

AutoCAD® Mechanical

AutoCAD or AutoCAD Mechanical? A productivity study

AutoCAD® Mechanical software, part of the Digital Prototyping solution, and a member of the AutoCAD® family of products, can help save countless hours of design and rework by automating many common tasks. This study details the productivity gains that users can expect to see when moving from AutoCAD to AutoCAD Mechanical.*

Executive summary

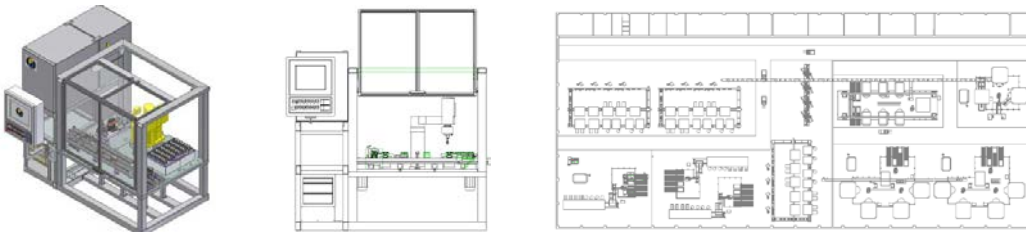
Designed by Autodesk and commissioned to an independent consultant, this study explores 11 common design challenges and shows direct comparisons of the time and effort required to accomplish each specific task in AutoCAD and AutoCAD Mechanical software. The same tasks were completed 65% faster on average using AutoCAD Mechanical.

Key findings

- For 2D CAD work, a total time reduction of 65% is possible with AutoCAD Mechanical.
- The risk of error is greatly reduced as well as more standardized functions with standardized parts are available.

The study

Today mechanical engineers use 2D CAD mainly to machine designs, plan factory layouts, or rework legacy data.



Based on these uses, we looked at a typical undertaking: modifying an existing robot automation cell. A team of designers, electrical engineers, programmers, purchasers, and technicians work together to build the upper robot cell, and different tasks required to modify it. The typical total cost for this project (time and material) is around \$80,000.

This comparison concentrates on 11 typical design tasks and their time ratio during the project.

Assuming that the existing robot cell should be reworked to assemble a new product and the cell needs to be updated in the factory layout, the estimated project design time is 100 hours (estimation: 70 hours pure CAD work; 30 hours of redesign time and rework).

Below you will see typical design tasks in detail (with the related times for this project):

CAD design tasks	%	time (hrs)
search/insertion for project data	6%	4.2
search/insertion for standard parts	3%	2.1
search/insertion for supplier parts	2%	1.4
search for data from other projects	2%	1.4
data loading	2%	1.4
data import (other CAD formats)	2%	1.4
creation of concepts	15%	10.5
detailing of concepts	10%	7
calculations	2%	1.4
structuring of data (layer, blocks, xrefs...)	8%	5.6
detailing of data out of assembly	5%	3.5
modifying	15%	10.5
dimensions	9%	6.3
annotations	9%	6.3
bill of material	8%	5.6
data export	2%	1.4
	100%	70

The different tasks should be ranked according to how often a designer uses them.

AutoCAD Mechanical offers a lot of enhancements for the major design tasks.

Before we start, here are some things to note about the preconditions regarding this study:

Two designers had to create the same results-one in AutoCAD and one in AutoCAD Mechanical. They reworked components of an existing robot automation cell and updated the factory layout with this data. To have proper results, only the pure CAD work was measured, not the redesign needed. AutoCAD was compared against AutoCAD Mechanical. With the enhancements in the different suites, the results would differ even more (with the Autodesk® Factory Design Suite functionality, for example).

We assumed that the AutoCAD user had already predefined templates with certain layer definitions, BOM structures, a basic library with standard parts and other settings. The time to prepare all of this is not included in the comparison (even though AutoCAD Mechanical offers all of this out of the box)

Now let's look at some of the tasks in detail, before we evaluate the complete list:

