AUTODESK UNIVERSITY 2014

Excellence in BIM: Strategies for you and your company to succeed in Revit

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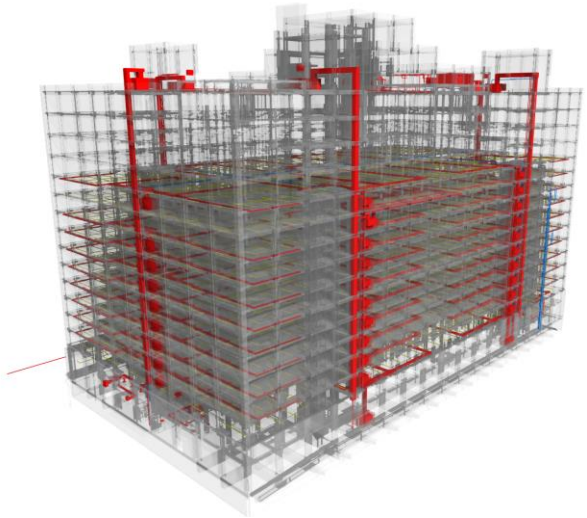
MP6676

Learning Objectives

At the end of this class, you will be able to:

- Understand the evolution of BIM and how it's changed the way we design buildings
- Create an effective design team strategy
- Use Techniques and templates to manage a successful project
- Coordinate designs and maximize efficiency through automation



About the Speaker

Morgan Abraham is an electrical designer at BuroHappold Engineering in New York, and he has several years of experience using Revit and AutoCAD software in the mechanical, electrical, and plumbing industry. He received his bachelor's degree in engineering from McGill University in 2012. Previous work has included large commercial and residential projects, as well as data centers. He is a current member of the United States Green Building Council and has been an instructor of sustainable design.

This packet is a reference guide with supplemental material on best practices in Revit BIM design. To learn more on how to perform specific tasks, visit the Autodesk website or use the Revit help function.

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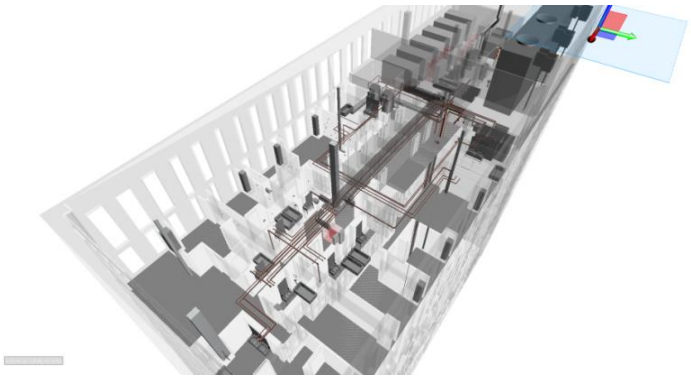
The Evolution of BIM

Introduction -It's all about data management

What is BIM:

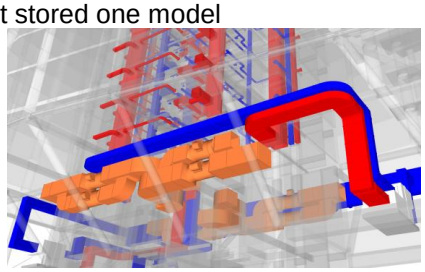


- Building Information Modelling – uses parametrics and databases to store information
- Replacing CAD as the current standard of design in the AE industry – Revit most common BIM program
- Built for collaboration between all disciplines and design teams involved in a project

BIM vs CAD:

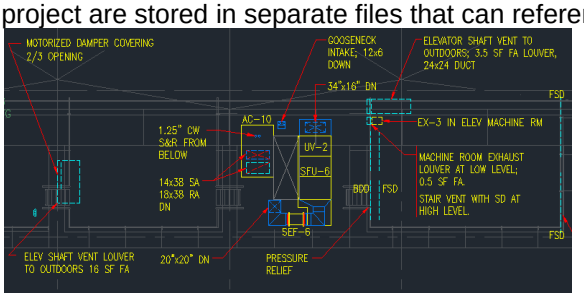
BIM:

- Parametric "smart" Objects – stores information in a database
- Sheets and plans in project stored one model



CAD

- Objects (typically) are shapes with limited properties
- Sheets and plans in project are stored in separate files that can reference each other



Create an effective design team strategy

File Layout:

Local Model: Personal model stored on user's computer. Sync with the Central model to upload all changes made in a local file.

Central Model: Model saved on a server which multiple people can work-share their designs. Elements are controlled by anyone modifying them making them locked to other users until the person working on them syncs with the Central Model. (Usually used for design teams within one office)

Revit server: A global server used to store central models for projects with design teams across multiple offices. This is not used in every Revit project but is very useful for users collaborating across the globe on a single project.

