Autodesk® Inventor™: Digital Prototyping with Design Accelerators

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MA215-6   Several component generators and mechanical calculators have been updated with new interfaces and interactive Dynamic Preview capabilities, saving users even more time when constructing digital prototypes. Learn how to take advantage of these very powerful tools in Autodesk Inventor to create shafts, fasteners, belts, gears, and much more.

About Speakers:
Vasek is a Software Development Manager for Functional Design Accelerators. Vasek has been working for Autodesk for 3 years, leading the team that is implementing mechanical engineering generators and calculators. Before joining Autodesk, he was R&D Manager in a small software company that was focused on knowledge driven CAD. Vasek has Masters Degree in Industrial Engineering and Management at West Bohemian University and Ph.D. in Mechanical Engineering.

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Mirek is a Technical Lead focused on Design Accelerators software architecture. He was driving integration of Design Accelerators to Autodesk Inventor. Mirek has more than 10 years of experience in designing and implementing tools for mechanical engineers and technical drafters in various CAD platforms.

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What is Design Accelerator?

Design Accelerator is a technology that helps you to reduce design cycle time by providing tools for instant creation of mechanically correct components and features.

Design Accelerator offers both geometrical calculations (sizes, shapes) and strength checks according to various standards (ANSI, ISO, etc.).

Design Accelerator makes mechanical engineering components and features (such as gears, bolted connections, shafts, key connections, etc.) smart and understanding their working conditions (load, etc.).

Generators

Generators offer a quick and intuitive way to create mechanical engineering components and features. You just need to click a particular Generator icon and fill in your requirements. Models and/or features are then created. Strength check is available to validate mechanical feasibility of your design.
Calculators
Calculators help you to do the right decisions during design process. Easy-to-use tools cover variety of common engineering calculations including welds, solder joints, breaks, tolerances, etc.

Results of Calculators can be stored inside your assembly for later re-use.

What is Design Accelerator - Summary
Design Accelerator is a way how to create your model quickly and more accurately. Just few clicks are enough to define typically used mechanical engineering organs such as bolted connections, shafts or set of gears.

Design Accelerator shortens the cycle of design and engineering feasibility check to one step. You can make your components right the first time.
Why to use it?
There are multiple benefits from using Design Accelerator. Design Accelerator gives Designers or Engineers the tools to dramatically increase Quality, Productivity, and Ease of Use.

- Hours become seconds in design time.
- Instant modeling of mechanically correct and intelligent components.
- Enables knowledge capture and allows intelligent models to be reused or validated.
- Almost 50 Accelerators to assist in design and design validation.
- Reduce engineer’s design time by up to 95%.
- Embedded Reference information like “Engineer’s Handbook”.

Knowledge Capture
All component and features generated by Design Accelerator keep knowledge about how they were calculated. All mechanical attributes such as loads, parameters, factors and materials are preserved for later re-use.

It allows any designer (not only the author of original design) any time later validate the design, create new versions, etc.

Captured knowledge of design intention dramatically increases value of Inventor models.
How to use it?

Design Accelerator is designed to be intuitive and easy to use. One of the most important information from this class is where to find it.
Productivity Tools
Design Accelerator could save you hours every day. Let’s take a look at example of using it as a tool to accelerate design of components and/or features.

Bolted Connection
Bolted Connection is one of the most powerful Design Accelerators. It helps you to create bolted connections in 3 easy steps:

1) Selection of placement of Bolted Connection. You can position it on two linear edges, concentric, on point, or in existing hole. You can drill the holes through multiple components.

2) Selection of thread type and diameter
3) Selection of fasteners. You can select any combination of fasteners that are available for given conditions (thread type and diameter). You can also change type of holes (for example to counterbore).

Then simply click OK and the entire bolted connection is generated.

Bolted Connection tool automates one of the most common and time consuming tasks. In less than one minute you can drill holes according standard (including clearance). Bolted Connection filters all available bolts to just a set that fulfills your need for a given diameter and thread type. After selecting a nut (only nut that fits your bolt are offered) the length of bolt is automatically adjusted according nut height. All components are mated using iMates. In addition, you can easily modify it later (add or change any fastener, modify diameter, etc.)
Mechanical Engineering Calculations

Design Accelerator is not only a tool for a productive geometry creation. It also provides guidance and helps you to design components and/or features to work under required load. It saves your time by creating the right solutions the first time.

