VEXTEC

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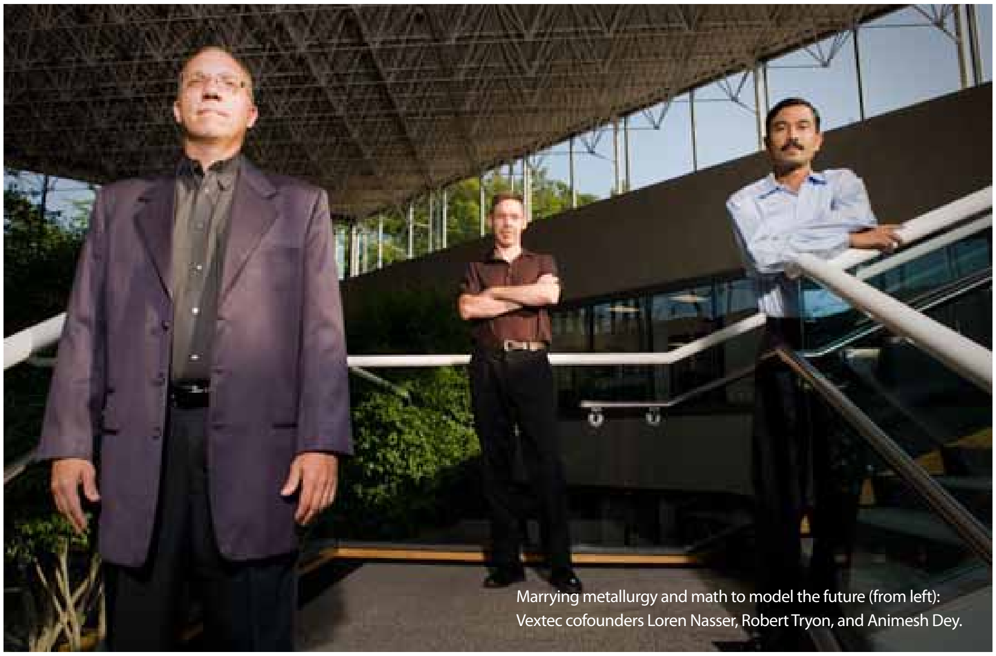
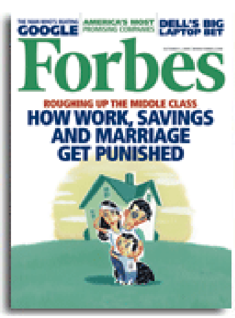

Marrying metallurgy and math to model the future (from left): Vextec cofounders Loren Nasser, Robert Tryon, and Animesh Dey.

Breakpoint

Vextec can predict with scary accuracy how and when products will fail—before they're made. By Maureen Farrell



Spare parts are to jet-engine makers what razor blades are to Gillette. Pratt & Whitney, General Electric and Rolls-Royce garner juicy 40% margins (before interest and taxes) making replacement engine blades and other components that have mandated life spans set by the Federal Aviation Administration. FAA certification requires up to a dozen tests during which the physical part is put through its paces until it breaks. Those tests can take up to a few years and gobble millions of dollars, crowding out little contract manufacturers, like EB Airfoils, in Palm City, Fla.

Until now. Last year EB, with only $12 million in annual revenue, spent $250,000 to test its replacement Pratt titanium blade for the engine in a McDonnell Douglas MD-80 commuter jet. Testing involved vibrating the blade on a "shaker table" to mimic 14 million pairs of takeoffs and landings, a nine-month process. Such thoroughness was enough to satisfy the FAA, but EB didn't stop there. It commissioned Vextec, in Brentwood, Tenn., to run some tests of its own.

Vextec's software predicts with scary accuracy how and when products will fail—even before they're made. The simulations, which took only three months to run and required the crunching power of a mere laptop computer, estimated where and when the cracking in the titanium would start—within a quarter of an inch (on a 3-foot-long by 6-inch-wide blade) and within 1% of the number of physical testing cycles. With Vextec's help, "maybe by the fourth [project], the FAA won't make [EB] run any physical tests at all," says Dominick DaCosta, chief operating officer of DERS Group Services, an engineering consultancy that advises the FAA on parts testing.

