A MOUSE IN THE O.R.

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Through all the chaos of the operating room, to ensure successful outcomes the surgeon has to maintain focus on the patient.

When clients come to IDEO with new surgical technologies that provide accurate real-time data about a patient's current state and anatomy, their hope is to dramatically decrease missteps that could lead to lifelong pain, paralysis—even death. But new technologies like this can be a double-edged sword: they provide more information about the patient, but they can also overload and distract the surgeon from the primary task. What we've found is that in many cases, when it comes to introducing new technologies in the operating room, less is actually more.

Photos courtesy of IDEO

In the field we often saw surgeons develop unique workarounds to interact sterilely with the on-screen interface to overcome the challenge of explaining what to click to staff members.

One surgeon dedicated a pair of sterile scissors to tap on the touchscreen while interacting directly with the interface.

Surgery is moving from being a primarily tactile task to being a precise interaction with tissue mediated by technological equipment. Many of these new surgical tools involve complex on-screen interfaces. Such tools employ a feedback cycle in which the surgeon feeds input into the system through mice, touchscreens, or other dedicated devices, and receives information through screen displays or other mechanisms.

In practice, the feedback cycle is rarely as simple as a surgeon interacting with a device. Operating rooms are complex team environments where everyone has clearly defined roles and responsibilities. The design of new surgical products has to take into account the dynamics between staff and surgeon, as well as sterile and non-sterile elements. Having staff members in the loop can shield surgeons from non—medically critical tasks. By understanding the operating room dynamics, we designers can shift appropriate parts of the workflow to staff members, providing surgeons with just the precise information they need to make life-saving decisions—and not more.

Case Study: The Medtronic Synergy Experience StealthStation System

We assembled a team of two interaction designers, an industrial designer, and a cognitive psychologist to work with Medtronic Navigation on designing the latest version of its spinal-navigation software, which allows surgeons to operate using accurate, real-time 3-D images. Sensors track the surgeon's instruments and movements as it manipulates the subject, resulting in a 3-D virtual image of the operation. Most spinal surgeries involve placing screws in the vertebrae; this system effectively gives surgeons x-ray vision, showing where screws could bump up against sensitive anatomy.

An operating room is arranged like an island, with a sterile field in the center of the room containing the patient, surgeon, and surgeon's assistants; and a non-sterile field around the perimeter of the room, where the rest of the staff circulates. On the periphery some ingenuity is needed for materials passing into the sterile field without contamination. The sterile input mechanism, which the surgeon generally needs access to, requires particular design attention so that it provides just the right amount of adaptability without excessive functionality that might unnecessarily increase the surgeon's cognitive load.

When designing a sterile-input device, the first step is to observe the surgery's existing workflow and determine which interface tasks the surgeon needs to perform. Even though surgeons often assert that they want sterile control over every element of the interface, when we watch them in practice, it's evident that they mainly perform those tasks that require expert medical knowledge and that affect a patient directly, and that their assistants take care of everything else.

In keeping such patient-oriented focus, most of the surgeons' interactions involve simply looking at anatomical images rendered directly on a screen, not having to touch anything. If the surgeon is using the virtual-image software, however, the virtual images must be calibrated to the patient's anatomy on the screen at the beginning of each surgery. As this would involve picking precise anatomical points on the images and mapping those points to physical landmarks on the patient, this is clearly a task for the surgeon. However, the original system had no designed method for surgeons to perform this task in a sterile manner. At every hospital, we saw a different work-around: Some surgeons put on an extra glove to use a mouse; others dedicated a surgical instrument to touching a touchscreen; some even gave commands to a peripheral member of the surgical team who was using one of the input devices.

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To determine the right continuous-input device with which surgeons could try picking precise anatomical points in the software interface themselves, we set up a series of experiments using mocked-up operating rooms in trade-show hotel suites. The devices ranged from standard mice on varied surfaces; to handheld remotes with trackpoint-like buttons; to an optically-tracked, pen-like interface. We showed the prototypes to approximately 40 surgeons attending the tradeshow.

