



The Standard in 3D

**This guide addresses the following topics:**

- Large assembly performance factors
- Creating production-level drawings from 3D design data
- Leveraging legacy design data to speed projects
- 3D visualization to help refine your design
- The power of configuration management tools
- Top-down and bottom-up assembly design techniques
- Layout based weldment design
- New intelligent assembly components
- Design communication, CAD productivity, and data management tools
- Tight integration between SolidWorks and more than 35 best-in-class add-on solutions



This 2,500-part milling machine was designed using SolidWorks software.

## 3D CAD Guide for Machine Designers

3D CAD solutions are revolutionizing the machine design industry by speeding development of innovative machines that can be easily customized to meet specialized requirements.

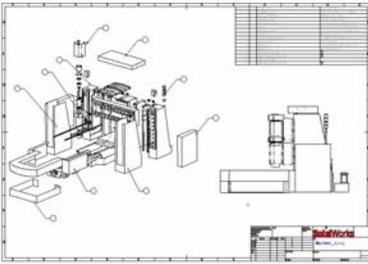
Your choice of 3D CAD tools is critical to your organization's ability to compete effectively in this challenging business environment. This guide identifies key issues and explains advantages of SolidWorks® 3D modeling software for machine designers.

### Large Assembly Performance

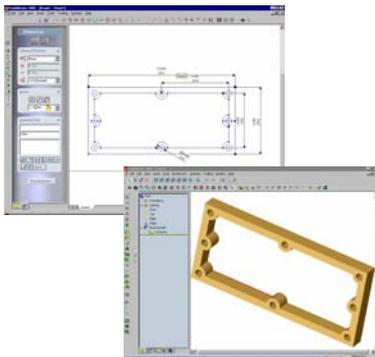
- The ability to handle assemblies comprising thousands of parts without compromising performance is a requirement of 3D CAD solutions for machine design.
- The capacity to manage large assemblies easily allows machine designers to take on a broader range of projects and gain greater flexibility in solving design problems.
- The challenges associated with large-assembly machine design are often unpredictable and complex. SolidWorks 3D modeling software, with its Large Assembly Mode, offers unparalleled performance for applications involving a large number of parts, allowing machine designers to design and assemble tens of thousands of components and evaluate complete assemblies.
- SolidWorks provides built-in tools for evaluating assembly designs, including motion visualization (Physical Simulation), interference checking, collision detection, clearance information, and creation of envelopes for defining the full range of an assembly's motion. These tools help machine designers identify necessary changes in assembly development, which can be easily made using simple drag-and-drop assembly structure reorder operations.
- Many manufacturers accelerate development through concurrent design approaches where several designers or teams work at the same time on separate components or subassemblies of a large assembly. SolidWorks 3D modeling software supports concurrent design, providing powerful capabilities that support configuration management, top-down design techniques, and design collaboration.



Designed by Bucyrus International, Inc. using SolidWorks software, the Bucyrus® Model 795B Electric Rope Shovel has more than 60,000 parts.



**SolidWorks capabilities provide for standard-view drawings (three views or any combination of views — user selectable), which are automatically generated from the model or assembly with bill of materials included. Additional views can be easily added, including new breakout section views and unique Alternate Position View Technology (patent pending) that enables documentation of a range of motion.**



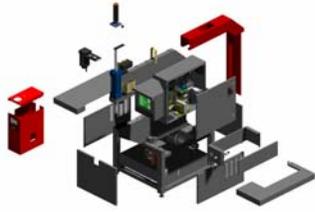
**SolidWorks offers easy import and reuse of various types of CAD data, including 2D DWG and DXF™. DWG/DXF details, including layers, lines, and formatting, can be maintained in the original drawing.**

## Production-level Drawings

- Production-level drawings communicate detailed design information, such as varied design views, dimensions, surface finish requirements, assembly instructions, and other pertinent design information required for manufacturing.
- Accurate and efficient creation and modification of drawing information is paramount for machine designers. Many machine design organizations rely solely on drawings to provide processing information to production groups, such as machining departments, mold builders, stamping departments, and assembly operations. Accuracy, completeness, and flexibility are essential for meeting the requirements of these groups.
- SolidWorks production-level drawing and detailing capabilities enable faster and more accurate development of drawings, including automatic generation of drawing and section views with breakout section views as well as development of bills of materials.
- SolidWorks drawings are fully associative, ensuring that changes made anywhere in the process automatically update all project documentation, including parts, assemblies, and drawings. Integrated links to Microsoft® Visio® 2002 Professional Edition provide for standard technical symbols and best-in-class wiring/hydraulic diagram development. SolidWorks continues to innovate in the area of production drawings with Alternate Position View, which enables a range of machine motion to be documented in a single drawing view (see figure at upper left).
- eDrawings is another innovative SolidWorks product that provides the ability to communicate intelligent drawing information created in SolidWorks to non-SolidWorks users via email (see *SolidWorks Collaboration Tools* section for more information). [www.solidworks.com/edrawings/](http://www.solidworks.com/edrawings/)