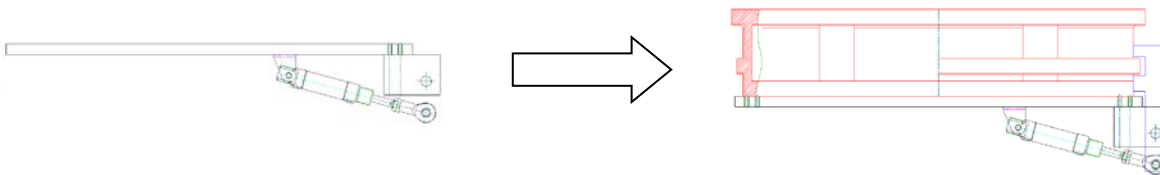
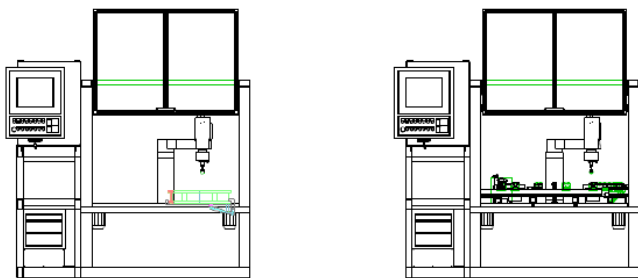
1. Design a new tray clamp

Task:

A new tray will be used in an existing automation cell; the old tray clamp held the tray only on one side, the new system should center the tray from both sides. Finally a recalculation is needed to see if the clamp forces are enough to center the tray.

Steps:

- Load existing data
- Rework existing data
- Create new clamp with tools like layers, blocks, construction lines, standard features
- Open sub assembly



1. Design a new tray clamp	AutoCAD	AutoCAD Mechanical
Prepare existing data	08:30	06:50
Create new concept	12:30	05:20
Structure data	03:30	01:20
Time savings with AutoCAD Mechanical		45%

(Figure shown in minutes)

Facts

Using layers and properties in AutoCAD is not a difficult task, but it requires many manual tasks. You can spend a significant amount of time and energy checking and moving entities to the correct layer in order to meet your company's defined set of rules.

The intelligent layer management system in AutoCAD Mechanical software automatically places items on the correct layer, color, and linetype as you create your drawing. And, it can be easily customized based on your company requirements. Customizable layer types include:

- Text and hatching
- Centerlines and construction lines
- Hidden lines
- Symbols and notes
- Title borders

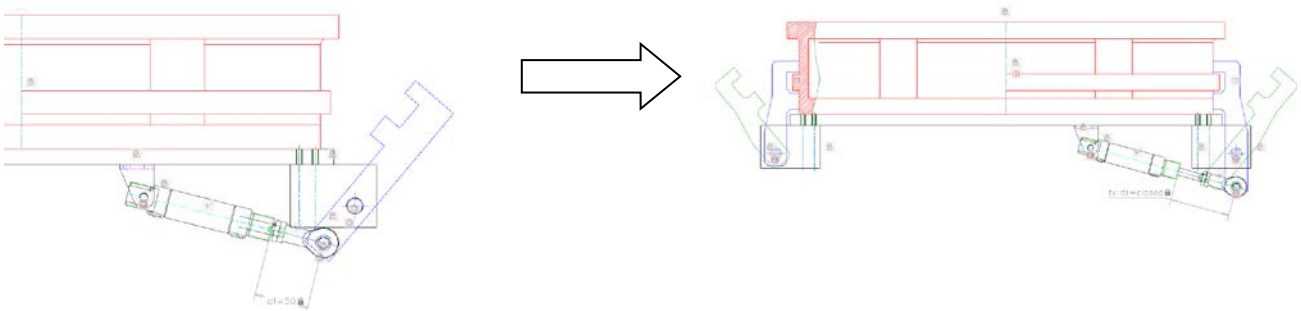
2. Detail and optimize new tray clamp

Task:

The clamp is now up to the major specs. It has to be checked that all positions work properly and the contour doesn't interfere anywhere.

Steps:

- Control position with constraints (open/close)
- Optimize geometry
- Modify the geometry on both sides of the tray



2. Detail new tray clamp	AutoCAD	AutoCAD Mechanical
Control positions	04:00	04:00
Create reference data	03:00	00:30
Optimize clamp	15:00	08:20
Complete assembly	11:30	05:10
Time savings with AutoCAD Mechanical		46%

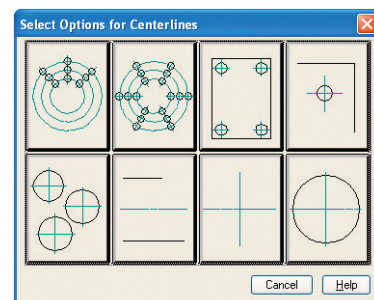
(Figure shown in minutes)

Facts

AutoCAD Mechanical offers a lot of commands that enhance the AutoCAD basic commands. On one hand, you save time, on the other you have easier access to commands you otherwise might not know about!

