Putting the Mechanical in AutoCAD

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Learning Objectives

- AutoCAD and General Design Product Design

- Going beyond software basics

- Discover the differences between AutoCAD and AutoCAD Mechanical

- Learn how to effectively use the AutoCAD Mechanical interface

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Description

Are you working with AutoCAD software but wish you had more tools designed specifically for manufacturing? Are you using one of the suites or collections but wondering what this included thing called AutoCAD Mechanical software is for?

In this fast-paced, rapid-fire class, we will look at the things that make AutoCAD Mechanical software special. We will explore why you should be using it for your mechanical and manufacturing design and detailing, including examining the built-in calculators, component library, detailing and annotation tools, defining structure—everything, and the nuts and bolts of it!

Speaker

Mike spent the first 12-years of his career in the Autodesk channel working for an Autodesk reseller as an Application Specialist. During his travels, he was fortunate to help solve many issues utilizing Autodesk software. Mike has been using AutoCAD since r13, cut his solid modeling teeth on Mechanical Desktop, and has been using Inventor since before it was known as Inventor.

Now he is the Technical Services Manager at Prairie Machine a mining equipment manufacturer. Reporting to the general manager, Mike is responsible for overseeing the company's technical operations and the strategic technical growth.

What is AutoCAD Mechanical

AutoCAD Mechanical (ACM) was initially released as an addition to Mechanical Desktop 2.0 (AutoCAD 2014) with a toolbar of extra "*mechanical*" specific functionality. With the release of AutoCAD Mechanical 14.5, Autodesk expanded the feature set. Autodesk then acquired German based Genius (one of their biggest acquisitions at the time) and the fun began.

	A snippet of the Genius press release:
	"Genius is a technology leader in mechanical applications for AutoCAD and Mechanical Desktop. For over 10 years, Genius has been developing software for Autodesk products, and since 1995 the company has been a vital member of Autodesk's Mechanical Applications Initiative"
	Initially AutoCAD Mechanical was available on its own and with Mechanical Desktop. Later it became part of the various Inventor bundles, and now it is available as part of the "*One AutoCAD*" platform.

An Autodesk commissioned study showed that AutoCAD Mechanical is more efficient for mechanical engineering drawing and detailing. The study found that tasks were completed 65% faster using AutoCAD Mechanical, drafting and annotation tasks 55% faster, design and engineering tasks 85% faster, and using AutoCAD Mechanical reduces the risk of errors from a 60% reduction in number of commands used.

AutoCAD Mechanical is AutoCAD software for manufacturing, built to accelerate the mechanical design process. Including all the functionality of AutoCAD plus libraries of standards-based parts and tools for automating common design tasks.
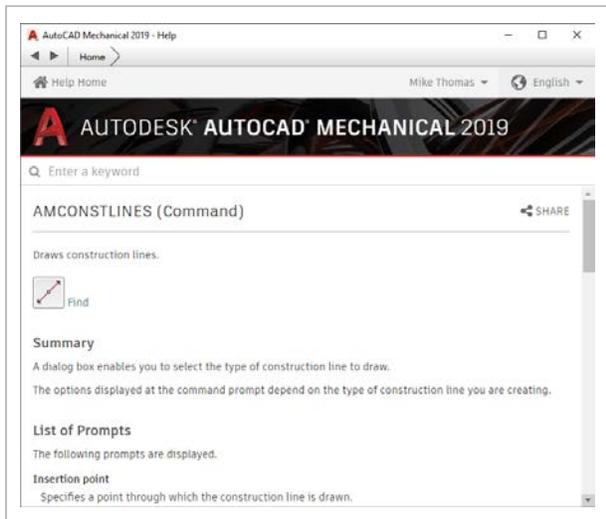
AutoCAD Mechanical benefits:

1. Thousands of Standard Parts and Features
2. Extended Draw Toolbar designed specifically for Manufacturing
3. Powerful and Smart Dimensions
4. Reusable Detailing Tools
5. Support for International Standards
6. Bill of Materials
7. Layer Management
8. Automatic Hidden Lines
9. Machinery Generators and Calculators

One of the biggest advantages to using ACM is that you can implement features at your own pace, or pick-and-choose the features that will have the biggest impact on your day-to-day operations. I have seen a company implement it just for the welding symbols!

Getting Help

This document is intended to provide an overview of the features and functionality AutoCAD Mechanical provides. It is by no means a step-by-step guide. However, the Help system within AutoCAD Mechanical is very extensive, describing every feature and providing examples.

Within ACM (and most Autodesk programs) the quickest way to access help about a specific command is to hover over the icon (ribbon) and hit F1. This launches the help, navigating directly to the command you were hovering over.

A is for AutoCAD

AutoCAD Mechanical (ACM) is based on AutoCAD. This means everything you can do in *vanilla* AutoCAD, you can do in AutoCAD Mechanical. You might have to look for it but it is in there, somewhere!
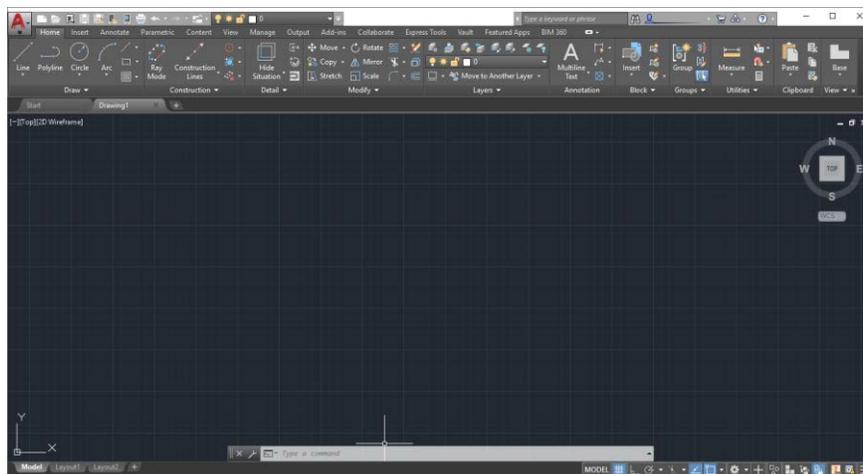
AUTOCAD MECHANICAL USER INTERFACE

