
FOUR TIPS FOR SUCCESSFULLY IMPLEMENTING YOUR CAD SYSTEM

BY L. STEPHEN WOLFE, P.E.

Overview

Congratulations! You have just purchased new 3D CAD software that promises to help your engineers design innovative products faster and with fewer errors. The steps outlined in this paper should help your company realize the benefits of your new toolset.



Introduction

Acquiring a new tool is only the first step in improving your business. To get the most out of that tool, you must use it correctly, treat it with the proper care, and examine how it will impact your existing process. If you fail to prepare or jump right into using the tool, you'll get a limited return on your purchase, at best—and at worst, you'll interrupt your workflow and affect productivity, setting you back hours, days, and even weeks.

Without well-planned implementation, you won't reap all of the benefits this new tool can provide. The most successful companies have followed these steps when deploying a new CAD system:

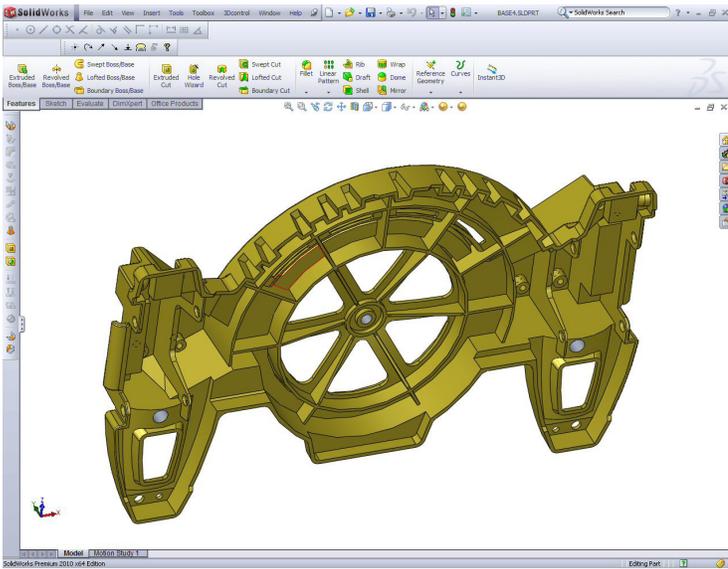
- **Identify productive activities.** By showcasing the benefits of the system early on, you will generate more buy-in from designers, administrators, and executives. Create excitement and enthusiasm for the new software by using it first in the areas that are the easiest to implement and that provide the greatest impact. Make these determinations before you start training.
- **Develop an implementation plan.** Rolling out your new CAD system will take time—unless your company is very small, you can't launch everyone at the same time, nor would you want to. Make a detailed schedule and budget and share it with the staff, so everyone understands the process and knows when and how they will be trained.
- **Establish good practices.** Any new system requires new procedures, new standards, and new rules. While you will certainly make discoveries along the way, start with a clear and well-documented set of guidelines for using the new tools and adjust them as necessary. You'll never have to play catch-up again.
- **Plan your system architecture.** Don't be caught off guard on installation day. Verify the requirements of your new system and ensure that all the hardware, software, and services are in place. Taking the time to thoughtfully implement your CAD system is planning for success. A little extra effort now will set up you and your entire organization for increased productivity—and will ensure that your employees and clients are satisfied.

Identify productive activities

It's important to demonstrate your new CAD system's productivity immediately. Executives want to see that their investment is increasing profits, and employees need to be shown that the new tools are worth learning and using.

To become productive quickly, identify tasks that the new system can do well including:

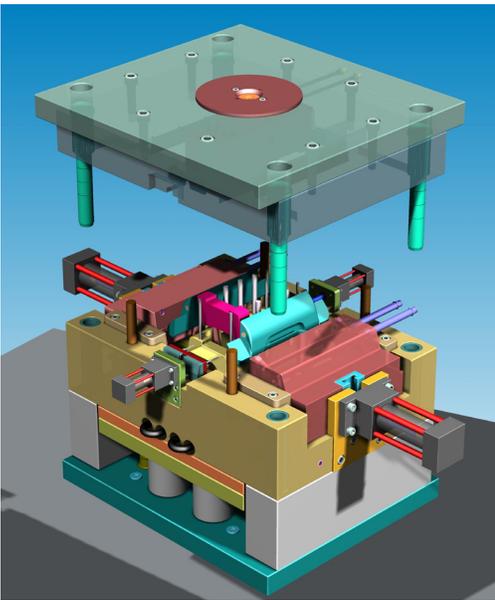
- Repetitive tasks or designs that are variants of a similar structure. Conveyor systems and material-handling equipment are examples.
- Parts and systems that are hard to visualize or that require many drawing views using 2D layouts. Molded or cast parts or subsystems for automobile, aircraft, and consumer product applications are examples.