## Leveraging Legacy Data

- Machine designers frequently have a large amount of legacy data (data created from previous projects or jobs).
- Legacy data may form a starting point for new designs or can contribute key elements to the development process including projects based on customer-supplied CAD data.
- SolidWorks software offers users the widest number of data translation formats of any CAD solution. Supported formats include DWG, DXF™, IGES®, STEP, SAT (ACIS™), STL, Parasolid®, Pro/ENGINEER®, Unigraphics®, Solid Edge™, VDAFS (VDA), Mechanical Desktop®, IPT (AutoCAD Inventor®), CGR (Catia®), HCG (highly compressed graphics), Viewpoint, RealityWave, TIFF, and JPG.
- Designers migrating to SolidWorks from 2D CAD will greatly benefit from new functionality including view folding, which enables legacy 2D drawing views to be used more efficiently to create new 3D models. A new import wizard with AutoCAD-oriented help system also streamlines the migration process for designers converting from 2D design systems such as AutoCAD



This exploded view of a hardware insertion machine provides a quick overview of assembly considerations and supports field service documentation development. [SolidWorks Animator](#) software allows you to create an animation of the assembly explosion instantly. (Image courtesy of Haeger, Inc.)



Developed by Hartness International, the dynamic accumulating conveyor system (DYNAC) was designed making extensive use of Configuration Management techniques to create a family of machines with various capacities for each version. Design tables and other Configuration Management techniques were used to design the helix conveyor, support structure, and other portions of the project — all based on external dimensional requirements. Configuration Management is making development of new specialty machines faster and easier. (Image courtesy of Hartness International)

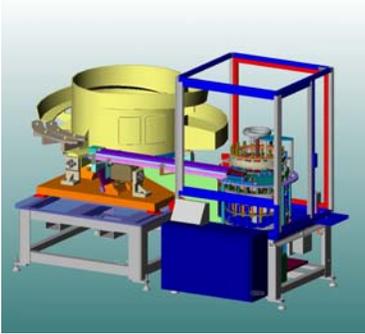
- After 3D legacy data is imported into SolidWorks, the FeatureWorks® integrated feature-recognition product (a component of SolidWorks Office) further speeds design work by searching the incoming file data for features, such as bosses, holes, ribs, sheetmetal features, and fillets. These features are then inserted in the SolidWorks FeatureManager® design tree as native SolidWorks features for easy modification, reordering, and other standard SolidWorks operations. (Please refer to the *SolidWorks Integrated Solutions* section for more details on SolidWorks Office Professional and FeatureWorks.)
- The ability to use these data formats helps machine designers leverage legacy data, work side-by-side with designers who use other CAD systems, speed development, and increase financial returns. Access to many sources of legacy data gives the machine designer greater flexibility in responding to market needs and customer requirements.

### 3D Visualization

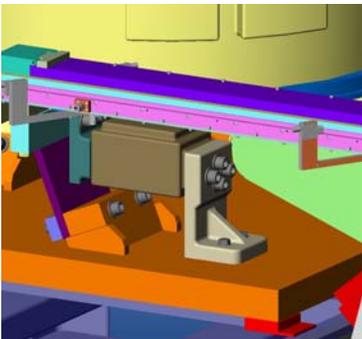
- 3D visualization provides a machine designer with a first check of design intent, proper operation, and aesthetics as the project develops.
- 3D CAD enables the designer to view a machine design from all angles and examine the internal parts of the machine throughout the design process. This gives machine designers a clear and accurate review of parts and assemblies early in the design cycle.
- 3D visualization reduces communication and fabrication errors, saving development time by more effectively conveying design information so that machine designers can find problems early in the design cycle.
- SolidWorks enables checks for interferences or specific clearances between components using Dynamic Assembly Motion and Collision Detection. Any interference will stop motion between parts that contact and the point of interference will be highlighted by changing color. Physical Simulation takes motion checking to the next level by presenting meshing parts, such as meshing gears, and showing their operation in the assembly. Exploded assemblies support evaluation of product assembly considerations prior to building parts.
- SolidWorks Office Professional includes PhotoWorks™, SolidWorks Animator, and 3D Instant Website software, that enable even greater visualization capabilities by providing photorealistic rendering and full-motion animation of the finished machine design. These capabilities help identify potential problems early in the design cycle, when design changes are relatively easy and inexpensive to make.