Crows EB President James Bickel: "This will get us to market more quickly, and that's a big competitive advantage."

Meet Vextec, No.1 on FORBES' new list of America's Most Promising Companies. Founded in 2000, Vextec is the brainchild of engineering trio Loren Nasser, 49, Robert Tryon, 50, and Animesh Dey, 40. Their aim: to hasten the design of everything from engine parts to medical devices—all while slashing research-and-development expenses and even opening doors for new competitors, like EB Airfoils. "They're part of what I see as a profound change from many decades of traditional physical design," says Thomas Cruse, senior consultant to the U.S. Defense Advanced Research Projects Agency and former chief technologist at Air Force Research Laboratory.

Tryon and Dey hooked up while getting Ph.D.s in structural engineering at Vanderbilt University—Tryon knew materials, Dey computer modeling--and later opened a consultancy to help U.S. automakers gauge the life spans of their components. Nasser, a rocket-propulsion scientist, met Tryon as an undergraduate at Rose-Hulman Institute of Technology, in Terre Haute, Ind.; he went on to spent 17 years at Sverdrup, an engineering firm, where he rose through the business-development ranks. When the company was acquired by Jacobs Engineering in 1999, Nasser convinced Tryon and Dey to expand their horizons. Tryon had "some stuff in his head," says Nasser. "If it was significant in Bob's head, I thought I could make money on it. He's one of the smartest people I know."

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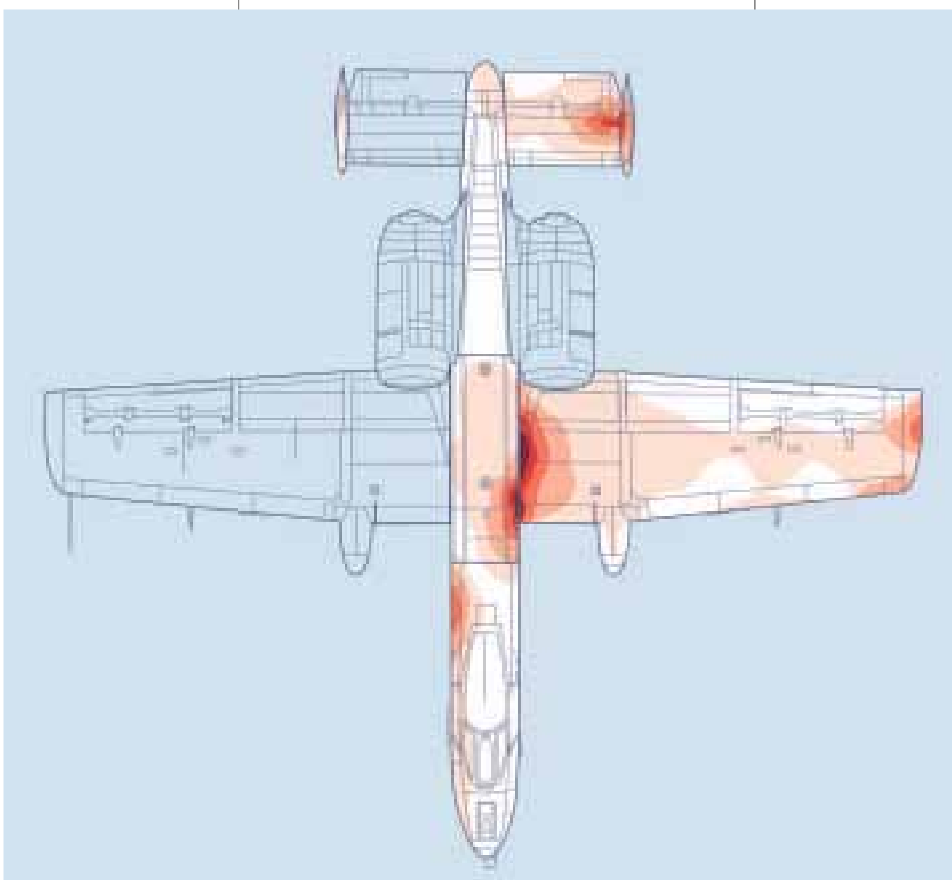
Vextec broke this barrier by marrying metallurgy with math. In this example, its models would be based on a statistical distribution of a beam's thickness, the beam's width and the grain stru cture , of the steel. (Steel is a blend of microscopic bits of iron and carbon, among other things.) The software would also weave in data on the common ways certain materials tend to break. (Just as different grades of steel bend, crack and shear differently, so do the same grades with slightly different grain patterns.) Armed with those variables, engineers could not only model how one beam would behave in operation but also the probability that any one of a family of beams would crack. Result: a more accurate estimate of what the bridge would ultimately cost to build—and all without having to do a single physical test.