AutoCAD Mechanical provides additional options over basic AutoCAD software for drawing creation. Included are:

- More than 30 options for rectangle, arc, and circle creation
- Nearly automatic centerline creation and updating
- Specialty lines for break out views and section lines
- A full suite of construction lines for aligning drafting views
- Manufacturing-focused hatching patterns and sizes

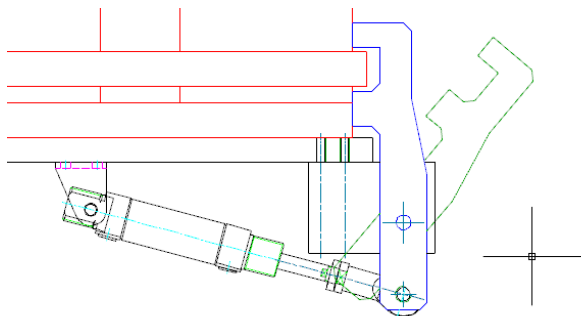


4. Prepare assembly with details

Task:

To understand all critical issues the foreground/background situation must be represented correctly.

- Create clear foreground/background
- Modify clamp
- Update background data



3. Prepare assembly with details	AutoCAD	AutoCAD Mechanical
Modify background contour	06:10	00:40
Modify holes in clamp	03:10	01:20
Update background contour	04:50	00:00
Time savings with AutoCAD Mechanical		86%

(Figure shown in minutes)

Facts:

AutoCAD software requires a lot of manual work and geometry manipulation to accurately represent parts and features that are partially or completely hidden in drawing views. Even in the simplest situation where one plate partially obstructs the view of another plate, several lines must be broken, trimmed, and then hidden in the drawing view. This design process is labor-intensive and tedious, reducing the time available for mechanical design.

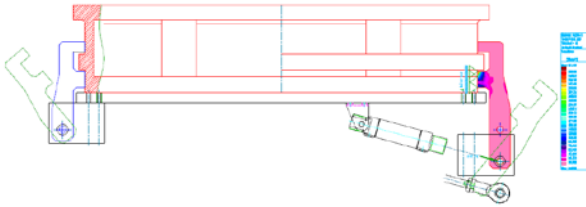
Ramp up productivity by defining simple foreground and background selections that automatically redraw geometry to show hidden or dashed lines of parts that are obstructed by other parts in a design. Hidden lines automatically update when changes occur, virtually eliminating the need to manually redraw geometry due to design changes. For the first time in 2D, identical parts can have different geometrical appearances when hidden, but AutoCAD Mechanical recognizes that they are still identical parts if you need to change the design or get an accurate count for the parts list. This means you spend less time and effort updating your 2D designs.

5. Calculate forces in mechanism

Task:

The existing robot cell caused problems when clamping the plastic trays. To set the right forces for the pneumatic cylinder, you will need to know which forces will act on the clamp faces.

- Calculate clamp forces



4. Calculate forces in mechanism	AutoCAD	AutoCAD Mechanical
Calculate forces that will affect tray	10:00	02:00
Time savings with AutoCAD Mechanical		80%

(Figure shown in minutes)

Facts:

