AutoCAD®
Utility Design
2012

Introduction to AutoCAD Utility Design 2012:
Integrating the Network Design Process

AutoCAD® Utility Design 2012 model-based design software helps deliver Building Information Modeling (BIM) for electrical distribution that combines the power of design and documentation with standards-driven workflows and analysis.

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Introduction

Utilities everywhere are putting in place “smart grid” infrastructure at the same time as they are driven to do more with less and improve their service delivery. Policy makers across the globe have recognized the need for smarter, more robust electricity infrastructure to accommodate greater amounts of renewable generation, plug-in electric vehicles and technologies and programs that enable consumers to become active participants the energy supply chain. But much has to be done to the existing infrastructure to make it smarter, safer, and more reliable and at the same time support all of the new technologies coming online. Not only does the existing infrastructure – transmission, distribution, substation – need to be considered in this evolution, but also communications networks must become an important part of this change. Given these changes, the infrastructure design process offers opportunities for improvements in productivity, standardization, and collaboration.

Often, the discussion centers around sensors, response systems, and operational systems such as outage, DMS and SCADA. But at the core of this change will be redesign and retrofit of existing networks to support the addition of new technologies and new distribution circuits. With increased focus on these projects, designs can no longer remain paper based, file based and only the domain of the designer and engineer. Designs need to become a model, one that is intelligent and can more easily be shared with other systems, with other agencies and engineering firms. Just as important as making a design more intelligent and shareable, designers must adhere to a whole new set of design standards and requirements to support multiple new technologies. How do utilities keep designers consistent? How do utilities onboard new designers and get them up to speed quickly? How can utilities make designs more intelligent? This whitepaper will address how model based design can play an important role in a utility’s smart grid project.

Smart grids must overcome design challenges

While network design is crucial to the overall success of a utility, few utilities have the integrated capabilities necessary to optimizes processes. In fact, the opposite is often true, with designers unable to move efficiently between tasks from design layout to validation and engineering calculations to bill of materials (BOMs) creation and cost estimation. Even the simplest designs often require that designers use—and toggle between—multiple applications, binders, and spreadsheets.

Although some processes may be driven by technology, such as CAD, GIS, work management systems, engineering calculation software, or materials databases, often these systems and databases do not share data seamlessly across the process.

When processes lack integration, users are less productive and consistent across the design process.

- Inconsistent interpretation and application of design standards: one designer has 20 years experience with vast institutional knowledge and understanding of design standards and another designer has a few years experience and understand technology better than the industry standards.
- Designs require multiple binders containing rules and standards, multiple spreadsheets and a calculator to help understand how to correctly size materials.
- Systems in silos make it difficult to accurately order materials and estimate material and labor costs.

All of these challenges can hamper efforts to design more reliable networks and standardize design processes, and can lead to expensive construction rework. To overcome these challenges, utilities need a more integrated design process that effectively supports the entire plan, design, build, and manage workflow.

Disconnected processes

Disconnected design processes are prone to inconsistencies, wasted time, and tedious duplicate data entry. As an example, we will focus on the design of an electric distribution system. Take a look at a typical day in the life of an electric utility designer:

The design process typically begins when a new residential or commercial customer (or their builder) makes a call to the utility's customer service center. In our example, a machine shop is moving to a newly built facility, and requires special equipment to meet its specific power requirements. While the request is straightforward, fulfilling the design portion of the request is a time-consuming, multistep process:

Step one: The construction manager for the machine shop calls the utility's customer service line to request service by a certain date.

Step two: The utility's customer service agent enters the request in the company's work management system and the request is routed to a designer/estimator.

Step three: The designer prints out the work request for easier reference. This is necessary because the work management system is not integrated with her design application, and toggling between the two systems is even more time-consuming than printing the document.

