AUTODESK UNIVERSITY

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Re-circuit the MEP workflow: Analytical elements and BIM system modeling

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Learning Objectives

- Identify opportunities to improve the electrical design workflow with advancements in conceptual and analytical tools integrated with the building information model
- Explore the use of analytical elements in the electrical conceptual model in Revit 2023 to diagram and analyze an electrical distribution system
- Implement a range of calculations and analysis tools for system design and equipment sizing that comply with code standards
- Apply the methods that one company used to evaluate and adopt a new modeling workflow to reduce the time spent on data re-entry

Description

Electrical distribution system modeling, analysis and calculations are typically accomplished in a disjointed fashion that makes it difficult to manage project changes with limited ability for BIM integration. Adopting a new workflow to overcome these limitations can be tricky for a design firm, and often there is resistance to take the plunge until enough compelling advancements become available that offset the concerted efforts required to re-tool the workflow.

In this case study, we will learn what considerations and assessments one A/E firm took before re-engineering their electrical schematic and conceptual design workflow. Several new features in Revit 2023 helped to make the evaluation more compelling, including the use of analytical elements in tandem with real-time calculations and synchronous conceptual and single-line diagram modeling as provided with Advanced Electrical Design for Autodesk® Revit®. We'll consider what advantages there are with integrating diagram modeling data to the Revit project, how new system analysis tools help to optimize the distribution system's design, and what other tools could support a project's electrical engineering workflow.

Who would benefit from the course

Anyone involved in building engineering and design with a focus on the challenges of efficient and accurate MEP coordination. Some example roles include but are not limited to: Electrical Engineer, BIM Manager, VDC Manager, MEP Department Manager, MEP Team Leads, CAD Managers, Electrical Design, Electrical Drafters, Electrical Technicians.

Not covered

This course material is focused on solutions for electrical distribution design for individual commercial building projects that use the U.S. National Electric Code. In the future there are plans for similar discussions involving code support for other geographical areas.

Speakers

April Kane

April is an Electrical Designer in Gresham Smith's Industrial Market, with more than a decade of experience working in electrical design and BIM management. April is a key player in coordinating with electrical groups to improve workflow, quality and efficiencies by troubleshooting and utilizing best practices in Revit. Her impressive portfolio is highlighted by a variety of clients, including manufacturing facilities, hospitals, labs and commercial projects. April specializes in Autodesk products and is passionate about leveraging new technologies to improve processes in electrical systems. Her role as Electrical Designer involves ensuring that electrical specifications are followed, and quality standards are met. She thrives on collaboration with diverse teams and individuals, and excels in client communications as a trusted advisor. April takes a fresh, value-based approach on electric design and understands the intricate processes of electrical systems.

Nicole Boucher

Nicole is the Product Owner for Advanced Electrical Design for Autodesk Revit in the BIM-Electric team at Schneider Electric. She comes to this role after more than 10 years of experience working in the BIM industry, and nearly 5 years of direct experience as an Electrical Designer. More recently she has achieved certification as a SAFe 5 Product Owner/Product Manager. Her role as Product Owner with SAFe-certification involves working directly with customers and development organizations to identify customer needs, defining requirements to clarify these needs, and prioritizing work in order to effectively deliver value. She is delighted that her current role involves listening to customers' needs and delivering solutions that can help in their day-to-day work life.

Yesterday's Electrical Design Workflows

Building Design….

- Tight deadlines
- Changing requirements
- Optimizing performance

Sound familiar? That's the world of the Electrical Engineer. Electrical designers know firsthand the way work is currently getting done in MEP and A/E firms to produce deliverables that are accurate and on time.

If you have watched courses with a focus on other engineering trades at Autodesk University and other learning platforms, you find that there are a variety of approaches to design analysis for structural, piping and mechanical systems. There are so many tools and solutions to make their system design work easier. For the electrical engineer and designer, industry tools are not staying in step with the demands for information and deliverables.

Identifying Opportunities for Improvement

Electrical designers and engineers want what other engineers already have.

- A way to conceptualize and manipulate our conceptual system design that encourages collaboration and 'what if' sessions, including the use of alternative energy sources
- A visual system of working that uses BIM data to automate calculation work and analysis
- The ability to use the BIM data in multiple ways for the representations and reporting in step with the design process
- A system that supports change

Today's Electrical Design Workflows

We use Advanced Electrical Design for Autodesk Revit to highlight some of the new methods that could be used to resolve the workflow gaps in electrical system design. This extension to Revit is developing a range of calculation and analysis tools for system design and equipment sizing that comply with code standards.

