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Linking Revit Facility Life-Cycle Data to ARCHIBUS – A Case Study of an Academic Institution

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Abstract

Building owners and facility managers are beginning to leverage spatial information and asset data in BIMs for efficient and sustainable building operations and maintenance. Extracting information from BIMs for import into FM platforms still poses an implementation challenge to many owners. Methods for bi-directional synchronization of data between a BIM and FM software for real-time access to lifecycle model data can be more advantageous over one-way data export approaches so the owner can take advantage of an as-built BIM that can have data updated in real-time with continuous asset data updates. This paper uses a case study of a renovation project on a university campus to illustrate the use of the ARCHIBUS Smart Client for bidirectional real-time data exchange with Revit. The Archibus workflows were compared to other methods for data exchange as to how they support the needs of the owner. Lessons learned and challenges related to this workflow are discussed.

1. Introduction

The number of building owners and facility managers needing to leverage spatial information and asset data in BIMs for efficient and sustainable building operations and maintenance continues to be on the rise. From a 2014 report, owners requested that BIM be used on 49% of the projects but only 25% of the owners in the survey required BIM to be used. In the same study, owners' involvement with BIM rose over a two-year period from 42% to 59% and was expected to continue to grow while expanding the level of involvement linked to BIM on the project [1]. Linking BIM data from the model to the FM system has proved very valuable as it reduces time and effort on the facility manager and allows for supporting immediate and efficient use of the CMMS prior to occupying the building [2]. This fosters more efficient work order management and building maintenance activities.

Extracting information from BIMs for import in FM platforms still poses an implementation challenge for many owners due to various barriers including lack of in-house technical skill, cost of system implementation, personnel or resource limitations, and lack of knowledge [3,4]. Proprietary BIM add-ins (or plug-ins) that provide direct synchronizing of BIMs with the FM software, including CMMS and IWMS systems, for real-time access to life-cycle model data provide an advantage over other solutions that use one-way data export approaches.

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This research resulted in the development of BIM-FM guidelines for a large educational university. Completed phases include data needs analysis and documenting the data into a Revit model. This paper examines one of the approaches explored to transfer the data from a Revit model into a CMMS for FM asset management.

1.1 Information transfer

Traditional workflows to get facility information into the owner's CMMS system use manual error prone processes that are time consuming and results in incorrect and incomplete information [5]. Using BIM as a data source to document facility information for post-construction use was proposed to streamline the workflow to get information into the CMMS in a more effective manner.

Prior research identified the information needs for the owner [6] and pilot tested electronic means for documenting the information through custom parameters within Revit [7]. In total, 80 assets are tracked by the owner with common parameters and customized attributes. Facility data is collected at various phases through construction to be supplied to the owner. Methods explored for data documentation included direct input into Revit schedule, the use of Navisworks DataTools, and third party plug-ins. Each method resulted in exporting schedule data from Revit into a CSV file, manipulating the file, and using Pentaho to map the data to appropriate fields with the CMMS.

The current phase of the research is exploring methods of reducing manual manipulation of the data. Three basic methods were explored as part of this research [8]. The first was to use Navisworks DataTools to document and track additional information and export data. The benefit of this method was an as-built model that can store structured and unstructured data through hyperlinks to related documents. The second method was to use Dynamo within Revit to create a customized workflow. Required information from the model was captured by the workflow and documented into an Excel spreadsheet in the required format that can be directly linked to the CMMS. In addition, the documentation of Dynamo to directly link the data to the SQL database and remove additional mapping needs was also explored. The last method was to explore the use of ARCHIBUS Smart Client and the corresponding Revit plug-in to examine bi-directional data transfer between the Revit model and CMMS. The ARCHIBUS Smart Client workflow, challenges faced, and lessons learned are discussed in more detail in this paper.

1.2 ARCHIBUS Smart Client and Extension for Revit

ARCHIBUS is an enterprise asset management solution that provides asset lifecycle and maintenance management for all types of assets (including equipment and space) on a single platform. The ARCHIBUS Smart Client is a Windows application that is used for bulk data entry, data transfer, and importing and exporting data from other systems, such as Revit, into the ARCHIBUS platform. It also provides tasks for robust data analysis. The Smart Client presents data in grid views for easy access to bulk data. To exchange data with Revit, an ARCHIBUS plug-in known as ARCHIBUS Extension, provides the graphical interface between Revit and the ARCHIBUS Smart Client.

