



The ABC's of AutoCAD Mechanical

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Code MA2870

Learning Objectives

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

- Effectively use the AutoCAD Mechanical interface
- Create BOM, use balloons, perform dimensioning, and use other mechanical detailing tools
- Use Structure to define "smart" components within your 2D geometry
- Use the Mechanical geometry creation tools and advanced layer management to more quickly and efficiently create your manufacturing drawings

About the Speaker

Mike graduated as the Most Distinguished Graduate from CAD/CAM Engineering Technology at SIAST, Kelsey Campus. For over 12-years he worked as an Application Specialist for an Autodesk reseller where he delivered demos, trainings, and implementations. He is specialist in the manufacturing industry with strong knowledge on the Autodesk mechanical products supplemented with a solid understanding of document management, hardware, networking, and other Autodesk technologies.

He is now the Technical Services Manager for Prairie Machine & Parts and is responsible for overseeing the engineering department's technical operations and the department's strategic technical growth. Primary duties include the ongoing support of critical computer systems and programs, the interactions between the department and between other departments, providing the engineering department with effective systems and technology, and working with the VP and Engineering Managers on the development and implementation of a cohesive strategic plan for the technical growth of the department

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 to include mechanical specific dimensioning tools, Mechanical Symbols (Welding, Surface Texture, etc), and Parts Lists and Balloon functionality

Autodesk then acquired German based Genius (one of their biggest acquisitions at the time) and the fun began. A snippet of the 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. It is now available on its own and as part of the various manufacturing specific suites.

Getting Help

This document is intended to provide a synopsis of what features and functionality AutoCAD Mechanical provides. It is by no means a user guide providing step-by-step procedures for using each feature. However the Help system within AutoCAD Mechanical is very extensive, describing each and every feature and providing examples in many cases.

The quickest way to narrow the help to the command you want to learn about is hover over the icon and hit F1 which will start the help but take you directly to the command you were hovering over.

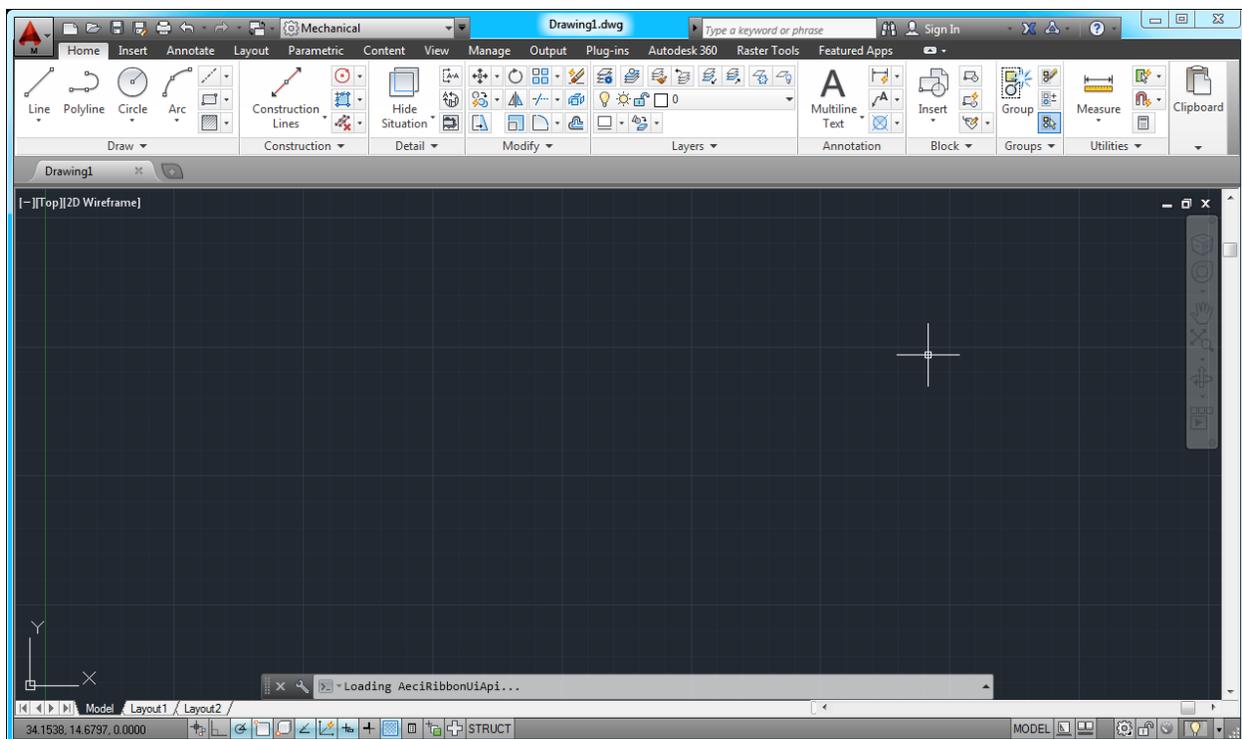


Is for AutoCAD

Category: General

AutoCAD Mechanical (ACM) is based on AutoCAD meaning that everything you can do in vanilla AutoCAD you can do in AutoCAD Mechanical....

- You might have to look for it or it may not be in the same location but it's in there, somewhere!
- 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 addins as you did with your vanilla AutoCAD





Is for Bill of Materials & Ballooning

Category: Mechanical Engineering Documentation



The **Bill of Materials (BOM)** is a collection of Part References or Components and their meta data. The BOM is “live” in that as the drawing changes the BOM automatically updates with the changes. This includes the quantity of each component instanced in the drawing. The meta data can be any data you want to track on your components, including descriptions, material, and vendor.