You can also take advantage of strength check, validate the feasibility of your design, and analyze “what-if” scenarios. Design Accelerators serves as a digital prototype of behavior of typical mechanical engineering organs (such as gear, splines, shafts, etc.)

Let’s take a look at example that shows how to use Design Accelerator abilities to check design and modify it to fit engineering requirements.

**Spur Gears**

Spur Gears generator could make your gears right sized for expected load. Adjusting geometry to fulfill functional needs can be done in two steps:

1) Input new functional requirements (such as increased horsepower) and take a look at results of the strength check.
2) Play “what-if” by changing various parameters or use powerful “Geometry Design” option that will change your model to fulfill the needs of increased load.

Spur gears tool makes design and engineering of gears much easier. It creates both models for gears and mates them together. It also provides help for calculating these gears to find out the results of the strength check. If the design validation fails, the generator offers methods to fix the failure in a couple of ways. There is a possibility to design geometry according to the load conditions or to calculate the minimal material properties to fulfill strength check needs.

**Engineer’s Handbook**
Formulas, recommended factors for calculations, materials values, explanation pictures for calculations and other useful information can be found in the Engineer’s Handbook.

You can see the Engineer’s Handbook as an electronic version of popular printed handbooks for mechanical engineers.
AutoDrop

AutoDrop is a tool that helps you to place the standard components in a smart way. Parts are resized based on the target geometry. For example bolts can be placed to multiple holes with different diameters.

Summary

With Design Accelerator you can create mechanically correct components instantly.

Generators:
- Bolted Connection
- Shaft
- Involute Splines
- Parallel Splines
- Key Connection
- Disc Cam
- Linear Cam
- Spur Gears
- Bevel Gears
- Worm Gears
- Bearing
- V-Belts
- Synchronous Belts
- Roller Chains
- Clevis Pin
- Joint Pin
- Secure Pin
- Cross Pin
- Radial Pin

Calculators:
- Plain Bearing
- Plug and Groove Weld
- Butt Weld
- Spot Weld
- Filled Weld (Connection Plane Load) Weld
- Fillet Weld (Spatial Load) Weld
- Butt Solder Joint
- Bevel Solder Joint
- Lap Solder Joint
- Step Tube Solder Joint
- Step Solder Joint
- Separated Hub Joint
- Slotted Hub Joint
- Cone Joint
- Tolerance
- Limits and Fits
- Press Fit
- Power Screw
- Beam and Column
- Plate
- Shoe Drum Brake
- Disc Brake
- Cone Brake
- Band Drum Brake
Design Accelerator - Tips and Tricks

General tips

a) Iconic tooltips – we use multi-line tooltips with images to describe the core of the problem.

![Start Plane](image)

- **Start plane**
  - Select a plane where the connection starts.
  - **0.25 in**

- **Thread size**
  - It limits selection of parts by nominal diameter.
  - **1.50e ul**
  - **Modulus o**
  - **Units mismatch**

b) More options button – this command is available in majority of dialogs and enables you to access additional setting options.

![More options button](image)
c) 3D graphics grips + double-click – most of the generators use 3D graphics for better orientation and workflow. 3D preview enables you to see the component in context with other parts of the assembly even before you actually create it. Do not forget to use 3D grips – move the grip to dynamically change important dimensions of displayed preview. Double-click the 3D grip to open the Edit dialog to enter the desired dimension directly.