ACM provides enhanced versions of standard AutoCAD commands, and uses these as the defaults. Don't be scared, try them, you'll grow to love them. You can also continue to use any custom LISP, VBA, or add-ins as you did with your AutoCAD.
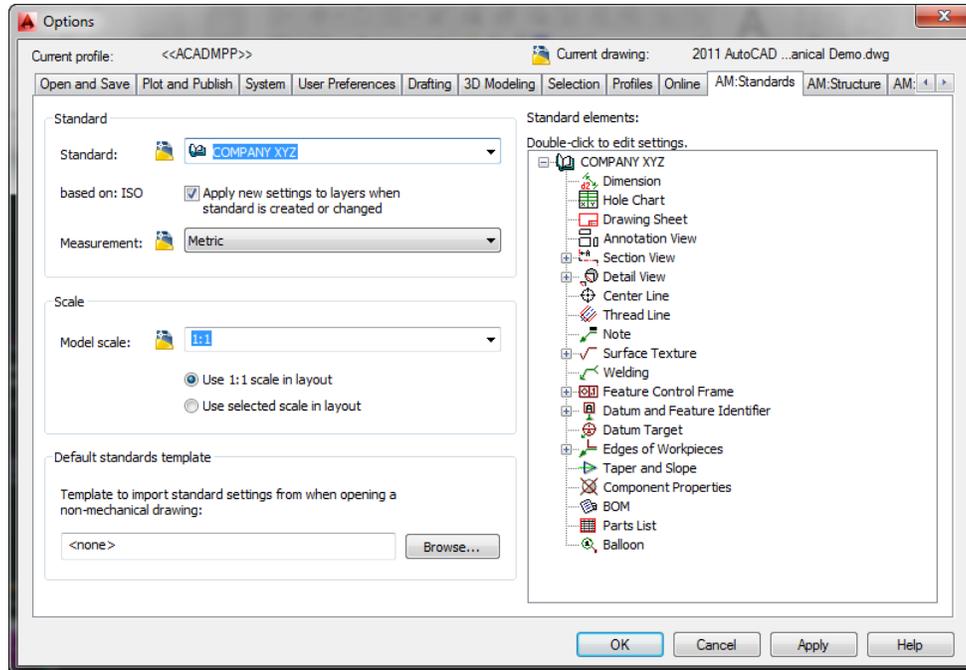
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Standards Management

International Standards

AutoCAD Mechanical is standards based. The included international drawing standards are the building blocks of efficient and accurate communication of design.

AM:STANDARDS

> To create a new Standard, copying an existing standard, enter the desired name into the **Standard drop-down** located in the upper left area of the dialog.
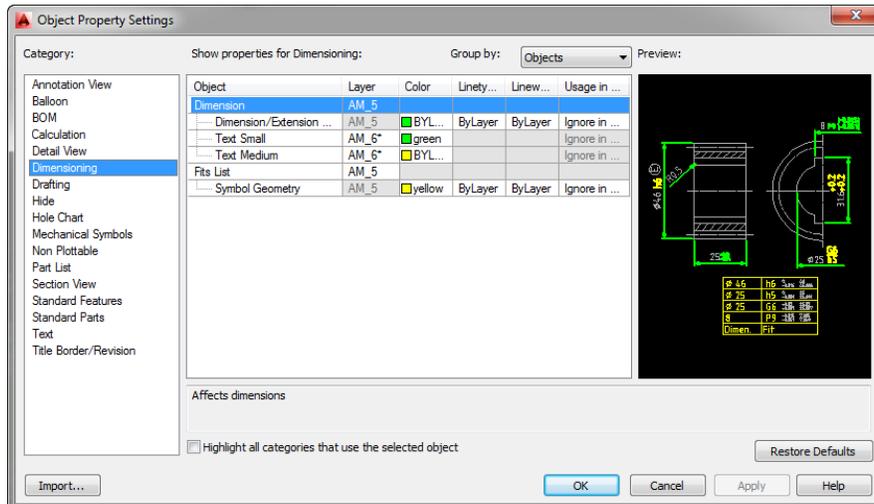
Mechanical Drafting Standards

With the **ACM Standards** you define the default settings for things including layers, dimension styles, text settings, and ACM specific entities like parts lists and balloons. Using these tools aid in delivering consistent design documentation for manufacturing.

Layer and Object Property Management

What is the most annoying thing when working with AutoCAD? Creating objects on the wrong layer!... but no longer with ACM!

ACM's standards system provides a workflow for quickly putting objects on the correct layer, with little effort. The benefit is two-fold, one this eliminates the repetitive work of setting the

correct layer active and two, objects are created on the proper layer defined by your company standard.

OBJECT PROPERTY SETTINGS

To set the preferences, access the **AutoCAD Options.** The tabs that affect settings for AutoCAD Mechanical are prefixed with *AM*. The **AM:Standards tab** sets the active standard, the current model annotation scale, and the default template. Use the tree view on the right side of this tab to configure specific feature settings.

Access the **Object Property Configuration** by double-clicking the standards name at the top of the tree. In the Standard Settings dialog insure "*Let AutoCAD Mechanical manage object properties*" is enabled so that the objects are automatically placed on the correct layers.

Select **Settings** to access the **Object Property Settings dialog**. Select the **Category** in the left-side panel to set it active and show the objects managed in that category.