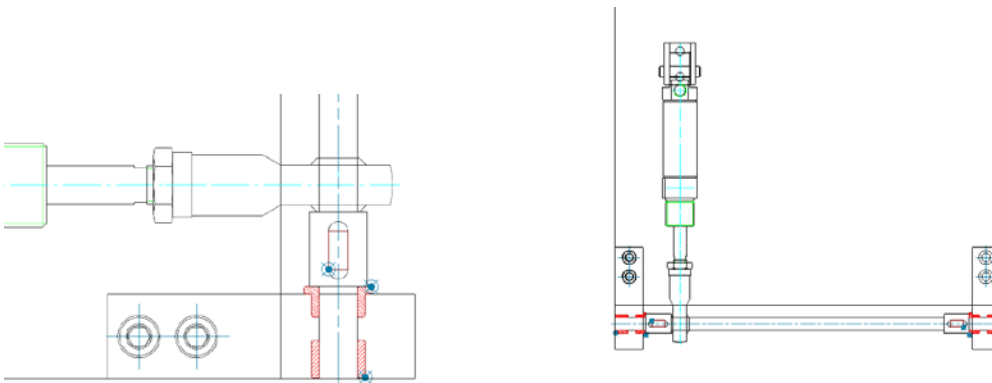
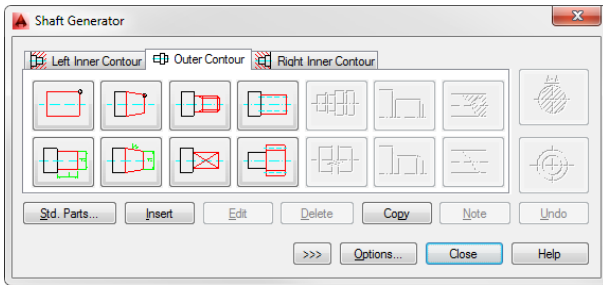
AutoCAD Mechanical offers a myriad of calculation functions. You can even perform an analysis on 2D geometry that is subject to static loads. You can calculate stress and deformation in a plane or a cross-section with individual forces and stretching loads.

6. Connect clamp with shaft

Task:

In total, four clamps will secure the tray. On both sides, a shaft is connecting the clamps. This helps to reduce the energy effort and helps to synchronize the system cost-efficiently.

- Create a shaft to connect the clamps on both sides
- Add standard parts to keep the shaft in position and transmit the power



5. Connect clamp with shaft	AutoCAD	AutoCAD Mechanical
Create shaft	08:20	03:40
Insert bearings and parallel keys	06:10	00:30
Modify shaft to adapt to selected plain bearings	03:40	01:10
Time savings with AutoCAD Mechanical		71%

Facts:

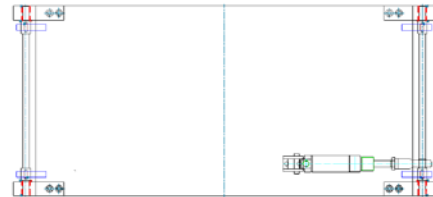
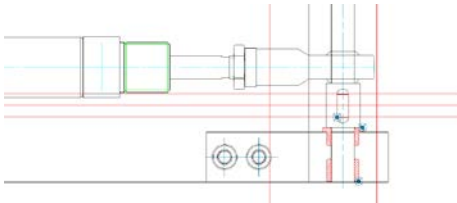
AutoCAD Mechanical not only offers standard parts, but assists in creating complete machine parts like shafts, gears, springs and others, by automatically connecting parts with all project information. Any change on one component will cause an automatic update on all other related components.

7. Complete assembly

Task:

The other views of the components need to be finished. Additional preparations are needed to get the new components organized in blocks and xref.

- Create side view of clamp
- Create xref of clamp
- Create xref of shaft
- Complete assembly



6. Complete assembly	AutoCAD	AutoCAD Mechanical
Create side view of clamp	04:20	03:50
Create xrefs	03:00	03:00
Complete top view	02:30	02:30
Time savings with AutoCAD Mechanical		5%

Facts:

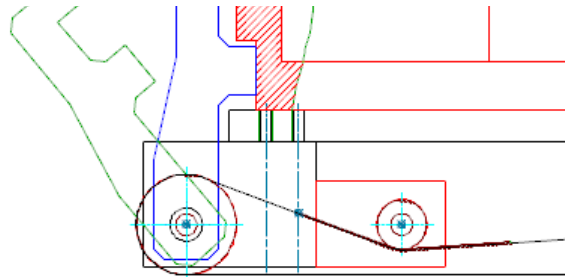
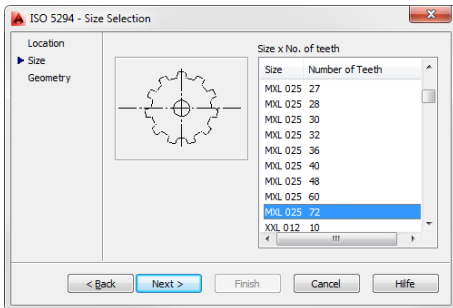
AutoCAD offers a highly sophisticated functionality to structure blocks and xref. AutoCAD Mechanical delivers additional value for drafting functions as well.

