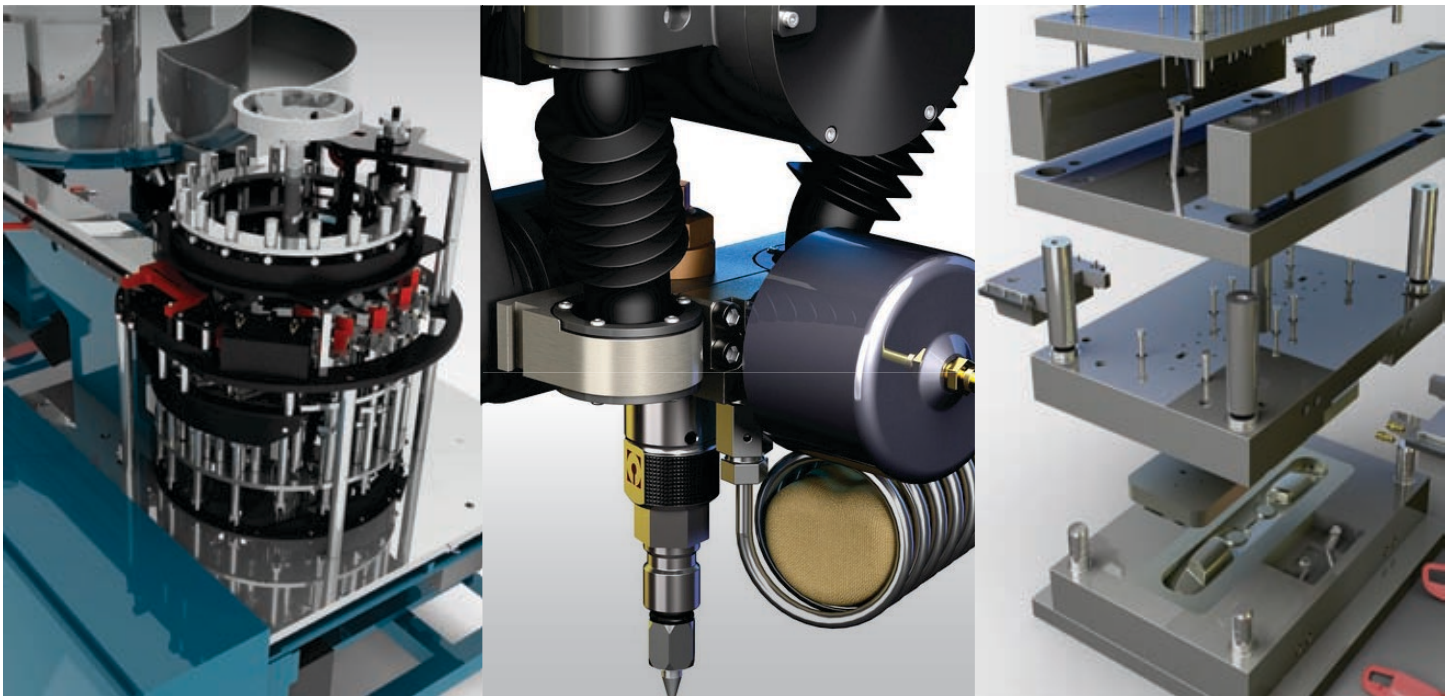


# SQUEEZE TIME AND MONEY OUT OF PRODUCTION USING DESIGN FOR MANUFACTURABILITY

## Overview

Product design does not occur in a vacuum and has a significant impact on manufacturing. In fact, 3D design carries even greater potential for streamlining production processes, especially when you take advantage of Design for Manufacturability tools and applications. With these technologies, you can avoid the manufacturing delays, cost overruns, and shop-floor retrofits that work against your company's success and competitive position.



## Design and manufacturing go hand in hand

Winning in today's global marketplace requires more than innovative and creative product designs. To succeed, you must also beat the competition to market, while controlling development costs and maintaining high levels of quality.