### Configuration Management

- Configuration Management is the ability to control design variations from within a single file or document. This applies to parts and assemblies, with the effects propagating to drawings.



**This packaging machine for handling plastic bottle caps was designed using SolidWorks. (Image courtesy of Haumiller Engineering Company)**



**SolidWorks enables the designer to create or modify simple features of individual parts like the machine base bracket stiffening rib within the context of the assembly. (Image courtesy of Haumiller Engineering Company)**

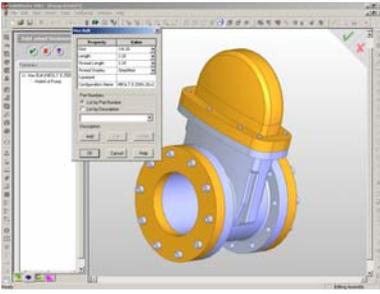


**Piping and tubing can easily be added to connection points of a machine to complete the fluid system design. (Image courtesy of Serfilco, Ltd.)**

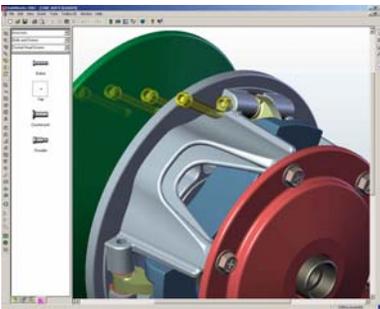
- Configuration Management enables the generation of multiple versions of parts, assemblies, and drawings in a single document with a minimal amount of time and effort. Configurations make use of design tables, derived design data, component properties, relationships, viewing states, and other attributes, storing part and assembly information in one area for greater efficiency. SolidWorks offers multilevel configurations, called nested configurations, to optimize the power, organization, and efficiencies of configurations.
- SolidWorks Configuration Management gives machine designers maximum flexibility in creating multiple design variations covering a wide range of needs. New configurations can easily be developed from previously created designs to further speed development and meet market needs for data reuse.
- A simple application of this capability would be to create various lengths (configurations) of steel channel sections to make up different sizes of machine bases or supports. All of these different lengths can be created within a single SolidWorks model file for simplicity and easy design control.
- The designer can explore various “what if” scenarios and requirements, such as container and package sizes, by turning on and off different configurations of a part or assembly. For example, the machine dimensions and sizing of conveyers or material handling equipment can be tied to design data for each size of package. As the package requirements change, the necessary machine dimensions automatically update to reflect the new design.
- Components involving multistage processing, such as casting and machining, or sheetmetal parts with progressive bends, can easily be documented by using multiple configurations of a single part. Configuration Management techniques can generate discrete versions of parts or assemblies to reflect a separate version or in-process state. These versions are extremely valuable to the machine designer for comparing designs, tracking costs, and developing process plans.
- Because change and flexibility are keys to effective design, the importance of configurations to the designer cannot be overstated and SolidWorks is the only product among powerful, easy-to-use products that offers configurations for both parts and assemblies.

### **Fully Associative Assemblies: Top-down and Bottom-up Design Techniques**

- For machine design, fully associative assemblies are critical for effectively using bottom-up and top-down assembly design techniques. Associativity guarantees that all elements of a design are electronically associated or connected, including assembly models, components, drawings, details, and bills of materials. This means that when a change is made to any SolidWorks part, assembly, or drawing, that change is automatically made in all associated elements.
- Bottom-up associative design encompasses the creation of new components and integration of these with existing components into assemblies. Each of these parts can be edited within the assembly as needed.



Unique Smart Fastener Technology enables you to populate a pattern of holes with a fastener, washer, and hex nut from [SolidWorks Toolbox](#).



Patented Smart Part Technology from SolidWorks enables easy assembly of standard parts.