Balloons can be created (manually or automatically) from any Part Reference in the drawing. Format is controlled by the active standard, the item numbers (or other information) shown in the balloon is controlled by the BOM

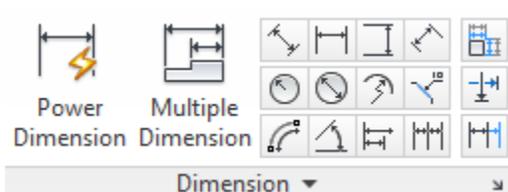
Item	Qty	Name	Description	Standard
1	1	Hex-Head Bolt - ISO 4017 - M6x20	Hex-Head Bolt	ISO 4017 - M6x20
2	1	Hex-Head Bolt - ISO 4017 - M6x20	Hex-Head Bolt	ISO 4017 - M6x20
3	1	Hex-Head Bolt - ISO 4017 - M6x45	Hex-Head Bolt	ISO 4017 - M6x45
4	1	Hex-Head Bolt - ISO 4017 - M6x45	Hex-Head Bolt	ISO 4017 - M6x45
5	1	Hex-Head Bolt - ISO 4017 - M8x25	Hex-Head Bolt	ISO 4017 - M8x25
6	1	Hex-Head Bolt - ISO 4017 - M8x70	Hex-Head Bolt	ISO 4017 - M8x70
7	1	Hex-Head Bolt - ISO 4017 - M8x70	Hex-Head Bolt	ISO 4017 - M8x70
8	1	Hex-Head Bolt - ISO 4017 - M8x70	Hex-Head Bolt	ISO 4017 - M8x70
9	1	Hex-Head Bolt - ISO 4017 - M8x70	Hex-Head Bolt	ISO 4017 - M8x70
10	1	Hex Nut - ISO 4032 - M6	Hex Nut	ISO 4032 - M6
11	1	Hex Nut - ISO 4032 - M6	Hex Nut	ISO 4032 - M6



Is for Power Dimensioning

Category: Mechanical Engineering Documentation

An Autodesk Study showed that placing dimensions with AutoCAD required twice as much time as with ACM



AutoCAD Mechanical's Power Dimensions are:

- smart and understand their *spatial relationship* with one another.
- quick and easy to be modified

One “power” command is used to create most dimension types but additional commands for semi-automating the dimension creation process are available too. With ACM you can also merging and split dimensions opposed to recreating

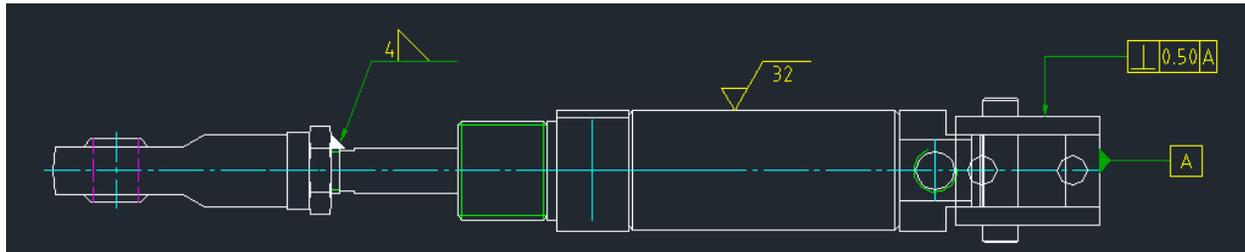


Is for Edge Symbols & other Mechanical Symbolology

Category: Mechanical drafting standards

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 via a double-click
- Treated as an annotation with the ACM scale drawing feature





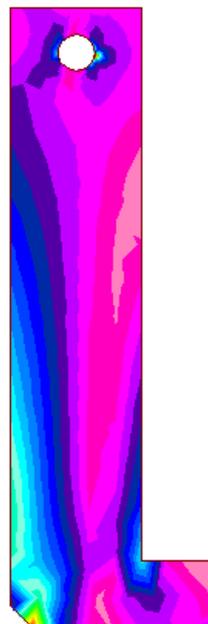
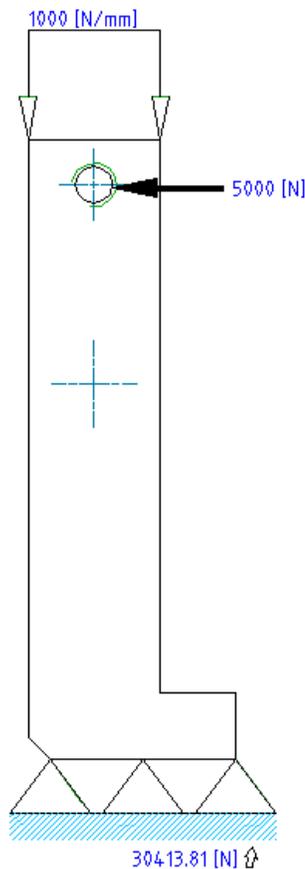
Is for Finite Element Analysis

Category: Mechanical Design Productivity

From the ACM Help...

“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.”