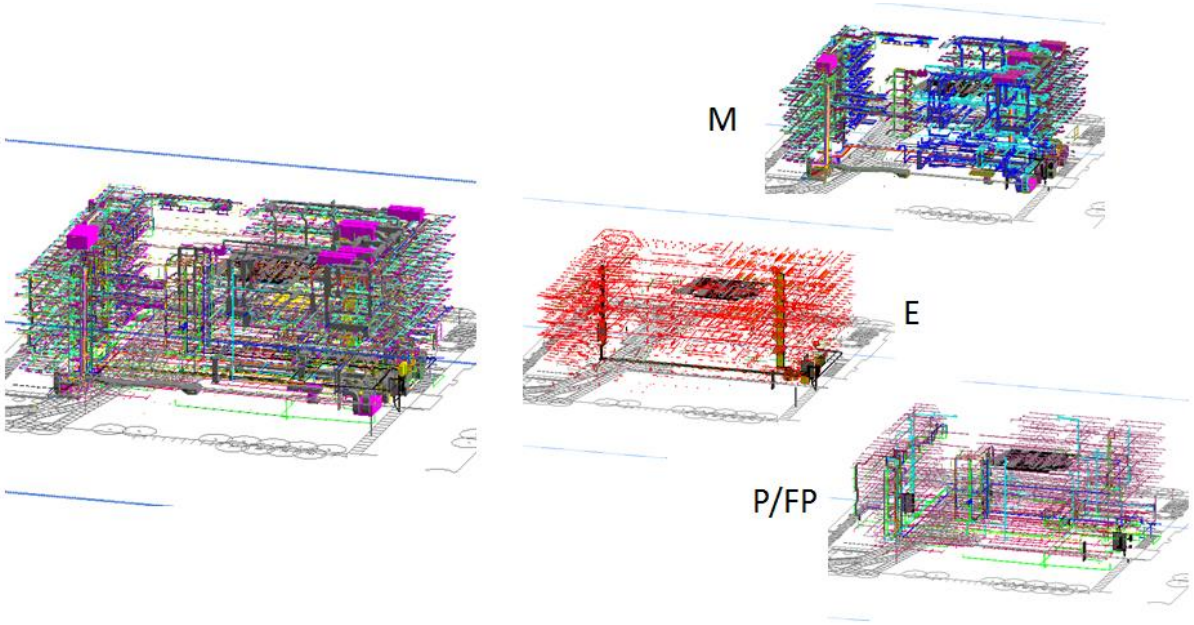
Many Disciplines Working on same project – what is the best way to share information?
The diagram below shows multiple models by different disciplines. Layouts from one model are passed to others by referencing them and controlling their appearance through by either visibility graphics or view templates (see section on view templates for more information). In addition, parametric information from referenced model can be passed to your central model through Copy Monitoring and Type Mapping (see section on Copy Monitoring and Type Mapping)

Understanding when to use a single vs split models:
It is important at the beginning of a project to know whether to use a single or split Revit model. Using split models increases is often used to prevent human error though by limiting inadvertently modifications to someone else's work.

What is less known is determining when to split a model in MEP. If a single model becomes large, it will degrade performance and Revit to perform functions slowly. At BuroHappold Engineering, we have used both single and split models and make our decision on which direction based on the physical size and amount of data a model has. We have found this to be a good general guideline to make this decision.

Less than 120 MB and 50,000 sq ft? **Larger than 120 MB or 50,000 sq ft?**

SINGLE **SPLIT**



NOTE: It is beneficial to make this decision at the beginning of a project. Splitting a model in the middle of a project (especially during CD when this typically happens due to the model growing by up to 300%) is very costly to the design team by causing additional overhead tasks and lost work.

BIM Execution Plan

Definition: Plan implemented by the entire design team at beginning of project to set up project deliverables and means of project coordination. Creating an effective BIM execution plan and adhering to it is key to a successful project.

Key Considerations:

- Who is responsible for model
- How is model set up
- How software will be implemented
- What level of detail is expected in each project stage
- What methods and tools will be used for coordination
- Frequency of data exchange

Level of Detail

This specifies the detail of information in a model during the design process. Below the AIA E202 protocol is the general standard for Level of detail during the design process.

- LOD 100 (SD) – Conceptual (Basic design layout)
- LOD 200 (DD) – Approximate geometry (Generic systems laid out)
- LOD 300 (CD) – Precise geometry (Refined system models and calculations)
- LOD 400 (CA) – Fabrication Design (Often includes shop drawings)
- LOD 500 – As-built (Project is ready for occupancy)

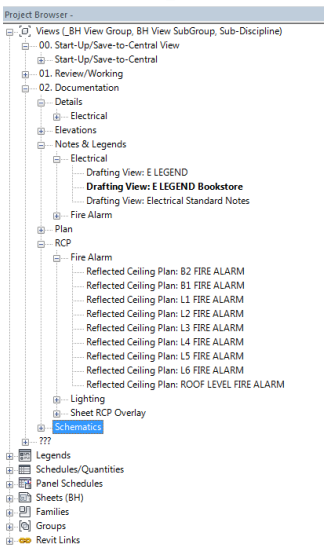
The E202 is a good generalization to understand what is expected at each design stage. To gain clarity and a better understanding of scope, some engineering practices a more detailed, system-specific model progression document. Below is and example of a model progression table that could be sent with a BIM execution plan.

Legend: Not modeled

				100% Schematic Design		100% Design Devleopment		100% Construction Documents		Construction Phase	
				LOD	MCA	LOD	MCA	LOD	MCA	LOD	MCA
D20	Plumbing	D2010	Plumbing Fixtures	100	ARC	200	ARC	300	ARC	400	S
		D2020	Domestic Water Distribution greater than 2" dia or main distribution	100	MEP	200	MEP	300	MEP	400	TC
		D2021	Domestic Water Distribution less than 2" dia or to space and final connection							400	TC
		D2030	Sanitary Waste greater than 2" dia or main distribution	100	MEP	200	MEP	300	MEP	400	TC
		D2031	Sanitary Waste less than 2" dia or to space and final connection							400	TC
		D2040	Rain Water Drainage greater 2" dia or main distribution	100	MEP	200	MEP	300	MEP	400	TC
		D2041	Rain Water Drainage less than 2" dia or to space and final connection							400	TC
D50	Electrical	D5010	**Electrical Service & Distribution**	x	x	x	x	x	x	x	x
		D5021	Front of House Hardwired Fixture - Normal and Emergency	100	ARC	200	ARC	300	ARC	400	TC
		D5022	Back of House Hardwired Fixture - Normal and Emergency			200	MEP	300	MEP	400	TC
		D5023	Floor-mounted light fixtures - Plug in fixture			200	ARC	300	MEP	400	TC
		D5024	Site Light Fixtures	100	ARC	200	ARC	300	ARC	400	TC
		D5070	**Other Electrical Systems**	x	x	x	x	x	x	x	x
		D5071	Lightning Protection System (if applicable)		MEP	100	MEP	100	MEP	400	TC
		D5072	Fire alarm		MEP	200	MEP	300	MEP	400	TC