Integrations with Revit - Analytical Elements

Analytical elements in prior releases were solely used for structural analysis. Revit 2023 brings the conceptual model to electrical system design.

Electrical analytical elements are components of the electrical conceptual model in Revit 2023. The introduction of an electrical conceptual model gives engineers the ability to start to plan the connected load for preliminary analysis of the system within a conceptual model before placing physical electrical families in the model.

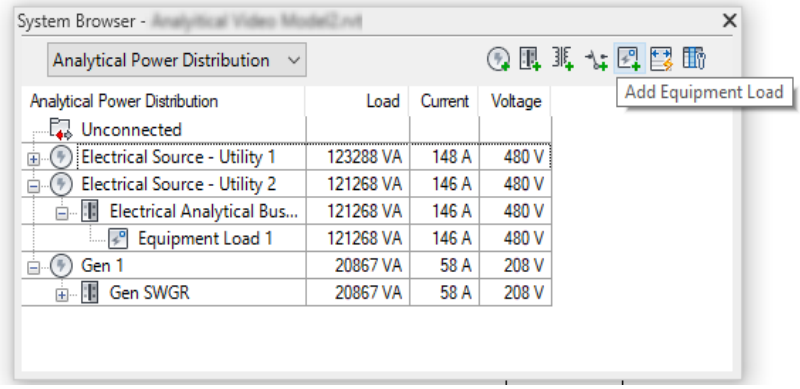

Figure 1 Adding analytical equipment loads in Revit

Analytical Power Distribution elements can be added as a networked system from the System Browser (figure 1). Area-Based Loads can be added to the model within Area Based Load Boundaries, within the Electrical Analysis panel on the Analyze tab (figure 2).

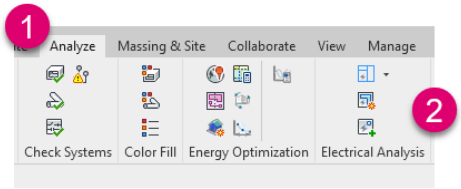

Figure 2 Adding analytical area-based loads tab in Revit

Advanced Electrical Design extends the analytical capabilities of Revit by providing additional functionality for defining elements of the electrical distribution system and generating calculation results. Engineers typically have to transfer much of this work outside of Revit and into tools that are disconnected from the conceptual model.

The electrical conceptual model elements in Revit and the diagram components in Advanced Electrical Design are linked so that a connection is established and maintained as the project moves through design phases. This makes it possible for the diagrammed system to keep in step when the conceptual system starts to become a physical model in Revit.

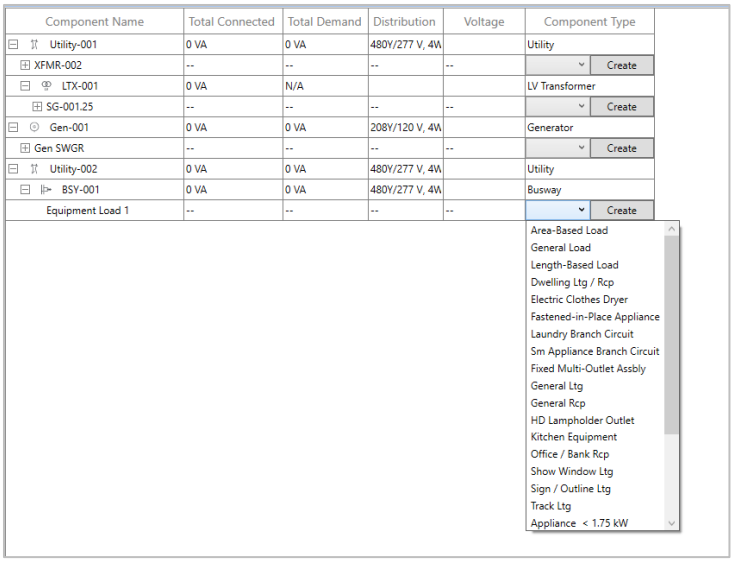

Figure 3 Creating and linking load components to Revit analytical elements

The linking process provides more granularity to selections of the type of loads, equipment, and power sources with default selections defined to maintain compliance with NEC requirements (figure 3).