Step four: The designer queries the company's GIS to get existing network information. Because the GIS is not integrated with the company's design software, designers at the utility must sometimes draw their own simple base maps before beginning the design process. On this occasion, the designer does need to draw a base map in AutoCAD® software. She then integrates the shop designs provided by the machine shop contactor; this process is easy because the designs are provided in the same DWG™ format used by AutoCAD

Step five: Using the base map as a starting point, the designer creates her design in AutoCAD. With her 15 years of experience and knowledge of the company's design standards, she is able to complete the design quickly despite having to draw all elements of the design manually. However, her productivity is slowed as she fields questions from a more recent hire about a similar design job he is completing.

Step six: To conduct the necessary engineering calculations, the designer must shift to her load-analysis application, enter the facility information, and reference the company's standards manuals. Even with her experience, she occasionally makes data entry

mistakes in the analysis application—leading to incorrect equipment specifications in designs.

Step seven: Turning to the company's materials database, the designer creates a bill of materials (BOM) by counting the pieces of equipment specified and manually entering the lengths of conductor required. She must toggle frequently between AutoCAD and the database. In her effort to account for sweeps and other estimates, the designer orders too much extra conductor. Once cut on the job site, some of this extra material will not be reusable.

Step eight: The designer manually enters all equipment quantities into the company's accounting system. Then she manually completes a work order package in the company's work management system, which moves the project to the construction phase.

Not only is the design process unnecessarily lengthy and time-consuming—its difficulty is compounded by the fact that a significant number of the experienced designers and planners at the company are eligible for retirement in the near future. Therefore the existing workforce is slowly being replaced by new hires with less experience. Many of these new hires expect greater process automation and less toggling between applications. The manual processes and current design technology employed by utilities today simply do not support the need to effectively transfer knowledge and meet the automation expectations of younger workers. Commonly used general design software does not embed institutional knowledge in the form of process automation, standards, and business rules.

To streamline every step of the design process, utilities need a multifaceted design application that:

- Integrates with the utility's work management system
- Accesses base map information from GIS and other data sources more easily
- Incorporates intelligent CAD-based standards and automation rules to help save time, prevent errors, and leverage institutional knowledge
- Completes design engineering calculations based on the construction layout
- Automates and standardizes the BOM creation process using the utility's business rules
- Optimizes equipment ordering to help reduce capital expenditures and waste
- Supports reliable distribution networks by embedding better design practices within design layouts

With AutoCAD Utility Design, Autodesk helps deliver each of the capabilities needed to streamline the design process

Evolution of Design

A model based design process can connect the tasks associated with designing electric distribution networks and automate many of the steps that can help with consistency across the design team. An intelligent model may provide the ability to integrate with other business systems, such as GIS (geographic information systems) and work management systems, to enable the seamless exchange of data beyond the design department. Building Information Modeling (BIM) is an intelligent, model–based process

that provides insight for creating and managing infrastructure and building projects - faster, more economically, and with less environmental impact. The adoption of BIM continues to spread across the architecture, engineering, and construction industry, and its benefits can easily translate to the complexities of the utility industry. Although BIM has not been a term associated with utility design as often as in other areas of infrastructure or building industries, there is value in understanding the need for and evolution toward BIM.

Traditionally, individual users working on CAD applications drafted utility networks and delivered construction drawings in paper or CAD files. Then, designers started to use GIS data as the base maps for design. Now, by applying the principles of BIM to utilities - starting with model-based design - designers and engineers can:

- Access GIS and design data in a single cohesive model
- Document and lay out networks with rules-driven productivity tools, standards, and workflows, and evaluate multiple options during the design
- Simulate loads and demands during the design process, and help analyze design alternatives in the context of current conditions
- Automate processes for documentation: designs, materials, and costs estimates

Ultimately, you are applying business and engineering rules continuously throughout the design process. Then, after you have this more intelligent model, designers and engineers can share more intelligent information:

- Visualize and share data with project stakeholders
- Better collaborate and share intelligent industry models throughout the plan-design-construct-manage lifecycle

Purpose-built for utilities, AutoCAD Utility Design is an intelligent CAD-based design tool. It features rules-based automation that enables designers, planners, and estimators to produce distribution network designs more quickly and accurately.

