# Benchmark Test Reveals Best CAD Tool for Assembly Performance

Speed is everything in product development, especially when it comes to creating and managing large assemblies. And while some 3D CAD vendors claim that model retrieval time is the only critical function, the truth is, there are many other equally critical capabilities required for exceptional large assembly performance.

Read the results of this important benchmark study and you'll not only discover all the essential capabilities for superior performance in large assembly creation and management, but you'll also discover which 3D CAD tool outperforms all the rest by a significant margin.

For engineers evaluating 3D CAD solutions, choosing a toolset based solely on assembly model retrieval times would be overlooking many other vital performance factors that can significantly impact productivity and time-to-market.

This important benchmark study not only highlights the most critical large assembly functions, it also analyses the performance of the leading CAD solutions on the market. Read the results and discover why PTC's Pro/ENGINEER performed up to four times faster than other popular 3D CAD packages.

## Assembly Performance—Much More than Retrieval Speed

If you're involved in designing complex products, you know that assembly performance is critical to your success. To deliver projects on schedule, you need to retrieve models, make modifications, regenerate assemblies, and create drawings with maximum speed.

Some CAD vendors will tell you that, far and away, model retrieval speed is paramount, and that other performance areas are far less critical. Yet, what value is retrieval speed if, once your model is on screen, you can't quickly add and modify parts, regenerate models, produce necessary drawings, and perform other critical tasks?

The fact is few CAD vendors can deliver exceptional assembly performance in all critical areas, which is why they'd rather focus solely on retrieval performance. Yet, if you're evaluating 3D CAD tools, it's important to know all the key functions in large assembly management, and which CAD tools offer superior performance across the board.

In this recent benchmark test of popular 3D CAD tools, Pro/ENGINEER proved itself superior in the design of both simple and highly complex products. Read on and discover why companies like Caterpillar, Boeing, John Deere, Ferrari, and Lawrence Livermore Labs—developers of the National Ignition Facility, created with over 1 million parts—rely on PTC for the most robust, high-performance large assembly management tools.

## Overview

This document presents the details of recent independent tests comparing assembly performance among 3D solid modeling applications, including PTC's Pro/ENGINEER Wildfire, Dassault Systemes CATIA® V5 R12 and SolidWorks®, UG NX 2® and Solid Edge® R14 from UGS, as well as Autodesk Inventor® R8.

Among other variables, this test measured the time and computer memory required to complete a variety of assembly creation tasks. The following pages describe the steps performed in Pro/ENGINEER to complete these tasks.

The actual steps performed in SolidWorks 2004, Catia V5, UG NX, Autodesk Inventor, and Solid Edge were dependent upon the functionality available within the respective software. This unbiased test was performed by an independent, third-party company who used only the capabilities available in each software package.

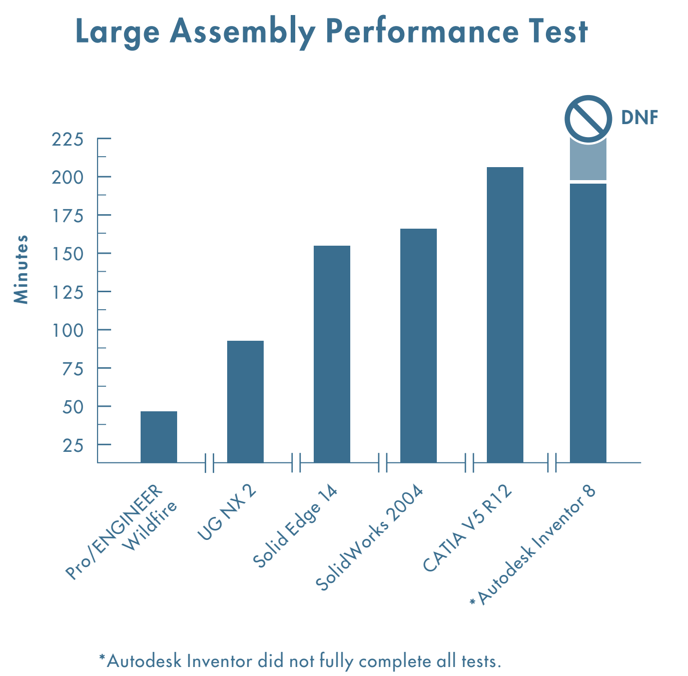


**Figure 1.** Test results show that Pro/ENGINEER Wildfire performed three to four times faster than the competition.

All packages were installed to a baseline configuration similar to the following system parameters:

- Pentium 4 2.0 GHz, 1,024 MB RAM, 64 MB nVidia Quadro4 Graphics Card, 120 GB Hard Drive
- Variances:
  - 2.4 GHz Pentium P4 chip used in Solid Edge, SolidWorks and Inventor tests
  - 3.0 GHz Pentium P4 chip, 128 MB nVidia Geforce FX Go5600 graphics card, and 10x10x10mm cube size used in CATIA V5 test
  - 2.0 GB of RAM used in UG NX test
- To optimize the system for working with and managing large assemblies, simplified representations or their equivalent, settings were used in all systems to enable the most efficient graphical representations for maximum assembly performance.
- Software: Windows 2000 SP4, 32-bit operating system

## Test Preparation

Certain preparations were performed in advance of the assembly performance test to ensure that results would reflect only the most relevant and meaningful performance metrics.

These preparations included preliminary steps such as creation of the base cube (3x3x3 inches) and spring with all relevant features. The cube included features such as a thru hole on each face measuring 1.0 inch

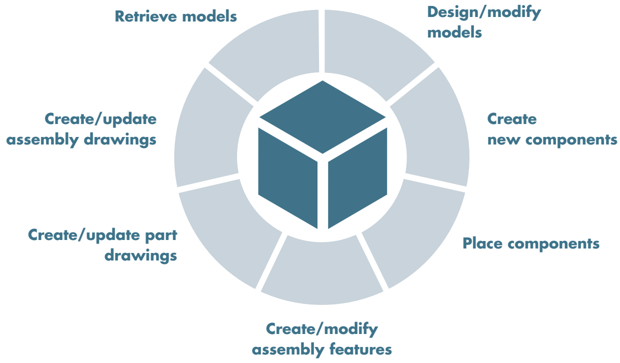


**Figure 2.** Because Pro/ENGINEER easily handles all critical areas of large assembly management—from model retrieval to component placement to creating the assembly BOM—it outperformed all other CAD tools in this benchmark study.

in diameter and a 0.25-inch rounds on all edges, including the holes on each of the six faces. The spring part measured 14.80 inches in overall length and 1.0 inch in outside diameter and included locating features on each end.

After these base features were created, the base assembly was constructed using 100 unique cubes that were arranged in a 10x10 configuration. It should be noted that 100 unique cubes are not the same as 100 occurrences of the same cube because they impart an increased burden on computational resources.

Next, a 500-cube assembly was created using the base assembly of 100 unique cubes assembled with the necessary constraints. In addition, a 2D drawing was created of the 500-cube assembly, containing a front view, two projection views, and an isometric view. Finally, a BOM table was added to the 2D drawing.

## Test Scenario

After all test preparations were completed, testing commenced according to the following general steps. Note: A more detailed description of the test procedure is included in Appendix A of this report.

During this test scenario, certain steps were included that were designed to simulate an engineer's or designer's normal working environment. For example, since it is common for an engineer to process many changes during the course of any particular day, whether due to new customer or market requirements, manufacturing adjustments, or general design alterations, the tasks required multiple changes to the model assembly.

In this case, the assembly was required to double in size, from 500 parts to 1,000. The new assembly was renamed to reflect the new number of cubes, and the engineer was required to track the assembly independently, as a new product or part number.

After the new assembly was created, the next task was to design and detail a pallet to properly accept the cube assembly. To accomplish this step, the engineer had to add additional features that would help in locating the cube assembly and in creating stability, so the assembly would not slide during transport.

Next, the engineer was asked to create another 1,000-part assembly and add this assembly to the original 1,000-part assembly, ultimately creating a top-level general assembly. After both assemblies were created, along with the pallet and its locating features, the engineer was required to connect the two 1,000-cube assemblies to each other by four springs: two on top, two on bottom.

After both assemblies were created, then located on the newly designed pallets and connected together with four springs, a 2D drawing of the assembly was produced to show final top-level general assembly. However, after creating the 2D drawing of the final general assembly, a new requirement was generated to make changes to some of the parts.

Of the 2,000 cubes in the general assembly, there were changes in the form of dimensional modifications that were necessary to be made to 24 of the cubes. Once these changes were in effect, it was necessary to update all drawings for release, including the existing 500-cube assembly drawing, the new pallet drawing, and the new 2,000-cube general assembly drawing.

## Test Results

As presented in Chart 1, the test results clearly favored Pro/ENGINEER's performance compared to the assembly performance of the software packages from Dassault, UGS, and AutoDesk.

Note: Complete test plan details can be found in Appendix A.

## Summary

This assembly performance test clearly shows the performance advantage of Pro/ENGINEER when handling large assemblies. As mentioned previously, this advantage is due in large part to the fundamental architecture of Pro/ENGINEER, which has been optimized to more efficiently handle assemblies of any size.

