

Scientists Develop Unique Surgical Tool

By Kim Hachiya, University Communications

One of the problems with being an ergonomist is that one notices badly designed things and has an overwhelming urge to fix them. At least, that's how Susan Hallbeck feels. An associate professor of industrial engineering at the University of Nebraska-Lincoln, Hallbeck is particularly interested in designing tools that perform tasks with the least amount of stress and trauma on the arms and hands of those using them.

A prototype surgical tool designed by Hallbeck and a team of undergraduate and graduate engineering students, in collaboration with physicians at the University of Nebraska Medical Center, promises to be better than current models.

Called the Intuitool™, it's an articulated grasping tool that can be used by surgeons performing minimally invasive surgeries. Often called laparoscopic or keyhole surgery, minimally invasive surgery is done through small incisions. Using specialized techniques and tools, miniature cameras with microscopes, tiny fiber-optic flashlights and high definition monitors, surgeons are able to perform a growing number of operations using the technique.

Laparoscopic surgery, the fastest growing surgical technique, was developed about 1990, said Dmitry Oleynikov, assistant professor of surgery at UNMC.

While this surgery has definite patient benefits— including faster recovery and less risk of infection — there are downsides for surgeons. Many are posed by the tools surgeons have to use.

"Current tools are essentially regular surgical tools on a long stick," Hallbeck said. The handles look like toy scissors and are "one size fits all," she said, meaning surgeons with unusually large or small hands are hampered. The tools also are usually to be used right-handed, forcing lefties to adapt.

"The current tools mean you are basically forced to perform complicated tasks with chopsticks," Oleynikov said. "They are rigid, unwieldy instruments."

Because the tools can grasp, but not rotate inside the body, the surgeon has to manipulate the tools outside the body, often using both hands. This forces the surgeon to hold the tools awkwardly, often causing stress and fatigue in the surgeon's hands, arms and shoulders.

Hallbeck said many surgeons report numbness, tingling, pain and other problems when doing these surgeries. Over time, this repetitive stress could shorten or end a career or cause permanent damage. And because of pain or fatigue, surgeons might have to stop during a surgery to rest before resuming the task, lengthening the surgery.

Training for minimally invasive surgery is also intensive, as surgeons must learn to work using the long tools inside the body while watching a video monitor that shows the procedure in two dimensions.

The breakthrough in the Intuitool™ is in the articulation function — the grasper end rotates up to 120 degrees side to side using a roller ball the surgeon actuates using his or her thumb.

"Essentially, the Intuitool gives you a wrist on the tool," she said.

"This is an unprecedented, even revolutionary breakthrough," Oleynikov said. "No one else has anything remotely similar. It absolutely excited the imagination of surgeons."

The Intuitool™, patented and trademarked by UNL, has been licensed to Gyrus Medical, based in Minneapolis, to develop, manufacture and market the tool. It's yet to win approval by the Food and Drug Administration for use in humans, but Hallbeck is confident that will come once the design is finalized.

The device won an honorable mention in the Third Annual User-Centered Product Design Award from the Human Factors and Ergonomics Society in 2004. The work was funded through UNL's Layman Trust Fund grants and other internal funding sources.

Hallbeck's lab at UNL contains two home-made surgical mock-ups — neoprene abdomens upon which researchers experimented with prototypes to look at how accurately users could aim and move the tool and also to study the stresses the tool put on users' hands, arms and shoulders.

The project provided "an unbelievable real-world application" for the students, Hallbeck said. The undergraduates, now graduates, are in master's programs and the graduate students have completed their theses and have jobs. Five students' names are on the patent with Hallbeck and Oleynikov.

Hallbeck met Oleynikov, co-director of UNMC's education and training efforts in minimally invasive and computer-assisted surgery, at a 2002 meeting to explore research collaborations between UNL and UNMC.

Oleynikov described the collaboration between the physicians and engineers as uncommon and unusual. "I can't think of a precedent nationally for this type of collaboration," he said.

Rather than looking to modify existing inadequate tools, they looked to start fresh. "We designed this thing from the ground up," Oleynikov said,

An initial survey of 18 surgeons asked them to describe their concerns with current tools and their goals for a new tool. A later survey of 38 physicians asked their impressions of the latest model. In the latter study, the prototype tool was preferred. Some 92 percent of those surveyed indicated they thought the articulated tool would be somewhat or

very useful and 89 percent said they would try the prototype once commercially available.

Hallbeck said that while an articulated tool was a high priority for surgeons, the "holy grail" for laparoscopy tools would allow the ability to distinguish tissue textures.

Oleynikov agreed. "The ultimate tool for surgeons is our hands. Laparoscopic surgery took our hands out of the mix. A surgeon really feels the most comfortable with his or her own hands doing the work on tissues. We are as close as we can get with current technology and a tool with tactile sensation would be extremely important."

Tactile feedback would help surgeons determine what they are grasping, confirming what they are seeing on two-dimensional video monitors.

"We want to determine how squishy is squishy," Hallbeck said.

Oleynikov and Hallbeck are pursuing development of a proposed Center for Advance Surgical Technologies.

"I'm really excited and proud that these kind of innovations are happening at UNMC and the university in Lincoln," Oleynikov said. "It's really a very unique thing."



Engineer Susan Hallbeck demonstrates a prototype of the Intuitool surgical tool jointly invented by UNL and UNMC researchers. Photo by Alan Jackson/Jackson Studios