However, AutoCAD Utility Design moves beyond design because it incorporates fully functional GIS software in AutoCAD® Map 3D 2012. This solution helps minimize the need to toggle between applications, making the design process more seamless. Utility designers can take advantage of a single design interface that helps with this evolution toward BIM:

- Standardized design, drafting, and layout tools
- Rules-based design automation
- Design engineering calculations
- Materials ordering
- Cost estimates
- GIS and work management system integration

AutoCAD Utility Design can be appropriate for utilities of every size. Any utility that routinely adds, modifies, or removes customers; orders materials; and makes engineering calculations can benefit from AutoCAD Utility Design. Small utilities can use AutoCAD Utility Design to extend limited design resources further. Large utilities can leverage it to support design consistency and to realize more value from their investments in other business systems. For example, utilities using SAP for work management can integrate designs and work orders. They can also integrate AutoCAD Utility Design with leading GIS technology, thanks to embedded feature data object (FDO) capabilities. FDO enables

users to work more easily and natively with a variety of spatial data formats without the need for data translation.

Increasingly, utilities of every type are outsourcing some of their system design needs. These outsourced designs must adhere to established standards. AutoCAD Utility Design is ideally suited to the engineering firms that provide design services to utilities. With AutoCAD Utility Design, service providers can more easily comply with diverse clients' design standards— while improving the efficiency and consistency of their design process.

Model based design: Key Benefits

AutoCAD® Utility Design 2012 model-based design software delivers Building Information Modeling (BIM) for overhead and underground electric distribution that combines design and documentation with standards-driven workflows and analysis. Designers and engineers can design, analyze, and deliver more productive and consistent electric distribution designs and documentation—all in a familiar AutoCAD environment. Ideally suited for designers and engineers at utility companies and engineering and construction (E/C) firms, AutoCAD Utility Design helps to improve design productivity and consistency with easy-to-use templates and customizable standards and workflows that help simplify the network layout process; analyze network layout to help optimize asset selection and sizing; and deliver more consistent and coordinated construction documentation and materials and cost estimates—all in a familiar AutoCAD environment.

Design: drive productivity and consistency

Address training/on-boarding costs, help to minimize rework, and more consistently follow rules, standards and workflows.

- Simplified design layout
    - Design overhead and underground electric distribution networks in a familiar AutoCAD environment, more quickly and easily evaluate alternatives, and generate construction drawings.
    - Use the powerful data access tools to create intelligent base maps from contractor drawings, geographic information system (GIS) data, and external imagery and data sources.
    - Extend the power of AutoCAD software with industry-specific design tools that create an intelligent, 3D, connected network model as you design.
    - More quickly and easily create and lay out design with standards-driven, easy-to-use templates and workflows, and access a user interface that steps you through the process with access to feature information, validation results, and materials editing and analysis.
- Rules-driven engineering standards and workflows
    - Build more intelligence into the design process with rules-driven engineering standards that utilize shared templates and workflows to help drive consistency across design teams. And important to note here is that these rules can be set up in the system by the engineer in charge of your standards.

Analyze: Optimize designs and enhance reliability

- Streamline facilities selection and placement with rules-driven analysis helping to improve design consistency and material ordering.
- Comprehensive set of rules-driven engineering tools including voltage drop and flicker calculations; underground cable pulling tension; overhead sag calculation for wind, ice and temperature; and pole sizing and guying. These calculations help you correctly size and locate facilities based on utility standards.
- Engineering reports enable you to make design changes and generate updates on the fly. Reducing extra steps during important tasks, such as calculating voltage drops and sag, helps to optimize the material ordering process.

Deliver: More consistent and coordinated documentation

Improve design-to-build process helping to reduce rework, truck rolls and material costs; and design-to-manage process by providing information to GIS, operations.

- Integrate with work management to automatically assign jobs, enabling designers, estimators, and planners to directly manage work orders related to the design.
- Integrate with materials and billing to generate a comprehensive report of material and labor cost estimates and automatically populate construction documentation.
- Integrate with asset management and financial systems to help “close the loop” on projects and properly account for assets.