"Those prognostics are something that's been sought after by manufacturers for decades," says David Odom, principal at Milcom Venture Partners, which works with the U.S. Army to bring its technologies to the masses.

Nasser and company spent the first seven years earning their grant money doing investigative research on things like faulty gearboxes in Navy helicopters used in Afghanistan. Now Vextec is moving into the commercial realm. In the last two years it has run 12 simulation projects for the likes of Cummins, BorgWarner, and Lockheed Martin, charging between $50,000 and $250,000 per project. Licensing its software will come later, says Nasser, though he is still working out a pricing scheme.

Last year Cummins wanted to know how accurately Vextec could predict cracking in cast-iron blocks from which its diesel engines for trucks, buses and tractors are made. Cummins had reams of data on block failures already, thanks to a lot of physical testing. Its engineers hook the blocks to hydraulic rigs and shake them until they crack, maybe a month later. To get a reliable picture, they run the tests three or four times, typically leading to multiple redesigns, involving various materials, thicknesses and dimensions. Each iteration, from casting to testing, might burn a few months and $150,000.

Enter Vextec's engineers, four of whom work in a 4,800-square-foot lab across from Terre Haute International Airport. Their first step: carving out a sample of the iron block, mounting it and getting a good look at its grain structure under a $300,000 electron microscope that Vextec rents from nearby Rose-Hulman University. The microscope scans cross sections of the sample and translates them into three-dimensional digital images.



Screen capture from the demonstration of a condition-based, predictive fleet maintenance system developed by VEXTEC.

Back at headquarters in leafy Brentwood, Vextec's developers built a statistical model that estimated what the blocks could handle, for how long and over what production volume. The variables this time: a series of structural designs and ranges of operating pressures and temperatures. "They accurately predicted a few areas that would crack first," says Sean Milloy, chief technology officer of Cummins' engine unit.

Better yet, instead of muddling through three or four alternative designs over the course of a year, Cummins could test up to 100 different designs (and with varying materials) in 45 days, saving at least $5 million in R&D expenses—well worth the $150,000 fee charged by Vextec. "We want to take it to the next level," adds Milloy. "It broadens our ability to design tremendously."

In 2008 an aircraft parts manufacturer was looking to tweak the design of a plane's aluminum skin in the hope of cutting production time. The skin surrounding the body and wings was connected to the airframe by thousands of rivets. The planemaker wanted to experiment with a new machine that promised to drill the rivet holes in half the time by reducing the number of drill passes. Vextec's software predicted that those holes would invite cracking around the rivets three times as fast as traditionally drilled holes would. The manufacturer scrapped the redesign, saving 18 months and perhaps $2 million in testing costs.

One problem with running custom simulations is that it's not exactly a scalable business. While Nasser figures "a four-times increase in staff can yield a ten-times increase in revenue," he would much rather license his software—even deliver it over the Web—and let manufacturers do their own number crunching. That is, if Vextec doesn't jeopardize its replacement-parts business at the same time.

For now Vextec is going after everyone. "The only reason we would limit ourselves is if someone pays us so much money that it would be a benefit not to sell to others," says Nasser.