Example of a complex casting modeled with SolidWorks software.

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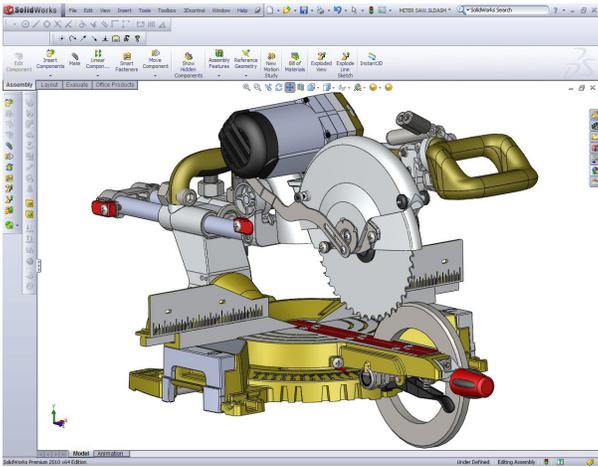
- Designs that require extensive tooling and in which mistakes or late changes can be expensive. 3D modeling helps avoid errors that cause late changes in tool designs, such as molded or die-cast parts and stampings.
- Complex tools. Molds, stamping dies, progressive dies, forging dies, and fixtures for holding complex parts or assemblies are good candidates for 3D design, especially if your customers provide 3D product models.



Example of an injection mold assembly created in SolidWorks software with MoldWorks from software partner R&B Mold Design Solutions

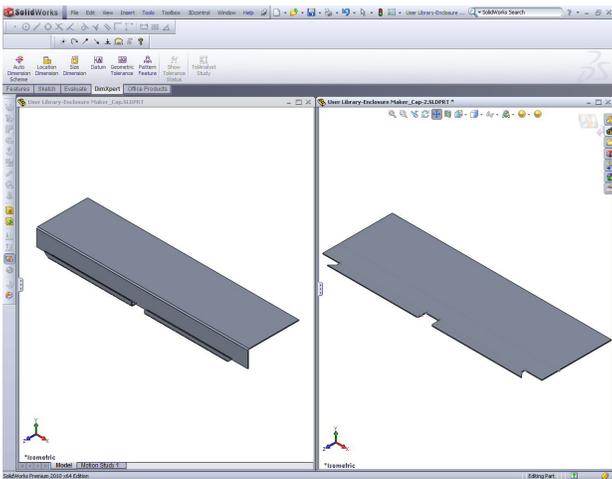
- Potentially dangerous products, in which failure can cause loss of life or injury, benefit from checking form, fit, and function in 3D. Analysis of such designs using finite element analysis (FEA) or computational fluid dynamics (CFD) also increases product safety by providing a better understanding of internal loads and failure modes.

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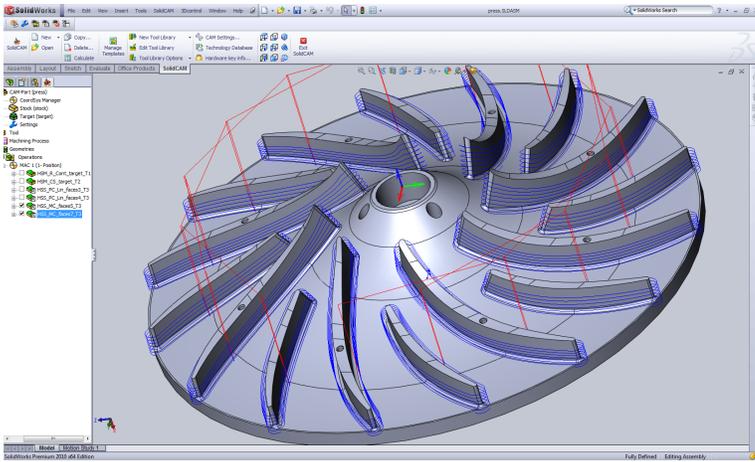
Analysis of potentially dangerous products improves safety by providing engineers with a better understanding of internal stresses and other physical behavior.