Deliver your project construction documentation—all estimated costs, materials, and construction details—in a single package. A complete bill of materials (BOM) report is automatically created, and you can associate the materials with unique stock numbers from your materials management or inventory system.

Support collaboration by sharing intelligent industry models across design teams and throughout the plan-design-construct-manage lifecycle. Make the design model available to GIS and records management, providing necessary symbology and attributes to help minimize as-built backlogs. Help share an intelligent design, which includes the geospatial and 3D information, more accurately in the context of the existing environment with visualization tools for proposal development or stakeholder communications.

AutoCAD Utility Design: Features and Functions

Because AutoCAD Utility Design is built to integrate with other business systems, it enhances business processes beyond the design phase. After distribution networks are designed, they are built, operated, and maintained. AutoCAD Utility Design integration capabilities help to make each of these downstream processes more efficient.

Bringing data into design process

Because AutoCAD Utility Design is built on AutoCAD and AutoCAD Map 3D, you get the same industry specific models that are in AutoCAD Map 3D for electric distribution. Instead if using separate processes to edit and update different types of information, use the same commands with CAD, GIS or industry model data meaning there’s no steep learning curve to overcome. This means that you can better utilize your CAD skills and CAD trained staff and do so within an environment that enables you to deliver an intelligent model.

Simplified Layout Capabilities

Improve design efficiency by making the process easier and more repeatable. Templates need only to be created once, and can be distributed and used many times over.

- Design Explorer – organize facilities on pallets to make the job easier. Access frequently used facilities, or even set up palettes based on specific job type or day-to-day workflows.

EXAMPLE: You have five transformers in your design: three with kVA value of 5 and two with a kVA value of 120. If you sort on the kVA attribute, the Model Viewer creates two groups of transformers – a group of 5kVA transformers containing three models and a group of 10 kVA transformers containing two models. The number of models in an attribute group is indicated in parentheses after the attribute name in the list. Or you have a job that requires a customer facility, such as a certain type of transformer mounted on a wooden pole. This can be created once and added to the Design Explorer to make facilities used by a designer more easily accessible.

- Dashboard - The Utility Design Dashboard contains the following four palettes:
  - Feature Info—Displays information about the selected features in your design. Contained features are displayed in a hierarchical view under the parent feature. Features that are connected to other features are indicated by the Connected To icon.
  - Validation Results—As you create features, validation rules help check for issues and display them in the Validation Results palette.
  - Material Editor—As you create features, the Material Editor generates a dynamic material list.
  - Analysis—Displays the available analysis operations, the features included and excluded from each operation, variables and rules that define the analysis, and results after the analysis is complete.

Both the Feature Library and Dashboard help make the layout process simpler, easier and more repeatable – meaning that design efficiency, quality and consistency can be improved.

Material Associations and Connectivity

AutoCAD Utility Design makes it easier to manage containment and connectivity helping designers and engineers create more accurate and intelligent designs.

- Containment is the association of your features such as the following:
  - A light is mounted on a pole. The pole contains the light.
  - A transformer is placed on a mounting pad. The pad contains the transformer.
  - A switch is placed within a vault. The vault contains the switch.
  - A duct is placed in a segment (trench). The segment (trench) contains the duct.
  - A conductor placed in a duct. The duct contains the conductor.
- Connectivity is another type of relationship between features. For example, a conductor that carries current to or from a transformer is connected to the transformer and the transformer is connected to the conductor. Similarly, a segment that runs to/from a vault is connected to the vault, and the vault is connected to the segment.
  - Point design features can be connected to zero or more line design features, but they cannot be connected to other point design features.

- Line design features can be connected to zero or more point design features, but cannot be connected to other line design features.

In the electric domain, two types of connectivity are supported: structural and conductive (or electrical). In structural connectivity, all the design features are structural. For example, a vault can be connected to a segment, which in turn can be connected to another vault. In conductive connectivity, all the design features are conductive. For example, a transformer can be connected to a conductor, which in turn can be connected to a service point.