The workflow is flexible. The conceptual framework can be started in the Revit project or by diagramming in Advanced Electrical Design. Any changes or new additions to power sources, equipment, and analytical load elements in Revit are synchronized within the Advanced Electrical Design diagrams. The reverse is true as well with these real-time updates. The distribution system keeps pace with changing requirements wherever the change is being applied.

With this connectivity in place, Advanced Electrical Design can be used to perform analysis and sizing calculations of the system that has been modelled, all while taking into consideration the applicable code and how it relates to those calculations.

Intelligent Diagramming

At the early stages of a project many of the requirements for the distribution system are already known. Up until now there hasn’t been a good place to assemble or visualize this information.

Along with this, there has not historically been a logical place to start the essential work of demand load analysis.

This is where the Key Line feature comes into play. It provides tools for visualizing and analyzing the major components of an electrical system while producing a basic design to assist in the sizing of equipment and power sources.

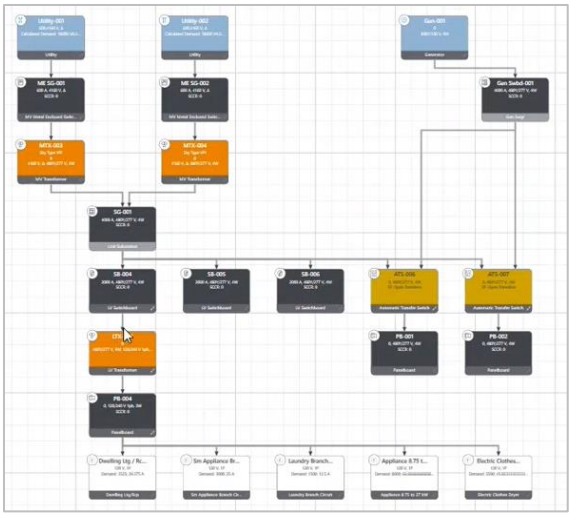

Figure 4 Simplified representation in a key-line diagram

The components of the key-line are represented by data ‘cards’ that are interconnected by conductor flow lines which indicate the direction of power. It’s a drag and drop process of connecting components in the system with the ability to refine parameters within a properties grid with a similar look and feel to Revit.

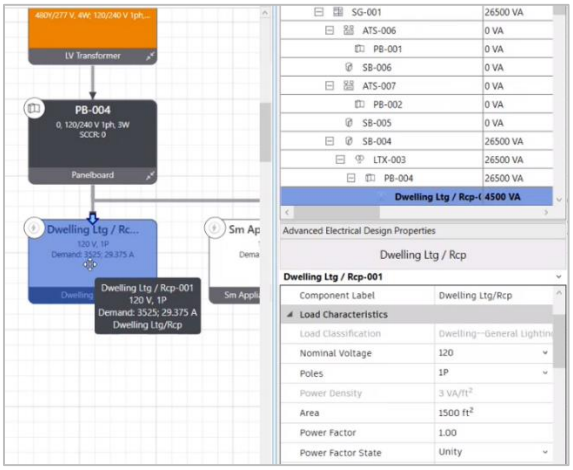

Figure 5 Simplified representation in a key-line diagram

Intelligent diagramming reduces rework for engineers. All diagram views use the same data model, meaning they are created and updated in unison. This provides the flexibility to start wherever it works best for your workflow - in Revit conceptual model using electrical analytical

elements, with a key-line, with a riser, or with a single-line. We're showing in this course a workflow from the most simplified diagram (key-line) into a more detailed visualization of the design. From the simplified key-line representation, a single-line diagram or riser diagram can be autogenerated where devices and panels (single-line) and levels (riser) come into play.

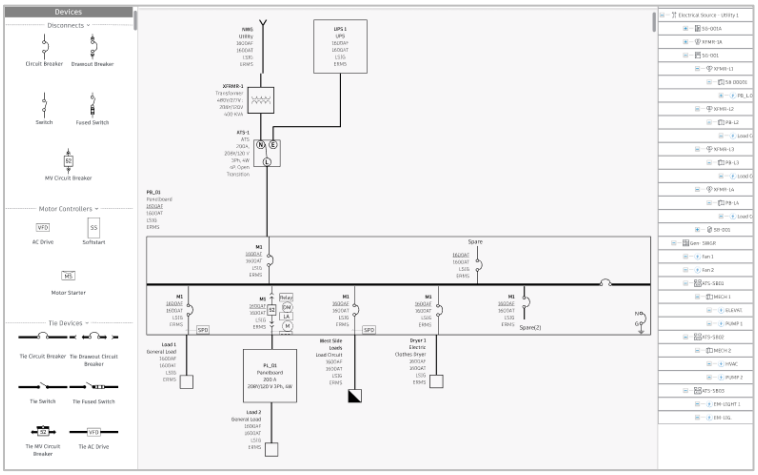

Figure 6 Single-line diagram with expanded panel

As you define your electrical components and as you build your single-line and riser diagrams, which are deliverables themselves, you are also triggering real-time analysis for load calculations and equipment and cable sizing. With every modification, increase to the system, or omission from the electrical distribution system, the values and sizes are updated for the project in Advanced Electrical Design and modifications are saved back to Revit.