Techniques and Templates to Manage a Successful Project

Revit Templates

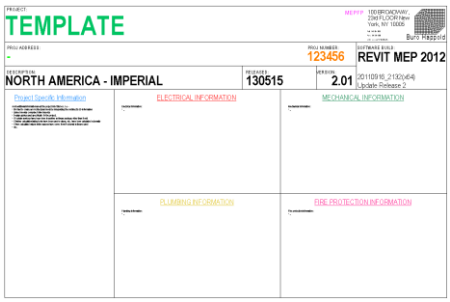


Revit Templates hold important views and settings used in building a Revit model and can be applied to multiple projects. It is important to build a Revit template that is geared towards what you need as a team and the projects you are working on. Depending the size and detail of a project, sure you balance the amount of information stored in a Revit template with model performance.

The following are common components of a Revit Template

Opening View

Contains the opening view to a project. Useful for users to get oriented to a project layout. It also reduces the time of opening a Revit file since it contains only text, basic images and detail lines.



Coordination Views

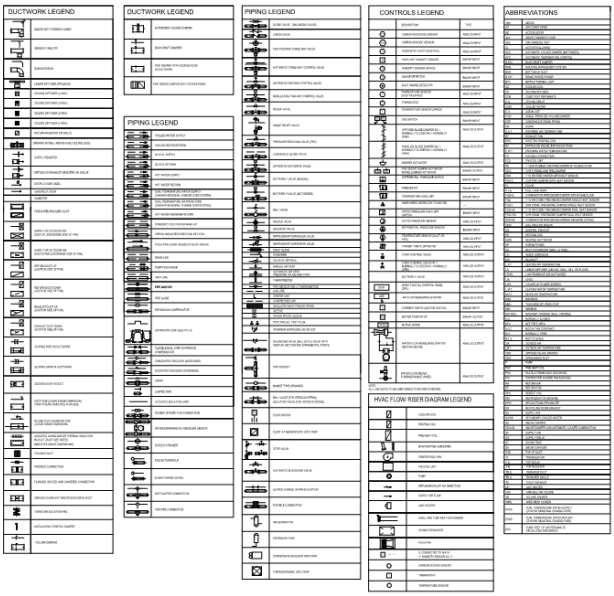
Views in which other disciplines' models are linked for coordination purposes. These typically do not have view templates to them so that the user can quickly make changes to individual views for analysis.

Documentation Views

These are views you use for issue sheets. These views typically contain plans that are submitted as your project documentation. These views usually have view templates applied to them to ensure consistency throughout a project and contain annotations.

Notes and Legends

These contain important symbols used in a project and explain important features of a design. This is usually at the front of any submitted project document. Using annotation symbols for this section can be beneficial as they can be used again in other parts of your project such as riser and one line diagrams.



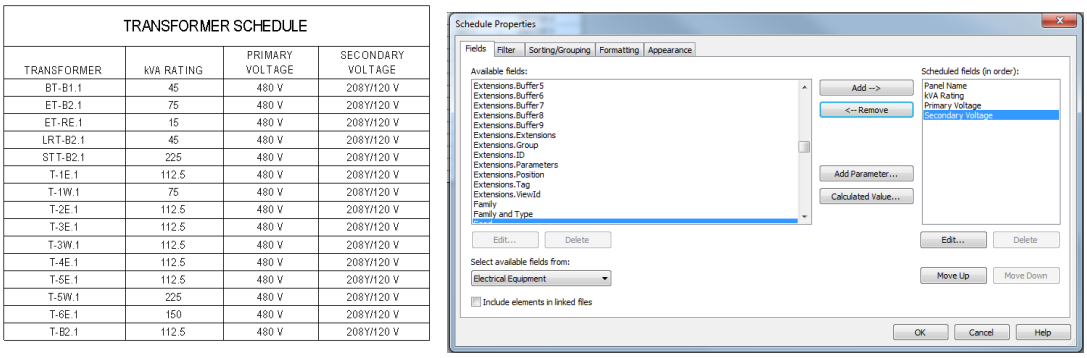
Risers/One Lines

Though these were traditionally done in CAD, we have found it beneficial to build risers and one lines in Revit for better file structure and consistent appearance. Using annotative symbols on the Notes and Legends page is a way to improve your ability to design risers and one lines in Revit. BuroHappold Engineering has created standard Revit annotation groups for typical one line devices to make drafting easier.

Details

Details are drafting views used to convey important project information. To reduce the template overhead, it is often useful to leave this section empty at the start of a project and load details as required from company library files.