AutoCAD Utility Design provides tools that can help drafters and designers do their jobs better and faster, drawing as they would usually do, while inherently building a 3D model, and the level of detail one needs to more accurately represent both structural and electrical devices on the network.

Rules-driven standards and workflows

Designers need to interpret calculations and choose the most cost-effective equipment. A big challenge across many utilities is designs that are consistent across designers and types of job. With the onslaught of new technologies being introduced to the grid, utilities need a way to help create and apply rules and standards to improve productivity, efficiency, and accuracy of designs.

The configuration tools in AutoCAD Utility Design 2012 help you to make your designs more accurate and consistent.

Example: A CAD manager or design engineer may need to consider not only industry standards and rules, but rules that may be unique to an organization as well. AutoCAD Utility Design can help to set the rules and standards for the design team. Facilities are defined in the Industry Model Dialogue. Rules will help guide the process by which a facility (such as a pole or transformer) becomes a sized facility (a 50-ft. wood pole, a 30 KVa transformer), and whether that sized facility is valid. From there, rules help determine and generate a list of orderable parts for assembly of facilities in the field.

There are four types of rules including:

- General rules – These are ‘helper’ rules. They’re variables that can be defined, and then used in other rules. They are often created from customer spec sheets (for example, if the voltage drop is greater than ‘X’, do ‘THIS’)
- Validation rules – These rules help to evaluate that the design is valid before it’s printed, or reviewed or built. For example, if you were to draw a pole, and didn’t give it a name, a validation rule could prompt for one (Thus making it a sized facility). These rules can either display a warning (which can be ignored), an error (which can’t be ignored) or suggest ways in which the user can fix the error. AutoCAD Utility Design 2012 ships with the Rural Utility Standard, and contains over 8000 validation rules.
- Material rules – These rules help to generate a bill of materials from sized facilities. For example, if you’re using a 35ft, class 6, wooden pole, it will contain x, y, z individual components.
- Analysis rules – These rules are equations and formulae which can be edited and customized. They determine the parameters for voltage drop, such as the type of transformer need for a certain network, or sag analysis, which would help to determine the thickness of a conductor, or the distance between poles. Again, these are customizable, for example, configuring the voltage drop analysis rules to factor in extra safety measures implemented by your organization.

AutoCAD Utility Design 2012 helps you to implement rules-driven, model-based design; in a way you can customize to better suit your organization. This helps you to improve productivity, increase efficiency and standardization, and deliver a more accurate model for design, and for engineering and operations.

Engineering calculations

More accurate designs support right-sizing facilities and optimal material ordering. AutoCAD Utility Design 2012 contains a comprehensive set of engineering analysis tools—including automatic guying, voltage drop calculations, clearance checking, and more— which can help designers correctly size facilities. These calculations can be configured based upon your particular utility's engineering standards.

- Engineering analysis can be run automatically as you design, meaning that you don't have to complete an entire design before analyzing it, and errors can be corrected as you go.
- Standardize your designs, which can result in improved network reliability and fewer over-orders of materials.
- Because calculations are run within the design environment, you need to use fewer applications to complete the design, and all the changes you just made are reflected in the model.

Delivery: Design to Construction

AutoCAD Utility Design 2012 has automated processes that can help you to improve your design-to-construction time even more.

- The ability to integrate with work management systems allows you to generate work orders, streamlining the design-to-build process.
- Integration with materials and billing systems means that you can generate reports of material and labor cost estimates, automatically populating construction documentation and associating company construction standards to layouts.

Example: each feature in the model may have an associated material code, that is used to pull information from the inventory system. This includes the material and part numbers as well as what is called compatible units (or things that go together to make these facilities), or costs of material or labour. This can give the designer a more accurate estimate of the job cost.

Delivery: Construction documentation in a single package

AutoCAD Utility Design 2012 helps you to deliver a more complete design model, from construction documentation to material and cost estimates, in one comprehensive package. The Drawing manager helps to manage and maintain DWG sketches per project or design job and integrates the construction documentation process. This means it can be easier to:

- Tell stakeholders what the estimated project cost will be
- Tell the warehouse and crew what materials are needed
- Provide construction details to the field crews.