Considering the unrelenting pressure that engineers are now facing to complete models faster, the results of the large assembly performance test are especially important. They clearly prove that Pro/ENGINEER can dramatically save time on a day-to-day basis, freeing the engineer to work on higher value-added activities. Note that Pro/ENGINEER completed this test in less than one hour as compared to CATIA V5 which needed over 3-1/2 hours. It's estimated this type of scenario occurs frequently during the course of any project, and most likely occurs often during the course of an average week. Therefore, if extrapolated, the amount of time and cost that could be saved by employing Pro/ENGINEER for handling large assemblies would produce a large ROI.

In addition to delivering excellent system responsiveness, Pro/ENGINEER offers many other capabilities to increase efficiency when managing assemblies. PTC software developers have continually optimized the software according to the requirements of large assembly customers. Today, Pro/ENGINEER is building upon a legacy of robust capabilities with excellent performance, rather than attempting to redesign existing code. These capabilities, detailed below, exist in no other solution and are what make Pro/ENGINEER uniquely qualified to manage assemblies in a legitimate top-down style:

- Top-down Design Methods and Tools. Working intuitively, users can quickly define and populate an assembly structure with new or existing components, collect critical design criteria in skeleton models, and propagate these criteria throughout the assembly. Users can also manage the top-down design process using Reference Control and Reference Viewing tools.
- Simplified Representations. Users can create collections of components to facilitate managing a large assembly design. These collections can be based on rules, such as model size, location, name, or any other model parameter. Other types of simplification tools enable users to load into memory only the graphics or the model geometry, without feature details. The Graphics and Geometry-Only Representations can also significantly improve performance by reducing the amount of component information brought into a session.
- Associative Shrinkwrap™. Pro/ENGINEER enables users to produce a 'lightweight' (minimal byte size) representation of the assembly that retains complete surface and mass property information. This 'shrinkwrapped' representation reduces the load on system resources, greatly improving performance. In addition, shrink-wrapped designs can be shared with suppliers and customers without distributing proprietary design information. As well, shrinkwrapped models are associative, so that design changes update automatically.
- Design Criteria Management. Pro/ENGINEER provides layouts for conveniently documenting, managing, and modifying high-level, critical engineering criteria. The layouts present operating specifications in the form of parameters and dimensions, which can then be used to govern the design and automate the assembly of components by identifying critical assembly interfaces.

# Appendix A

## Detailed Test Procedure

### Assembly Performance Test Plan Detail

The following are detailed instructions for the four modifications that must be performed to complete the assembly test.

This test measures the time required to complete each task as well as the amount of memory used. The following describes the steps that must be taken in Pro/ENGINEER Wildfire to complete the above tasks. The actual step-by-step procedures performed in SolidWorks 2004, Catia V5, UG NX, Inventor and Solid Edge will depend upon the functionality that exists within the respective software.

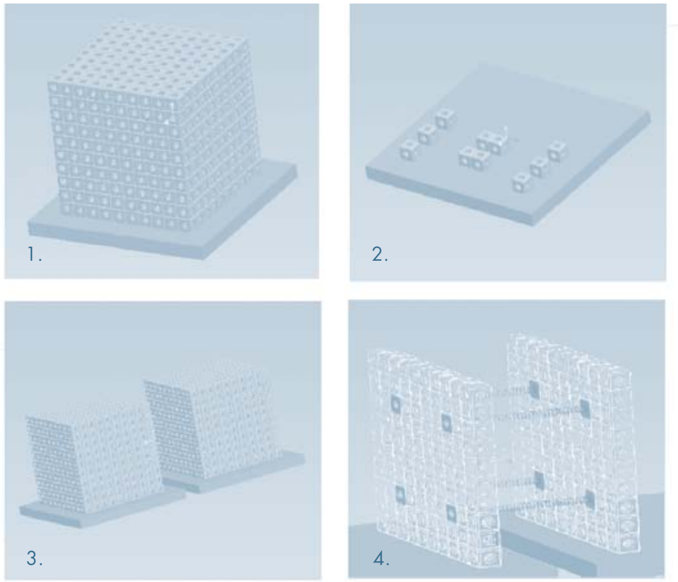


**Figure 3.** Steps in the Benchmark test, from top. 1) Create 1,000-cube assembly. 2) Create 20 locator holes in the pallet. 3) Create 2,000-part, top-level general assembly. 4) Assemble four springs in the top-level general assembly. Above, Simplified Representations are used to show only relevant geometry.

### Overview of Assembly Performance Test (Using ECO Scenario):

The assembly needs to be increased in size to 1000 parts (10x10x10) and the name of the assembly changed to reflect the new number of cubes.