8. Add pulleys and belt

Task:

The left and right side of the clamps need to be synchronized. This can happen easily with a belt or chain system.

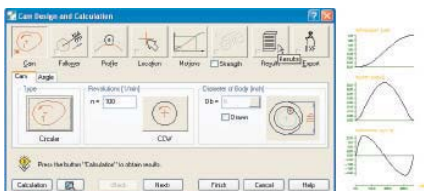
- Add pulleys and belt
- Add adjuster pulley
- Calculate correct position to be able to order a standardized belt type and length



7. Add pulleys and belt	AutoCAD	AutoCAD Mechanical
Add pulleys	05:30	02:00
Add belt	08:00	03:00
Add adjuster pulley	05:50	02:30
Optimize adjuster pulley position	10:00	01:20
Time savings with AutoCAD Mechanical		70%

Facts:

If you are building mechanisms from paper catalogs and doing manual calculations, then these comprehensive tools can be a huge time-saver. Built into the application environment, they are extremely helpful when making small, iterative changes to improve a design. They not only create parts according to specifications, but also create all of the reports and calculations needed to analyze the design. AutoCAD Mechanical software includes shaft, spring, belt, chain, and cam generators.

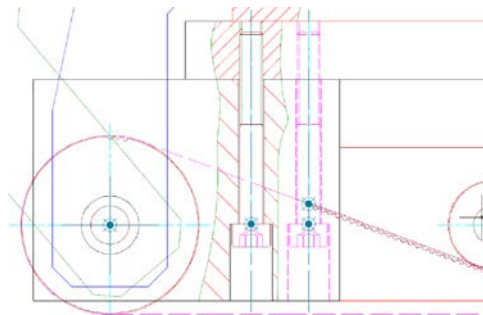
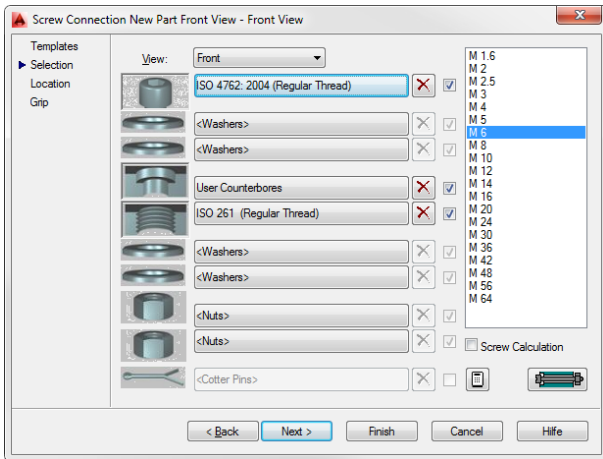


9. Mount clamp fixture with screws

Task:

The newly created components need to be secured with screw connections.

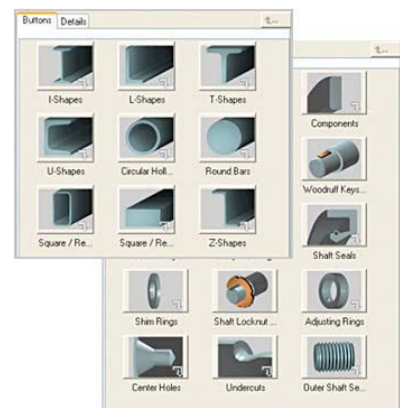
- Insert screws
- Add holes to the components



8. Mount clamp fixture with screws	AutoCAD	AutoCAD Mechanical
Search correct screw size	05:10	02:00
Add holes to parts	02:10	00:00
Complete view with breakout and hatch	05:10	02:20
Insert 2nd screw connection in hidden mode	10:00	01:20
Time savings with AutoCAD Mechanical		75%

Facts:

AutoCAD Mechanical contains more than 700,000 standard parts like pre-drawn screws, nuts, washers, pins, rivets, and bushings. It also includes 100,000 pre-drawn standard features such as undercuts, keyways, and thread ends. When incorporated into a design, the feature cleans up the insertion area automatically in the drawing so you don't have to edit manually. AutoCAD Mechanical also contains more than 8,000 pre-drawn holes such as through holes, blind holes, counter-bored holes, countersunk holes, oblong holes, and others.