[PhotoWorks](#) software enables powerful, photorealistic rendering of components and assemblies, providing visual checks of internal components. (Image courtesy of APCA)

- Top-down associative design involves working with an existing assembly to develop new components for use with that assembly. Because new components reference existing parts in the assembly, any changes made to any of the parts are reflected throughout the design.
- Top-down associative design techniques allow machine designers to capture design intent easily and automatically, including inter-part relationships. Modifications automatically propagate throughout the assembly and drawings, maintaining design intent.
- Examples of top-down design include: adding design details such as machine support stiffening ribs, changing a Woodruff key and keyway size, developing a protective sheet metal enclosure for an existing machine design, and routing piping or tubing assemblies to necessary connection points in an existing design. The ability to perform these types of tasks from within an assembly saves time by maintaining continuous references between existing parts and new parts.
- In most cases, designs will likely be a combination of bottom-up and top-down design techniques. Regardless of the approach, SolidWorks design flexibility and the availability of Configuration Management ensure the generation of designs that fit the necessary design intent (also see Configuration Management).

### Layout Based Weldment Design

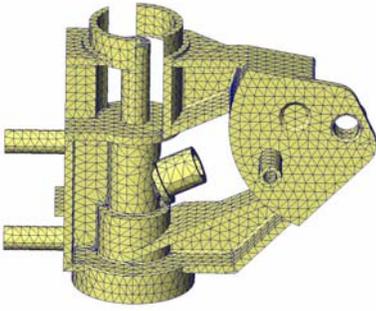
- Only SolidWorks allows users to automate weldment design by using layout sketches. Structural members are easily added by selecting sketch segments. Solidworks automatically creates an associative cut list, including length, of each structural member. Addition process specific tools are provided for gussets, end caps, and weld beads.

### Intelligent Assembly Components

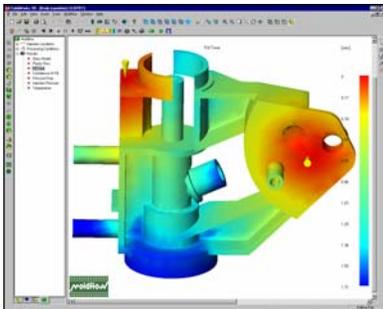
- Designs that incorporate many fasteners and concentric mating of hubs and other parts can benefit from new part-mating techniques. This innovative technology is much faster than older 3D assembly development that required multiple mating relations.
- Only SolidWorks supplies patented Smart Part Technology, which enables parts to be assembled in place simply by clicking on the mating surfaces of both parts. SolidWorks has expanded this technology to enable automatic insertion of fasteners, along with all necessary washers and hex nuts, in a pattern of holes. This innovation called Smart Fasteners, coupled with SolidWorks Toolbox, a comprehensive library of standard parts, saves the designer significant time in the development process.

### Integrated Solution Partner Products

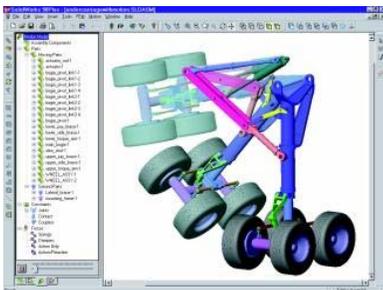
- Available, best-in-class partner solutions are fully integrated into the core SolidWorks 3D modeling software to offer a complete, single-window approach to machine design.



**Sophisticated Solution Partner analysis capabilities such as this finite-element mesh allow you to test and better control all aspects of product performance.**



**Only SolidWorks Gold Certification ensures single-window, fully associative integration with best-in-class add-on solutions. Analysis products provide color-coded output of results, immediately highlighting problem areas.**



**Study mechanisms in motion using integrated kinematics analysis software from SolidWorks Solution Partners.**

- SolidWorks software development focuses solely on 3D design tools to ensure continuous innovation. CAD companies that build strong ties to Solution Partners for best-in-class, extended solutions — such as finite element analysis (FEA), computer-aided manufacturing (CAM), product data management (PDM), and kinematics — make sure that development is done by the companies best suited for the job. The results are more complete product design and development solutions.
- SolidWorks provides an unmatched selection of Solution Partner products plus the highest level of add-on product integration in the industry. Certified Gold Products offer the look-and-feel of SolidWorks software, simplifying learning and use and extending best-in-class functionality. All Certified Gold Products offer single-window integration with SolidWorks, are fully associative, and undergo a rigorous testing and certification process by SolidWorks to ensure compatibility with every release of SolidWorks.

Engineering tools: MechSoft.com offers a variety of engineering tools, including calculation, parts library, and online handbook solutions.