- A pallet needs to be designed, detailed, and assembled to the 1000-part assembly.
- A second, 1000-part assembly needs to be added to create a 2000-part, top-level General Assembly (GA).
- The two assemblies then need to be connected with four springs.
- A new Top Level GA drawing needs to be created of the 2000-part assembly.
- 24 cubes will be modified dimensionally.
- All drawings need to be updated for release: 1) the existing 500-cube Assembly Drawing; 2) The new pallet.prt drawing; and 3) the new 2000-cube General Assembly drawing.

### Detailed Description of the Assembly Performance Test

Create the additional five sub-assemblies and assemble to the existing 500-cube assembly.

1. Retrieve a 100-part sub-assembly.
2. Save a Copy of the assembly and use a template to rename all the parts to 500-599, etc.
3. Do this four more times for assemblies with parts 600-699, 700-799, 800-899, and 900-999.

4. Using On-Demand Graphics Reps, add the additional sub-assemblies to the top-level assembly.
5. Retrieve the drawing to view the changes.
6. Rename Top-Level Assembly to cube_assy_all_1000_parts.asm.
7. Save the drawing, close all windows and erase models from memory.

### Create a Pallet Part and Drawing as Follows:

1. Create a part with the following dimensions: 40Wx40Lx40H.
2. Assemble this part into the 1000-part cube assembly. In Pro/ENGINEER Wildfire, this will be done using External Simplified Reps to include only the pallet and the 100 cubes that are in direct contact with the pallet. Figure 1 shows the entire 1000 cube assembly with the pallet assembled.
3. In the assembly, create 20 holes in the pallet as assembly features that reference the mating surface hole in each of the following cubes: Cube 0, 9, 104,105, 200, 209, 304, 305, 400, 409, 504, 505, 600, 609, 704, 705, 800, 809, 904, 905.

   In Pro/ENGINEER Wildfire, this will be done using a Simp Rep of the pallet and 20 parts. Figure 1 shows the pallet.prt with the first10 cubes that will be referenced for the assembly holes.
4. Create a detail drawing of the new pallet part, with 3 views.
5. Create a hole table on the drawing showing hole locations in the plate.
6. Add an ISO view of the entire cube assembly (with pallet) for reference. In Pro/ENGINEER Wildfire, an associative Shrinkwrap of the entire assembly will be used.
7. Save the drawing.

### Create a New Top-Level Assembly Named GA_ASSY_1000_CUBES:

1. Assemble the first 1000-part assembly.
2. Assemble a second 1000-part assembly (same assembly, 2 instances) to the top-level assembly. Use a mate offset to offset the pallets 5 inches from one another. Align the bottom and side surfaces of the pallets to fully constrain the assembly.
3. Assemble the SPRING.PRT to connect the 2 assemblies as follows:
   - The 1st SPRING assembled to ASM1>Cube922 to ASM2>Cube22
   - The 2nd SPRING assembled to ASM1>Cube927 to ASM2 >Cube27
   - The 3rd SPRING assembled to ASM1>Cube972 to ASM2>Cube72
   - The 4th SPRING assembled to ASM1>Cube 977 to ASM2>Cube77

   In Pro/ENGINEER Wildfire, this will all be done using Simplified Reps, retrieving only the parts required during assembly as shown in Figure 1.
4. Save the assembly.
5. Create a new GA Assembly drawing, using the same name as the GA Assembly.
6. Place the assembly on the drawing with 3 views and an ISO view.
7. Create a BOM.
8. Add BOM balloons.
9. Save the drawing.
10. Exit.

### Make the ECO Changes to the 24 Parts as Follows:

1. Cube 922 depth changes from 3 to 6 inches, regen and save.
2. Cube 27 depth changes from 3 to 8 inches, regen and save.
3. Cube 672 depth changes from 3 to 4 inches, regen and save.
4. Cube 577 depth changes from 3 to 5.5 inches, regen and save.

   The above four changes will change the length of the springs assembled to each of the cubes. Using Flexible Components, all the springs will be different lengths but all will still be the same part (essential for correct BOM).
5. Cube 0, 9, 104,105, 200, 209, 304, 305, 400, 409: Change from 3 inches to 4 inches wide, regen and save.
6. Cube 504, 505, 600, 609, 704, 705, 800, 809, 904, 905: Change from 3 inches to 3.5 inches wide, regen and save.
7. Open the 2000-part assembly, regenerate.
8. Open the pallet drawing and make changes to the Hole Table, as required.
9. Open the Top-Level GA Drawing, regenerate to view Updated changes to all views, BOM, etc.
10. Save changes.
11. Exit.

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