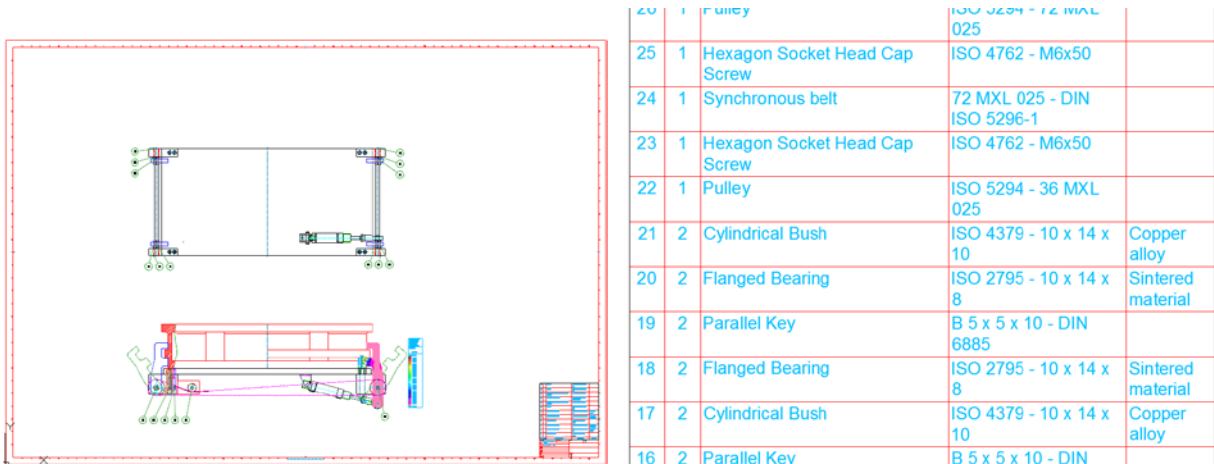


10. Prepare production drawings for assembly

Task:

Create production drawing for assembly

- Insert drawing border
- Insert balloons
- Insert bill of material



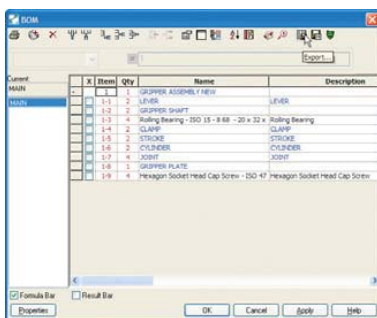
The image shows a technical drawing of a mechanical assembly with balloons pointing to various components. To the right of the drawing is a Bill of Materials (BOM) table listing the parts and their specifications.

20	1	Pulley	ISO 5294 - 12 MXL 025	
25	1	Hexagon Socket Head Cap Screw	ISO 4762 - M6x50	
24	1	Synchronous belt	72 MXL 025 - DIN ISO 5296-1	
23	1	Hexagon Socket Head Cap Screw	ISO 4762 - M6x50	
22	1	Pulley	ISO 5294 - 36 MXL 025	
21	2	Cylindrical Bush	ISO 4379 - 10 x 14 x 10	Copper alloy
20	2	Flanged Bearing	ISO 2795 - 10 x 14 x 8	Sintered material
19	2	Parallel Key	B 5 x 5 x 10 - DIN 6885	
18	2	Flanged Bearing	ISO 2795 - 10 x 14 x 8	Sintered material
17	2	Cylindrical Bush	ISO 4379 - 10 x 14 x 10	Copper alloy
16	2	Parallel Key	B 5 x 5 x 10 - DIN	

9. Prepare production drawings for assembly	AutoCAD	AutoCAD Mechanical
Insert drawing border	01:00	01:00
Insert balloons	08:30	02:10
Insert bill of material	05:10	01:50
Time savings with AutoCAD Mechanical		66%

Facts:

Create automated and associative parts lists and bills of materials (BOMs) that were specifically developed for manufacturing and that automatically update as the design changes. Included is support for multiple parts lists per drawing, collapsible assemblies, automatic recognition of standard parts, and customizable options so features can be revised to match current company practices. Change a design once, and updates ripple through the entire drawing, helping to keep everyone on schedule and reduce costly stops in production from incorrect part counting, identification, and ordering. Export or link BOM data to manufacturing resource planning (MRP) and enterprise resource planning (ERP) systems, or data management systems such as Autodesk® Vault Professional software.