- Sheetmetal parts, for which automated flat-pattern development can save time.



Automatically generating flat patterns (right) from 3D models of sheetmetal parts (left) saves labor and reduces manufacturing errors.

- Parts or tools that are milled with 3-, 4-, or 5-axis numerically controlled tools.



Example of a tool path for a 5-axis numerically controlled mill program created in SolidWorks software with the SolidCAM partner application

- Products whose sales can be accelerated through 3D visualization before they are even built.



Realistic renderings of CAD models can help stylists visualize how a product will look and can help marketing people design sales materials before physical prototypes have been made.

Develop an implementation plan

Moving from CAD software, used mainly for 2D drawing production, to a 3D design and modeling system requires changes in development processes. Process changes must be planned carefully, or operations may be disrupted.

Unless you are a sole proprietor with one or two employees, CAD implementation plans should be clearly written so that everyone can learn and remember them. Your CAD implementation plan should include:

1. Objectives and descriptions of work to be done.
2. Costs and personnel resources.
3. A schedule.

Before writing the plan, answer these questions:

- Which design activities will be done first on the new CAD system?
- Which employees will be the first to use the system?
- Who will perform support functions, such as system administration, development of training programs, and library management?

As noted above, choose activities for the new CAD software that offer the greatest business benefits such as:

- Saving time and labor.
- Making your company more responsive to sales inquiries.
- Improving the quality of your designs or reducing design errors.

Prioritize the activities to automate based on their business importance. In developing these priorities, consult with senior operating executives who are responsible for business decisions.

Once you have chosen the initial design activities and have decided who will do the work, plan to train all the people involved. Training costs money and takes workers away from other productive work, so it should be included in the implementation budget and schedule.

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Establish good practices

Most companies have detailed drafting standards, but many forget to update their standards when they adopt 3D methods. The time spent establishing standards for 3D CAD will be recouped many times over the life of the system. Here are some sound practices your company should adopt.

Model and drawing templates

Before deploying new CAD software, create templates for parts, assemblies, and drawings. Templates are files that provide setup information common to every new CAD file. They save designers time and provide a consistent starting point for each new drawing and model. Configure CAD software to look for templates in a directory on the file server where they are stored.

Before making the templates, study the available options for parts, assemblies, and drawings and be sure you understand them. Choose the options that best fit your company's current design and drafting practices.

Even more time may be saved by creating specialized templates containing embedded drawing views, such as top, front, and side projections for classes of drawings that are made often. Don't forget to add isometric views, if appropriate, as these can make drawings easier to understand.

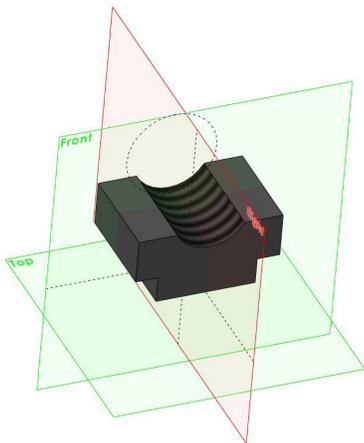
Part orientation

Establish company standards for placing parts in model coordinate systems. Following conventions makes it easier for designers to quickly place parts and position them with respect to one another or to datum planes. Standard part orientations also make it easier to apply predefined mating relationships.

Locate part models at the part origin. If a part has a plane of symmetry, the plane should lie on one of the primary planes passing through the origin. If it has two planes of symmetry, they should lie on two primary planes. Choose a standard for planes of symmetry, either the top, front, or right plane.

Locate part mating faces on one of the primary planes at the origin. Choose a standard plane that makes sense for your products. For example, if you design products that mount on a horizontal base, the mating face should be the top plane.

Cylindrical parts should lie on the same part axis. Cross-sections of extrusions should all be sketched on the same plane. Extrude either from one end or symmetrically, depending on how the parts are used.



The plane of symmetry for this part has been located on the right coordinate plane with the front face on the front plane for easy placement.

