Dartmouth expertise leads to a new way to attach limbs

It's irritating when your shoes that fit so comfortably in the morning are unbearably tight by nightfall. But it's downright embarrassing when your artificial leg falls off as you're getting out of your car, or riding your bike, or just walking up the street.

What?! That's right. Getting a perfect fit for an artificial leg can be tricky: what feels right in the prosthetist's office may not feel so great later on. That's because the residual limb—which used to be called the stump—can shrink and swell during the day and interfere with how a suction-fitted limb stays attached.

Leg: Dartmouth orthopedic surgeon Michael Mayor, M.D., is all too familiar with that problem. He lost a leg to cancer at age 17 and has been getting around on an artificial one since the 1960s. Pretty soon he'll be helping to test a new kind of artificial leg, one developed with his input by Simbex, a Lebanon, N.H.-based R&D firm.

A contraction of "Simply Better Exercise," Simbex is one of several high-tech companies founded by fluids engineer Robert Dean, Sc.D., an adjunct professor of engineering at Dartmouth. Dean has an artificial leg, too. He lost his real one some 60 years ago "in a crawler tractor—it ate my leg up through the knee joint," he says.

Until the early 1990s, Dean's artificial leg—an older model held in place with straps—fit fine. But then he lost 40 pounds while recuperating from what he describes as a "near-fatal heart attack." He replaced his old leg with a modern one equipped with a fiberglass socket that fits on the stump, like a thimble on a finger, and is held in place by suction. But Dean could not get his new leg to fit all day long.

"Tissue dynamics are complex," explains orthopedist Mayor. The socket can knead the residual limb, forcing fluid out. As that happens, the limb shrinks. On the other hand, the weight of the artificial limb can "produce a vacuum inside the socket, causing fluid to collect in the tissues," thus increasing the volume of the residual limb.

Dean noticed even small changes in volume. "I can feel a change of half a percent," he says. A 2% change made his leg wobbly, and at 6% he'd lose it.

"The number-one problem for lower-limb amputees is the fit of the limbs," says biomedical engineer and Simbex president Richard Greenwald, Ph.D. Prosthetists can make the artificial limb fit perfectly—in the office. But as the volume of the residual limb fluctuates, by as much as 10% over the course of a day, the socket loses suction and the artificial limb may become detached. In addition, an improperly fitting socket can irritate the skin and cause infections.

Dean spent nearly a decade attempting to resolve the problem the only way that he knew how—by inventing something better. Now, with Greenwald, he's created what they call the Active Contact System (ACS),

This research participant is trying out the new Simbex limb on a treadmill.

which allows the socket to monitor and respond to changes in the residual limb's volume. An incompressible liquid—a nontoxic, water-based material—is pumped into bladders inside the socket. As the limb shrinks, the bladders fill with fluid to compensate, and vice versa.

"This is biofeedback," Greenwald says. "The device responds to whatever the body is doing." There are over a million amputees in the U.S., he adds, and the ACS is suitable for "little old ladies as well as a 20-year-old."

Idea: Clinical trials are under way, and Mayor is testing the system, too. In fact, trying out Dean's inventions is nothing new for the orthopedist. "He and I lurched around on various prototypes," Mayor laughs. One early model was a "whirling, bubbling gadget." Another had bladders filled with wax. But Mayor discovered a problem with *that* idea when he left the leg in the trunk of his car on a hot day.

Laura Stephenson Carter

In neonatal care, is more too much of a good thing?

"The more the merrier" can be said of friends, of flowers, and of fresh-baked cookies. But not of neonatal specialists, according to a pair of recent DMS studies.

One team of researchers, led by pediatrician David Goodman, M.D., showed that newborns in intensive care units have a nearly uniform mortality rate, despite varying resources across the country. And a related study, led by Lindsay Thompson, M.D., compared neonatal outcomes in the U.S. to those achieved in three other countries.

Due to vast technological improvements—from new drugs to ventilators designed especially for babies—as well as to an increase in the number of neonatologists, a premature newborn's chance of survival has improved dramatically over the past 30 years. But a continuing increase in the supply of neonatologists and neonatal intensive-care resources may not be efficacious. "We seem to have reached the point where more neonatologists do not lead to further decreases in newborn mortality," explains Goodman, an associate professor of pediatrics and of community and family medicine.

Data: Goodman and his team collected data on the nearly 3.9 million infants born in 1995 with a birth weight of more than 500 grams (1.1 pounds). They then broke the U.S. into 246 neonatology service regions and divided the regions into five