Default Template

By setting a default template, any AutoCAD drawing first touched by ACM is automatically updated to match the templates configuration. At any point you can use this template to refresh the standards of the current drawing, matching it to your template

Mechanical Engineering Documentation

Centerlines

Centerlines are an important part of mechanical drafting. Centerlines represent many things including axes of symmetry, the identify holes and other circular features, and they are important for distinguishing cylindrical shapes.

ACM provides tools to quickly generate **centerlines,** automatically placed on the correct centerline layer. The **centerline toolset** additionally provides options to creates circles with the proper centerlines.
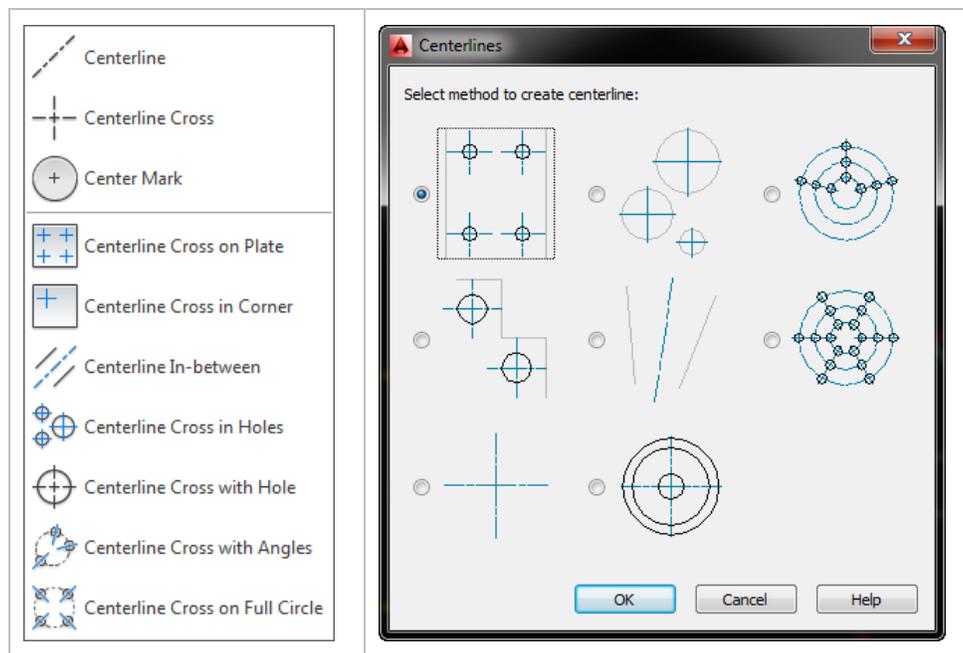

CENTERLINE CREATION OPTIONS

💡	To specify multiple diameters, use the pipe (|), for example 0.25|0.5|2. Do not forget that spaces in AutoCAD are the same as enters, so enter the desired values without spaces.

The ACM standards define the settings including the overshoots and offsets from the geometry.

Power Dimensioning

ACM's **Power Dimensions** are smart and understand their spatial relationship with one another. They are quick to create and easy to be modified.
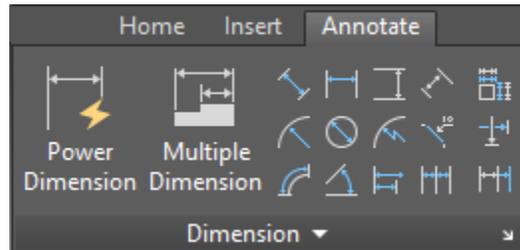

POWER DIMENSION FEATURES

Use one "*power*" command to create various dimension types. Additional commands for semi-automating the dimension creation process are available too. With ACM you can also merge, and split dimensions opposed to recreating.

Hide Situations

AMHIDE draws hidden lines to represent hidden edges, when you specify what objects lie in front and what objects lie behind. The real bonus is they automatically update as you make changes to the geometry!
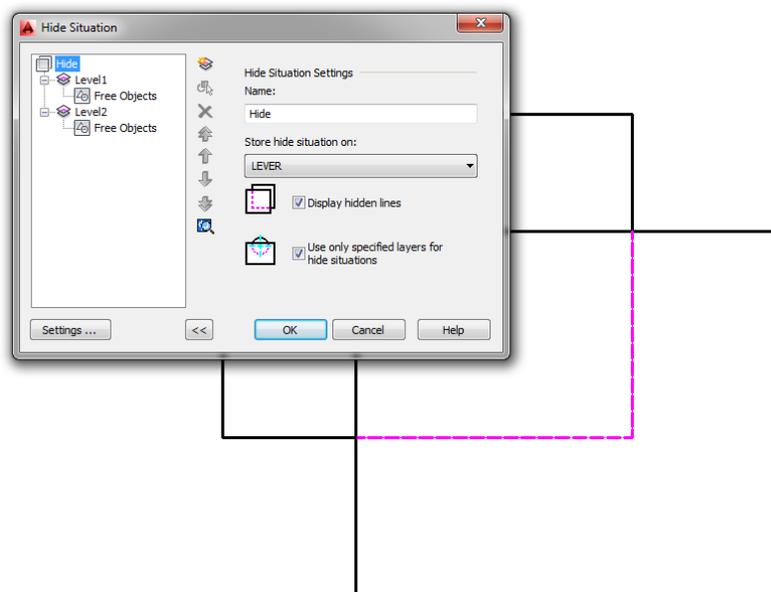
HIDE SITUATIONS