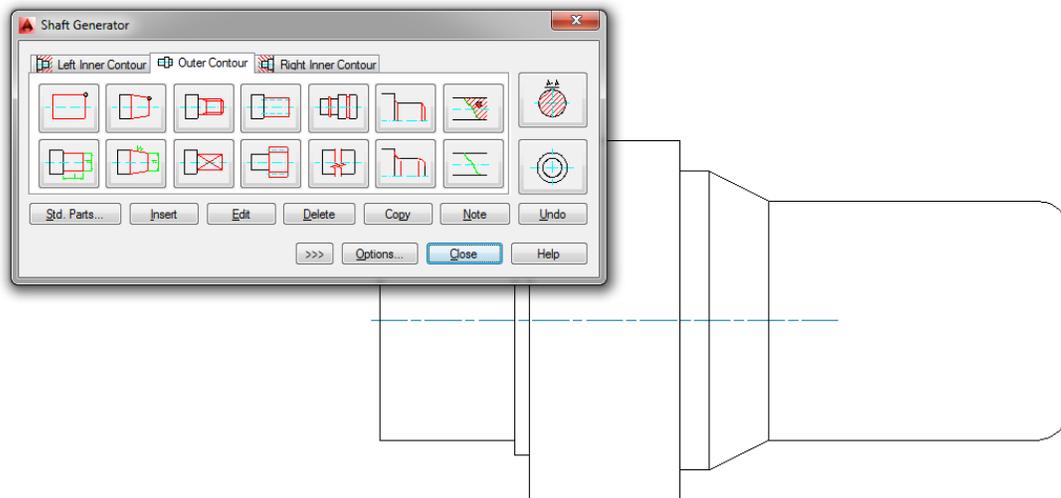
Material: S235JR	
Yield Point 235	
Thickn.d = 10	
Def.in Z Enabled	
Von Mises	
[N/mm ²]	
Max:	806.49
	773.10
	739.71
	706.32
	672.93
	639.54
	606.15
	572.76
	539.37
	505.98
	472.59
	439.20
	405.81
	372.42
	339.03
	305.64
	272.25
	238.86
	205.47
	172.08
	138.69
	105.30
	71.912
	38.522
Min:	5.1322



Is for Shaft Generators

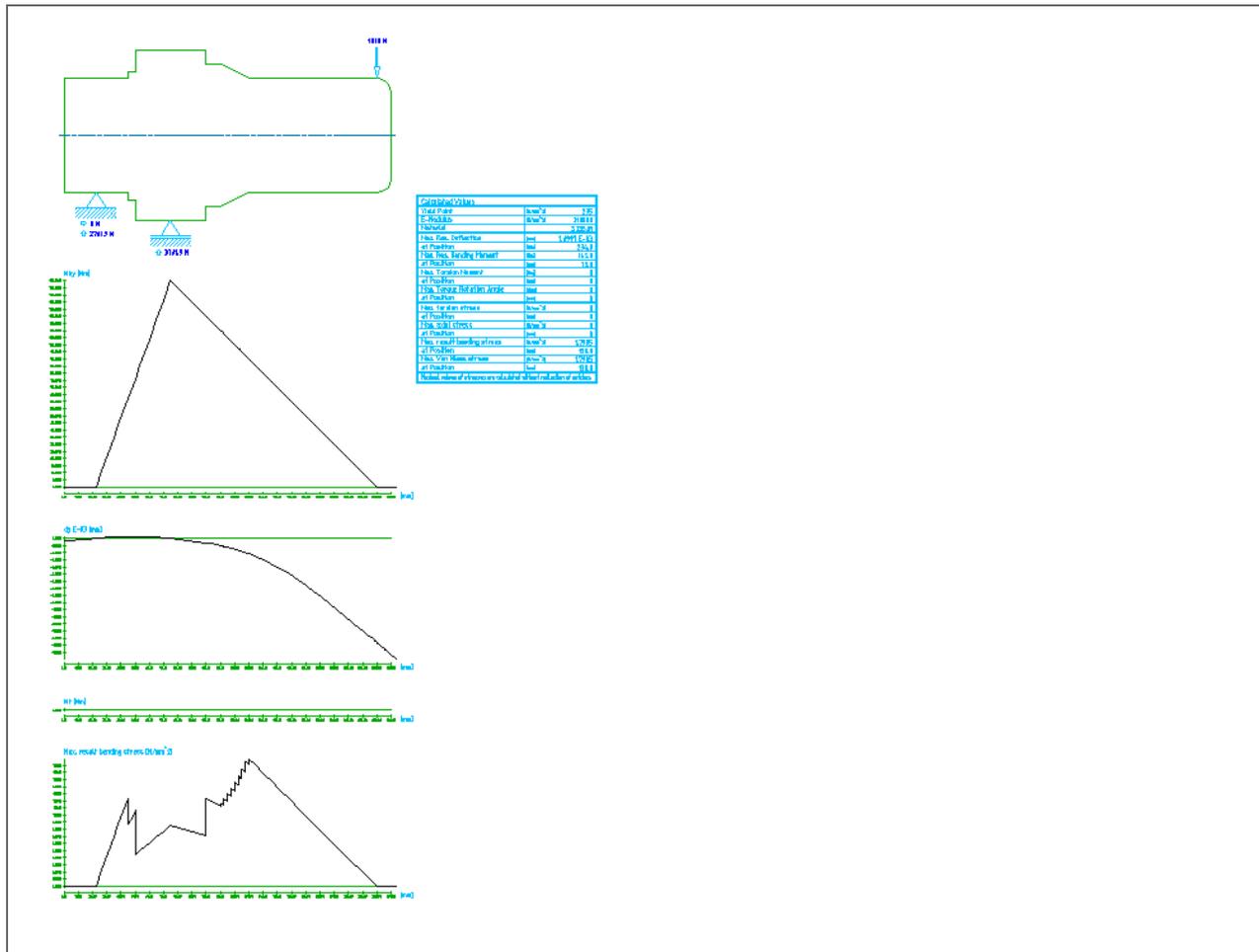
Category: Mechanical Design Productivity

Quickly build-up shafts using different sections which ACM positions automatically one after the other



- Add cylindrical or conical sections, features (holes, chamfers / fillets, grooves, threads, profiles and wrench fittings) and standard parts (bearings, gears, retaining rings, seals, etc)
- Edit at any time via a double-click

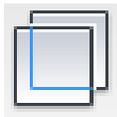
Use the Shaft Calculator to calculate deflection lines, bending moments, torsion moments, and safety factors. Also can be used to determine shaft strength at selected points