Integrated Electrical Codes and Standards

How often are we not taking advantage of, or adhering to, the full breadth of code provisions and allowances when it comes to calculating load? Tracking these code-related allowances, demand factors, and load classifications can be difficult and oversizing sometimes leads to an unnecessary cost increase for clients.

The calculations that are generated within Advanced Electrical Design are driven through the selected electrical code for a given project. For example, pre-loaded demand factors and load classifications that are based off the code selection for that project. Cable sizing calculations are generated based upon NEC reference tables and derating factors straight from the code itself.

A Load Analysis Example

To compare the software with the NEC, we can use load calculation examples in the NEC 2020 *Informative Annex D* and build a comparative diagram in Advanced Electrical Design to test the outcome. Most of the parameters for the preset load components, such as Power Density, are already set up to provide compliance with the NEC. Values

you need to enter include the Area value for the Dwelling/Lighting Receptacle Load, for Small Appliance Branch Circuit and for Laundry Branch Circuit, set the Quantity to determine the allowable VA value. Choose from a number of Appliance loads with ranged values. For this example, we will choose an Appliance Load that has an upper threshold of 8 kW per the NEC. You will find that the software matches the examples in the NEC for total connected load, total demand load, and demand current.

The ability to customize calculations is also important as certain situations deviate from code requirements or require you to be more conservative than the electrical code. Calculation adjustments and overrides are provided for this reason. Examples of this include the ability to customize demand factors, load classifications, voltages, and make adjustments to load calculations (figure 4).

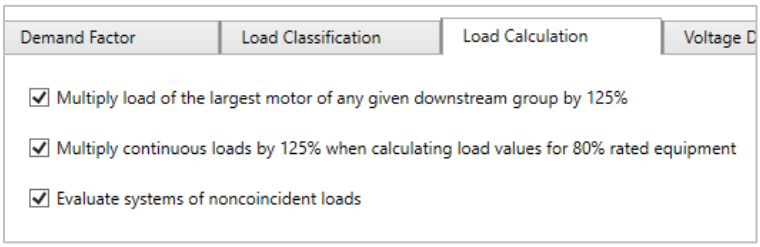

Figure 7 Adjustments to the load calculation method

Additional options are provided for non-coincident, continuous, or motor loads (figure 5), and an override to automatic conductor sizing.

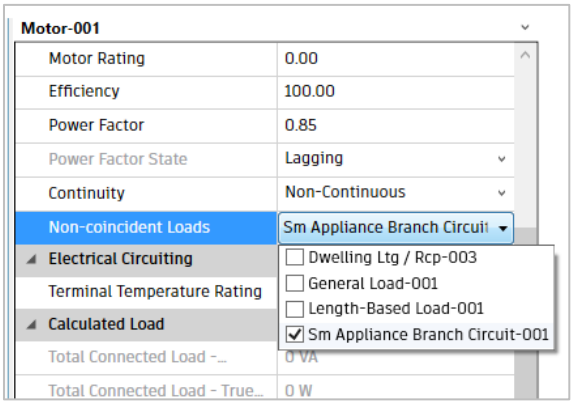

Figure 8 Specifying non-coincident loads

Having software calculations that already apply electrical code guidelines and requirements, with the ability to apply overrides, saves time and reduces oversights throughout the various stages of the project.

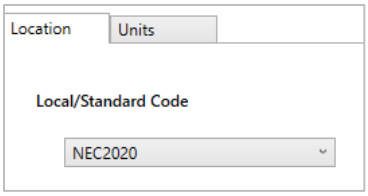

Figure 9 Selecting the project's electrical code

Examine a Subset of the Distribution System

What if you need to analyze the demand load for a subset of the system, such as emergency power?