Detail Views

With mechanical and manufacturing type drawings it is common to need an enlarged view of a portion of view, typically referred to as **Detail Views**. AutoCAD Mechanical provides a **Detail View** tool to select a circular or rectangular area of your drawing and create a large view of it that is associated with the original geometry and updates as it updates.
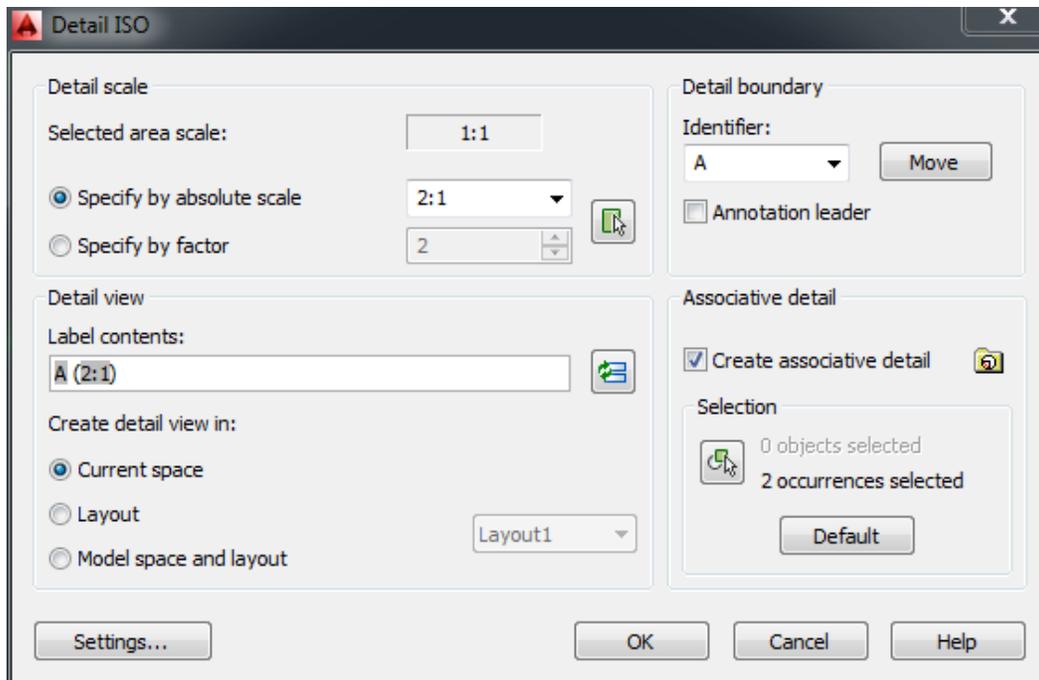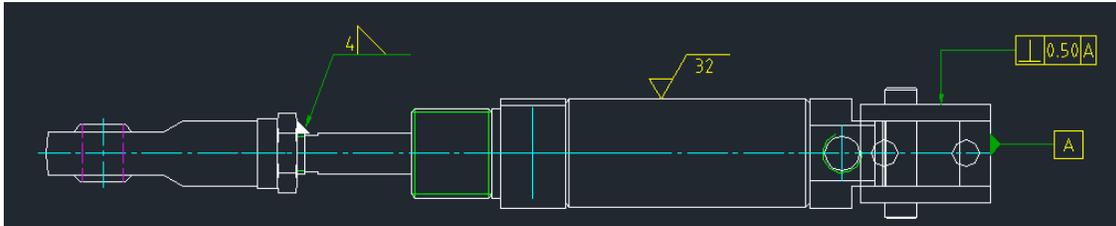

ACM DETAIL VIEW FEATURE

💡	The detail view can be placed into Model Space or a Paper Space Layout as a viewport

Mechanical Symbology

Use the built-in ACM symbol tools to quickly create standards-based surface texture symbols, datums, geometric dimensioning and tolerance symbols, targets, weld symbols, and notes. Quickly modified the symbols via a double-click.
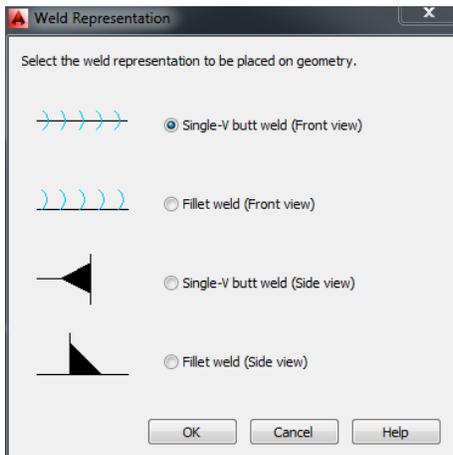

AUTOCAD MECHANICAL SYMBOLS

> ACM treats these symbols as an annotation, like a dimension, meaning they honour the ACM scale drawing feature

The ACM **Simple Weld** quickly draws simple welds including seam and fillet welds.
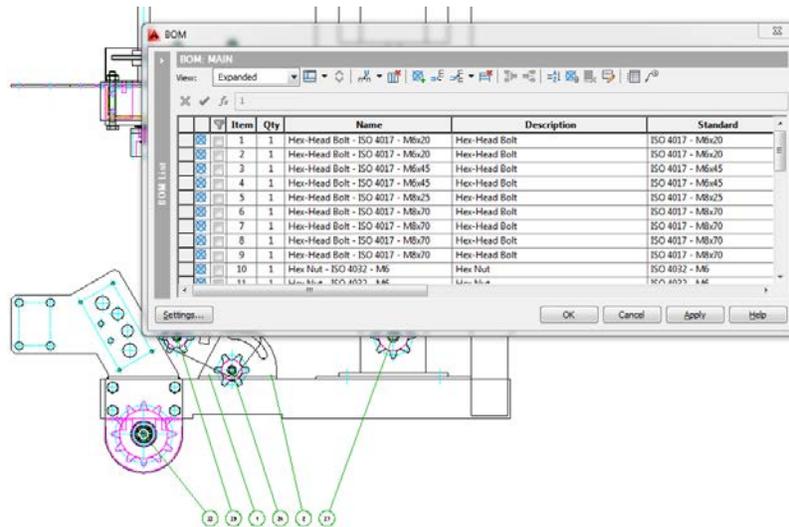
Bill of Materials

Part References

2D objects like lines, arcs, circles, and even polylines do not form a part, even though the combination creates a representation of the part. Use **Part References** to identify the geometry with attribute-like information.