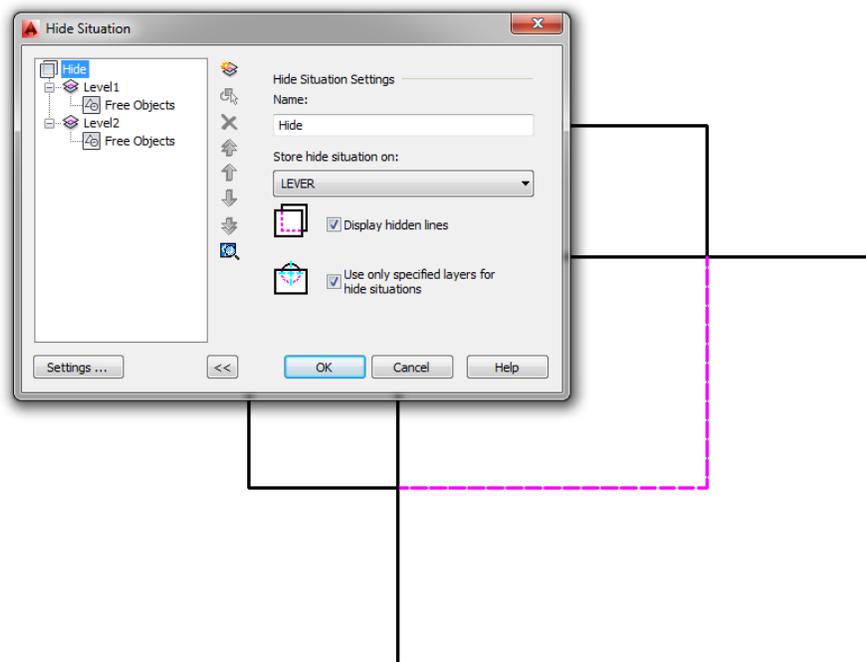


Is for Hide Situations

Category: Mechanical Engineering Documentation



“Draws hidden lines to represent hidden edges, when you specify what objects lie in front and what objects lie behind” ... and they automatically update as you make changes to the geometry!





Is for Infer Constraint Reference

Category: General

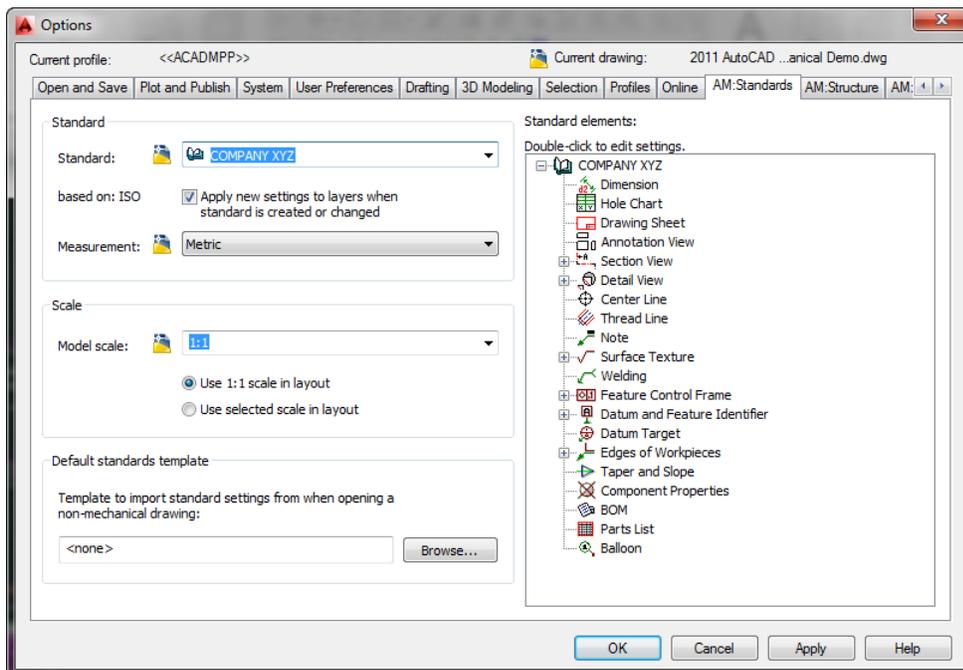
A reminder that anything AutoCAD does so does AutoCAD Mechanical, including Advanced features like Parametric Constraints. With Infer constraint reference enabled ACM will automatically apply constraints as you create your geometry



Is for JIS & Other International Standards

Category: Mechanical drafting standards

With ACM's Standards you can define multiple standards starting with settings based on international standards like ANSI, ISO, and JIS.





Is for Killer Standards Management

Category: Mechanical drafting standards

With the ACM Standards you can configure default settings like layers, dimension styles, text settings, and ACM specific entities like parts lists and balloons.

Quickly adjust the scale of the drawing updating all annotation objects (dimensions, text, leaders, linetype scale, etc)

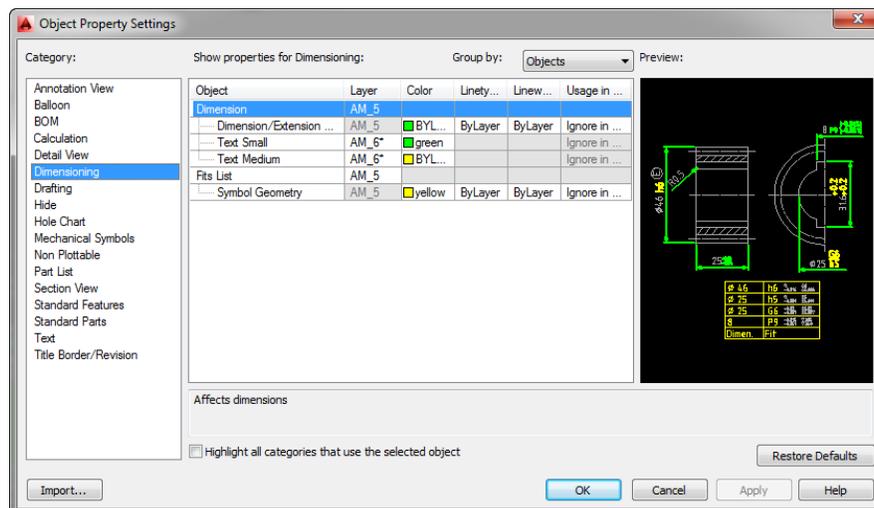


Is for Layer Management

Category: Mechanical drafting standards

With the ACM Standards you can configure default settings like layers, dimension styles, text settings, and ACM specific entities like parts lists and balloons. Quickly adjust the scale of the drawing updating all annotation objects (dimensions, text, leaders, linetype scale, etc)