d) Splitters + double-click – use splitter to adjust the size of the Results and Summary of messages areas. Double-click opens or closes these areas.
e) output units change – double-click on a result value to change units. Simply enter new desired units.

```
<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole_{min}</td>
</tr>
<tr>
<td>mm</td>
</tr>
<tr>
<td>Hole_{upper}</td>
</tr>
<tr>
<td>Hole_{lower}</td>
</tr>
<tr>
<td>Shaft_{min}</td>
</tr>
<tr>
<td>Shaft_{max}</td>
</tr>
<tr>
<td>Shaft_{upper}</td>
</tr>
<tr>
<td>Shaft_{lower}</td>
</tr>
<tr>
<td>Interference_{min}</td>
</tr>
<tr>
<td>Interference_{max}</td>
</tr>
<tr>
<td>Midpoint</td>
</tr>
</tbody>
</table>
```

f) File naming – auto-popup – To disable the automatic display of the File Naming dialog uncheck the “Always prompt for filename” box within the File Naming dialog.

```
File Naming

<table>
<thead>
<tr>
<th>Item</th>
<th>Display name</th>
<th>File name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subassembly</td>
<td>Limits and Fits</td>
<td></td>
</tr>
</tbody>
</table>

Always prompt for filename
```

g) Real Value Edit controls - use expressions, but without parameters only.

```
Basic Size 2.5 in + 1 mm
```

h) Calculation On/Off – If you do not wish to perform the calculation, switch the calculation off. This speed up the performance of generator and you can fully concentrate on your design.
i) Items lists – drag & drop – use the drag & drop method in most of the generators – you can change the order of generated components. For example, in the Bolted Connection Generator you can change the order of nuts and washers.

![Drag & Drop Example](image)

j) Promote/Demote trick – use Promote command to copy components from the sub-assembly. The component however remains parametrically driven by the generator and you can move it to another assembly.

![Promote/Demote Example](image)
k) Engineer's Handbook – provides a summary of used calculation formulas, terminology and used methodology.

l) Learning – Inventor->Help->Learning Tools->Skill Builders / Tutorials – try our Tutorials. They enable you to learn the basic principles and workflows of generators faster using real models.
m) CTRL + command - initializes the default values – Each generator and calculator is programmed to “remember” the default installation values. Hold CTRL key when opening generator and calculator to start generator or calculator with these default values.

**Content Center tips**

a) Check availability (Bolted Connection, partially Shaft, Key, Bearing, Pins) – many generators use Content Center as source of components. Make sure that Content Center works fine for you. It is necessary to be connected to the functional CC server and to have desired libraries loaded in order to select components.

b) Custom content must be authored properly (Category, iMates, Parameters) – you can use your own components in Design Accelerator generators and Calculators. Such user components need to be Authored and Published to CC before you can insert them using DAcc generators. Especially for Authoring Tool it is necessary to define the correct category, define proper iMates, and insert the mapping values.
Generator/Calculator specific tips

a) Bolted Connection – Threads.xls – Bolted Connection uses only three types of threads from the Thread.xsl table. Those are: ANSI, ANSI Metric and ISO. You can adjust those values freely, or add and delete them. Such threads are then displayed in the generator.

b) Bolted Connection – Use it as a hole generator (without inserting any fasteners). You do not necessarily need to use Content Center and to insert fasteners using the generator, but you specify only the placement and size of holes.

c) Gears: make the sub-assembly flexible and rotate the gears – the motion mates are automatically created between the gears. It enables you to dynamically rotate with the gears and to see the teeth in contact. However, your subassembly must be set as Flexible to enable this behavior.

d) Shaft->Options - turn the 2d preview on – Shaft Generator uses the 3d Preview by default. You can enable 2D Preview directly in Design and Calculation tabs.
e) Belts, Chains – use your existing models in the assembly – Belts and Chain Generators can work with existing components. In case you already have your pulleys, select them and the generator automatically generates belt or chain only.

Folder structure and customization tips
a) all default values and templates are stored into this location c:\Documents and Settings\<user>\Application Data\Autodesk\Inventor 2008\DesignAccelerator

b) tables customization – all external data are saved into this location: <Design Data>\Design Accelerator in the XML format. You can modify this data.

c) Custom models customization – all models for non-standard components are located here: <Inventor folder>\Design Accelerator\Models. You can modify this file to some extent - you can modify iProperties without any problems, but we do not recommend to modify the iMate parameters or to delete the DA_ parameters.

d) Calculation reports customization – all templates are within this location <Inventor folder>\Design Accelerator\Reports in HTML format. You can modify the templates to better reflect your company needs and standards.

We sincerely thank you for your time and attention,

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