Schedules



TRANSFORMER SCHEDULE

TRANSFORMER	kVA RATING	PRIMARY VOLTAGE	SECONDARY VOLTAGE
BT-B1.1	45	480 V	208Y/120 V
ET-B2.1	75	480 V	208Y/120 V
ET-RE.1	15	480 V	208Y/120 V
LRT-B2.1	45	480 V	208Y/120 V
STT-B2.1	225	480 V	208Y/120 V
T-1E.1	112.5	480 V	208Y/120 V
T-1W.1	75	480 V	208Y/120 V
T-2E.1	112.5	480 V	208Y/120 V
T-3E.1	112.5	480 V	208Y/120 V
T-3W.1	112.5	480 V	208Y/120 V
T-4E.1	112.5	480 V	208Y/120 V
T-5E.1	112.5	480 V	208Y/120 V
T-5W.1	225	480 V	208Y/120 V
T-6E.1	150	480 V	208Y/120 V
T-B2.1	112.5	480 V	208Y/120 V

Schedules show parametric data. It is important that the correct project information is shown in schedules and that the shared parameters of project elements are correctly linked to schedules. For an MEP standpoint, schedules can be your best friend. Below is a list of how we found schedules useful in projects

- Documenting parametric information of systems
- Determining device counts
- Understanding MEP system/building performance
- Updating parameters is usually faster on a schedule than on plans
- Checking for errors
- Location of elements (especially if they aren't visible in any views)

Parameters

Parameters are the properties of Revit objects and stored as data. The two schedulable parameters are project parameters and shared parameters. Another type of parameter is family parameters, but these are not schedulable and are used to store properties of objects.

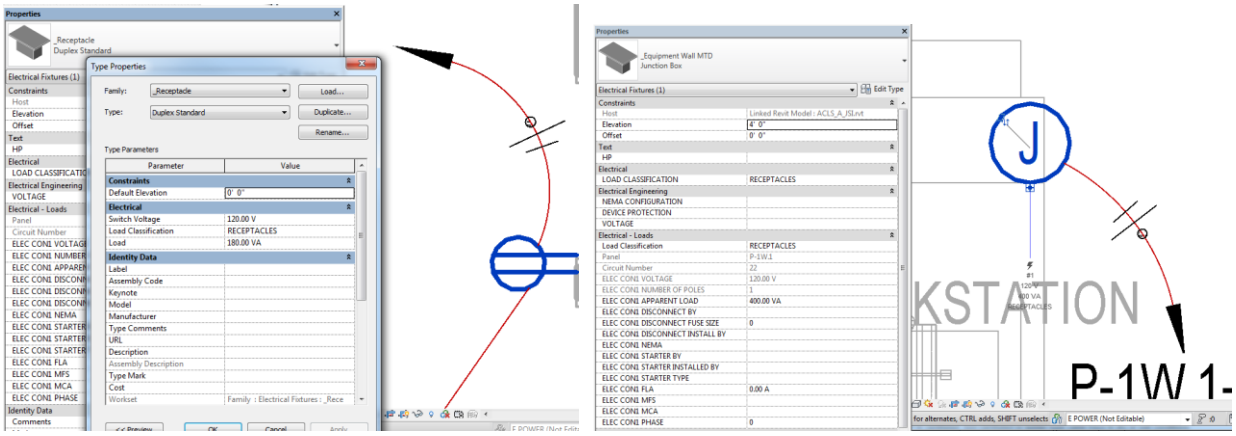
Shared Parameters are incredibly useful in MEP systems, as information can be passed between objects and models. Once a shared parameter is loaded into a project, it can be loaded into any of the project families. They are designed to easily be tagged and placed in schedules.

Project Parameters are specific to a project and cannot be shared between models. They are of used to convey important project information such as circuit information, air velocity and water flow. Project families are loaded into families by selecting project categories.

Type vs Instance Parameters

It is important to understand in making families when to use schedulable parameters as type or instance parameters.

Type and Instance parameters are more specific to the way the object will be used and how you're representing you data. The following is an example of two elements with the same shared parameter (Load Classification) stored as either a type or instance parameter. The first is a general purpose receptacle which is always a receptacle load, and hence the parameter is stores as a Type parameter. The second is a junction box which can be used to represent different equipment and fixtures in a project and uses an instance parameter here. Below outlines the basic differences between type and instance parameters.



TYPE

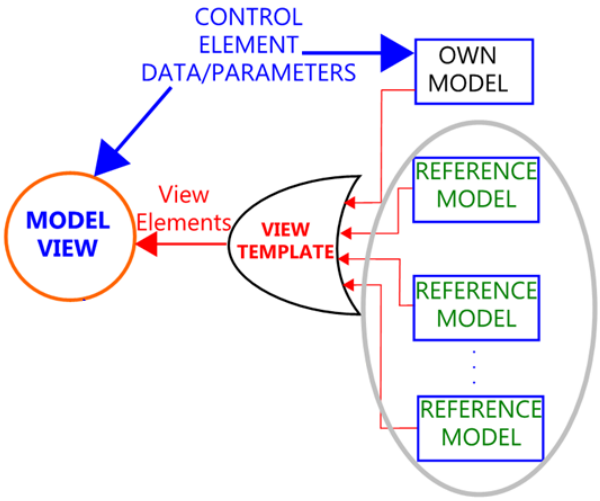
- Has uniform value across same family type