What's one of the most annoying things when working with AutoCAD? Creating objects on the wrong layer!... but no longer with ACM! With ACM's Object Property Settings you define the layers and the objects that should automatically placed onto these layers!





Is for Moment of Inertia & Other Calculations

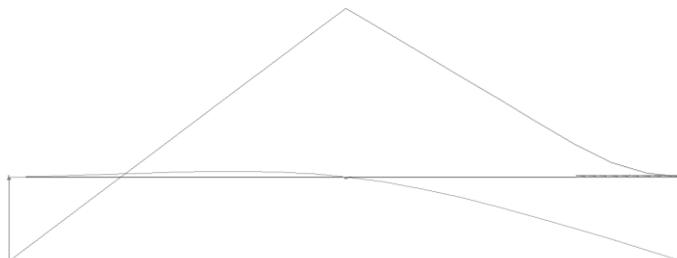
Category: Mechanical Design Productivity

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

W	
I ₁ [mm ⁴]	515567
I ₂ [mm ⁴]	505193
S _c [mm]	25
S _t [mm]	25
A [mm ²]	2474.722

Deflection Line calculates & draws the deflection line / moment line of a beam that you've applied forces.

Moment of Inertia I1	[mm ⁴]	515567
Moment of Inertia I2	[mm ⁴]	505193
Moment of Inertia Ieff	[mm ⁴]	515567
Max. Border Dist.	[mm]	25
Safety Factor		0.5813
Yield Point	[N/mm ²]	235
E-Modulus	[N/mm ²]	210000
Material		S235JR
Max.Deflection S1	[mm]	0.166457 E-15
Max.Bending Moment Mb1	[Nm]	0.5105 E-12
Max.Deflection S2	[mm]	2.663749
Max.Bending Moment Mb2	[Nm]	8336.5
Max.Stress Res.	[N/mm ²]	404.24
Max.Deflection Sres	[mm]	2.663749
Max.Bending Moment Mbres	[Nm]	8336.5
Scale for Defl. Line		23.46:1
Scale for Bending Mom. Line		1:66.69



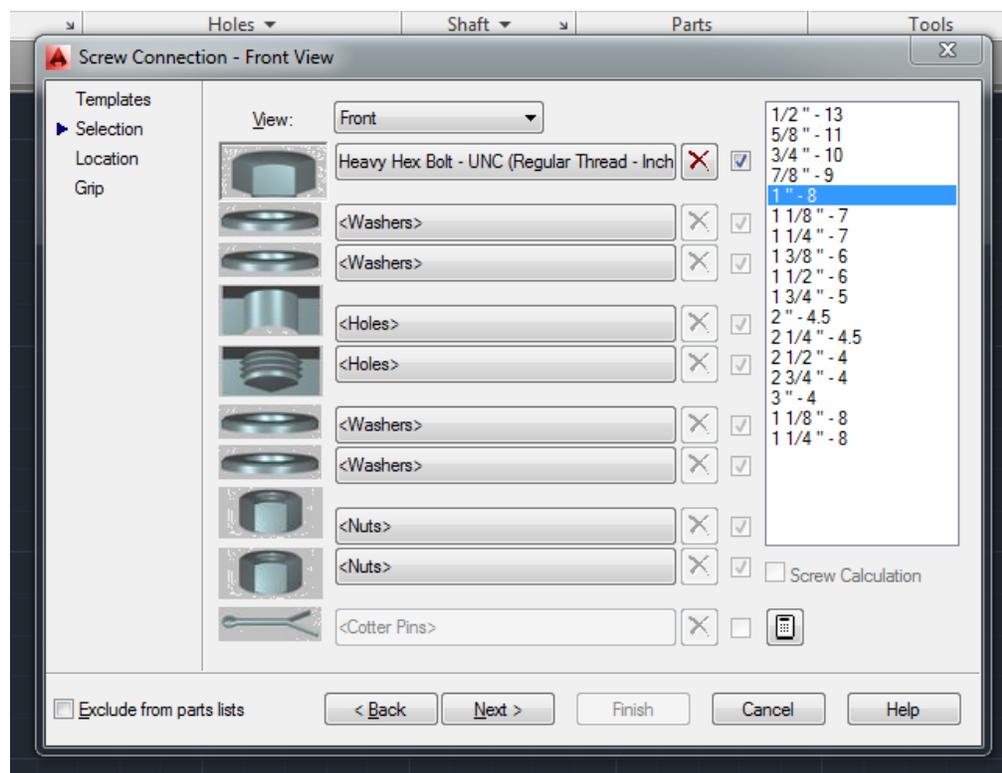


Is for Nuts & Bolts (Screw Connections)

Category: Mechanical Design Productivity

Use the screw connection wizard to quickly create fastener assemblies including 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 from a standards perspective) and you can save combinations for future use (making it quicker)

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 can be performed to determine diameters



NOTE: Power Erase will remove the screw connection (all components and features) and repair any geometry effected by the screw connection