Using the ARCHIBUS Smart Client and the Extension, life-cycle parameter data captured in the Revit BIM model during the design and construction phases can flow in both directions and map directly into ARCHIBUS prior to or during commissioning and building handover.

One-way data export tools from Revit such as the COBie Data Export plugin, CTC Spreadsheet Link and Revit Reports Export process data in one direction out of Revit. With bidirectional data exchange capabilities, the ARCHIBUS Smart Client allows for automatic updating of the ARCHIBUS database. Similarly, information added or updated in ARCHIBUS platform is automatically transferred back to Revit to update the model parameters, allowing the BIM to remain up to date during the facility operation and maintenance phase.

These bidirectional workflows allow owners and facility managers to directly access and modify critical information from within Revit or ARCHIBUS, increasing flexibility and significantly reducing the level of effort required to update or edit data. Additionally, no intermediate steps are needed to transfer and link the exported data to the FM system as required by many one-way export tools.

2   Case study description

To examine the ARCHIBUS Smart Client workflow a renovation case study project was used. The project consisted of a $1.7 million (USD) HVAC, lighting, and exterior window upgrade of a 1953 Occupancy Class Group A laboratory and office building. As-built 2D drawings and project scope of work documents (submittals) were reviewed to understand the specifics of the renovation work. In total, 29 pieces of mechanical equipment in nine asset groups were included in the study. For the purpose of this paper, the asset group "Air Handler Unit" (AHU) is used as an example.

Since a Revit model was not available for this project, a basic model was created to resemble the main features of the architecture and all the mechanical components. The Revit model is shown in Figure 1. Data was identified by reviewing project documentation and then input into the model using the previously documented methods [7]. The air handler used as an example of the data flow for this paper was a make-up air handler with child assets of a supply fan, three heaters, and humidifier. The owner's data requirements used for tracking assets are divided into common asset properties and specific asset properties are listed in Tables 1 and 2 respectively. Each asset group has its own list of attributes. Common asset properties are further broken into five groups to match with the CMMS functionality that is currently in use. Common or specific asset properties that are associated with a particular piece of equipment are identified as "instance" (I) parameters within Revit and those that are dependent on the model type are identified as "type" (T) parameters.
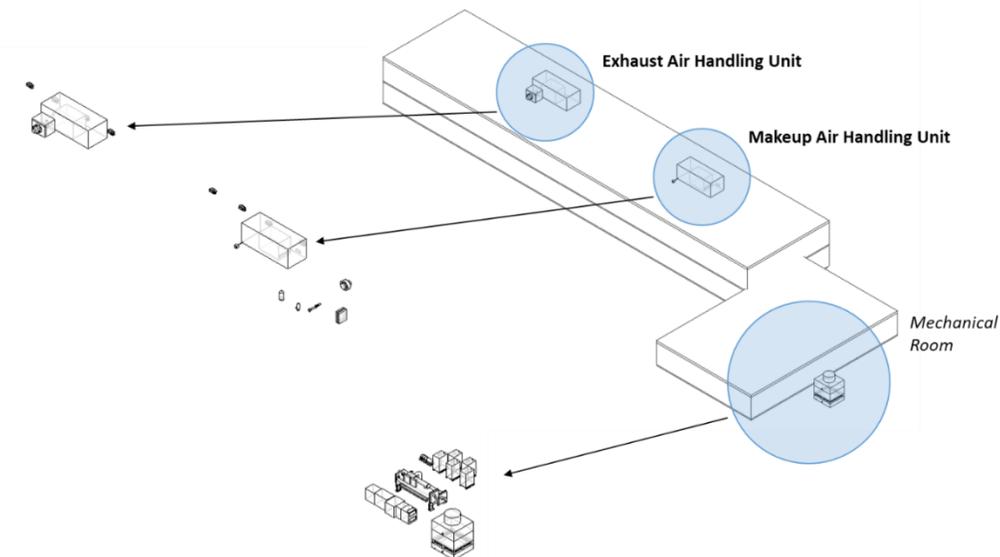
Fig. 1. Basic Revit model for the case study.