INSTANCE

- Has varying values across same family type

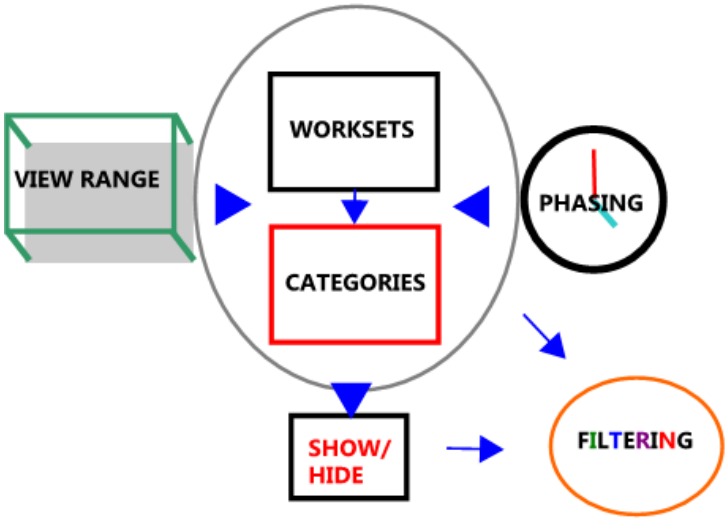
View Templates:

View Templates determine whether and how Revit data appears in your views and how it appears. The diagram below shows the external flow of information of a view template how it can manage a view's appearance by controlling how information is passed from your model and the models it references.

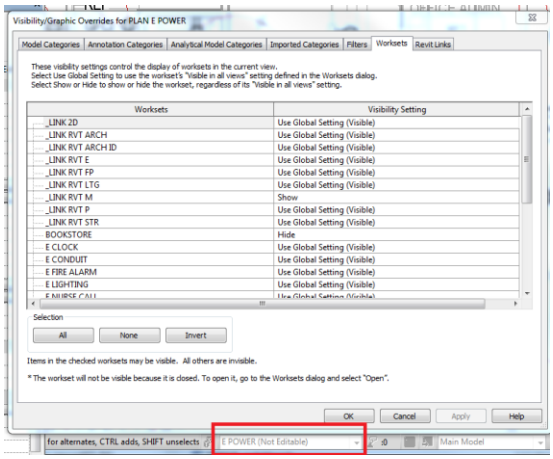


BuroHappold uses view templates in most of its projects. These are usually within a Revit Template and help keep your views consistent across a project. View templates are preferred as they can be applied to multiple sheets which makes it easier to create changes through a set of plans (such as HVAC, piping, or power) rather than by one view at a time. It also leads to model congruency as all views with the same view template appear the same. Let's look at some of the main parts of a view Template.

Below is the internal diagram of a view template that shows the components and how they work together to create a view template. These can be set differently between your view and every referenced view in your project.

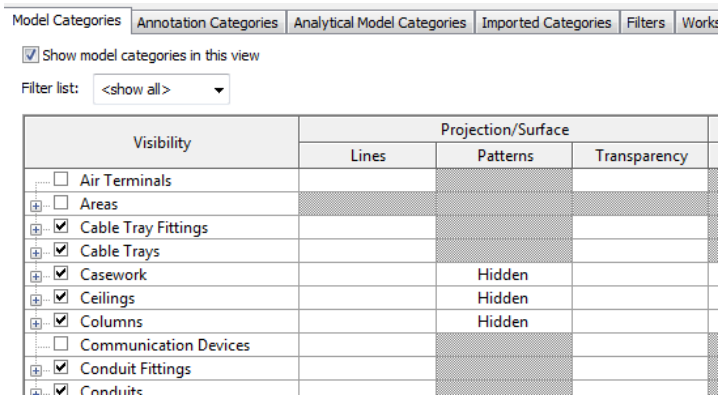


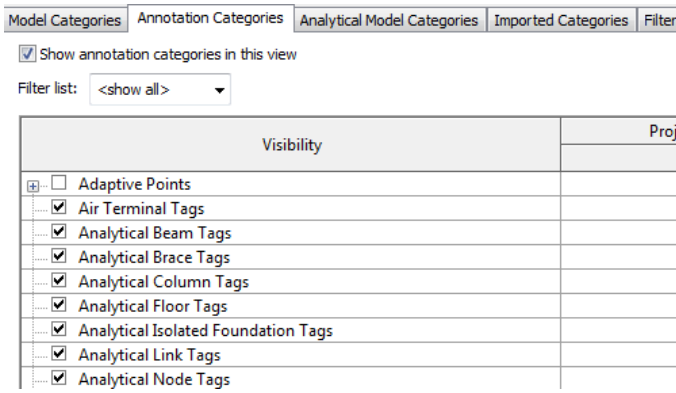
Worksets



- Good way to separate disciplines
- Ideal for coordination
- Can also be used for fit-outs and separating overlapping data
- Primarily purpose is control work sharing

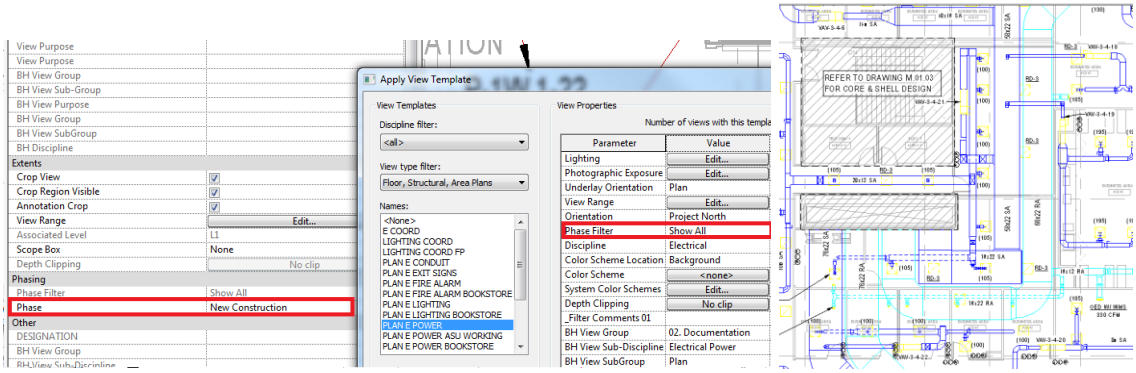
Categories





- Show objects in view based on based on element type
- Good for differentiating systems
- Visual coordination
- Use subcategories for greater customization (categories with a “+” sign have subcategories)