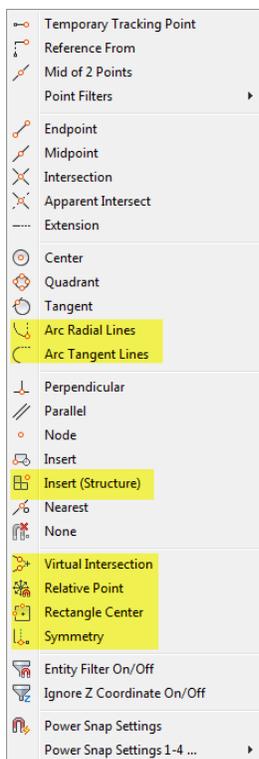


Is for Power Snaps

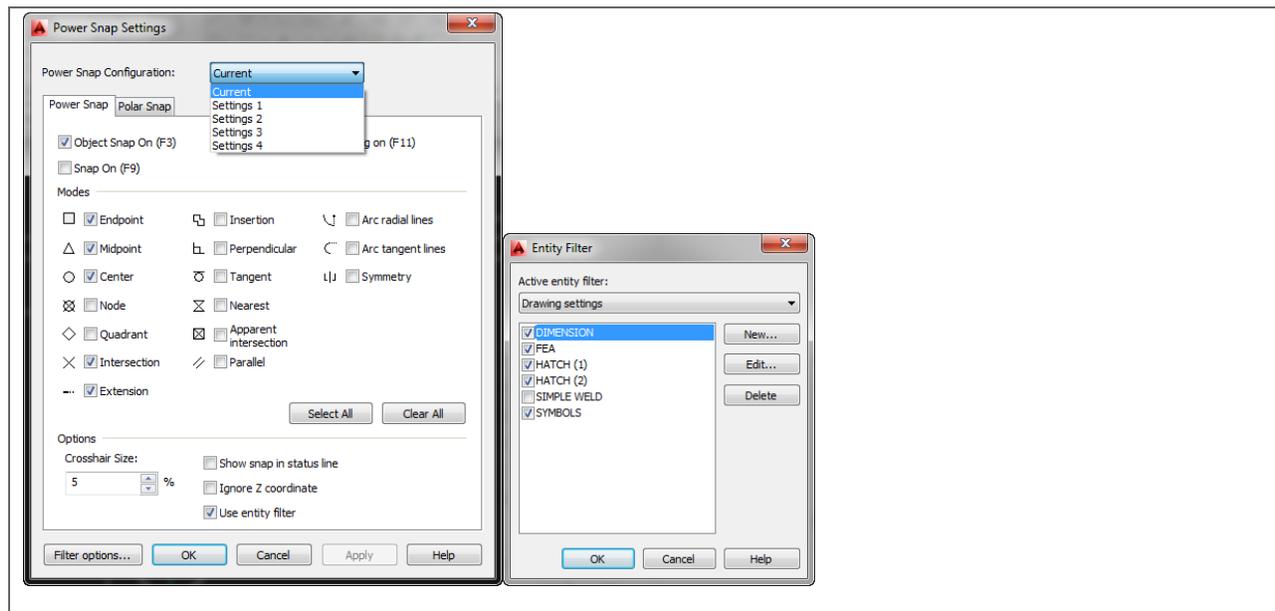
Category: Mechanical Design Productivity

ACM expands on AutoCAD's Object Snaps by adding additional snapping options:

- **Rectangle Center** – pick two sides of a rectangle (or lines) and it prompts for the offset amount (default is half)
- **Virtual Intersection** – Snaps to the “virtual” intersection, the extension of two lines. Works by picking two lines
- **Arc Radial & Arc Tangent** – for working with arcs, snapping to a point on the phantom line that passes through an arc center point and one of the arc endpoints.
- **Relative Point** - Define a point relative to the last used point



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



Is for PowerCopy, PowerRecall, PowerErase and PowerView

Category: Mechanical Design Productivity

ACM understands how its components are intertwined and related and provides tools to efficiently work with its 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, but with **PowerErase** you can select any singular object representing the screw connection and PowerErase 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

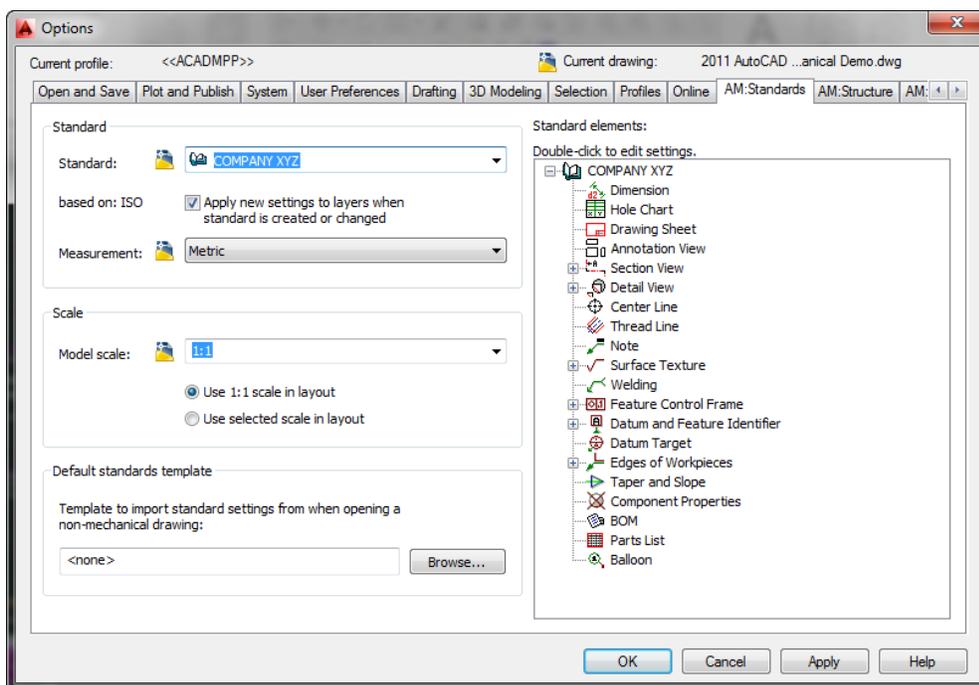
Although you are working in 2D there are many situations you require views of your components from different angles, like a bolt from the side and from the top. With PowerView you select an inserted standard content item and it will prompt you for which view you'd like to create. The view is created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