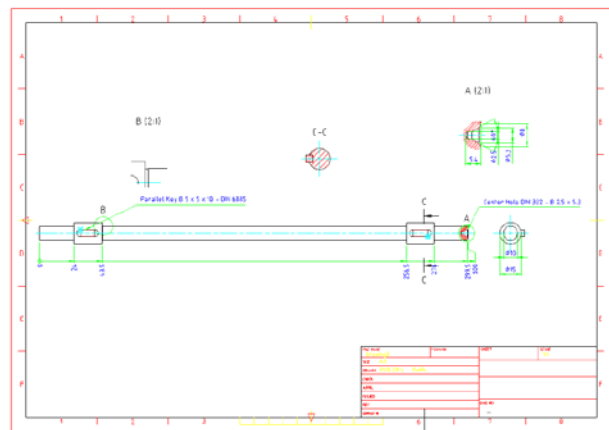
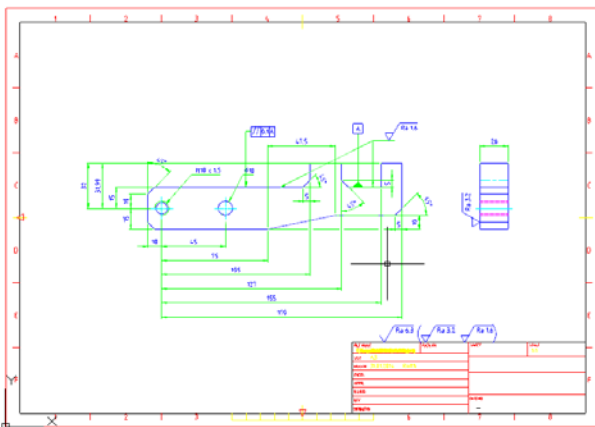


11. Prepare production drawing for clamp and shaft

Task:

Create production drawing for parts

- Create detail drawing of clamp and shaft
- Add details
- Add dimension
- Add symbols
- Update drawings based on changes



10. Prepare production drawings for clamp and shaft	AutoCAD	AutoCAD Mechanical
Create missing views/details on parts	11:00	04:00
Add dimensions	07:30	04:50
Add annotations	05:00	03:20
Modify drawing scale	03:00	00:30
Add details	02:00	01:00
Insert 2nd screw connection in hidden mode	10:00	01:20
Time savings with AutoCAD Mechanical		61%

Facts

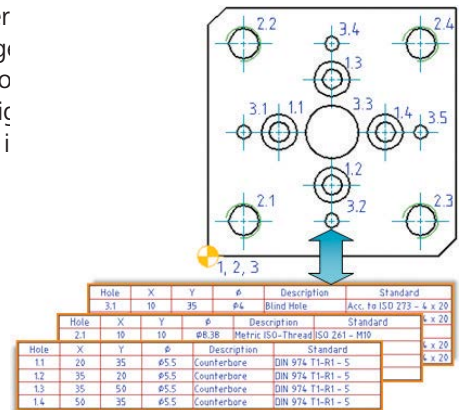
Powerful and smart dimensions

With the streamlined tools in AutoCAD Mechanical, you can create dimensions using abbreviated dialog boxes that conveniently control and expand only the relevant variables for manufacturing. With automatic dimensioning, you can create multiple dimensions with minimal input, resulting in instant groups of ordinate, parallel, or symmetric items that are appropriately spaced. Smart dimensioning tools force overlapping dimensions to automatically space themselves appropriately while integrating tolerance and fit list information into the design. Dimension input can even drive and change design geometry to fit certain sizes.

Reusable detailing tools

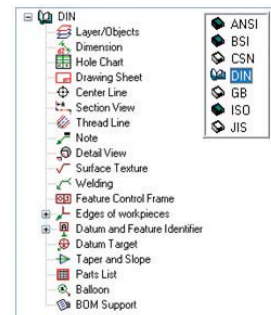
Built to save you time, AutoCAD Mechanical has a specific tool for almost every mechanical drafting process. Many of these drafting tools have the intelligence to help users easily re-edit features without having to remove and recreate the feature. For example, users can easily resize a chamfer or fillet through the origin parameters by simply double-clicking on the chamfer or fillet. The list of tools is not limited to:

- Detail Views – easily create linked views at different scales
- Hole Charts – automatically updated charts for the shop floor
- Scale Areas – change drawing scale without making duplicate copies
- Title and Revision Blocks – English and metric versions available



International drafting standards

Multiply productivity with tools that help project teams deliver consistent, standards-based design documentation. AutoCAD Mechanical supports ANSI, BSI, CSN, DIN, GB, ISO, JIS and GOST drafting environments. Adhering to a standard environment helps project teams maintain a common form of communication for consistent production results. AutoCAD Mechanical includes drafting tools to create standards-based surface texture symbols, geometric dimensioning and tolerances, datum identifiers and targets, notes, taper and slope symbols, and weld symbols.