Phasing

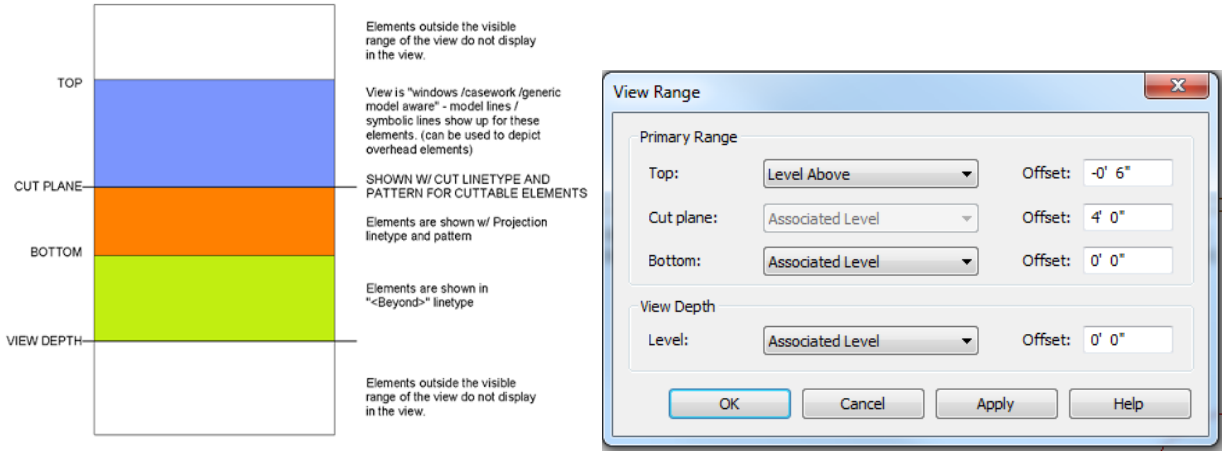


Project Phases | Phase Filters | Graphic Overrides

	Filter Name	New	Existing	Demolished	Temporary
1	EXIT SIGNS	Not Displayed	By Category	Overridden	Not Displayed
2	Show All	By Category	Overridden	Overridden	Overridden
3	Show Complete	By Category	By Category	Not Displayed	Not Displayed
4	Show Demo + New	By Category	Not Displayed	Overridden	Overridden
5	Show New	By Category	Not Displayed	Not Displayed	Not Displayed
6	Show Previous + New	By Category	Overridden	Not Displayed	Not Displayed
7	Show Previous Phase	Not Displayed	Overridden	Not Displayed	Not Displayed

- Useful in differentiating construction stages
- Unique parameter to show time progression
- Has own filter placed in view template – use view templates and phase filter to control appearance
- Often used in projects to differentiate between Core and Shell and Tenant Interior for construction

View Range



- Controls what object appears based on vertical view depth
- Good for vertical coordination and identifying
- See elements and systems at given levels
- Can be set per view or be part of the view template

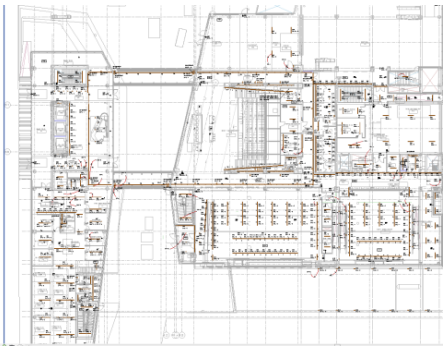
Plans

The two types of plans used in a project are floor plans in which the viewer is looking down on a project, and a reflected ceiling plan where the viewer is looking up to the ceiling. The two types of views are respectively intended for floor and ceiling coordination.

Floor plan: top-down

Shows floor coordination

For floor-hosted elements



Floor plan – Typical Disciplines

Power

HVAC* (when raised floor)

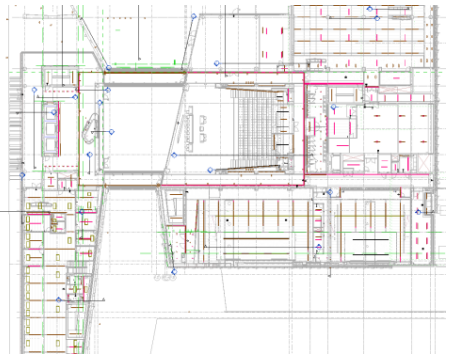
Plumbing

Mechanical Piping

RCP: mirrored down-up

Shows ceiling coordination

For ceiling-hosted elements



RCP – Typical Disciplines

Fire Protection

HVAC*(when ceiling diffused)

Lighting

Coordination and Automation

Coordination

Coordination is an important part of our design. It is the process of ensuring consistency between design team members. One of Revit's benefits over CAD is utilizing its intrinsic ability to design and analyze systems in 3D space which leads to a better ability to discovering system clashes earlier in the design phase.