Following conventions makes it easier for designers to quickly place parts and position them with respect to one another or to datum planes.

Naming features and mating relationships

3D CAD models consist of relatively simple geometric features combined to make complex shapes. CAD systems automatically assign names to these features, such as extrude 1, extrude 2, hole 1, hole 2. These names may not be meaningful to people who must modify part models in the future.

If you plan to re-use CAD models often, assign meaningful names to important part features such as mating holes, faces, or flanges whose positions must be controlled in manufacture. If sketches are used by more than one feature, give them descriptive names as well. Time spent documenting models as they are built will reap savings beyond the life of the current product.

Applying dimensions and constraints

A powerful benefit of feature-based CAD software is the ability to embed the designer's intentions in a model. For example, if a part is symmetrical, its features should be arranged around a line or plane of symmetry so that changes to part dimensions retain their symmetrical character. Develop standards for dimensioning common parts used in your products, and require that designers adhere to them.

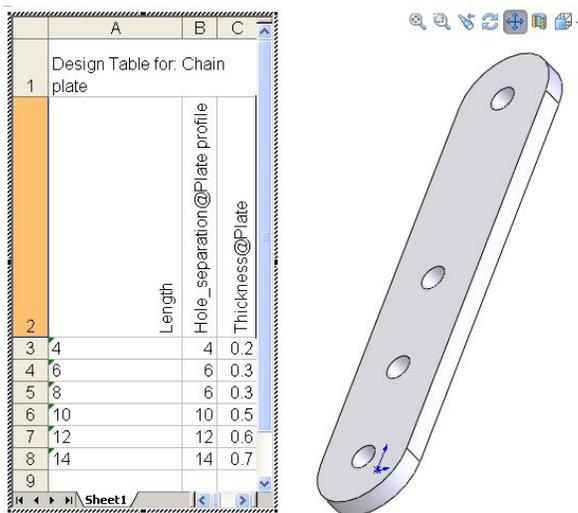
Naming variables

Every feature dimension in a 3D CAD model is a variable. Change its value and the dimension changes.

Families of similar parts with different dimensions can be generated using tables, equations, and other automated tools. This technique can save time for companies that design a variety of similar components.

Just as it does with features, CAD software assigns names to variables such as D1, D2, and so forth. Since it is equally important for variables to have sensible names, change the length of a shaft to "shaft length" rather than leaving it as the more random "D7" it may be assigned.

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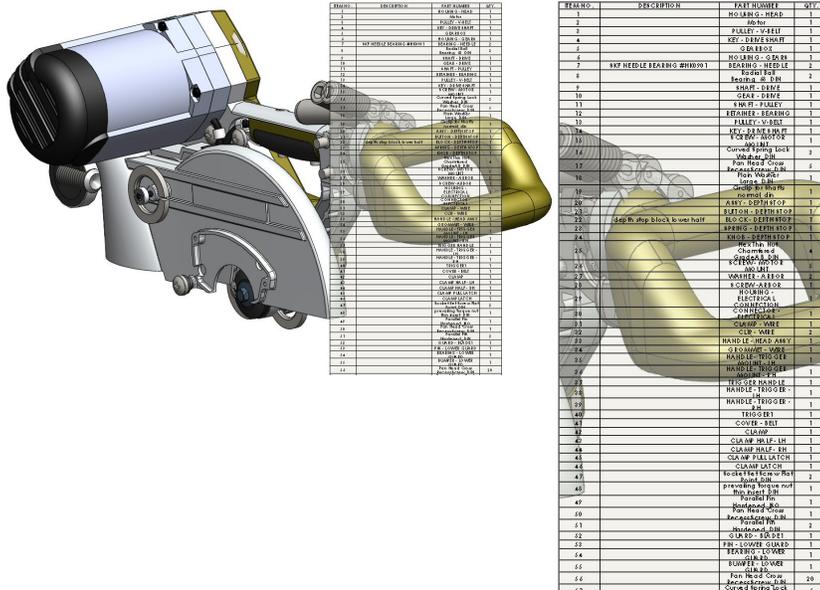
SolidWorks software 3D assembly with parts list.