BOM

The **Bill of Materials (BOM)** is a collection of **Part References** (or **Components)** and the associated meta data. The BOM is "*live*" as when the drawing changes, the BOM automatically updates with the changes. The meta data can be anything you want to track, for example descriptions, material, part number, and the manufacturer.

BILL OF MATERIALS & BALLOONS

Parts List

The BOM is a collection of the parts and all of the parts attributes, whereas the Parts List is the graphical representation (as a table) of the BOM, listing just the Parts and just the attributes you want displayed in the drawing.

Balloons

Place **Balloons** into the drawing manually or automatically, referencing any Part Reference or Structured Component in the drawing. The format is controlled by the active standard and the item numbers (or other information) shown within the balloon is set by the Bill of Materials.

Mechanical Geometry Creation

AMFILLET & AMCHAMFER

Fillets create arcs between two objects, extending or trimming these objects to be joined by a rounded edge. The rounded edge is an arc, created by the fillet feature. The ACM fillet works very similar to AutoCAD, with some noticeable differences. When using fillet, a contextual ribbon tab appears, providing options for the fillet.
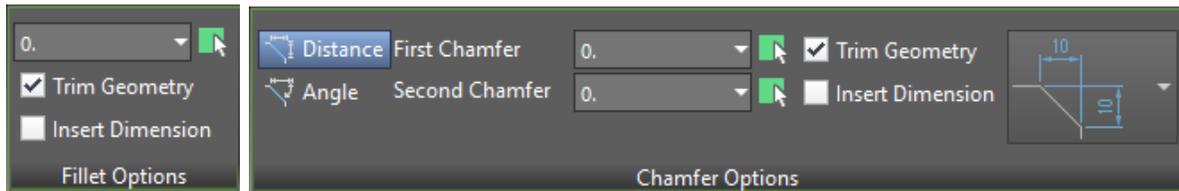
Similar in workflow to Fillet, **Chamfers** create a beveled edge (line) connecting two selected objects.

Holes

AutoCAD Mechanical includes thousands of standard features including holes, undercuts, keyways, and thread ends.
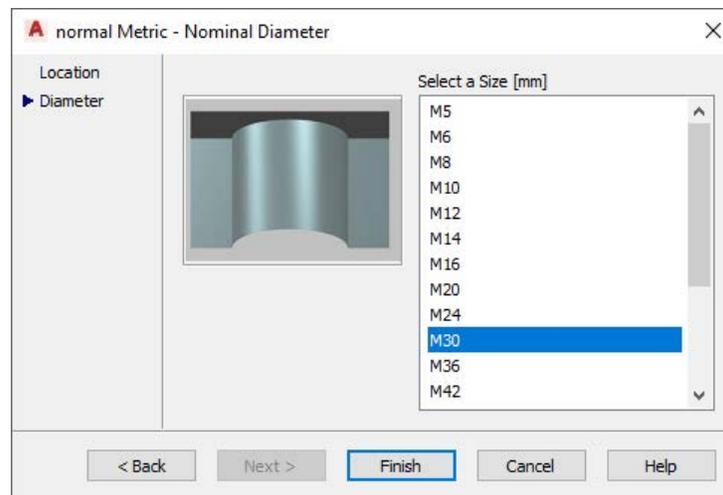

INSERT HOLE

Content

AutoCAD Mechanical includes over 700,000 standard components. This includes Features (Holes), Fasteners (Screws, Buts, Washers, etc.), Shaft Parts (Bearings, Clips, Retaining Rings), and Steel Shapes (HSS, Tubing, Pipe).

Use the ACM **Content Library** to access content from all libraries loaded on your system. As a panel it is modeless meaning it can remain open as you work with your drawing.
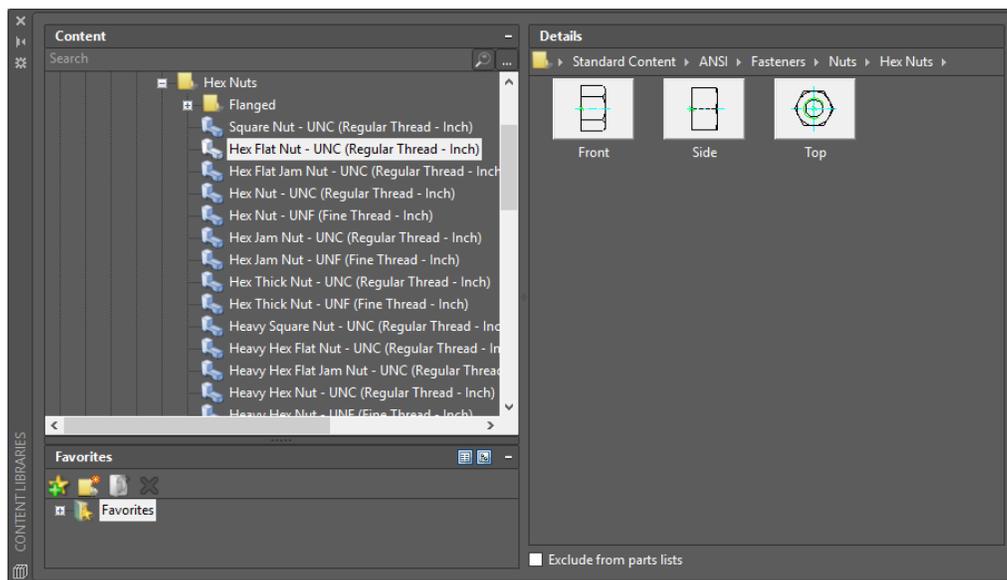
CONTENT LIBRARY

As the content is based on international standards it will only provide sizes defined by the standard. As most sizes and options are already contained within the library, this reduces the amount of effort to create and maintain a symbol library

The **Content Library** is customizable, adjust what is there or add your own. Use the **Content Manager** to manage the content contained within the libraries.