Table 1. Common Asset Properties.

Category	Label	Description	Revit
General	ASSET_TAG	Owner specified code	I
	ASSET_GROUP	AHU – Air Handler Unit	T
	DESCRIPTION	Example: MAKEUP AHU	I
	LOCATION_CODE	Example: ROOF	I
	DATE_PURCHASED	Purchase date	I
	LONG_DESC	Long description of asset	T
	LOCKOUT	Yes or no – lockout required	T
	SERIAL_NO	Serial Number	I
	MANUFACTURE_CODE	Manufacture (TRANE)	T
	MANU_PART_NUMBER	Part number by manufacture	T
	PROCEDURE_YN	Specific run procedure	T
	PARENT_ASSET_TAG	If the asset has a parent	I
	YEAR_INSTALLED		I

Parts	PART	Common maintenance parts	T
	QUANTITY	Quantity needed	T
Warranty	WARR_DESC	Warranty Included	T
	WARR_DATE_FR	Warranty coverage start	I
	WARR_DATE_TO	Warranty coverage end	I
Locations Served	LOCATION	Location equipment serves	I
	USAGE_FACTOR	% of each location served	I
Classification	CLASS_STANDARD	OmniClass & MasterFormat	T

Table 2. Specific Asset Properties – Air Handler Unit.

Asset Attribute Label	Description	Revit
BAS POINT ADDRESS	ID in Bldg. Auto. System	I
HEATING SOURCE	Example: BOILER	T
HEATING CAPACITY	Volume of air	T
TOTAL AIR FLOW	Volume of air	T
EXTERNAL STATIC PRESSURE		T
MIN. OUTSIDE AIR		T
MAX. OUTSIDE AIR		T
COOLING SOURCE	Example: Chiller	T
TOTAL COOLING CAPACITY		T
SENSIBLE COOLING CAP		T
ECONOMIZER	Yes or No (is there one)	T
ECONOMIZER TYPE		T
TOTAL STATIC PRESSURE		T
TYPE	Example: Roof Top	T

3   Data transfer using ARCHIBUS plugin and Smart Client

The overall process with a de-tailed description of the data exchange process of linking Revit to ARCHIBUS database using ARCHIBUS Extension and Smart Client Ver. 23 is summarized in Figure 2.

4   Results

This paper provided an overview for the ARCHIBUS Smart Client and Extension Ver. 23. ARCHIBUS Smart Client and Extension for Revit connect parameter information defined in Autodesk Revit with the ARCHIBUS asset management and maintenance platform. The Smart Client synchronizes data in both directions enabling owners and facility managers to modify equipment and space maintenance information in either platform, significantly improving data editing and updating workflows and reducing the level of effort required to access the information.

Several issues and lessons learned related to the ARCHIBUS Extension were observed and documented.

1. Revit Assemblies are not recognized - Elements with parent-child relationships (e.g. air handling units with fans installed in the overall assembly) were first modeled as Revit Assemblies by combining various mechanical components. This allowed the assemblies (AHU) and the components within the assembly (FAN) to have their own independent parameters. However, the ARCHIBUS Extension does not recognize assemblies as graphical elements to be mapped through the Smart Client to the ARCHIBUS platform. In addition, Revit does not allow for defining customizable parameters for different types of assemblies so they could not adequately represent the parent-child relationship required for the facility management platform. An alternative solution, though not graphically the best option, families were modeled in the same geometric space to represent both the parent and child assets. For instance, a non-descript block is used to identify the location and size of the air handling unit (AHU). This modeled object can then support the attributes and parameters associated with the AHU asset type.