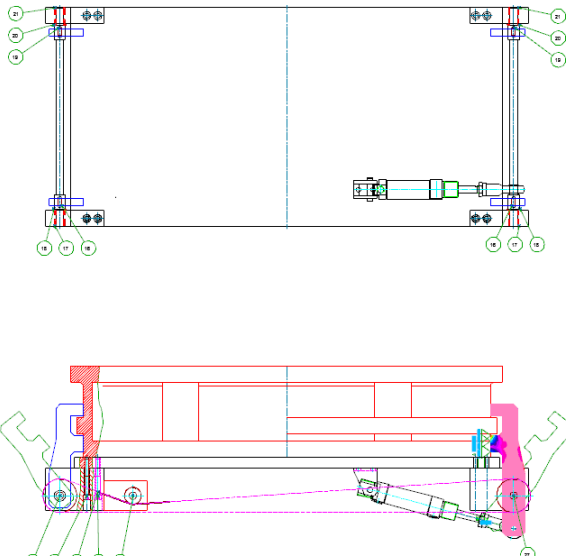


12. Modify shaft in part and assembly drawing

Task:

Due to detailing and feedback from production, some changes need to be made.

- Change shaft
- Add circlip
- Update part drawing with dimensions for circlip



11. Modify shaft in part and assembly drawing	AutoCAD	AutoCAD Mechanical
Insert circlip on shaft	05:10	01:20
Update all annotations in part drawing	03:10	03:10
Update assembly	02:30	02:10
Time savings with AutoCAD Mechanical		38%

Facts:

AutoCAD Mechanical commands recognize power objects and use the attached information to react to them intelligently. Power Commands are commands that use object information to accelerate user operations, such as editing and copying objects. Using Power Commands, you can bypass pull-down menus, toolbars, and tablet locations, using the objects themselves as "command menus." Start the Power Command you want to use and click an object.

Conclusion

In this study, the 11 common design challenges we analyzed were just a few examples taken from the complete project.

Let's have a look at the needed CAD working time for the complete project:

	time (hrs) AutoCAD	time (hrs) AutoCAD Mechanical
search/insertion for project data	4.2	4.0
search/insertion for standard parts	2.1	0.4
search/insertion for supplier parts	1.4	1.4
search for data from other projects	1.4	1.4
data loading	1.4	1.4
data import (other CAD formats)	1.4	1.2
creation of concepts	10.5	5.3
detailing of concepts	7	2.1
calculations	1.4	0.3
structuring of data (layer, blocks, xrefs...)	5.6	2.2
detailing of data out of assembly	3.5	1.4
modifying	10.5	4.2
dimensions	6.3	1.3
annotations	6.3	1.9
bill of material	5.6	2.0
data export	1.4	1.3
	70	31.7

With AutoCAD Mechanical it is possible to save, on average about 65% of the 2D CAD working time. For this simple project, that would mean a cost reduction of around 38 hours of design time; or, in financial terms, about \$4,000 (out of \$80,000) with just this one project.

The advantages of AutoCAD Mechanical

Based on these studies, AutoCAD Mechanical software provides a level of productivity for mechanical designers and drafters that is not possible with general-purpose CAD applications such as AutoCAD. Because AutoCAD Mechanical is built specifically for mechanical design, you could realize immediate productivity benefits such as the ones discussed in this paper. For more information about AutoCAD Mechanical including test driving the product, go to www.autodesk.com/autocadmechanical or contact your local reseller. To locate the reseller nearest you, visit www.autodesk.com/reseller

*As with all performance tests, results may vary based on machine, operating system, filters, and even source material. While every effort has been made to make the tests as fair and objective as possible, your results may differ. Product information and specifications are subject to change without notice. Autodesk provides this information "as is," without warranty of any kind, either express or implied.

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