The content is easily adjusted after placing, just *double click.*

💡	Use **Power View** to quickly generate the different views of the component or feature

Screw Connections

Use the **screw connection wizard** to quickly create fastener assemblies. This includes generating the holes, fastener, nuts, and washers required to bolt two plates together. The wizard only shows components that you can combine (as in go together) and you can save combinations for future use (making it quicker)
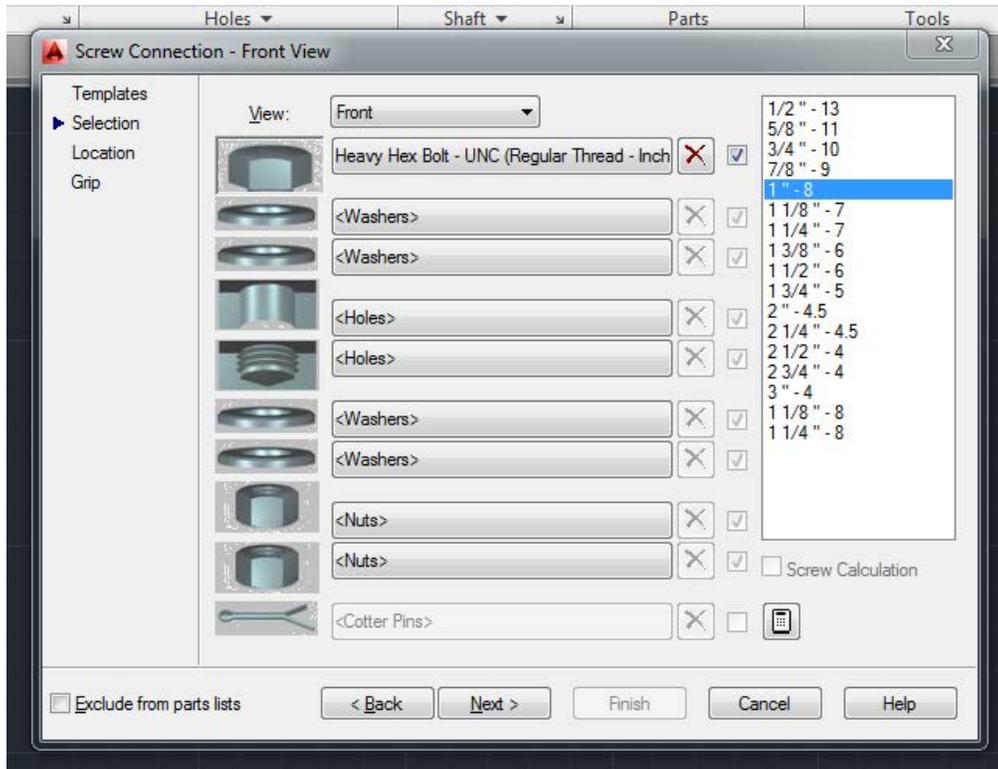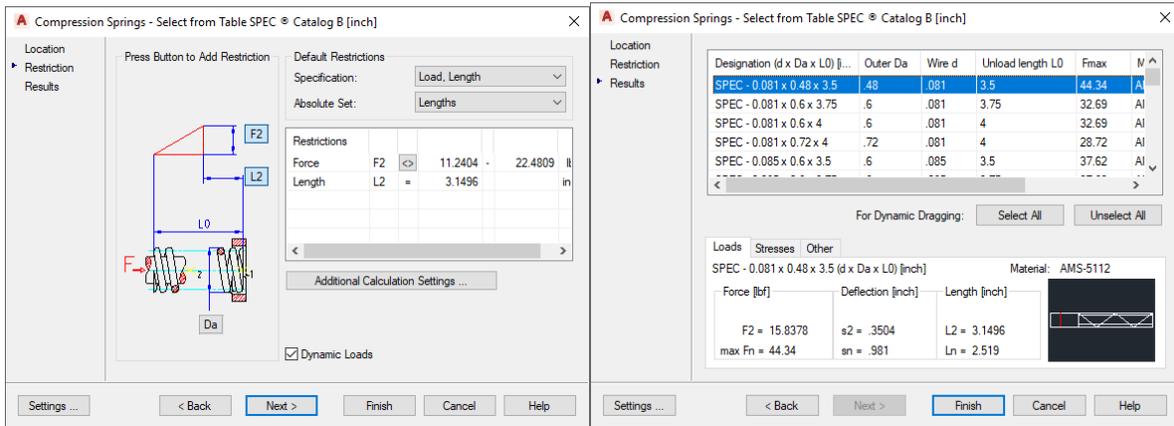

SCREW CONNECTION DIALOG

The length of the fastener will be automatically selected based on your point selection, you will be warned if no suitable length is found. Use the **Check Calculations** to determine diameters

💡	**Power Erase** removes the screw connection (all components and features) and repair any geometry effected by the screw connection

Shaft Generator

Use the embedded **Shaft Generator** to quickly build-up shafts with different sections which ACM positions automatically one after the other. The features include cylindrical and conical sections, features (holes, chamfers / fillets, grooves, threads, profiles, and wrench fittings), and standard parts (bearings, gears, retaining rings, seals, etc.)

Edit the shaft at any time via a double-click.

SHAFT GENERATOR

Use the **Shaft Calculator** to calculate deflection lines, bending moments, torsion moments, and safety factors. Also, use the calculations to determine shaft strength at selected points

Springs

AutoCAD Mechanical includes four **Spring Generators**: *Compression, Extension, Torsion, and Belleville.*


ACM SPRING GENERATOR

Mechanical Design Productivity

Construction Lines

ACM provides a set of tools for the creation of **Construction Lines**. Quickly generate xlines and rays for mechanical application and then quickly turn off / on and delete the construction lines.