Because the data is already in the place, it should be possible to exclude the loads that are not in play in order to identify the demand load for emergency power. This is provided in a feature called Power Scenarios which accounts for the loads that are part of a particular subset of the system. The indication is both visible in the diagram and applied to the calculated load values.

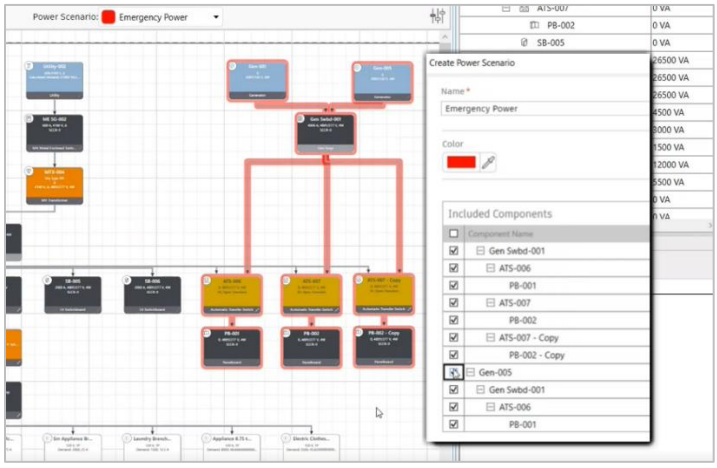

Figure 10 Selecting components for power scenario analysis

Check Conductor Sizing and Voltage Drop

With the goal of reducing rework, the software is preset with NEC ampacity table requirements. This means that conductor families and values are available in the software and automatic conductor sizing is applied as conductors are added to the diagram. As changes are made to upstream and downstream connected components, conductor sizing is updated automatically.

Deliverables

The data is already there, so automation comes as a natural evolution allowing you to generate accurate and up to the moment reporting using the distribution system design and calculation results.

Diagram Output

Another form of collaboration is thinking ahead to deliverables that could be included in printed sets in preparation for construction and building operation. To prepare for this, a preview of the page area can be displayed in the editor space for each diagram. As you build the diagram, you can plan for how it would be split amongst pages depending on the desired sheet output size and desired size of text and components on each sheet.

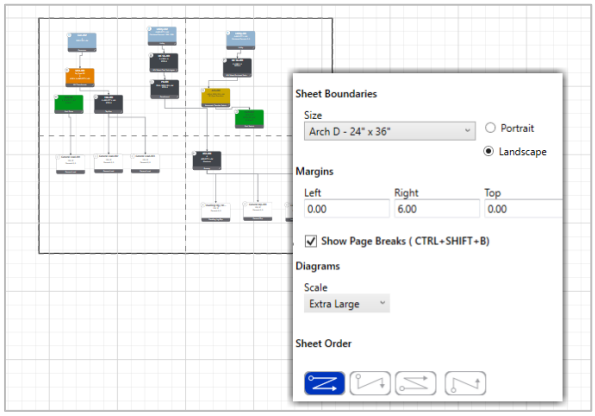

Figure 11 Sheet indicate and settings

Conductor Schedule

Use the conductor schedule to verify automated sizing in a summarized format and export it to use alongside project deliverables.

Conductor Schedule

Name	L-L Voltage	From Device	To Device	Length	Material	Type	Insulation Ty	Size
CD-002	480Y/277 V, 4W	Utility-002	ME SG-003		Copper	1/C	THHN	
CD-003	4160 V, Δ	ME SG-003	SB-003		Copper	1/C	THHN	
CD-004	480Y/277 V, 4W	SB-003	MTX-002		Copper	1/C	THHN	

Figure 12 Review the conductors in the system in a schedule

Load Letter

What we were looking for was a process that linked the diagram to the output document, so that there was a reduction of transposition errors and a workflow that can adapt to changes in the project without excessive rework.

The necessary definitions and calculations from the project advise the selections for services and loads to include in the report.