Analysis tools: Designers can now run initial stress analysis checks on their part designs up-front using COSMOSXpress™ FEA software from COSMOS (the analysis business unit of SolidWorks) that is included with every license of SolidWorks. Optional COSMOS products in the COSMOSWorks™ analysis software product line enable thermal, buckling, non-linear, and electromagnetic analysis. Partners such as MSC Software (MSC.visualNastran FEA for SolidWorks) also provide Certified Gold Product Solution analysis product products for use with SolidWorks. COSMOSFloWorks™ from COSMOS provides CFD (computational flow dynamics) analysis for flow and heat transfer applications.

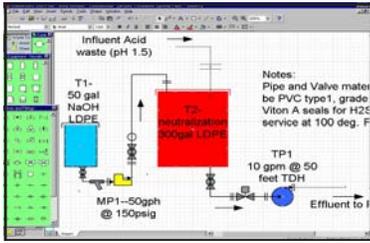
Kinematics tools: Kinematics analysis is helpful for developing products requiring complex motion including complex packaging access panels requiring easy product maintenance. COSMOS (COSMOSMotion™) and Certified Gold Product Solution Partner Solid Dynamics (MotionWorks) offer these type of analysis tools.

CAM tools: After the design is complete, CAM (computer-aided manufacturing) packages provide part checking and machine programming capability for tool path generation with TekSoft CAD/CAM Systems offering their Certified Gold Product CAMWorks™.

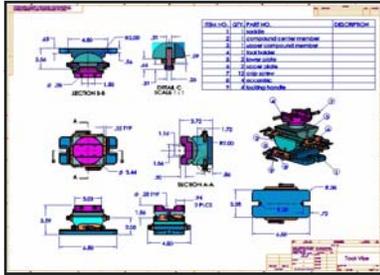
For a complete listing of SolidWorks Solution Partner products, see the “Partner” section of the SolidWorks web site at [www.solidworks.com](http://www.solidworks.com).

### SolidWorks Collaboration Tools

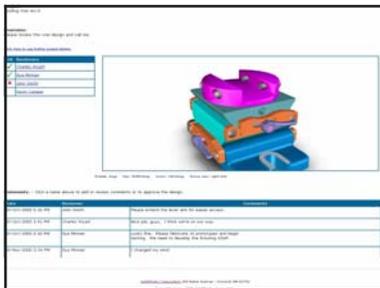
- Design collaboration has become an increasingly important part of the product development process, enabling designers to share designs easily with anyone, anywhere.



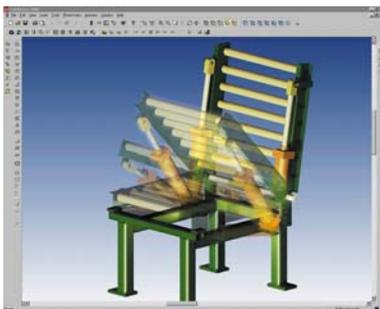
Create production-level drawings rapidly with SolidWorks software, including wiring and process diagrams, using optional Microsoft Visio, which runs inside of SolidWorks.



An easy-to-email [eDrawings](#) file offers shaded views, animations, and innovative navigation capabilities that allow recipients to better understand 2D drawings and 3D models.



[3D Instant Website](#) enables design communication worldwide. You can publish to a hosted web site instantly.



[SolidWorks Animator](#) allows you to demonstrate how products perform in full motion.

- Collaboration tools offer new ways for product designers to work more effectively with other members of the development team. The ability to share design resources over the Internet benefits all product designers, from independent consultants to engineers in large multinational corporations.
- SolidWorks provides innovative collaboration tools that enable the machine designer to convey 2D and 3D product design information to colleagues, customers, and suppliers easily and efficiently. SolidWorks collaboration tools are part of SolidWorks Office Professional and include eDrawings Professional and 3D Instant Website.

**eDrawings Professional** is the first email-enabled communication tool that dramatically eases the review of 2D and 3D design information across your extended product development teams. With eDrawings Professional you can generate accurate representations of 2D and 3D models that anyone can view, mark up, and measure without having to purchase their own markup tools. eDrawings files provide an effective means of communicating 2D and 3D design information to customers, vendors, production personnel, and everyone else involved in the product development process.

[www.solidworks.com/edrawings/](http://www.solidworks.com/edrawings/)

**3D Instant Website** provides the capability to publish product design data to a live web site of interactive 3D design content. A few simple mouse clicks from within SolidWorks allows a designer to publish a SolidWorks model to a web site and communicate the design to the entire work team, including other designers, manufacturing staff, marketing management, purchasing agents, suppliers, and customers. Visitors to the site can easily view, rotate, zoom, and evaluate the design as well as offer comments.

