



Does Your Interface Device Help or Hamper 3D Design?

An introduction to navigation devices for CAD systems

Executive Summary

By now, we all know that the 3D CAD process increases product design quality, offers great competitive advantage, and makes it easier to visualize parts and assemblies.

Leading companies know that efficient operation of 3D CAD software requires powerful PCs with ample RAM, hard disk storage, and high-end graphics cards, along with high-bandwidth network performance. Yet the user interface hardware is a critical consideration, too.

Innovative manufacturers also recognize the need to evolve 3D CAD design beyond using “2D” interface devices—keyboard and mouse. By adding navigation input devices to their CAD systems, companies aim to improve and accelerate the navigation of models and objects, and reduce operator hand-fatigue and arm-fatigue, at a fraction of the purchase price of a CAD workstation. ROI is easily measured and validated.

This document also includes a first-person look at using a navigation device specifically to enhance Autodesk Inventor workflows, courtesy of design engineer Gregg Reinhart of Acme Cryogenics.

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What are navigation devices?

Navigation input devices, also known as 3D motion controllers, are interface devices specially optimized for CAD that both complement and reduce mouse and keyboard usage— giving professionals a more functional and enjoyable approach to their software use. Navigation devices fluidly enable translational and rotational movement via gentle twisting, tapping, and lifting of a simple, ergonomic cap. Designers can simultaneously position and orient objects, scenes, images, and documents with one hand while selecting, creating, or editing with the mouse in the other hand.

Using a mouse to position and orient 3D models involves tedious, sequential steps. Navigation devices eliminate these repetitive mouse movements. Their programmable buttons eliminate the need for keyboard shortcuts.

How can navigation devices help ease the transition from 2D to 3D CAD?

Designers can optimize CAD software performance with a navigation device explicitly designed to let them simultaneously and intuitively pan, zoom, and rotate on-screen objects. Navigation devices make it easier, both physically and conceptually, to interact with the rich and complex data flows intrinsic to 3D CAD. If you're modeling in 3D, you need to input with a 3D-savvy device.

Through the use of programmable speed keys, navigation devices enable people to customize workflows for improved efficiency and productivity. This streamlines the design processes while reducing wear and tear on their hands and arms.

How do navigation devices affect productivity and reduce physical fatigue?

Productivity Gains

According to the independent product consultancy, Technology Assessment Group (Los Altos, CA), people using navigation devices working in tandem with mice as compared with people working with mice alone:

- are nearly twice as fast at orienting 3D objects or views
- implement menus with an error-rate lowered by 45 percent
- create user-input to CAD applications 1.36 times faster

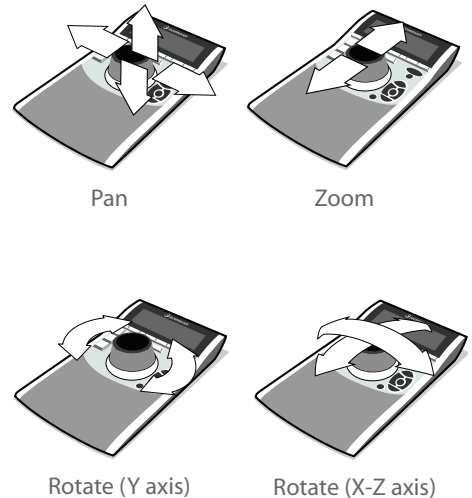
Improved Ergonomics

According to the independent ergonomics consulting firm, Ergonomic Technologies Corporation (Syosset, NY), navigation devices as compared with pointing devices (i.e., the mouse):

1. Reduce left-hand motions by 67 percent
2. Reduce right-hand motions by 64 percent
3. Reduce average muscle-activity by 33 percent
4. Reduce peak muscle-activity by 35 percent



SpacePilot™



Pan

Zoom

Rotate (Y axis)

Rotate (X-Z axis)

5. Reduce average wrist flexion and extension by 57 percent
 6. Reduce peak wrist flexion and extension by 34 percent
- and**
7. Improve comfort on nine measurable body metrics affecting hands, fingers, wrists, forearms, and shoulders in both one-handed and two-handed use.

What is 3Dconnexion's relationship to navigation devices?

3Dconnexion designs and builds only navigation devices, and manufactures a complete product line. 3Dconnexion offers extensive device support across a vast range of visual computing applications, and the company maintains excellent partnerships with the leading CAD software companies.

Who invented the technology?

3Dconnexion holds all the basic patents for navigation devices, which implement a drift-free measuring system that needs no calibration. The opto-electronic measuring system was developed in 1985 by German robotics researchers. Today's models are wear-resistant and rock-solid, powered through the attached PC's USB port. Ergonomically, they feature an appealing cap designed so that the hand may rest on it without fatigue, requiring only slight finger pressure to operate.