Is for Quick Templates

Category: Mechanical drafting standards

By setting a default template when any AutoCAD drawing is first touched by ACM the template configuration is automatically loaded, updating the AutoCAD drawing. At any point you can refresh the standards of the current drawing matching it to your template





Is for Retaining Rings & the Shaft Generator

Category: Mechanical Design Productivity

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

Once created it is quickly editing via a double-click. You can use the Shaft Calculator to calculate deflection lines, bending moments, torsion moments, and safety factors.



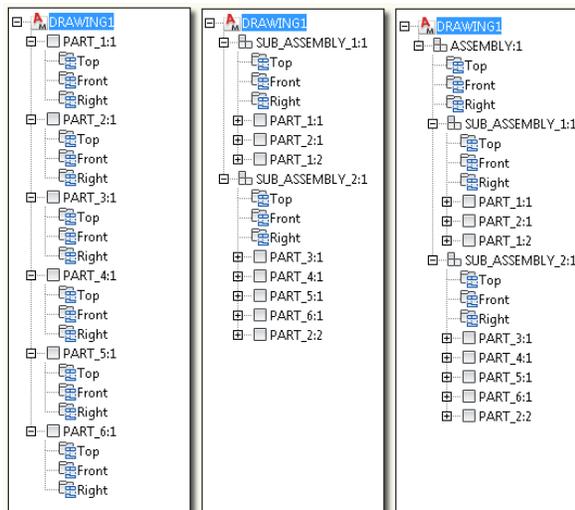
Is for Structure

Category: Mechanical Design Productivity

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.

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).”





Is for Test it, sTart using iT

Category: General

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've seen a company implement it just for the welding symbols!

The built-in help is very extensive providing high-level overviews and detailed steps for just about every feature contained within ACM. When in doubt hold your cursor over an icon and hit F1 to start the help, right at the section describing the command your cursor was above



Is for Unlimited Access to Content

Category: Mechanical Design Productivity

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

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

The Content Library is customizable, adjust what's there or add your own.

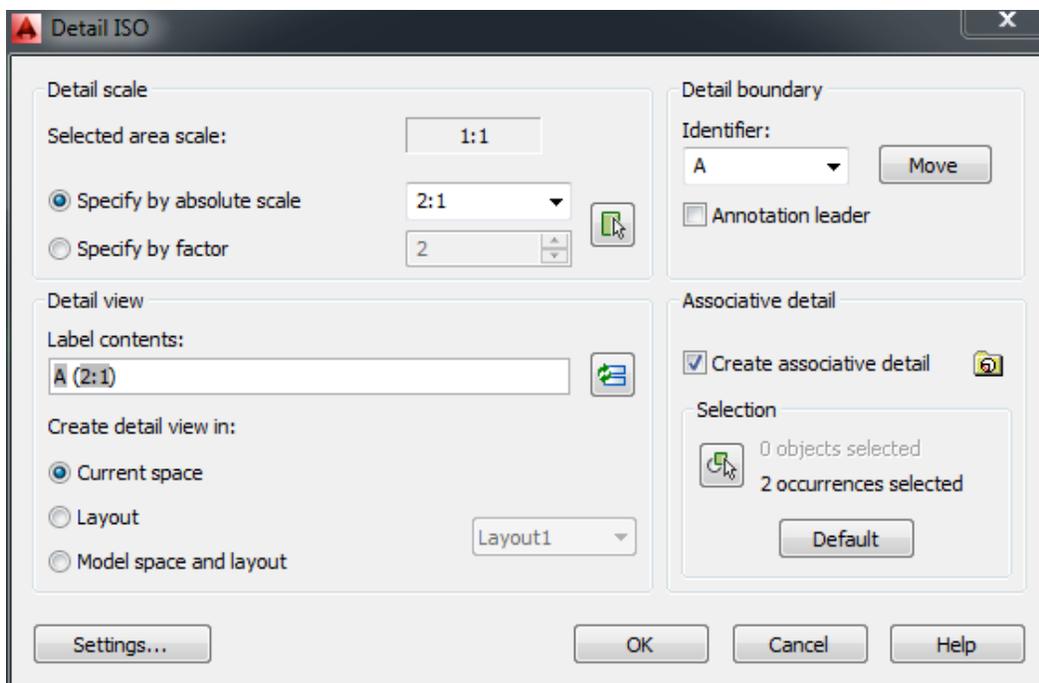
The Content is easily adjusted after placing, just double click. And remember you can always use Power View to quickly generate the different views of the component or feature



Is for Detail Views

Category: Mechanical Engineering Documentation

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 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.