2. The 'Default' dropdown is not labeled and must be changed to 'Equipment' before logging anything (Figure 3) - This process could use more clarity on what the dropdown list is, as well as how critical it is to select Equipment when cataloguing data. Possibly place this dropdown menu in a more strategic location within the plugin.
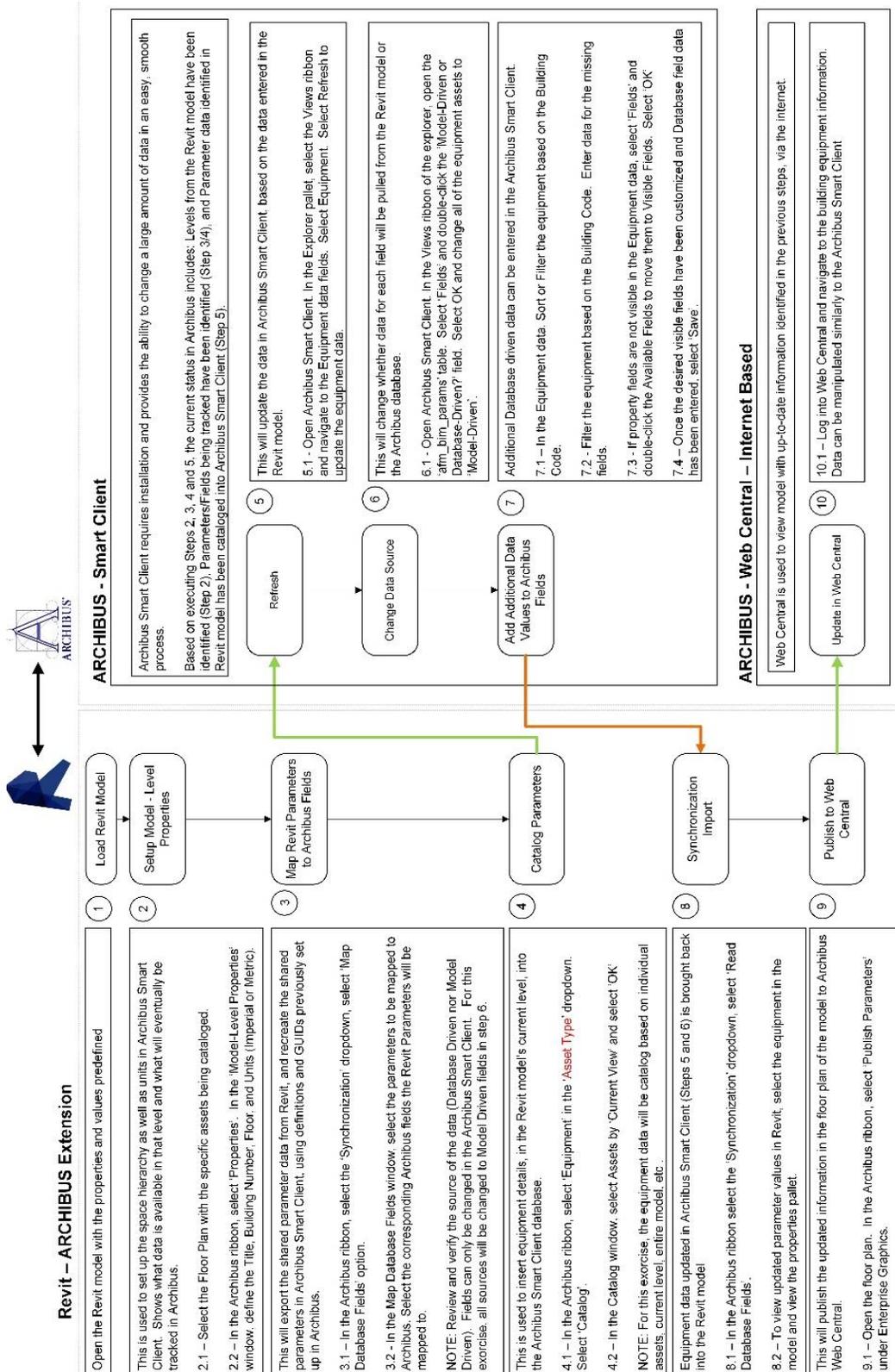
Revit – ARCHIBUS Extension

1. Load Revit Model

Open the Revit model with the properties and values predefined

2. Setup Model - Level Properties

This is used to set up the space hierarchy as well as units in Archibus Smart Client. Shows what data is available in that level and what will eventually be tracked in Archibus.

2.1 – Select the Floor Plan with the specific assets being cataloged.