Standards for non-graphic attributes

Product designs include non-graphic attributes, such as materials and their properties, surface finish, supplier names and part numbers, costs, the name of the designer, and the date the part was designed. Store this type of information in CAD part or assembly files where it can be accessed for a variety of purposes.

Bills of materials on drawings or in manufacturing resource planning systems can be generated automatically from non-graphic attributes in part models. Weights and other mass properties can be calculated if material properties are stored with the part. Entering product data during the design phase and referring to it throughout manufacture increases accuracy and saves time.

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Example of a design table with meaningful variable names.

Establish standards for non-graphic data that is stored with various classes of parts. All parts should have names, part numbers, and release dates. You will probably want to store different types of data for parts that are purchased or fabricated in a shop.

Part number assignments

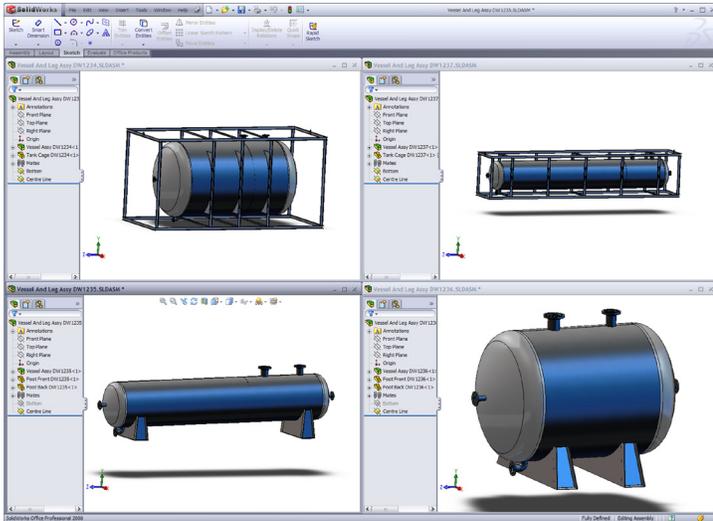
Assigning part numbers is like balancing your checking account. Nobody likes to do it; but if you don't, you will experience problems that could impact your productivity. To avoid this, have numbers assigned automatically by either a PDM system or a change-control system. Automatic numbering saves time and limits delays by eliminating the need to request number assignments from a clerk.

Employing part families

As mentioned above, automating the design of similar part families saves time. Before deploying your CAD software, think about which part classes in your organization could benefit from design automation.

It's hard to fully automate the design of a complex product such as a school bus or a tractor. However, many subassemblies of these complex systems, such as seats, brackets, and sheet-metal panels, can be automated efficiently. Companies can find many opportunities to automate the routine design of designed-to-order products, including production machinery, material-handling equipment, and tools.

Encourage engineers to look for families of parts and subassemblies whose design can be automated. Make lists of these activities and prioritize them according to the maximum potential savings.



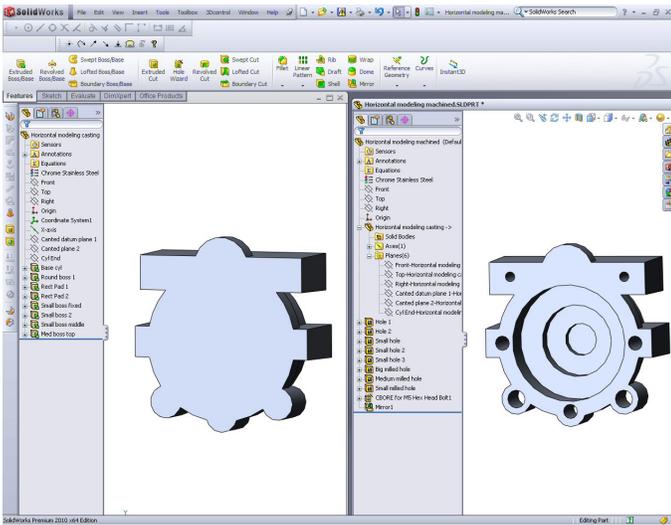
Design automation software, such as DriveWorks®, a partner application for SolidWorks software, enables an infinite variety of similar products or subassemblies to be designed automatically.

Flattening feature trees

Design complex parts with logical structures that minimize the dependencies among features. When parts contain many parent-child relationships, a change to one of the features higher in the tree can cause multiple features to fail.

