MEET YOUR NEXT SURGEON

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ANK CLEMENT glimpsed the robot only once. After the operating room attendant finished shaving his chest, she asked him if he wanted to be knocked out or if he would like to see the machine that would soon be inside him, navigating the space beneath his rib cage, cutting and cauterizing, and then sewing two of his arteries back into his heart. Clement wanted to see the machine. It was draped in plastic, its four jointed arms folded back toward its body. In a few months Clement would celebrate his 71st birthday, and the idea of submitting to such a device felt futuristic. He was fascinated. Then he felt a warm rush all over—the anesthesia kicking in—and he fell into a deep, drug-induced slumber.

Clement’s body disappeared under a blue smock, his chest swelled from the CO₂ pumped in to keep it expanded, and his skin
Surgery—a particularly exacting branch—have adopted robotics in droves. While physician buy-in is crucial, patients are also driving demand. Last year the Journal for Healthcare Quality reported that 41% of hospital websites advertised robotic surgery; of these, 37% did so on their homepage. Hospitals with robots are pulling in more and more patients, and in some cases, the existence of the robot actually increases the number of surgeries performed. A study conducted by the American Cancer Society found that the number of radical prostatectomies has "risen substantially" in the past decade, and patients travel great distances to be operated on with a robot. Today, four out of five prostatectomies are performed with a robot. The result is an industry at an inflection point. Robots have arrived, and hospitals, doctors, and patients are scrambling to adapt to this new technology.

The most popular of such surgical robots—the one used on Frank Clement during his operation last fall at Swedish Medical Center in Seattle—is the da Vinci. Patented and manufactured by Intuitive Surgical—a publicly held Silicon Valley–based company that posted revenue of $1.76 billion, a 24% increase over 2010—the system costs up to $2.3 million. It includes the console, the robot, and a tall server bay that connects them. It is, in more ways than one, the iPhone of its category. Surgeons say it is easy to use and elegantly designed. And like iPhone maker Apple, Intuitive has developed a closed model: its software and hardware are proprietary, and the company controls all aspects of the da Vinci’s production, bringing new meaning to the term “closed operating system.”

Despite its dominant position (Mayo Clinic alone has seven machines!), its success is far from assured. Another, just-formed robotics company’s robot offers a competing vision of what might be possible in the operating room of tomorrow. Made by Applied Dexterity, a startup, and called the Raven, it is a smaller, cheaper experimental machine built on an open-source model, which makes it hackable, and more like Google’s Android platform for mobile phones. Put another way, innovation at Intuitive tends to come from within the company, while nearly anyone can invent, add to, and study the Raven. Both models are pushing the field into previously unimaginated territory. The $85 billion question for the future of surgery: Will there be (operating) room for more than one kind of robot?

**Clement’s chest cavity** looked like the vast landscape of an alien planet—or that’s how it appeared on one of Lehr’s consoles. Occasionally, in the distance, another planetoid form came into view—rising and falling on the horizon. I asked Lehr what it was. “That’s the lung,” he replied. Lehr, who has been a cardiothoracic surgeon at Swedish Medical Center for 18 months, navigated the camera toward the heart’s casing. An artery emerged, a branch covered in a thick layer of pink and white jungle vines. The robot’s tools—a cauterizer and forceps—were huge in the foreground. The forceps tunneled at the vines, then the cauterizer swooped down and delicately fried bits of Clement’s flesh. Tug, swoop, sizzle, tug, swoop, sizzle—again and again until the branch began to come free of the flabby vines. I leaned back, away from the screen, and watched Lehr’s hands during this deft work. His delicate gestures caused me to breathe in a rosy. From his motions, billions of
bytes of information traveled through thick
cords running from the consoles to the server,
and back out and into the robot, which was
moving its instruments mere millimeters.

HE DA VINCI is an exceptionally
intuitive system. In a recent
study, researchers found
that children who are adept at
video games are even better
at using the system than most
surgeons new to the interface. Seated at the
console, a surgeon hooks his thumb, middle finger,
and forefingers through two controllers. The
controllers move in every conceivable direc-
tion. Tapping on one of seven pedals engages
different tools and controls the $63,000
endoscopic video cameras, which gives users
a sense of depth. In place of tactile informa-
tion, surgeons are immersed in stunning
visuals and a remarkable sense of moving
through space inside the body.