Accomplishing these goals demands the implementation of efficient and consistent processes throughout the product development cycle. If you create fantastic product designs but experience difficulties in manufacturing, you cannot achieve the healthy profit margins, ambitious production schedules, or consistent product quality that are necessary for your company's success.

3D product design is an important piece of the manufacturing puzzle because it can truly make your manufacturing processes run like clockwork. In addition to helping you shorten design cycles, a 3D design platform that incorporates Design for Manufacturability (DFM) tools and applications can help you address production pitfalls by automating and streamlining manufacturing.

Whether you are machining parts, building molds, fabricating sheet metal, forging or casting metal components, or assembling pieces and subassemblies, 3D DFM capabilities can help you trim time, cut costs, and improve quality.

## Design for Manufacturability streamlines production

### Design for machining

Although the advent of CAM software represented a quantum leap in machining productivity, you can reap additional efficiency gains by using an integrated 3D design system that provides DFM tools. No matter what process you utilize—milling, drilling, punching, laser/waterjet cutting, multi-access machining, or wire EDM—the critical requirements are starting with accurate, clean 3D geometry and using the machining technology that best fits your needs.

The ability to import design data into a CAM system is just the beginning. What happens when you need to make design changes or process an engineering change order (ECO)? Are your CAD and CAM systems integrated, so that changes propagate between the “designed” and “machined” model? Has someone checked the model for manufacturing issues with a DFM tool? For example, do the holes line up? Has someone completed tolerance stack-ups, conducted interference checks, or optimized the design to reduce material usage? What are the documentation consequences of making changes during machining?

All of these issues carry the potential for causing downtime, incurring costs, or increasing scrap/rework. The last thing you want is to get a surprise on the shop floor. DFM tools can help you minimize hiccups in your machining processes.

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### ...a case in point

TiSport, a leading manufacturer of high-performance, titanium wheelchairs, automated its machining operations by using a CAM package that is fully integrated with SolidWorks 3D design software. This integration enabled the company to use SolidWorks software configurations to drive machining, resulting in annual production cost savings of \$400,000.

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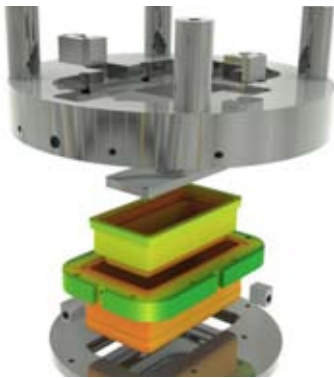
## Design for moldability

Manufacturers utilize molds to produce a growing number of products. As any mold maker will tell you, however, not all shapes are moldable. Regardless of the mold method used—including injection-molding, thermoforming, resin fills, blow-molding, and rotational molding—considering a design's moldability is a key factor for shooting quality parts at volume.

Although 3D core-and-cavity capabilities can facilitate the development of molds, using DFM tools to assess moldability can help you avoid production problems and extend mold service life. For example, has someone done a draft analysis to ensure the part will pop out of the mold without damaging the part? What about undercuts, which increase the cost of the mold? Can you locate undercuts and eliminate them prior to tooling design? Is the part thickness consistent and/or is it too thick? Is your parting line in an acceptable location for the aesthetics of your design? Would a fluid flow or thermal simulation help you optimize your mold design and forming process? What happens when changes need to be made? Does your mold tool update automatically with part design changes? Can you quickly compare the current design of a part to a new design to see where material is added and removed, as well as what aspects have been modified? Have you compensated for shrinkage in your mold design?

Avoiding mold production issues and extending mold service life can help your company save time and money. DFM tools can help you achieve your mold production goals.

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### ...a case in point

Using SolidWorks Flow Simulation software, World Kitchen LLC, the maker of Pyrex bakeware, was able to optimize its thermoforming production operation to maintain precise temperatures in the molding fixtures used with molten glass. This improvement reduced production time by 40 percent and saved the company \$230,000 in annual production costs.