2.2 – In the Archibus ribbon, select 'Properties'. In the 'Model-Level Properties' window, define the Title, Building Number, Floor and Units (Imperial or Metric).

3. Map Revit Parameters to Archibus Fields

This will export the shared parameter data from Revit, and recreate the shared parameters in Archibus Smart Client, using definitions and GUIDs previously set up in Archibus.

3.1 – In the Archibus ribbon, select the 'Synchronization' dropdown, select 'Map Database Fields' option.

3.2 – In the Map Database Fields window, select the parameters to be mapped to Archibus. Select the corresponding Archibus fields the Revit Parameters will be mapped to.

NOTE: Review and verify the source of the data (Database Driven nor Model Driven). Fields can only be changed in the Archibus Smart Client. For this exercise, all sources will be changed to Model Driven fields in step 6.

4. Catalog Parameters

This is used to insert equipment details, in the Revit model's current level, into the Archibus Smart Client database.

4.1 – In the Archibus ribbon, select 'Equipment' in the 'Asset Type' dropdown. Select 'Catalog'.

4.2 – In the Catalog window, select Assets by 'Current View' and select 'OK'

NOTE: For this exercise, the equipment data will be catalog based on individual assets, current level, entire model, etc.

8. Synchronization Import

Equipment data updated in Archibus Smart Client (Steps 5 and 6) is brought back into the Revit model

8.1 – In the Archibus ribbon select the 'Synchronization' dropdown, select 'Read Database Fields.

8.2 – To view updated parameter values in Revit, select the equipment in the model and view the properties pallet.

9. Publish to Web Central

This will publish the updated information in the floor plan of the model to Archibus Web Central.

9.1 – Open the floor plan. In the Archibus ribbon, select 'Publish Parameters' under Enterprise Graphics.

ARCHIBUS - Smart Client

5. Refresh

Archibus Smart Client requires installation and provides the ability to change a large amount of data in an easy, smooth process.

Based on executing Steps 2, 3, 4 and 5, the current status in Archibus includes: Levels from the Revit model have been identified (Step 2), Parameters/Fields being tracked have been identified (Step 3/4), and Parameter data identified in Revit model has been cataloged into Archibus Smart Client (Step 5).

This will update the data in Archibus Smart Client based on the data entered in the Revit model.

5.1 - Open Archibus Smart Client. In the Explorer pallet, select the Views ribbon and navigate to the Equipment data fields. Select Equipment. Select Refresh to update the equipment data.

6. Change Data Source

This will change whether data for each field will be pulled from the Revit model or the Archibus database.

6.1 - Open Archibus Smart Client. In the Views ribbon of the explorer, open the 'afm_bim_params' table. Select 'Fields' and double-click the 'Model-Driven or Database-Driven?' field. Select OK and change all of the equipment assets to 'Model-Driven'.

7. Add Additional Data Values to Archibus Fields

Additional Database driven data can be entered in the Archibus Smart Client.

7.1 – In the Equipment data, Sort or Filter the equipment based on the Building Code.

7.2 - Filter the equipment based on the Building Code. Enter data for the missing fields.

7.3 - If property fields are not visible in the Equipment data, select 'Fields' and double-click the Available Fields to move them to Visible Fields. Select 'OK'

7.4 – Once the desired visible fields have been customized and Database field data has been entered, select 'Save'.

ARCHIBUS - Web Central – Internet Based

10. Update in Web Central

Web Central is used to view model with up-to-date information identified in the previous steps, via the internet.