Intuitive builds all its robots at its lump-
vale, Calif, facility. The company’s CEO, Gary
Guthart, is a mathematical engineer who
used to work nearby at NASA Ames facility,
where he helped design interfaces for fighter
pilots. Robotic systems for surgeons aren’t
so different. In both, he says, you are deal-
ing with many sources of data, all possible
distractions from the task at hand, or perhaps
vital to it. And surgeons, like fighter pilots,
must make snap decisions that can have fatal
consequences. “There is a cognitive task that is
time-critical, and a physical task,” Guthart says.
“It is a fantastically deep challenge.”

At Intuitive, the research team is con-
stantly developing new techniques for the
da Vinci. The company has just released
what’s called a single-site system, which uses
curved tools to, as its name suggests, enter
patients through a single incision in the
belly button. A new project uses fluorescent
imaging to identify cancer cells. On the da
Vinci interface, the tumors appear bright
green, making it easier for surgeons to iden-
tify and remove them, and harm little else.

Catherine Mohr, who oversees a small
research team at Intuitive, says she believes
robots will one day be used to treat ailments
that are not traditionally considered surgical
diseases. When you perform a gastric bypass, for example,
you rid a patient of Type 2 diabetes. Hypertension can
also be cured this way, via surgery. There are even experi-
ments to fix forms of addiction via surgery. “What if, in
the future, we can go in and tinker with the machine?” she
asks. “Do a little procedure, a little incision, and a lifetime
of medical costs simply goes away.”

Mohr is one of a few dozen people in Intuitive’s research
centers working on R&D to develop new products and
users for the da Vinci. (Total R&D budget: $140 million
a year). Her competition isn’t so organized. The Raven
was developed out of robotics labs at the University of
Washington and the University of California at Santa Cruz
by two engineering professors who initially sought to un-
derstand the “language of surgery” by tracking physicians’
movements. When the pair were unable to gain access to
Intuitive’s data, they set out to build their own machine.
The result is smaller than a da Vinci—it can fit on an office
desk—and sells for $300,000. At the UW lab it’s hooked up
to a Microsoft Kinect—the $150 motion-sensing device for
gaming—to create a real-time 3-D map of the surgical area.
A team at Harvard is using imaging and mapping software
to discuss the situation. It was a little more than six hours since Clement had gone under. The average non-robot-assisted coronary bypass lasts about four hours. After Lehr hung up, he marched over to the table, an orderly entered with more tools, and suddenly the room was alive with activity. I sat and watched from a distance as the attendant removed the robot and the cannulas. Then I heard a loud rip, like a sword embowling a couch cushion. When things settled, Lehr called me over.

He stood over Clement’s chest, and I wedged behind a plastic partition a few feet from Clement’s head, where the anesthesiologist worked. The chest was open in the middle, the ribs and skin held back with big metal clamps. “I told the patient going into this that there was a 35% chance of us having to open him up,” Lehr said. To double-check the blood flow and perform the second bypass, Lehr had decided to go the traditional route. The ripping sound was Clement’s sternum being sawed open so that Lehr could finish the procedure with his hands.

We waited beside Clement as his body warmed and his heart began to beat. Staring into his open chest, I found myself in awe of a different machine: the human body.

Clement woke up in the intensive care unit late that night. His wife was with him, and she told him there had been a problem, that they had had to open him up. Lehr came in and explained what had happened and why. “When I found out,” Clement says, “it was just like, ‘Oh jez, you know? I had more holes in me than a normal person would have, yeah, it was painful.’ ”

Clement celebrated his 71st birthday on Dec. 22. Aside from his heart troubles, he is a healthy man. Three weeks after the operation, he is upbeat. “I feel much better now,” he says. He can walk for about 30 minutes. Before the surgery, Clement walked 65 minutes to his health club, where he spent about three hours lifting weights and taking yoga and spinning classes. Then he walked 45 minutes back. It was at his health club where Clement first heard about the robot. “A guy at the club had his prostate removed by one,” he says. “And another recently had his spleen sucked out through his belly button. Would I recommend surgery with a robot? Given all that happened? Oh, yes—definitely. It’s the new, modern way.”

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