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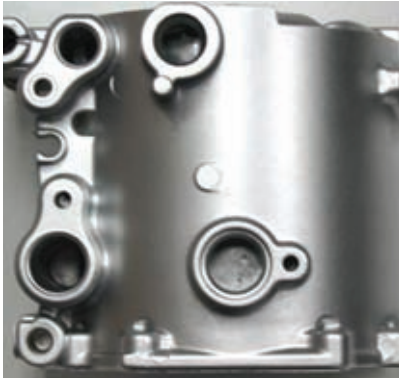
## Design for casting and forging

Many manufacturers produce metal parts that are not machined, either through forging or casting. Forging is the preferred method for creating extra-strong metal parts, in which the metal's grain is hammered or pressed into the shape of a part using a combination of pressure and temperature. Casting is typically reserved for metal parts having complex geometries that preclude machining or in instances where casting is faster and less expensive than machining. Cast parts are produced by pouring molten metal into sand, metal, or investment-cast molds. As with mold development, using DFM tools can benefit both processes.

Regardless of whether you cast or forge parts, 3D design and DFM tools can help you check the draft of your parts, and evaluate the strength and precision of your fixtures, dies, and molds. For example, can you improve the performance of your power hammers and presses during forging operations? Would you like to avoid die-lock? Can you leverage 3D printing to economically create starch-based molds for casting? Would integrated PDM allow you to better manage production?

Using 3D DFM tools can help you more accurately predict the product of your forging and casting operations—instead of working through trial and error—saving you time and money in the process.

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### ...a case in point

Through the implementation of SolidWorks Enterprise PDM software, Burlington Technologies, Inc., was able to automate its workflows. This leading producer of high-pressure aluminum castings, which are used to manufacture automotive parts, leveraged PDM to streamline its workflow and approval process, eliminating design errors and cutting the time required to make changes by 50 percent.

## Design for fabrication

Fabricating assemblies requires the accurate and efficient processing of sheetmetal parts, welded structures, and fastening systems. Turning sheet-metal designs into finished pieces consistently, quickly, and cost-effectively—including the precise handling of weldments and fasteners—is imperative to saving time and trimming costs.

Many manufacturers work closely with companies that specialize in fabricating assemblies. You want to ensure that the sheetmetal parts and structural components that you design are ready to go to the shop floor for manufacturing with little or no need to modify or re-engineer the part to meet your partner's manufacturing capabilities. DFM tools can streamline interaction with fabrication vendors, as well as automate and increase the accuracy of fabrication operations. Are you taking advantage of folding/unfolding capabilities and forming tools to view sheetmetal models as flat patterns and in their bended shapes. Do you have the ability to assess manufacturability prior to handing off a design to a fabricated assembly vendor? Can you model weldments effectively based on stock structural shapes readily available at your supplier or access libraries of commonly used fasteners?

DFM tools can streamline interaction with fabrication vendors, as well as automate and increase the accuracy of fabrication operations.

Reducing iterations with fabricating vendors and eliminating rework during fabrication makes the process faster and more cost-effective.



### ...a case in point

BigBelly Solar utilized SolidWorks sheet-metal design, simulation, and interference detection tools to streamline fabrication of the world's first solar-powered trash compactor. These capabilities not only helped the company develop an innovative, first-of-its-kind product, but also enabled it to reduce its material costs by more than 30 percent.

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## Design for assembly

The methods utilized to assemble parts and subassemblies into final products can vary greatly: from pick-and-place robotics to machine-driven assembly/packaging to human manual operations. With any assembly operation, the ability to visualize and simulate how a product goes together is essential for preventing assembly-related bottlenecks. In the case of assembly machines, this capability can also help you develop the best-performing, most cost-effective system by using simulation data to design and size it perfectly.

Simulating assembly operations—whether manual or automated—is becoming increasingly important for squeezing additional time and costs out of production. Are you creating assembly animations for your operators to follow, or still using paper-based instructional methods? What about mechatronics? Are you using kinematics and dynamics simulation tools to design and size your machinery appropriately? Are you selecting electric motors and drive mechanisms that balance service life versus cost? Can you use 3D design data to streamline assembly operations, improve packaging, or create documentation?

