Penelope, the robot, could scrub in

In the future, if you’re short on staff, you might be able to call on Penelope, the surgical robot, to scrub. Penelope is the first robot in the OR that is a coworker, says her inventor, Michael R. Treat, MD, associate professor of clinical surgery in the College of Physicians and Surgeons of Columbia University in New York City and attending surgeon at New York Presbyterian Hospital.

Named for Ulysses’s wife in the mythic *Odyssey* by Homer, Penelope will watch over the surgeon’s instruments and have them ready to use.

Penelope, still in testing, has a “brain” focused on surgical instruments, says Dr Treat. She looks at the instruments, counts them, knows where they are, and hands them to the surgeon.

A prediction algorithm allows the robot to anticipate what the surgeon needs.

Penelope’s role in the OR will be to scrub for small cases to free human scrub personnel for more complex cases, Dr Treat says.

**Penelope’s components**

Penelope’s control software gives her routines for speech recognition to “listen” to the surgeon as well as “vision” to see the instruments, motion control to move her arm, and speech generation to give her a voice.

With a lightweight robotic arm and electromagnetic hand, Penelope unpacks instruments from a vertical back tray composed of stand-up cases, arranges them on the forward Mayo tray, and hands them to the surgeon. The hand can pick up instruments weighting up to 8 ounces. It can pick up sponges with the addition of a magnetic chip.

Penelope keeps instruments most likely to be needed on the Mayo tray. She monitors the progress of the operation and makes predictions about which instruments will be needed next. The Mayo tray has space for 12 instruments, and the vertical back tray holds 42 types of instruments, arranged in sequence on pegs.

Penelope is voice-activated. When the surgeon asks for an instrument, the robot extends her arm to a pre-set point and waits a few seconds before releasing it.

“The handoff point right now is fixed in space, which probably is not the best way to do it, but it is an acceptable starting point,” Dr Treat notes.

Penelope views the scene through a device like a web cam with software that can tell the robot where the instrument is. For example, when the surgeon is done with an instrument, he or she puts the instrument down. Scanning the field, the robot sees the instrument, determines how far to reach, picks up the instrument, and brings it back.

**A robot that can learn**

At the start of a case, the circulating nurse uses a personal digital assistant (PDA) to interface with Penelope. The circulator might say, “We are going to do a hernia, and it is Dr Treat’s hernia.” Penelope knows what instruments to pick for a hernia case and knows Dr Treat’s preferences, and she lays those instruments out. The circulator drapes the robot and covers the arm and hand with a sleeve-type drape.

Penelope has one arm at present but may be given another later. She currently does not have the gripper hand that would be needed for laparoscopic cases but might later on.

“The cool thing about Penelope is that she can learn,” Dr Treat says.

Penelope’s prediction engine—artificial intelligence software—listens to the surgeon’s last few requests and predicts what instruments will be needed next.

To develop the software, Dr Treat hypothesized that, even though no two sur-
gical cases are exactly alike, cases had enough structure to make reasonable guesses. To provide the hypothesis, he recorded cases in the OR for six months. He then compiled a database of a couple of thousand instrument requests and wrote artificial intelligence prediction algorithms.

The rate of predicting the right instruments improves with time. After Penelope works with someone for a while, he says, it really would seem as if she could read the surgeon’s mind.

If the surgeon asks Penelope for an instrument she doesn’t have, she could use her voice to ask the circulator or communicate with the circulator through the PDA.

**What about emergencies?**

Would Penelope be able to handle an emergency, or would a human have to scrub in? Dr Treat says he doesn’t know yet, but he believes she could handle an emergency in the future. In the next level of software development, he plans to give her “a sense of what to do when stuff hits the fan.”

Because of the robot’s design, the surgeon can reach over and take what he or she wants quickly.

Penelope will have an uninterruptible battery power supply like a computer in case the electricity goes off so she does not forget what instruments she is handling and where they are.

Because the robot would be labeled for use in cases that can be done with a minor instrument tray, such as a lipoma excision, emergencies would be rare.

**Entering the market**

Penelope is about nine months away from use in the clinical setting, Dr Treat estimates. He anticipates review under the Food and Drug Administration’s 510(k) process.

“I think we can fill a need and save hospitals money,” he says. Penelope should be able to work for under $7 an hour. She will cost about $100,000 and should last five years with software upgrades. And she will take call.

Dr Treat predicts there also will be robotic first assistants and eventually robotic surgeons.

The military is especially interested in the robots and is funding Dr Treat’s research through the Advanced Technology Research Center of the U S Army. He also receives funding from the New York State Office of Science, Technology, and Academic Research and Telemedicine. Support has also been received from the National Science Foundation.

*More information on Penelope is at www.roboticsurgicaltech.com*