How do CAD designers learn and use navigation devices?

Here we describe three manufacturers that currently use 3Dconnexion navigation devices:

Acme Cryogenics (Allentown, Pennsylvania) is a 150-person firm that manufactures gas and fluid handling systems and related equipment for use in semiconductor, chemical, pharmaceutical, medical, food, packaging, and other industrial applications throughout the United States. Design engineer Gregg Reinhart is responsible for all mechanical layouts. He does both 2D and 3D design work, concentrating on 3D since 2002.

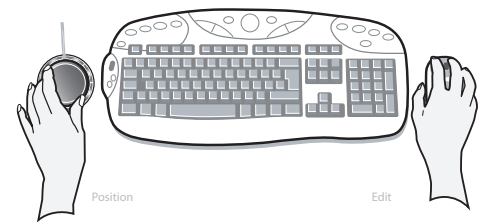
Reinhart was introduced to navigation devices when his reseller, Synergis (Quakertown, PA), offered a deal: a 30-day trial with a SpacePilot provided for free when Acme Cryogenics upgraded from Autodesk AutoCAD to Inventor. After using the SpacePilot for a day or two, he said to Synergis, "I am not giving the SpacePilot back! What do I have to do to buy this?"

Reinhart found learning to use the SpacePilot was easy: "I ran the demo two times to get the hang of it, and then I customized the function keys." Now that both his hands share the interface functions, Reinhart says his arms never get as tired as they did when his CAD process involved constant mouse-clicking and dragging. Depending on his software environment mode, he changes the setting of his speed keys; but, "most of the time I don't even have to look at the LCD screen to know which commands are active."

"I feel my posture is better and more natural," Reinhart also reports. "I'm not slouching. I feel I work more efficiently, because I am not hunting all over the screen all the time."



SpaceTraveler™



Adam Aircraft Industries (Denver, Colorado), manufacturer of general aviation aircraft, is based at Centennial Airport in Denver and employs more than 500 people. Pat Fairchild is the A500 Structures Supervisor. He supervises designers in Adam's composite group, where engineers design fuselages, wings, and tails.

Almost immediately after Fairchild joined Adam in 2000, the aircraft company adopted Unigraphics and Solid Edge 3D CAD software. And along with upgraded computers and new software licenses, six navigation devices (SpaceBalls) were purchased, because that is what their software VAR used in their training classes. According to Fairchild, the company observed that the SpaceBalls were "very practical and made modeling much easier."

Today, every one of Adam Aircraft's 40 designers uses a SpaceBall navigator. "They are so easy to use," says Fairchild. "No one had trouble learning to use them. You can pan and zoom and you don't have to go to the icon bar for most things you want to do." Fairchild reports that the most useful function-key for him is the 3D lock, because it allows him to hold a model steady while panning and zooming.

In 2005, at the Solid Edge user conference, Fairchild first tried and bought a SpacePilot navigator. "I love it so much," says Fairchild. "There is a much better level of control with the fiber-optic technology [basis of the latest drift-free optical measuring system] versus a potentiometer. The pre-programmed buttons for standard views and ESC, CTRL, SHIFT, and ALT are real time savers."

At **Precision Medical, Inc.** (Northampton, Pennsylvania), Blair Hollshwandner is a mechanical designer for this 170-person firm that manufactures respiratory equipment. He "fell in love" with a navigation device in 1999, when his CAD software reseller, Prism Engineering (Horsham, PA), gave him one to try after he spotted an advertisement for a SpaceBall and thought, "That's really neat!"

After using a SpaceBall for several years, Hollshwandner purchased a SpacePilot immediately after it came on the market. "Within 10 minutes of using it with SolidWorks, I realized all the buttons were in the right places," Hollshwandner says, "and it only took half a day to integrate my brain and hand. It's much quicker than working one-handed with a mouse."

Hollshwandner's technique for mastering his use of the navigation device: practicing with it during his lunch hours, so he wouldn't think about moving the cap, but, as he says, "I would let my mind think I was holding a model in my hand, and think about how I would move it. Over time, my left hand acted as if it had a mind of its own."

Using a Navigation Device to Optimize Autodesk Inventor

By Gregg Reinhart, Acme Cryogenics design engineer

I'm using the SpacePilot with Inventor, so I use the cap to rotate my model. I use the ESC and SHIFT keys instead of the ones on the keyboard. I also set up my part and assembly models to make use of the SpacePilot's four standard view buttons (front view, top view, left-side, and right-side views). And I configured the six speed keys below the screen so that I can activate the commands I use most—which depends on the current "drafting mode" I'm in (sketch, part, assembly, sheet metal, presentation, or drawing). I set them up so that after a few days I remember which commands are on what key for each mode, and most of the time I don't even have to look at the LCD screen to know which commands are "active."