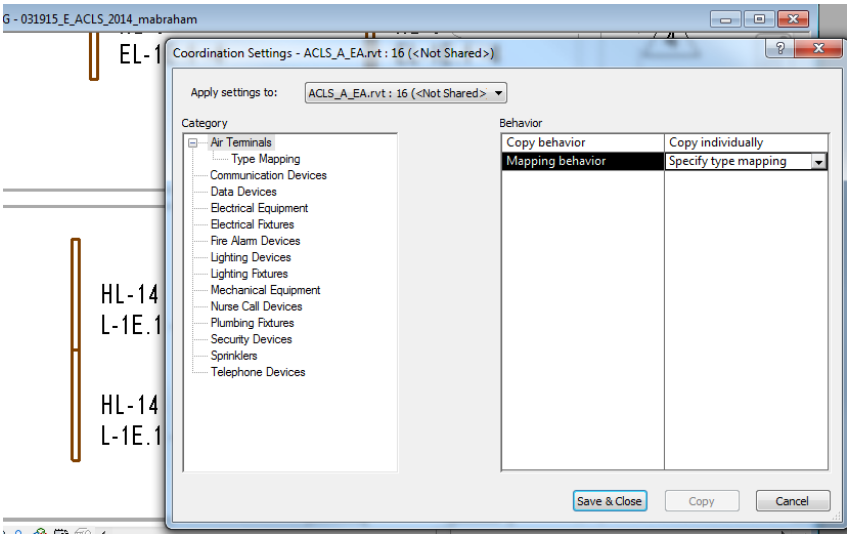
It is important to account for model coordination from the beginning of a project to eliminate the increased overhead of making changes later on in a project. At the same time a project should be coordinated to a reasonable level of detail to account for change during the design process. For example, it probably wouldn't be practical to coordinate 2" pipes at the onset of CD as those would be able to easily move around. Here are some key concepts we've used to ensure coordination.

Copy Monitoring and Type Mapping

Copy Monitoring and Type Mapping are used to bring parametric information from a referenced model into your model.

Copy monitoring creates copies of objects in your model. For example, if you want to bring parametric information of mechanical equipment into an electrical model to circuit them, copy monitoring is an option at your disposal. You can add additional parameters to objects for your use, but be sure not change any of the existing parameters or move the object.

Type mapping is a form of Copy Monitoring. It links object coordinates and type from a referenced model but doesn't copy the family. Instead you must use families already in your model as a map. This gives you full control of its parametric information while its location and type is linked to the other model. While there is more work involved in maintaining information, type mapping can be advantageous over copy monitoring when the project is large, and a lot of objects are being linked in from the referenced model.



Stratification

System stratification is usually decided at the beginning of a project. It is when disciplines agree to use certain areas or elevations for their systems. It is a good method to reduce clashing during the design process. This is a simple procedure but can eliminate a lot of potential clashes in the project

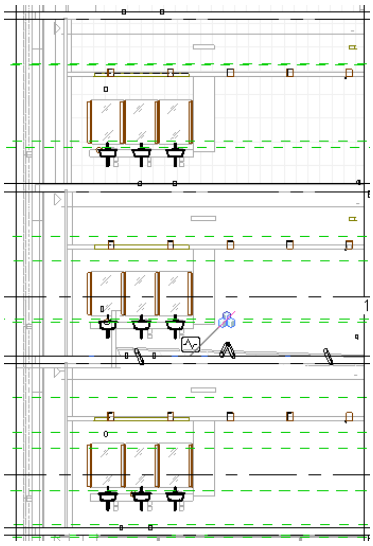
Coordination Views

Some companies use coordination views to ensure coordination on a 2D plan. This is a fast method of ensuring systems are coordinated. It is often used to ensure floor and ceiling devices are coordinated (such as lighting fixtures and sprinklers). It is also useful to ensure that plumbing and mechanical fixtures that require power are provided with electricity.

BuroHappold Engineering tends not to use coordination views as this adds to project size which can reduce performance. Instead, we rely on making temporary view changes to coordinate systems in 2D views.

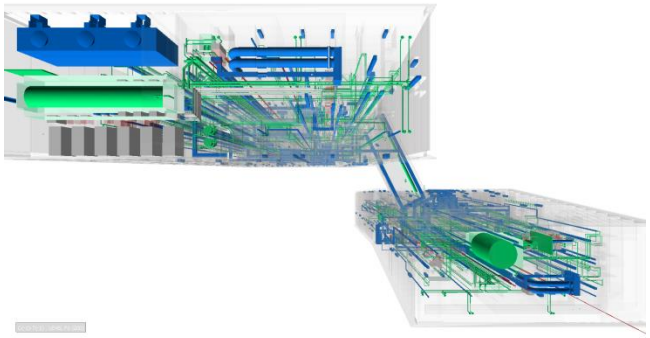
Sections

Sections are a vertical slice through a plan and are very useful in ensuring systems are coordinated vertically. It is great for seeing that systems are at correct elevations for example Ducts, pipes and conduits are not clashing with each other or the structure/architecture.



3D Models

3D models (3D plans and sections) lead to the most comprehensive coordination review. In the next section we will look at clash detection software that is used in running 3D coordination.



Clash Detection

The Autodesk community has three important software tools typically used to perform clash detections.

Revit

Revit has a built in clash detection function called an Interference Check. It is useful as no additional software is required to run clash detections, and you can run it in your working Revit model. It produces a list of clashes of overlapping objects in your model and selectable systems in linked models. It allows you to update the list of clashes as you review them.