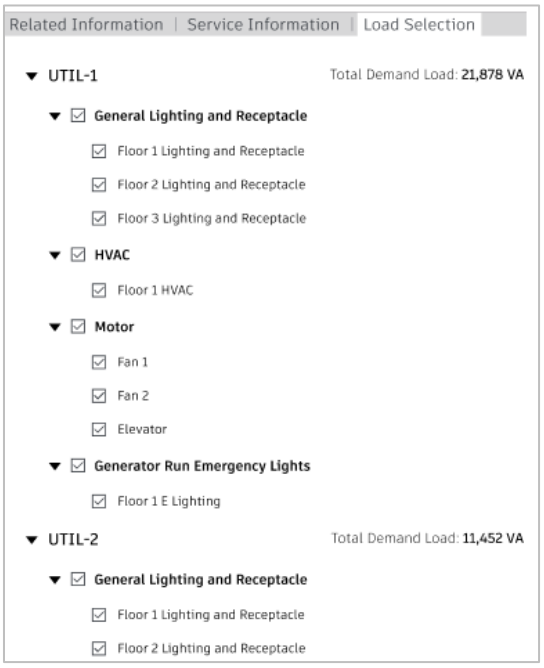

Figure 13 Selecting loads for inclusion in the load letter

Dealing with Change

Change happens in projects, all the time, but most painfully right before deliverables are being prepared. For example, coordination with HVAC loads, where the HVAC engineer makes changes to powered equipment that effects upstream electrical distribution. This type of change typically means recalculations, and transpositions of calculation results from one tool to another. What we've been looking for is a system that supports change with real-time calculation updates. This is where today's workflow, using Advanced Electrical Design, provides essential value in saving time and reducing errors. The process in the software becomes a replacement or addition of equipment in the network, and the calculations are auto-generated. If there are compliance issues in result of the change, a notification appears on the upstream component in the diagrams to flag the problem.

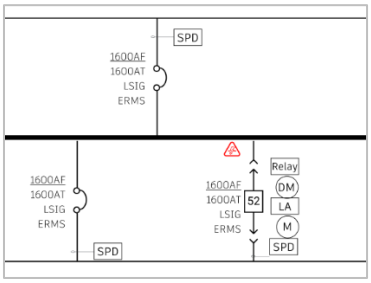

Figure 14 Overload indicator in an expanded panel

Making the Assessment - Comparing Workflows

We set out to evaluate whether this new workflow would provide improvements for electrical distribution system analysis and design.

Does it save time?

Very likely, because key benefits that were discovered include:

- Time savings navigating code requirements
- Better visualization in diagrams helps to prevent oversights
- Faster process for revisions when the project requirements change both within the tool and because of the Revit integration
- Synchronization between diagramming, modeling and calculation results means entering data just once for many purposes

Will it bring our business more jobs?

We're optimistic that the innovative methods for analyzing electrical distribution systems we evaluated in Advanced Electrical Design are going to help A/E firms and MEP engineering firms respond to new energy requirements and meet tighter deadlines.

Tomorrow's Electrical Design Workflows

The tools we've shown in this course help us to bridge a gap in early-stage analysis and conceptualization. Now that there is BIM data associated with this representation, the natural progression would be to use this data to provide other system representations. Here's the direction of innovation that electrical engineers have shared with us:

Diagram the distribution system within the building in a Riser View

A riser representation would let us express where equipment is located (floor-by-floor).

Identify when components are needed or demolished

Appling construction phases from Revit to diagrams will help to identify what components are added or removed throughout the various stages of the building project, useful for both renovation and new projects.

More Integration

Tighter connection with Revit project, parameters, and families will help to align model and diagram work for each project.

More Analysis

More analysis to optimize the design, including tools to support the changing landscape of energy sourcing and distribution, short circuit current, arch flash, and others.

More Sizing

Equipment sizing is the next step in the electrical team's workflow, and a natural progression after the distribution system is established. Functionality for sizing equipment and devices from the electrical standpoint including warnings and advisements based upon the NEC code for the project.

Supporting workflows with other codes

Multinational firms and teams who work on projects outside of the U.S., are looking for support for more regional standards.

Your Insights

We would like to hear from you about what successes you have had in your workflow, and what improvements you need. Through collaboration with ideas we can move the workflow for electrical system design forward.

Nicole Boucher https://www.linkedin.com/in/Nicole-L-Boucher

April Kane https://www.linkedin.com/in/april-kane

Additional Resources

Revit 2023 Electrical Analytical Elements

- Autodesk Revit Blog: Revit 2023: New Analytical Workflow for Electrical Conceptual Design by David Smolker
- Autodesk Revit 2023 Help: Electrical Analysis for Preliminary Design

The Gresham Smith Approach

- Gresham Smith Blog: Working with an A/E Firm to Deliver a Capital Project, by John Wharton, P.E.
- Gresham Smith Blog: The Building Enclosure: An Integral, But Sometimes Overlooked Design Element, by Robert Barfield, AIA, CCCA, BECxP, CxA+BE