Learning to use the cap for model rotational and zoom control is extremely easy. Once you set the cap's sensitivity, learning how the model will move (i.e., which direction) and how fast it will move as a result of a given movement of the cap is really straightforward—especially if you use the 3Dconnexion tutorial software.

Using the speed keys is easy too, although do take the time to memorize the commands you assign to each key. They change depending on mode, so in the case of Inventor, there are 12 possible sets of commands to memorize, each set having six commands. As long as you use the "most used commands" and don't change the speed key configuration, you soon memorize them.

This pays off, because once you memorize everything, you can work so much faster without having to use your mouse all the time to chase around the screen to activate commands. Even if you can't remember them all, the SpacePilot screen tells you which commands are available on which button.

My management questioned whether the device would live up to the claims put forth by 3Dconnexion and truly be worth the investment. But since getting the device, I've found it has more than lived up to 3Dconnexion's claims, which made my internal sell to management easy. The ROI for the device is well worth the price. It has truly helped me speed up my workflow and increase my productivity. Anyone who's worked in 3D for any length of time will quickly learn and adapt to the device.

This worksheet is designed to help identify the financial implications behind purchasing a navigation device for each design engineer within your company.

Although our case studies suggest time savings of 22.5% on average, your results may vary slightly from this percentage.

Please answer the 5 questions below to help determine the financial benefits you will receive by using a navigation device:

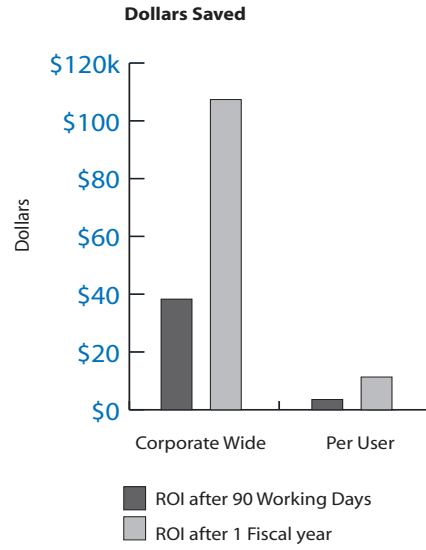
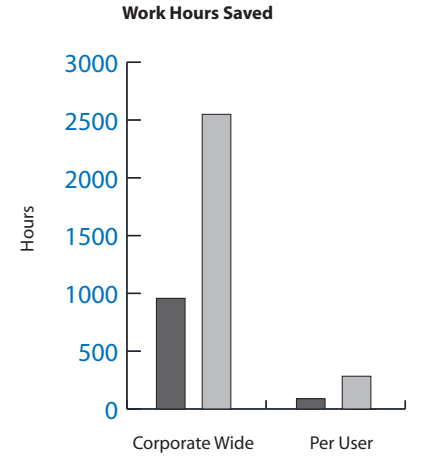
| | |
|---|-----------------|
| Number of Design Engineers | 10 |
| Average Burden Rate (hourly wage) | \$45.00 |
| Average Hours Spent In CAD App Per Day | 7 |
| Assumed Time Saved Using a Navigator Per User | 15.00% |
| Unit Price | \$449.00 |

| Return On Investment using Dollars and Days | Corporate Wide | Per User |
|---|-----------------------|-----------------|
| Return on Investment after 90 Working Days | \$38,035.00 | \$3,803.50 |
| Return on Investment after 1 Fiscal year | \$108,910.00 | \$10,891.00 |
| Number of Days Until the Investment has Paid for Itself | 9.50 | 9.50 |

| Return On Investment Using Percentage Returns: | Corporate Wide | Per User |
|---|-----------------------|-----------------|
| Return on Investment after 90 Working Days | 847.10% | 847.10% |
| Return on Investment after 1 Fiscal year | 2425.61% | 2425.61% |

| Work Hours Saved: | Corporate Wide | Per User |
|--------------------------|-----------------------|-----------------|
| After 90 Working Days | 945 | 94.5 |
| After 1 Fiscal Year | 2520 | 252 |

By using the variables defined above, we are able to determine that given a 15.00% increase in efficiency, due to a navigation device, your company can gain the full cost of their investment back in 9.50 days, and gain a 2426% return on their investment that equals roughly \$108910.00 per year!



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