Designers should learn to put in the important features first, adding details such as fillets, chamfers, and fastener holes at the end. Tie important features to construction planes, rather than to each other, so that features can be positioned independently.

Teaching designers to employ manufacture-driven modeling is one of the hardest aspects of implementing 3D CAD. However, the benefits are designs that cost less to manufacture and that are easier to modify.



Models with logical structures are easier to improve and to use for manufacturing planning. In this example, the rough casting model at the left is used as the basis of the finished milled part on the right. The reference planes are organized at the top of the model. Cast features come before milled and drilled features.

Well-structured designs become especially important if you need to generate models of intermediate process steps. For example, if a part begins with a rough casting, is then milled or turned, and finally has holes drilled in it, model the part in the way it will be deconstructed for manufacture.

Teaching designers to employ such discipline is one of the hardest aspects of implementing 3D CAD. However, the benefits include designs that cost less to manufacture and that are easier to modify.

Checking models before release

In the days of pencil-and-paper drafting, nobody would have issued a drawing without checking it. Today, many companies release 3D models without formal checking procedures. Checking 3D models should be accomplished on many levels:

- Completeness, dimensional accuracy, and meeting form and functional requirements.
- Modeling structure. Is the model tree as flat as possible? Are there buried features in the part or cuts in empty space? Are fillets and small holes applied last?
- Conformance to company standards. Are dimensions applied properly? Are required non-geometric attributes included?
- Problem-free geometry. Does the part contain small faces or geometric irregularities that could stall manufacturing or analytical processes?

Higher-level checks must be performed by experienced designers who understand both your company's products and standards and good CAD modeling processes. Engineers should develop checklists to assist in reviewing models.

Routine conformance checking can be performed by software, such as SolidWorks® Design Checker. It can check for errors such as improper units, non-standard hole sizes, missing part properties, and parts with rebuild errors or partially defined sketches.

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Plan component libraries

Allowing designers to use any component they find on the Internet can be costly. You can save money by limiting the types, brands, and sizes of components used in your products. For example, most companies have found they can limit the fasteners they stock to a fraction of the sizes available. Limiting the selection that designers employ reduces purchasing, inventory, and product support costs. It also allows components to be bought in higher volumes, resulting in better prices.

You will save designers time and labor by building libraries of components commonly used in products. Most CAD software comes with libraries of fasteners, structural steel shapes, springs, bearings, gear sprockets, and pulleys. CAD software companies also offer online libraries of proprietary components, such as pumps, gearboxes, electrical connectors, fixtures, mold bases, and valves. One example of the type of service is 3D ContentCentral® (www.3dcontentcentral.com) available with SolidWorks software.



This automated bottle packaging system from Hartness International is an example of a product configured uniquely for each customer using common components.

Even though CAD models can be located in a variety of sources, each company should create its own library of approved components. These CAD models should be stored on your company's file server in read-only format or in a PDM system. Assign someone the role of component librarian to prevent duplication of parts and to assure they are modeled in accordance with company standards, contain necessary attributes, and are properly classified.

Components should be organized into folders by type to enable designers to find them quickly. When adding components to the library, take the time to assure they comply with your company's part-modeling standards. Include custom properties such as the vendor's name and part numbers as well as your company's part number, vendor numbers (if used), and any other information (such as compliance with environmental standards) that might be needed by designers or purchasing agents.

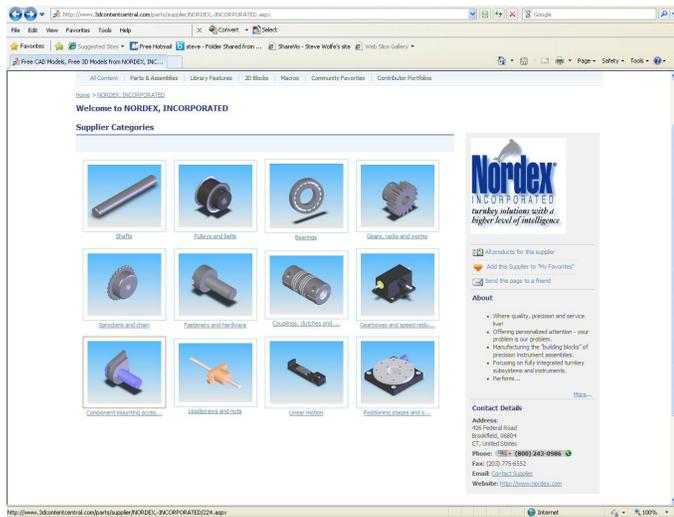
Parts imported in standard formats should be stored in the native format of your CAD software. Imported parts may require repair work, which should be done once by the librarian, not each time the part is used. If your CAD system allows it, add SmartMate technology to components to enable them to be placed quickly.