Assembling manufactured parts into final products is an important aspect of many manufacturing operations. You can leverage 3D design data in ways that can transform your assembly operations into a more efficient and cost-effective operation.

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"SolidWorks software not only allows us to create an elegant design that performs its intended function, but also enables us to manufacture parts in a way that holds down costs. We rely on SolidWorks software design for manufacturability tools—such as using TolAnalyst™ to automate tolerance stackups and draft and wall thickness analysis, which enabled us to work with our suppliers to create high-precision injection molds—to ensure that we can manufacture and assemble products efficiently."

*Christopher Narveson  
Design and Engineering Services Manager  
Cardiovascular Systems, Inc.*



### ...a case in point

Cardiovascular Systems, Inc., is revolutionizing the treatment of vascular disease through the development of a disposable diamond-coated, catheter-based device that grinds away arterial plaque. The company used SolidWorks design and simulation software to cut its manufacturing costs by 20 percent, and 3DVIA Composer™ technical communications software to automate its clean room assembly operations through the creation of easy-to-follow assembly animations.

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## 3D design helps you integrate design and manufacturing

Even though different manufacturing processes have their own unique characteristics, they have common goals. You want to manufacture products and parts of consistently high quality as quickly as possible while controlling or trimming costs. This paper has touched on the potential opportunities for leveraging DFM for your particular type of manufacturing.

This section will more specifically address how SolidWorks 3D software solutions—including SolidWorks CAD software, SolidWorks Simulation, SolidWorks Enterprise PDM, SolidWorks Sustainability, and 3DVIA Composer—can help you tap into DFM capabilities, integrate design and manufacturing, and achieve your goals.

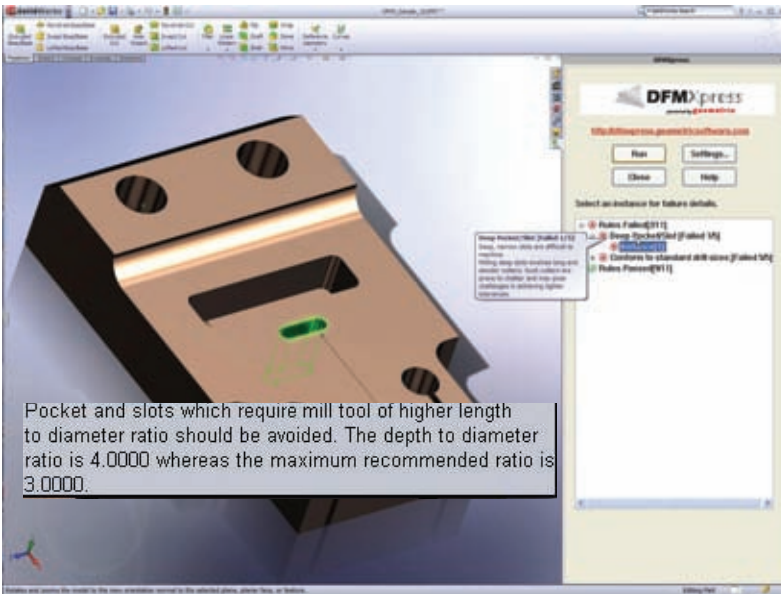
### Increasing profitability

Competition compels manufacturers to seek out ways to grow profits. From the manufacturing perspective, there are several ways to contribute to increased profitability:

- **Cut or control manufacturing costs.** SolidWorks CAD software is integrated with leading manufacturing systems, such as CAM, mold analysis, and mechatronics software. This integration gives you seamless access to SolidWorks software DFM tools, including DFMXpress, TolAnalyst, moldability (draft) analysis, and interference checking capabilities. Integrated DFM can help you cut or hold the line on manufacturing costs.
- **Eliminate downtime and production stoppages.** SolidWorks CAD software ensures precise 3D geometries for clean fit and assembly, and also facilitates the processing of design changes. SolidWorks Enterprise PDM software enables you to automate manufacturing workflows and accelerate ECO processing. These capabilities give you the agility you need to rectify changes on the fly and prevent downtime.
- **Reduce scrap, rework, and waste.** With SolidWorks software DFM tools, you will experience fewer geometry surprises on the production floor, resulting in less scrap and rework. By using SolidWorks Simulation to validate designs and tooling, you can avoid waste related to production failures. SolidWorks Sustainability software can give you the materials information you need to minimize wasted material. These tools can help you avoid unnecessary costs by reducing scrap, rework and waste.
- **Optimize material usage.** Reducing material usage is an easy way to cut costs. With SolidWorks Simulation, you can validate designs and trim away wasted material. SolidWorks Sustainability software provides materials information that will help you choose alternative, less costly materials.
- **Eradicate wasted or duplicated effort.** In today's technology-based manufacturing environment, there should never be a need for a manufacturer to redraw or remodel your designs. Because SolidWorks CAD software is integrated with leading manufacturing systems, you can eliminate data translations, file conversions, or model redraws.

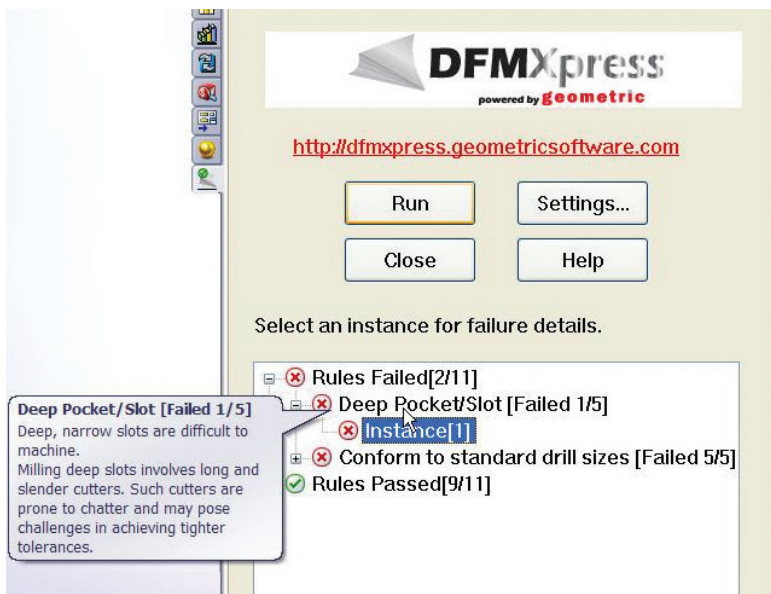
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With SolidWorks DFM tools, you will experience fewer geometry surprises on the production floor, resulting in less scrap and rework.



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Making sure that a product is manufacturable requires the use of DFM tools to evaluate whether it can be made cost-effectively in the specified shape and material.



With SolidWorks CAD software and DFMExpress, you can fully interrogate the manufacturability of your design to make sure it's ready to be manufactured. Using these tools, you can:

- Check to make sure your hole, tool, corner radius, and tolerance settings are correct.
- Use Hole Wizard holes, Smart Hole Series, and Smart Components to ensure standardization of holes based on manufacturing requirements.
- Leverage Library features to standardize the modeling of typically machined features, such as milled pockets, tabs, oil passages, etc.—this will improve standardization for manufacturability.
- Easily adjust design features like fillets, holes, and chamfers.
- Convert imported geometry to “machine” friendly features.