[www.solidworks.com/3dinstantwebsite/](http://www.solidworks.com/3dinstantwebsite/)

## SolidWorks Design, Productivity and PDM Solutions

SolidWorks offers a unique degree of integration with add-on solutions, supplying valuable functionality beyond that found in the core CAD product. These solutions operate from within SolidWorks and can be added at any time to meet new or existing needs.

- [SolidWorks Office Professional](#) combines the full functionality of SolidWorks CAD software with the following design communication, CAD productivity tools, and data management tools:

**SolidWorks Office Professional Design Communication Tools** Demonstrate more effectively how products look and perform with SolidWorks design communication tools:

**SolidWorks Animator**— animation software for creating compelling AVI files from SolidWorks parts and assemblies.

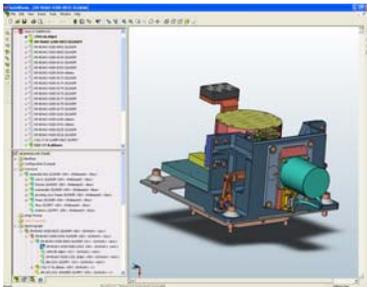
**PhotoWorks**— rendering software for creating photorealistic images.

**3D Instant Website**— an easy-to-use tool for publishing live web sites with 3D interactive content.

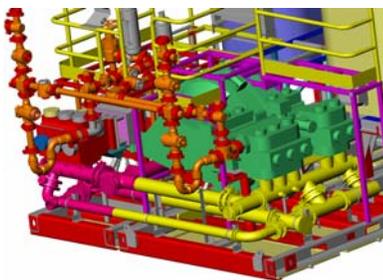
**eDrawings Professional**— tools necessary to visualize, interpret, measure, mark up, and expedite the review of 2D and 3D product designs across your extended design team.



**SolidWorks Toolbox** product offers a time-saving library of standard fasteners, bearings, structural steel shapes, and cam design tools.



**PDMWorks** provides tools to define and organize projects, easily check documents in and out of a vault, control document ownership and manage revisions. PDMWorks will automatically handle all SW file relationships. Additionally, non-SW documents can easily be managed and linked to relevant documents and projects.



The **SolidWorks Routing** add-on solution enables faster design of assemblies with piping components, such as pump skid systems. (Image courtesy of Halliburton Energy Services)

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### SolidWorks Office Professional CAD Productivity Tools

Reduce design steps with SolidWorks CAD productivity tools:

**SolidWorks Toolbox**— a time-saving library of standard parts providing automated assembly through SolidWorks Smart Part Technology

**SolidWorks Utilities**— productivity enhancement software for working more efficiently in collaborative environments that require multiple design changes

**FeatureWorks**— feature recognition software for simplifying the reuse of 3D CAD data created in various file formats

**SolidWorks Task Scheduler**— automation of resource intensive tasks, such as batch printing, running of analyses, and updating of project files during periods when you will be away from your workstation

### SolidWorks Office Professional Product Data Management

Organize, vault, and control project data for use by all team members involved with the product

**PDMWorks™**— offers production proven product data management solution that is uniquely adapted to the requirements of SolidWorks® engineering workgroups. Easy to set up and use, PDMWorks allows your design team to control CAD file revisions and manage all project data more efficiently.

- **Specialty Productivity Tools**

*(optional for SolidWorks Office Professional)*

**SolidWorks Routing** – a fast routing tool and part library for designs involving piping, tubing, and cabling systems

**SolidWorks MoldBase** – a complete library of injection mold base models for use in SolidWorks

For additional information about SolidWorks and its products, checkout the online **SolidWorks Express** newsletter at:

<http://www.solidworks.com/swexpress/index.html>.

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### Recent Industry Awards:

CADALYST magazine: National Design Engineering Show Best-of-Show Award (2002)

CADENCE magazine: National Design Engineering Show Show Stopper Award (2002)

Design News magazine: Best Product of 2001 (March 2002)

CIM 2001 Show-UK: Best-of-Show Award

UPSIDE magazine: Hot 100 for 2001

START magazine: Hottest Companies 2001

National Design and Engineering Show: Best-of-Show (2001)

CADALYST magazine: NDES Best of Show Award (2001)

CADENCE magazine: NDES Show Stopper Award (2001)