With model based design, since the construction deliverables are derived from the model, changes to the model can be reflected more easily in terms of the construction document.

Delivery: Design to As-built

Projects don't just suddenly go away when they've been built. They need to be managed and operated. With AutoCAD Utility Design, utilities can help to minimize as-built backlogs and manage assets with more accurate information

Because AutoCAD Utility Design 2012 is built on AutoCAD Map 3D 2012, the industry model used is the same. This means that you're able to deliver an intelligent model that has all the attributes, connectivity and containment information needed for you to better manage the assets. By integrating the design into your corporate GIS, you can help to eliminate data entry backlogs, and minimize the costs and potential errors of data re-entry. The rules-driven, model-based approach of AutoCAD Utility Design can help you to better leverage information from all systems, either upstream or downstream of the design.

Distribution Design: A Day in the Life

AutoCAD Utility Design allows utilities to adopt a design process that is more integrated, automated, and consistent—all by leveraging a single CAD-based tool. In our earlier example, we detailed a design process plagued by disconnected applications and manual tasks. Now let's examine how AutoCAD Utility Design helps to transform this process

Step one: The construction manager for the machine shop calls the utility's customer service line to request service by a certain date.

Step two: The utility's customer service agent enters the request in the company's work management system and the request is automatically routed to a designer/estimator.

Step three: The work request specifications appear within the designer's AutoCAD Utility Design interface, and she is able to begin her design immediately. She directly accesses the company's GIS to select a base map, and she then takes advantage of the design layout tools and embedded standards within AutoCAD Utility Design to help complete the preliminary design in record time.

Step four: The designer completes her engineering calculations within AutoCAD Utility Design, helping to save time and reduce the risk of calculation errors as she does not have to enter the information into another application. Because the rules-based functionality helps her select the optimal equipment for the project, she often modifies the design to better match the precise needs of the project, helping to prevent over- and under-ordering of materials and supporting system reliability over the long term.

Step five: She quickly reviews the BOM that AutoCAD Utility Design automatically generates and closes her work request. She estimates that automated BOMs save her at least 30 minutes on small jobs and hours on larger ones. With this additional time, the designer can perform what-if analysis or consider a lower cost way to serve the machine shop. She might also consider using conceptual design tools, such as Autodesk® Infrastructure Modeler 2012 software, to create a couple of options for the design teams to discuss. Also, in her preliminary design analysis she might notice a minimum clearance issue and change the design to avoid any issues later that could require rework. The fact that AutoCAD Utility Design is integrated with the company's SAP work management and accounting systems also helps save her time—and helps eliminate the tedium of duplicate data entry. When she's done with a design job, the required construction drawings are readily generated, and the project more seamlessly moves into the build stage.

AutoCAD Utility Design helps the experienced designer in the example do more in less time. But for new hires, the benefits are even more dramatic. Though many new hires join the organization with little utility experience, thanks to AutoCAD Utility Design, after an accelerated training program they are more quickly able to apply their prior AutoCAD knowledge to their work at the utility. During their training, they are able to focus on mastering utility-specific tasks from within a familiar AutoCAD environment instead of learning to juggle multiple applications. Today, AutoCAD Utility Design helps new and experienced designers at the utility make smart design choices quickly through the use of embedded design standards and business rules. The automated BOM capabilities of AutoCAD Utility Design have proven particularly beneficial for new hires as they help prevent common mistakes, such as ordering inconsistencies

Conclusion

AutoCAD Utility Design software is model-based design for electric utility distribution networks that combines design and documentation with standards-driven workflows and analysis.

Utility designers and engineers can improve productivity, analyze and optimize network performance and reliability, and deliver more consistent and coordinated construction documentation—all in a familiar AutoCAD environment.

- Design - Drive greater productivity and consistency with rules-driven, model based design.
- Analyze - Optimize designs and enhance reliability.
- Deliver - Provide a more consistent and coordinated set of construction documentation.

To learn more about transforming your processes with Model Based Design visit: www.autodesk.com/autocadutilitydesign.