Construction lines (xlines) are a type of AutoCAD object created infinitely in both directions. **Rays** are infinite in one direction, which means they have one end. **Construction Lines** are used for construction purposes and are useful during initial creation of your drawing, to lay out the drawing.

AutoCAD Mechanical provides many additional construction line creation methods, especially compared to AutoCAD. The required input is dependent on the construction type selected. For example, Horizontal and Vertical only require one-point selection, whereas 2-Point requires two points, and the Bi-sect option requires the selection of two objects.
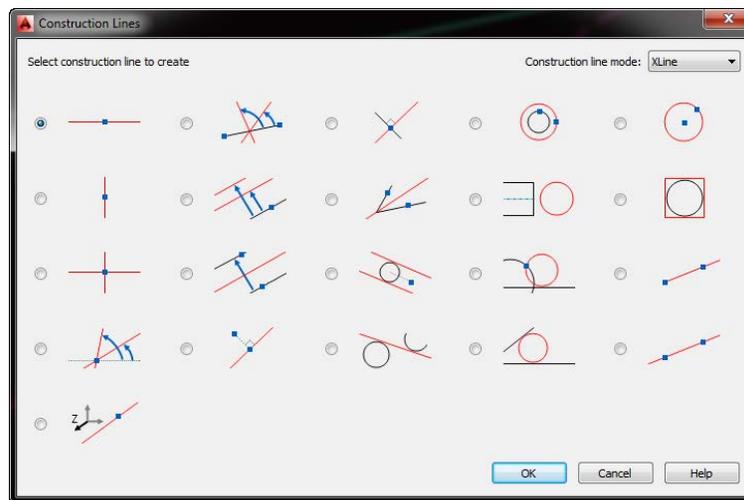
CONSTRUCTION LINE DIALOG

To quickly generate horizontal and vertical Construction Lines, use the **Automatic Construction Line** feature. AutoCAD Mechanical generates Construction Lines from the selected contours.

Two Layer tools are available specifically for working with Construction Lines. **Construction Lines On / Off** toggles the Construction Layer between frozen and thawed. **Construction Lines Lock / Unlock** toggles the Construction Layer between locked and unlocked.

> In addition to Centerlines and Construction lines, use the **Symmetrical Line** feature to create symmetrical polylines about a user-defined centerline. This offers all the same features and options as drawing polylines

Power Snaps

ACM expands on AutoCAD's Object Snaps by giving the ability to save "*sets*" of object snaps to set the available snaps and apply filters.

The **Power Snap Settings** is used to configure the running object snap modes. This includes enabling or disabling Object Snaps (OSNAP), Object Snap Tracking (OTRACK), and Snap. The available modes list both the AutoCAD standard object snaps and the AutoCAD Mechanical additions.
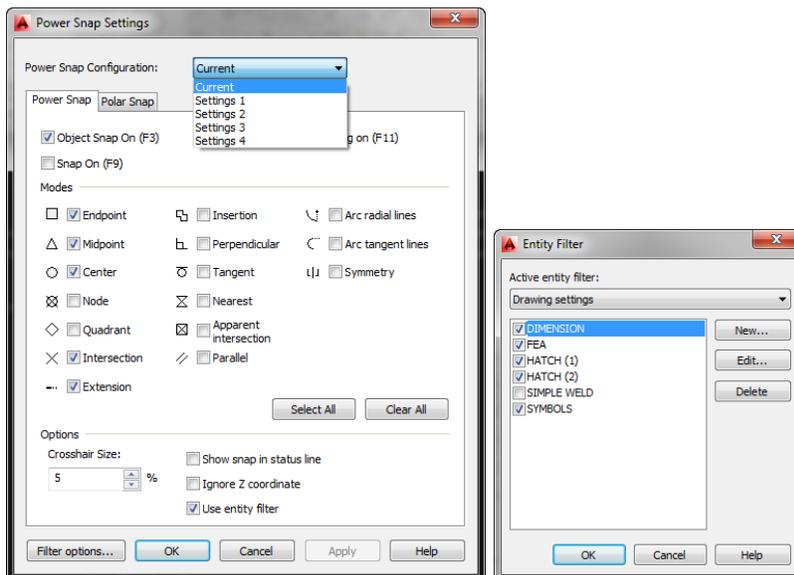
P is for Power

ACM understands how its components are intertwined and related. It provides tools to efficiently work with these objects.

For example, if you insert a screw connection if you used the vanilla AutoCAD erase command you would have to select line by line the objects to erase. With **PowerErase** you can select any singular object representing the screw connection and it will remove the fastener, nut, washers, hole and even "heal" the geometry broken by the insertion of the screw connection

Very similar to **PowerErase**, the **PowerCopy** feature recognizes the related components and allows for the copying of ACM objects by a single selection

Although you are working in 2D there are many situations you require views of your components from different angles, like a bolt from the side and from the top. With **PowerView** you select an inserted standard content item and it will prompt you for which view you would like to create. The view is created but it does not affect the quantity of the item in the BOM

CAM

The **Cam** feature creates cams based on sections drawn in motion diagrams, using fifth degree polynomials, the law of movement to offer the widest range of applications.
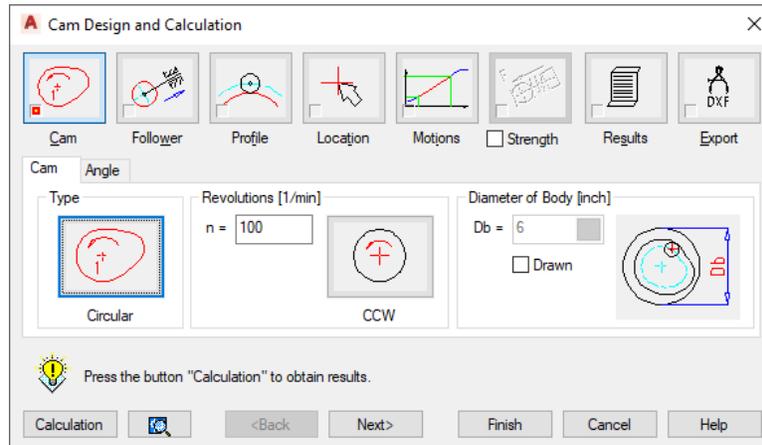
CAM DESIGN AND CALCULATION