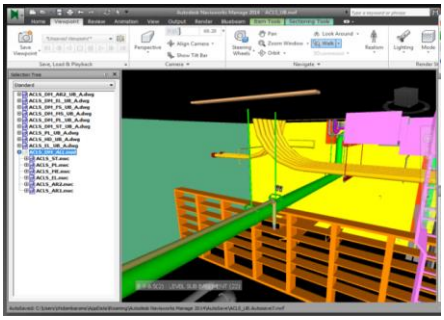
Glue

Glue is great for collaborating. Its benefit is that project files are stored on the cloud and can be updated in real time. It also runs 3D clash analysis that allows everyone to determine if the systems they design work in the model. It is ideal for keeping all design members up to date with existing clashes in the model and letting everyone know when they have been resolved

Navisworks

Navisworks allows for the most advanced clash detections. This software not only allows you to create clash rules for what it detects (such as ignoring clashes of pipes 2” or smaller), it also can produce

detailed clash reports for the design team to use in multiple formats such as excel and HTML. It allows for the greatest precision in finding clashes and allows you to control what clashes you are looking for.



Automation

There are multiple functions with Revit to automate and speed up your design efforts. In addition there a programs and add-ons that are available on the Revit market place. The following are two such programs that we use.

Rushforth Tools

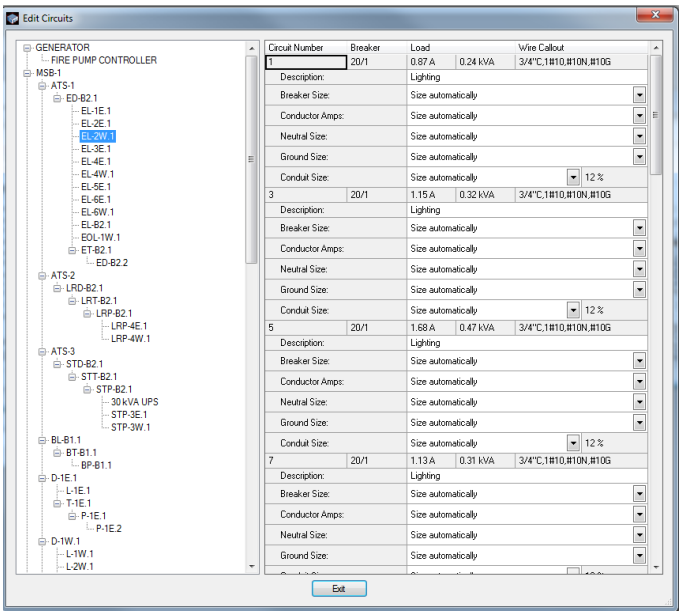
RF Tools pulls parameters from Revit schedules and exports them to Excel. In excel, it is easy to perform quick manipulations of this data and pass it back to your Revit project. Below is an RF produced Excel file. The green column on the left is the Element ID where an element is stored in the Revit database. The right blue columns are selected parameters that can then be modified in excel and pushed back into your Revit model.

	A	B	C	D	E	F
1	XL PARAMETER WRITER DATA		NOTE: YOU MUST SAVE CHANGES TO THIS FILE BEFORE VALUES CAN BE READ BY THE TOOL (Save-As a new file name			
2	FILTERING PARAMETERS		EXPORTING/IMPORTING PARAMETERS			
3	These 2 columns are for filtering only. Default is ElementID to itemize every instance, but these can be used to itemize elements by other parameter values. The parameters at the right will only affect elements matching the criteria on the left when importing data into Revit. (Not case sensitive)					
4	Filtering Parameter 1 Name:	Filtering Parameter 2 Name (optional):	Parameter Names (not case sensitive) to Export/Import (Create additional columns/parameter names as needed).			
5	ElementID		Family and Type	DESIGNATION	Load Classification	OAD CLASSIFICATION
6	ElementID	Column1	Family and Type	DESIGNATION	Load Classification	LOAD CLASSIFICATION
340	2316606		Receptacle: Quad Standard		none	none
341	2316639		Receptacle: Quad Standard		none	none
342	2316739		Receptacle: Quad Standard		none	none
343	2316861		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
344	2316869		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
345	2316876		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
346	2316883		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
347	2316890		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
348	2316910		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
349	2316911		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
350	2316912		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
351	2316913		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
352	2316914		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
353	2317090		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
354	2317092		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
355	2317094		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
356	2317352		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
357	2317524		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
358	2318069		Receptacle: Quad Standard		none	none
359	2318151		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
360	2318165		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
361	2318179		Equipment Wall MTD: Junction Box		RECEPTACLES	RECEPTACLES
362	2320164		Receptacle: Duplex Standard		none	none
363	2320428		Receptacle: Duplex Standard		none	none
364	2320474		Receptacle: Duplex Standard		none	none

Sheet1 Sheet2 Sheet3

Design Master

This tool is specifically designed for the electrical trade in automating electrical design. Design Master RT is a Revit addon that can perform analysis on your current model and run calculations to update your electrical information withought the need to produce a second model in other software. Tasks include: presenting useful electical and circuit information, producing fault trables, sizing feeders and conduit, calculating voltage drop and sizing overcurrent protective devices.



Build Your Own Programs

Sometimes a company has unique needs or a new design process, and the software to run these specific tasks doesn't currently exist. Revit's API has made it easy to design you own software. BuroHappold's software design team has made tools to help with automation, project set up and performing engineering analysis. There are two programs used commonly to design tools and add-on programs in Revit. The first is programming in the C# programming language. The second is using Dynamo, a free visual programming from Autodesk. This tool has a similar interface to Rhino software and also allows you to run your own Python scripts.

Dynamo