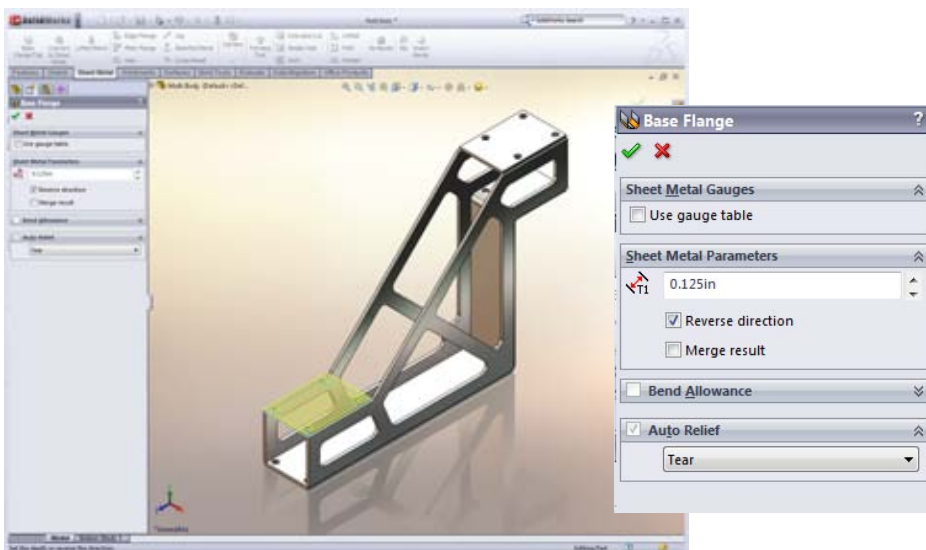
## Accelerating time-to-market

Manufacturing can help shorten time-to-market by making sure a design is ready for prime time—suitable for manufacturer—and by streamlining processes and interactions.

- **Ensure manufacturable designs.** Making sure that a product is manufacturable requires the use of DFM tools to evaluate whether it can be made cost-effectively in the specified shape and material. With SolidWorks software DFM tools, you can assess materials and geometries, so you deliver a problem-free design to production, avoiding unnecessary delays.
- **Guarantee production-ready data.** Providing your design in a CAD data format that is ready to go for production can help you save additional time. SolidWorks CAD software is integrated with leading manufacturing systems and can even output DXF files. FeatureWorks® software can also help you quickly heal problem geometries.
- **Streamline vendor interaction.** Eliminating time-consuming iterations with vendors is vital for speeding time-to-market. With SolidWorks software DFM tools and SolidWorks software compatible data formats, you can eradicate time consumed with vendors addressing manufacturability and file compatibility issues.
- **Accelerate assembly operations.** Assembly operations not only consume time to perform, they also require time to design and develop. The integration of SolidWorks Motion kinematics and dynamics analysis software with leading electronics and control systems development packages enables you to leverage mechatronics to more quickly design assembly machines. 3DVIA Composer software can also help you configure assembly operations, make animated assembly instructions, and create product documentation.
- **Facilitate late-cycle changes.** How your manufacturing organization handles late-cycle design changes and ECOs is also a factor in reducing time-to-market. SolidWorks CAD software facilitates design changes, and SolidWorks Enterprise PDM can automate manufacturing workflows and accelerate ECO processing.

"Switching to SolidWorks software was a critical move in our manufacturing transformation. SolidWorks software streams data out to our robots and CNC machines, and our line workers simply set up raw stock, punch in the SolidWorks software part code, and watch as the panel, part, or aluminum member is machined in a fraction of the previous time."

Chris Henhoeffter  
Project Manager and Design Coordinator  
Sport Systems Unlimited Corp.



With SolidWorks software DFM tools, you can address manufacturing problems prior to production.

Using SolidWorks DFM tools, you can check your sheetmetal designs to make sure your fabricator can make them without a hitch. With these capabilities, you can:



- Check important sheetmetal settings, such as the recommended bend radius, hole diameter to thickness ratio, hole to part edge distance ratio, etc.
- Easily create flat patterns, as well as compensate for stretching due to bends.
- Automatically generate cut lists for welded structural frame members.