Moment of Inertia (MOI)

Moment of Inertia (MOI) calculates the moment of inertia of a closed shape (if you can hatch it you can do a MOI calculations). After specifying the cross section and the direction of the load force ACM computes the: location of the center of gravity, direction of the main axes moment, moments of inertial along both axes, and the effective moment of inertia

A	
I_1 [INCH^4]	1.733877
I_2 [INCH^4]	0.315054
S_c [INCH]	0.8341
S_t [INCH]	1.1395
A [INCH^2]	1.7448468

MOMENT OF INTERTIA

Deflection Line

Deflection Line calculates & draws the deflection line / moment line of a beam that you have applied forces.
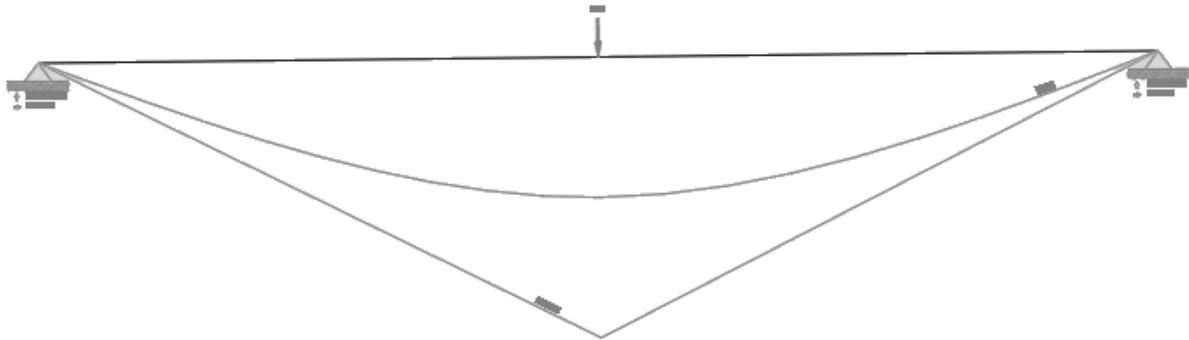
*DEFLECTION LINE RESULTS*

Finite Element Analysis

From the help, the ACM FEA toos "*performs a Finite Element Analysis on a two-dimensional object that is subject to a static load.*" Summary: you can calculate stress and deformation in a plane for plates of a given thickness or in a cross section with individual forces and stretching loads.
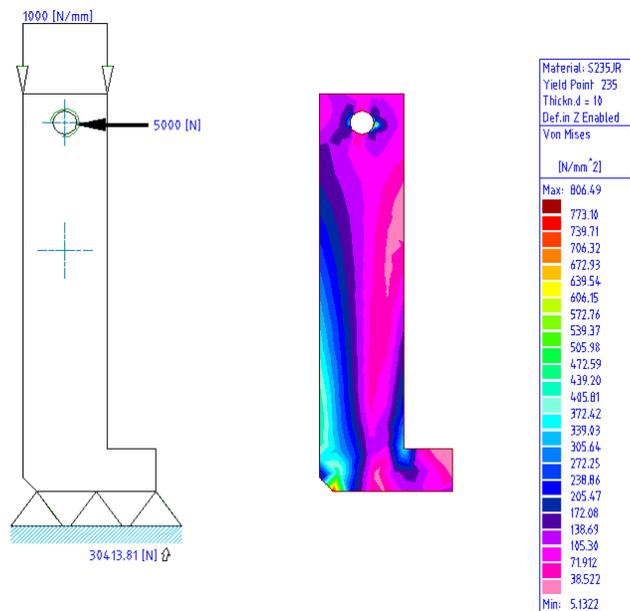
AUTOCAD MECHANICAL FINITE ELEMENT ANALYSIS

Structure

Structure could really be a class on its own, just because of the features and functionality and the workflows possible. ACM Structure is like blocks on steroids, a combination of blocks and groups, to define components. Although just 2D geometry the components defined by ACM are both parts and assemblies defining the structure of the assembly you are building. The BOM is automatically built as the structure is defined.
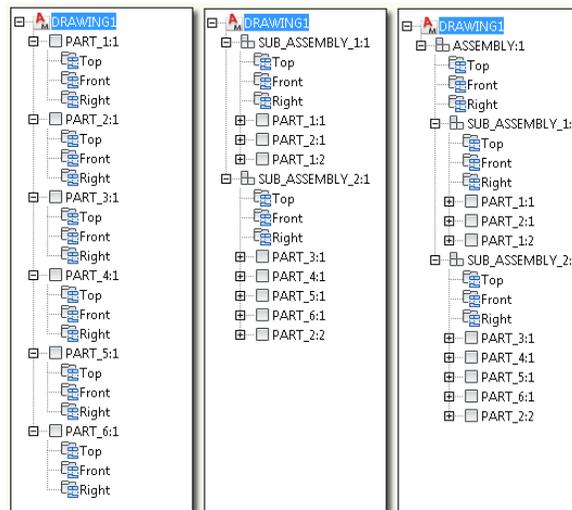
STRUCTURE BROWSER VIEWS

From the ACM help… "*Mechanical Structure offers all the advantages of both Blocks and Layer Groups and more. Since mechanical structure is designed for the explicit purpose of organizing a drawing. The features go beyond visibility enhancements (offered by layer groups), reuse of geometry, and automatic BOM updates (offered by blocks)."*