As determined by consensus, an optical mouse with a transparent sterile bag around it did the trick. It may not feel like the most technologically forward solution, but it makes sense; like most of us, surgeons are avid computer users, and the mouse is a familiar tool. Also, the mouse requires less dexterity and practice to pick precise points compared with other continuous-input mechanisms like the trackpad or the trackpoint. Using a mouse requires a surface, though, and surgeons quickly discovered that the patient's backside makes a good one. We were somewhat surprised by this, but the solution worked. Optical mice don't require a flat surface for precise mousing, and frankly, a patient's posterior is well located for mousing.

Surgeons are accustomed to having a great deal of assistance—from having instruments handed to them to having the ringing pagers on their belts answered. The sterile mouse technically provides the surgeon with control over every element in the interface—although in practice, we observed that the surgeon still expects the staff to perform the non-medical interface tasks. In other surgical systems, we've designed handheld sterile input devices that only control a subset of the tasks performed by the equipment, depending on non-sterile staff to perform other administrative and less expert tasks. For this reason, we devised a distinction in our design process between 'instructed manipulation' and 'direct manipulation.'

For any function that a surgeon might verbally ask a staff member to manipulate, we created interface elements built specifically for instructed manipulation. These interface elements afford easy verbal descriptions by having buttons with clear icons and text labels, and employing discrete steps so that a surgeon can say, for example, "Go two more bars up," rather than "More, more, more. . . wait, stop. . . . You went too far!" Because the sterile mouse would allow comprehensive control if available, we also provide fast, direct-manipulation shortcuts for surgeons who want to use the mouse without an intermediary.

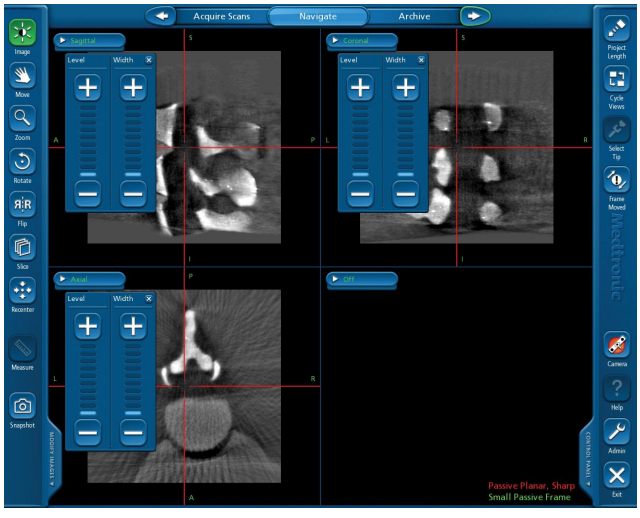
Reflections

Although the sterile mouse was the appropriate input device for the Medtronic Synergy Experience StealthStation System, it's not always the right instrument for sterile control. We begin every operating room project with research—analyzing which tasks belong to the surgeon and then building a series of early prototypes that we put into surgeons' hands to get direct feedback. For this reason, even though products may have similar contexts, differences in workflow and surgeon-control requirements often lead to different sterile-input devices.

We rely heavily on prototypes, because though it's relatively easy to guess how users will interact with a system that runs on a standard computer with a keyboard and mouse, with novel input devices, there's little on which to base such a guess. Often the sterile-input device is a custom handheld with a few buttons that map directly to the interface. Whatever it is, we must see these devices in action early to ensure that they provide control over the right elements and that they actually do reduce cognitive load without any frustrations.

Sterile-input solutions aren't about technological wizardry, but about insight and refinement, which we only achieve through diligent iterations on prototypes. With all new technologies, we hope the design will mitigate danger and make products safer. By providing fluid access to functions that surgeons actually need—and not more—we help them stay focused on the parts of the surgery that really matter.

In the Medtronic Synergy Experience Stealthstation system, the surgeon can use a sterile mouse for direct control of on-screen elements.



The software provides widgets for both instructed manipulation and direct manipulation of major functions.