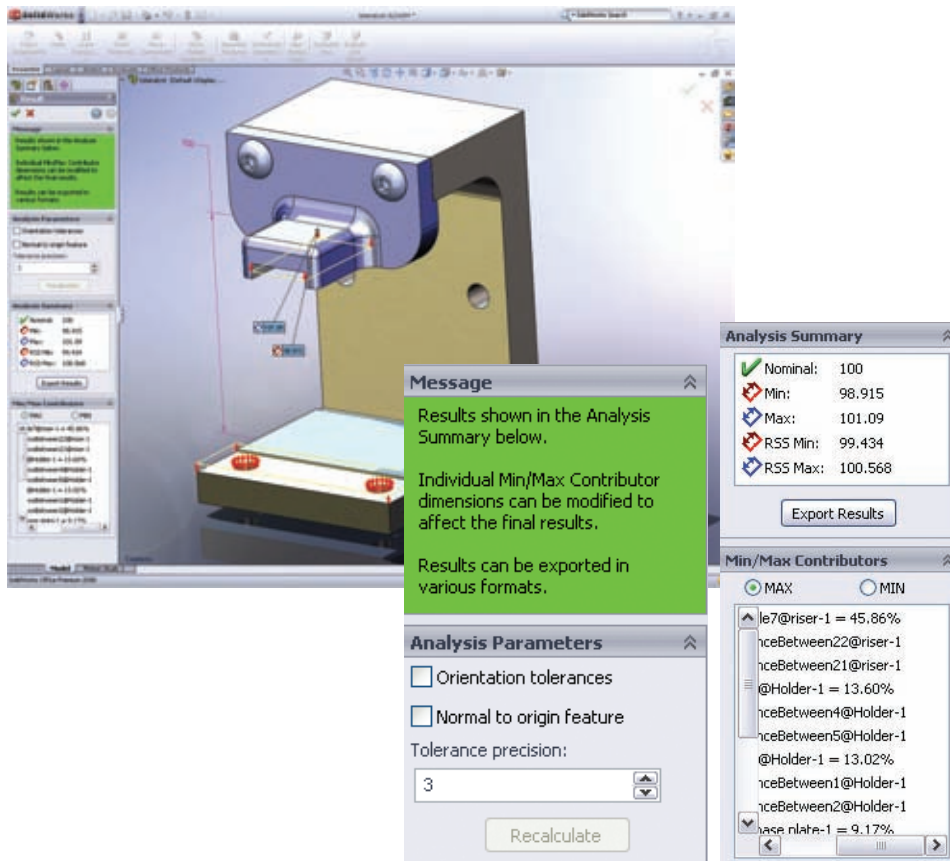
"Visualizing just how our machines will operate in 3D before building them has enabled us to incorporate the manufacturability, reliability, and serviceability upon which we have built our reputation."

Patrick Grimes  
Mechanical Engineer  
Kinematic Automation, Inc.

## Reducing returns/warranty costs

The best way to cut costs related to product returns and warranty claims is to manufacture a quality product.

- **Enhance product quality.** There are two facets to quality in terms of manufacturing. One has to do with manufacturability. The other involves performance. With SolidWorks software DFM tools, you can address manufacturing problems prior to production. SolidWorks software gives you the ability to validate design performance and pinpoint potential design errors before manufacturing. By improving quality, you can help your company reduce returns, warranty claims, and associated costs.
- **Increase accuracy.** You can ensure product quality by increasing the accuracy of your development effort. SolidWorks CAD software ensures precise 3D geometries for clean fit and assembly. When combined with SolidWorks Simulation analysis software, you have the design tools you need to make sure your product performs as designed.



SolidWorks software provides a range of DFM tools for addressing fit and function issues, such as the TolAnalyst shown here, which automates tolerance stackup analysis. Using other SolidWorks software DFM tools to make sure that your parts will fit together for assembly, you can:

- Easily manage geometric dimensioning and tolerancing specifications with the SolidWorks DimXpert.
- Use the specialized functionality for fastening analysis found in SolidWorks Simulation to figure out the correct size and number of fasteners required to actually hold your parts together. Reducing the number of fasteners in your design can decrease costs, complexity, weight, and time to manufacture.
- Evaluate fastening methods—such as bolted connections, welded connections, etc.—to determine which method works best to gain a cost advantage, reduce weight, or accelerate assembly.
- Leverage interference collision, and clearance checks tools to ensure that the design will work properly at nominal tolerance values.
- Conduct motion simulations to understand part deflections due to dynamic loads, and make sure that the design will operate properly while in motion.
- Generate a BOM (bill of materials) for your design that updates automatically with design changes.

