagram file management is a new process where Revit master files have been developed and project updates are made by the consultant. Maintaining both ARC Flash files and riser diagrams requires consistent formatting and uniform processes across all facilities and projects.



ARCH FLASH FILE MAINTENANCE



ELECTRICAL RISE DIAGRAM

Conclusion

The success of the CMC-Lincoln project launched the BIM program, starting with project and construction management and expanding into facilities information management. As the BIM program evolved, the value of the technology and process improvements were required to be demonstrated. The value or return on program investment has been seen in project costs as well as reduction in resource time.

Design and construction projects have seen a 25% reduction (from 2.2% to 1.66%) in errors and omissions on BIM projects compared to similar non-BIM projects. The approximate value of this reduction is equal to $500k of the 2013 capital project value of $100 Million. CHS continues to see an overall trend of errors and omissions rates declining 5% annually from 2014 and 2015.

Another cost savings due to the implementation of BIM has been the reduction in reimbursable costs. BIM requirements have mandated digital submissions, eliminating the need for multiple paper copies and the cost associated with the transportation and storage of these prints. The overall cost savings has been $500k over the past 5 years.

The space management data integrations and the asset management data transfer efficiencies have resulted in cost avoidances. The change from CAD to Revit input of space data has shown an annual labor cost avoidance of $30K due to reduction of FTE hours spent entering SF data. The asset management data transfer has shown an annual labor cost avoidance of $45K due to the reduction in FTE hours spent manually entering assets into EAM.

Due to these savings, the total annual CHS benefit from the overall BIM program has exceeded $1.7 million over the last five years. The evolution of the CHS BIM program from contract standards, to collaborative delivery, and into facilities information management has shown the value and integration of BIM into CHS Facilities Management. The program continues to seek process improvements and technological innovation while supporting the Carolinas HealthCare System values of caring, commitment, teamwork, and integrity.