The Internet has become an integral tool for many aspects of CAD, including obtaining support and solving problems, researching new materials and components, communicating with suppliers, and providing off-site data backup.

Most CAD software comes with libraries of common components, such as fasteners, structural steel shapes, springs, bearings, gear sprockets, and pulleys.

Tips for building libraries fast

Use part libraries that come with your CAD software or download part models from the Internet and check them. Don't worry if downloaded parts lack dimension-driven features. There is no need to change dimensions of purchased parts.



SolidWorks 3D ContentCentral from Dassault Systèmes SolidWorks Corp. provides engineers with 3D models of thousands of commercial parts that can be used in designs of mechanical systems.

If part models aren't available, employ parametric part families where possible to save time. Add only enough detail to part models to enable designers to check form, fit, and function.

Design your library classification and filing schema before beginning to use your CAD system, but don't build all the parts you need at once. It's faster and less costly to add parts as needed and check them into the library for reuse.

Develop a checklist of information required in every library part, and make sure designers know how to use it. The checklist enables engineers to prepare their own parts on an expedited basis if necessary.

Train workers

Companies that say they can't afford to train workers will pay for the lack of training later. Untrained employees are less productive because they make mistakes that must be corrected, and because they fail to take full advantage of the CAD system's capabilities.

Although outside experts, such as your CAD reseller, should be enlisted to help with training, don't leave training exclusively to others. Resellers and local school programs can teach workers the basics, such as how to make a sketch or shape feature, but outsiders can't educate them about your company's procedures and processes. Resellers and college professors can't be expected to know how to optimally design your products.

Money can be saved by limiting the types, brands, and sizes of components used in your products.

Training curricula should be tailored to meet the needs of your company. Develop a training outline in consultation with your vendor that fits with your plan. Focus on system capabilities that your people will use and omit features they don't need. Therefore, if your company fashions products from sheet metal and structural steel, there is little reason to teach workers about sophisticated surface-modeling features for industrial design.

Your course syllabus should also include:

- Procedures for file naming, numbering, storage, and release
- Where libraries are located and how they are organized
- Which templates are available and how to use them

As designers become more experienced with your new CAD system, they will discover ways to use it more productively. These improvements should be added to training curricula and reference materials.

Plan your system architecture

The architecture of your CAD system includes computer hardware, local network configuration, software setup, data management, and Internet services.

Hardware requirements

If you are upgrading from 2D to 3D CAD software, you should plan on upgrading your designers' workstations, departmental file servers, and networking gear, as well.

Designer workstations

Choose professional-grade models certified by your software suppliers. Ask them about graphics adapters, the type of processor, and the amount of RAM and memory recommended for each engineering application.

Departmental file servers

Servers store CAD models and component libraries, and they run data management software. The most important characteristics of a CAD file server are disk capacity and reliability. A good rule of thumb is that server disk capacity should equal the disk capacity of all the CAD workstations networked to it.

RAID (Redundant Array of Inexpensive Disks) storage systems protect engineering data through redundancy. RAID levels 1 through 6 distribute data across multiple disks to minimize the impact of disk drive failure. If a drive breaks, no information is lost.

Networking gear

Depending on the size of your files and the speed of your local area network, you may need to upgrade your networking equipment. To test the capacity of your network, move representative-sized parts and assemblies from servers to clients, and assess the transfer times to see if they are acceptable. If you find it too slow, gigabit Ethernet equipment is reasonably priced and eliminates delays moving large models to and from file servers.