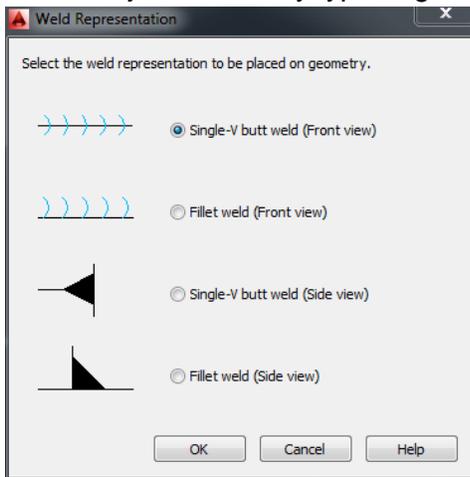
The detail view can be placed into Model Space or a Paper Space Layout as a viewport



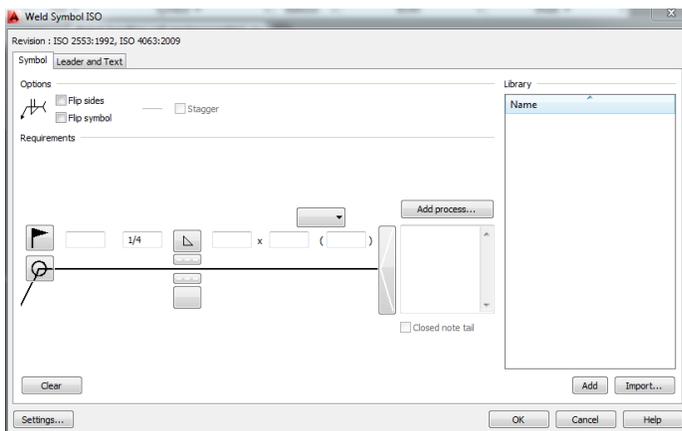
Is for Welding

Category: Mechanical Engineering Documentation

AutoCAD Mechanical Simple Weld tools quickly draw simple welds including seam and fillet welds on just about any type of geometry including ellipses, circles, arcs, lines and polylines.



The ACM Welding Symbol dialog provides a mechanism to configure your weld symbol before you create it. You can also save the configuration as a template to make it quicker to insert in the future. Once the weld symbol is placed a double-click allows you to edit it with the same dialog you used to create it.



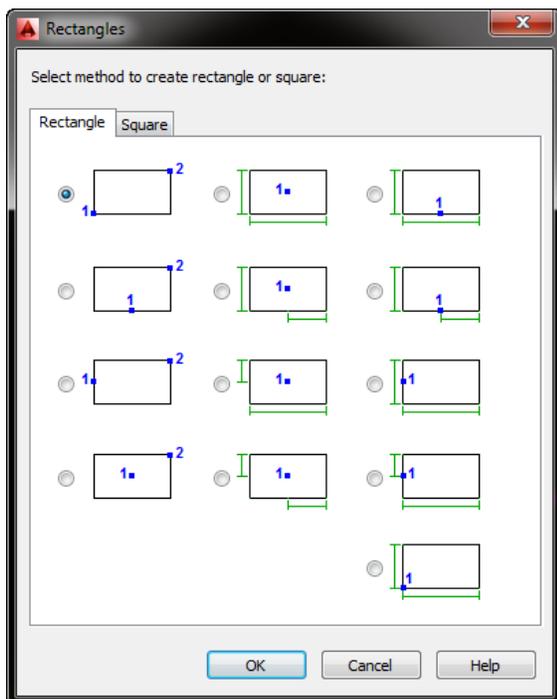


Is for eXtended Functionality

Category: Mechanical drawing and detailing tools

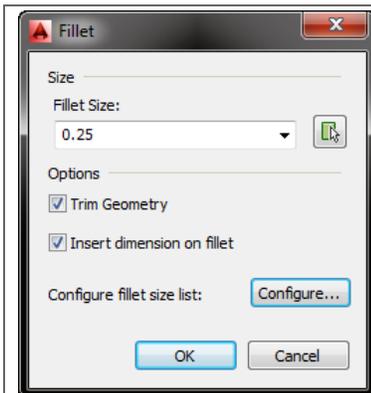
AutoCAD Mechanical takes standard AutoCAD commands and extends their abilities, either for efficiency or to add additional features and options.

The best option that showcases this extended functionality is the ACM rectangle command. With AutoCAD you get one option to generate a rectangle (2-corners) where ACM expands the options to over 13!



ACM takes standard fillet and chamfer functionality and:

- makes the configuration and usage dialog driven
- makes resizing easy via a double-click
- provides an option to only trim out part of the selected geometry



AMJOIN

Similar to the AutoCAD join feature but provides its own workflows and options... “You can also join overlapping entities to form a single element. When overlapping entities join to form a single element, the “overlapped” line draws only once during plotting, preventing the plotter pen from tearing the paper.”



Is for Studies prove it

Category: General

Multiple studies prove that AutoCAD Mechanical is greatly more efficient for mechanical engineering drawing and detailing. The Autodesk study “*AutoCAD or AutoCAD Mechanical? A Productivity Study*” found that the same tasks were completed 65% faster using AutoCAD Mechanical vs. AutoCAD.

- Drafting and annotation tasks are **55% faster**.
- Design and engineering tasks are **85% faster**.
- Risk of errors was greatly reduced because of a **60% reduction** in number of commands used.

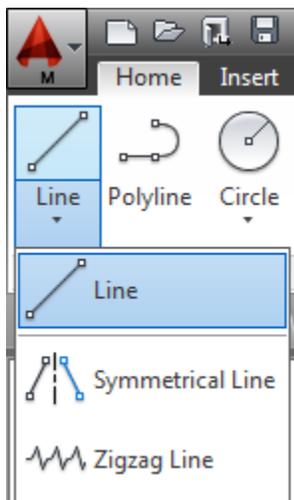


Is for ZigZags and other linetypes

Category: Extended draw toolbar for manufacturing

AutoCAD Mechanical adds additional options for creating lines:

- **Zigzag Line** – Draws a Zigzag line placed on the appropriate Layer
- **Symmetrical Line** – After creating or specifying the center line this mirrors the polyline you are creating about the centerline



Construction Lines - ACM provides a set of tools to

- quickly generate xlines and rays for mechanical application
- quickly turn off / on and delete the construction lines