10.1 – Log into Web Central and navigate to the building equipment information. Data can be manipulated similarly to the Archibus Smart Client
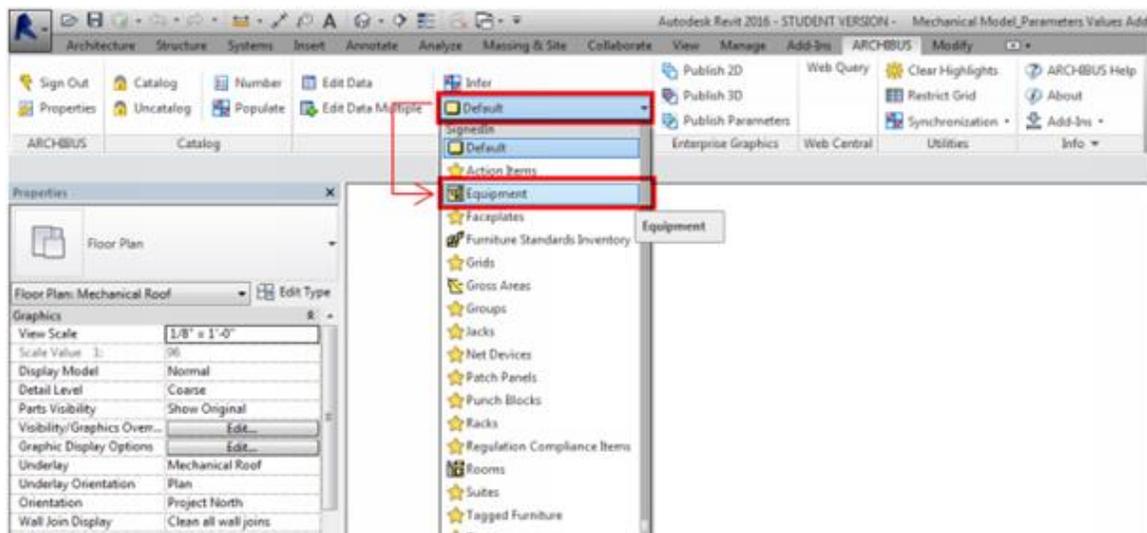
Fig. 2. Revit – ARCHIBUS data exchange process.

Fig. 3. Selecting Equipment in the Default Menu.

3. Cannot change the data source (Model Driven vs. Database Driven) in Revit – User must return to the Smart Client to change the data source. The Data Source allows to define the default source for the life cycle data for any asset; the Revit model or the ARCHIBUS Smart Client. The user can then map parameter fields and catalog data without having to return to the Smart Client.

4. Cannot add a new field or change an existing ARCHIBUS field – Revit parameters are mapped to ARCHIBUS fields that reside in its database. Adding new fields or editing existing fields can only be done in the Smart Client. Also adding new fields is a tedious and confusing process. To allow a user friendly process, fields should be modified within the ARCHIBUS Extension and the process should be streamlined.

5. When a change is made in the ARCHIBUS database using the Smart Client, the changes are not automatically reflected in the Revit model. Also there is no refresh button available in Revit to update the data. It is very cumbersome to go search for map database fields each time a change is made in database driven fields.

6. Naming convention for ARCHIBUS fields should be better explained – Identifying the appropriate ARCHIBUS field to map the Revit parameter to is cumbersome and unclear. It would be helpful to easily provide a formal list of current default ARCHIBUS fields with description to simplify the mapping process.

7. When creating/manipulating tables, the add fields option doesn't always display the same/all of the available fields in Smart Client. System should allow user to have access to all fields when adding fields to tables. For example: In equipment table in Smart Client, the 'Field Name' is displayed, but this is only abbreviations for the equipment fields. Example: num_serial is displayed instead of Serial Number. Add the field that would display the actual field and not the abbreviation to the available fields in the Add Field window.

5 Conclusion

The purpose of the project was to identify how a proprietary workflow of the ARCHIBUS Smart Client can be used to support data transfer needs on a pilot project into the Archibus CMMS. The pilot project involved mechanical and electrical assets that were being tracked as part of a lab building update on campus. When this

was complete, lessons learned were identified on the project. A comparative analysis was also completed as to how this process related to other processes that were explored.

Overall, there are benefits to a clear bidirectional workflow that Archibus provides with a Revit plug-in that allows users to easily map Revit parameters to Archibus fields. It is easy to change and update the data extraction needed and format required. Though data export tools such as Dynamo proved to be very customizable for a system that does not have a plug-in for direct data export through Revit, it does require extensive programming when modifying the data output needs.

For the case study project looked at, the owner would be required to adopt a completely new CMMS system in order to take advantage of the Archibus plug-in which was the motivation for examining the workflows. The ultimate decision was to keep their current CMMS platform and develop a customized workflow to extract model data and import into the CMMS while working with their current platform vendor to develop a more user friendly plug-in that will not require modifying their current data and workflows to a new CMMS system.

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