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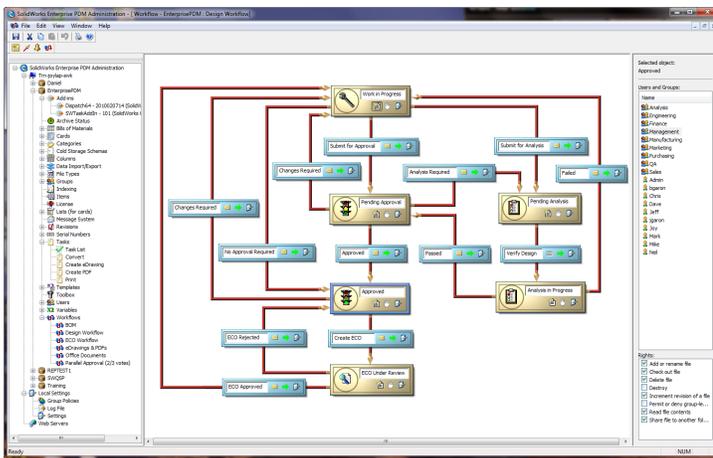
Standardized setup

If your organization has a dedicated CAD administrator, standardizing the options installed on each workstation can reduce labor costs. Allowing designers to choose their options individually makes diagnosing problems and answering questions more difficult for support personnel. If you have never installed software using an administrative image, ask your software dealer to help with the installation.

Data management

If your company has more than a few people using CAD software or if teams of designers work on the same product, then you need product data management (PDM) software. An administrative system that regulates the flow of the design process, PDM software prevents errors such as one designer overwriting the work of another. It also enables designers to identify current revisions and search for the latest information using attributes and key words.

PDM software can be complex. Assure that at least two people in your organization are formally trained in how to set up and use the software. It is also worth hiring specialists from your CAD dealer or other service company to assist with the initial installation and training.



PDM software prevents errors such as one designer overwriting the work of another. It also enables designers to identify current revisions and search for the latest information using attributes and key words.

This flow diagram of a design approval process in SolidWorks Enterprise PDM is one example of an advanced application that can help engineers perform administrative tasks more efficiently.

When implementing PDM software, start with a simple system that provides check-in and file tracking. Once everyone is comfortable with a basic system, add capabilities such as change management, bill-of-materials management, direct access by suppliers, and links to manufacturing resource planning. These applications can save time and reduce errors by assuring that only approved data are released for manufacture.

Internet services

The Internet has become an integral tool for many aspects of CAD, including obtaining support and solving problems, researching new materials and components, communicating with suppliers, and providing off-site data backup. As with any Internet connection, your network of CAD workstations must be protected from malicious software that can damage files or slow system performance.

Safeguard your investment by installing firewall routers to protect internal networks and anti-virus software on individual workstations. A new class of security software, such as Google's Postini Services, operates outside internal networks to catch threats before they reach your firewall router.

Conclusion

Just by taking the time to read this document, you have taken the first step to successful implementation of your 3D CAD system. If you follow through by identifying the most productive activities, establishing best practices, and carefully planning both system implementation and architecture, your organization will derive the maximum benefit from this acquisition. To further ensure success, remember to:

- **Be patient.** Don't try to switch everyone to a new CAD system at once. Phase in new systems starting with the most productive tasks.
- **Assess your progress.** Include quantifiable objectives in your plan. Find out if these goals are being met. If so, let others know about your success. If not, find out why the system isn't working as expected.
- **Be flexible.** If new technology turns out to be less productive than expected for a particular set of tasks, change the plan and try something else.
- **Evolve.** The most successful companies continuously improve their processes. Set goals for enhanced productivity, and give workers time to improve their methods.

Your new CAD system is a powerful tool. With it, you can revolutionize your work processes, improve your products, grow your business, and even change the world. Plan carefully, train well, develop good habits, and design better products.

To learn more about SolidWorks CAD software, visit www.solidworks.com or call 1 800 693 9000.

L. Stephen Wolfe is a professional mechanical engineer based in San Diego, California. He was founder and publisher of the *Computer Aided Design Report* and the *Product Data Management Report*. For more than 20 years, these publications filled the role of Consumer Reports for the CAD industry. Wolfe has written two books on how to pick CAD/CAM systems: *The Smart Manager's Guide to Selecting and Purchasing CAD Systems* and *The CAD/CAM Strategic Planning Guide*. He currently consults in the mechanical engineering software field, assisting customers in defining their requirements, conducting independent research, identifying and negotiating with software suppliers, and implementing new software efficiently.

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