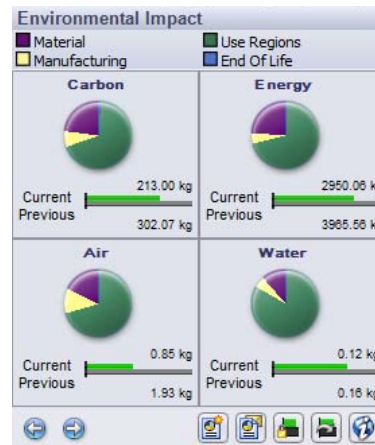
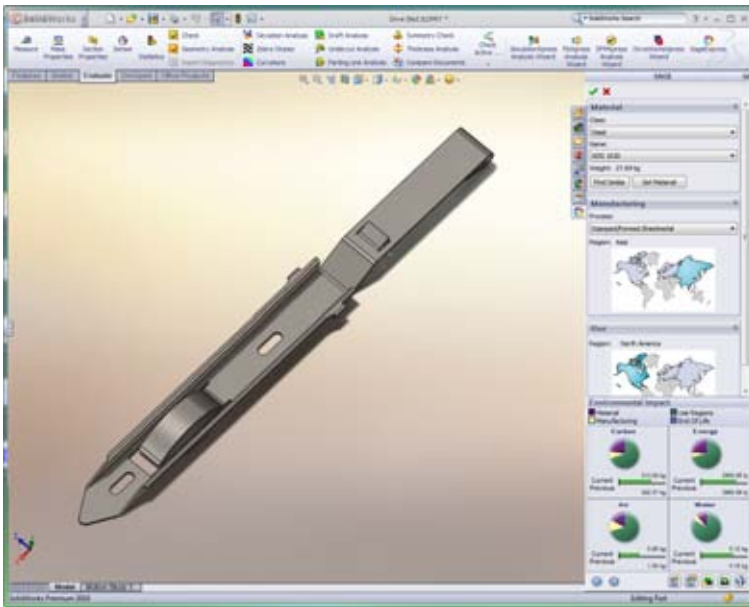
### Minimizing environmental impacts

Manufacturers can do more than develop green products. They can also apply the principle of sustainability toward lessening the environmental impacts, and attendant costs, of their production processes.

- **Reduce shipping and transportation costs.** With SolidWorks Sustainability software, you can evaluate transportation and shipping costs as they apply to materials, components, and product distribution. With this information, you can make important decisions about your design that can lessen its environmental impact.
- **Identify energy savings.** Energy costs are a big part of today's manufacturing operations, so the ability to reduce energy usage is important from both a cost and environmental standpoint. SolidWorks Sustainability software enables you to identify potential energy savings as they relate to production.
- **Eliminate waste disposal costs.** As with energy, waste disposal is becoming a much larger line item for manufacturing operations. SolidWorks Sustainability software allows you to optimize material selection and usage as they apply to waste reduction.

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Using SolidWorks Sustainability software, you can assess the environmental impact of your designs and evaluate areas where you can cut costs, such as identifying potential energy, transportation/shipping, and waste disposal savings.

## Energizing production through Design for Manufacturability

Product design and manufacturing are no longer separate, autonomous functions, but rather two sides of the same coin. By taking manufacturing issues into consideration during initial design, manufacturers can avoid time-consuming delays, unnecessary costs, and undesirable quality issues.

With DFM tools and applications—like those available with the SolidWorks software design solution—you can improve the performance of your manufacturing operations and make a valuable contribution to your company's bottom line.

Squeezing time and costs out of production are very attainable objectives, if you have the capabilities you need to make sure a product design is really ready to leave the virtual world and become real. It does not matter how you make it—whether it is by machining, mold-making, fabricating, metalworking, or assembly. If you can make sure that the design can be made efficiently and cost-effectively—with few, if any, unanticipated surprises—you will save your company time and money.

To learn more about how SolidWorks software solutions can make DFM work for you, visit [www.solidworks.com](http://www.solidworks.com) or call 1 800 693 9000.

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