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The Taming of theScrew

Jonathan Fahey, 09.19.05

The humble screw has changed little in 2,000 years, until a stubborn engineer at Illinois Tool Works came up with a fascinating new twist.

For centuries now the screw has held things together, and for almost as long it has been frustratingly inept at its central purpose. Concrete cracks when it is punctured by a screw. Plastic creeps away from the pressure, sliding down the threads so that even a tightened screw loosens almost instantly. Carmakers have to mold brass inserts into plastic parts to accept screws; otherwise they might loosen and cause a dreaded rattle.

Kenneth LeVey has a better idea. A product development director at Illinois Tool Works, the nation's biggest screwmaker, he has reinvented what the company dubs the threaded fastener in a way that lets it grip tight where it used to let loose--and compete with cheaper screws made by offshore rivals.

"People have been trying to come up with a new screw for 100 years, to the point where you get sick of hearing about it," LeVey says. "What we knew for sure was that our customers could use more performance." Even then he had a hard time convincing his own colleagues inside the company that his effort was anything but a screwy pursuit. "We thought he was out of his mind," says William Tursky, a general manager at an Illinois Tool Works factory outside of Chicago that turns out 6 million screws a day.

LeVey usually carries with him a laptop and a large silver briefcase to make his case. It holds a handful of white plastic blocks, a motorized screwdriver wired to torque sensors and a bunch of his new screws, which look pretty normal. He twists one into a plastic block, and moments later a graph on the laptop screen shows the screw's tension holding steady, even when jostled. A regular screw loses its grip on the plastic right away.

Thanks to LeVey's invention, Illinois Tool Works, which gets $400 million of its $12 billion in revenuefrom screws, can now sculpt threads to match any application a customer needs. "We've removed the screw from the commodity realm,"says Eric Parker, an ITW vice president.

The Glenview, Ill. company just landed an order from General Motors for 60 million annual units of the new design, to fasten the plastic door panels of GM's new pickups and SUVs; a decade ago ITW had lost GM to a lower-cost competitor. ITW's sales of big concrete screws, three-quarters of an inch in diameter, are growing 30% a year. The product debuted in 2003.

The need for a screw with threads shaped to mate with the substance it is penetrating has always been out there. But the screw is so simple and cheap--most cost less than a penny apiece to make--that it has been easier to design around its deficiencies than to come up with a better model. But LeVey, 40, says he was "too dumb"to listen to naysayers; with his name on 19 patents and with 18 more pending, he thought it was silly to keep working around the problem when he could try making a better screw.

LeVey's first target was the concrete screw. He bought a chisel at Home Depot and studied the business end of it. If only he could wrap teensy chisel tips into the threads of a screw, it could chip its way into a tight seat instead of compressing and cracking the concrete. He traveled to ITW factories around the country, asking the wizened experts how it could be done. "I got laughed out the door," LeVey says.

Screws are made, oddly enough, by squeezing metal rather than cutting it. A steel or alloy blank, a cylinder with no threads, is rolled between two heavy dies that are grooved with diagonal lines. The blank is put under so much pressure that metal is squished into the diagonal grooves, forming a threaded spiral. Manipulating the shape of the threads using this method, called thread-rolling, was thought to be impossible because it would be too hard to control the structure of the screw if metal oozed into odd shapes.

LeVey considered stamping screws instead, but engineers couldn't figure out how to get the threads all the way around the screw, and they couldn't make the screws unscrew. He dreamed up a new way of shaping the screws, using two spinning discs instead of dies, but it would have required expensive new equipment and the writeoff of millions of dollars in old equipment. So he returned to thread-rolling to try to revamp a century-old process.

He was flabbergasted by how archaic screw design was. On rare occasions when a new screw length or width was needed, an engineer would consult a 300-page manual dating from 1936 that explains the relationships between certain heights and pitches of threads and the lengths and widths of the resulting screws. "They would go do math for a couple of days and come back with an answer,"LeVey says--to how the grooved dies should look, how much pressure should be applied to the blank, and what the diameter of the blank should be.

LeVey had a handful of interns spend three months putting the mummified math of the old screw guide into software. Meanwhile, he grabbed an old thread-rolling machine out of a nearby factory and wired it to operate very slowly to let him observe exactly what was happening. Using three-dimensional solid-modeling software, LeVey gleaned a finer understanding of how the metal moved when it was squished. Possibilities opened up. LeVey could design intricate dies that, on a computer at least, could wrap screws with a helix of shaped threads.

To make dies capable of pressing tiny, intricate patterns onto the threads, LeVey had to borrow a technology often used to create injection molds for detailed plastic parts. The pattern of the die is milled into a soft, graphitelike carbon. The carbon is placed next to

the steel die form, and very high voltage is sent between the carbon and the steel, creating a powerful arc of heat, which vaporizes the steel in the desired pattern. "No one had bothered to take advantage of all of this new technology available to us and apply it to this very old product," LeVey says.

By 2003 LeVey and ITW finally had a product. The company, under its Tapcon brand, began marketing large-diameter concrete screws with tiny, arrowhead-shape chisels wrapped around the screw, to cut into concrete like sharks' teeth. Builders previously had to insert adhesive into predrilled holes to get screws to hold when they attached wood framing to concrete foundations; now they can just use LeVey's breakthrough.

Last year ITW introduced a plastic fastener that it calls the BosScrew. Its threads have tiny notches on their upper surfaces that grab the plastic before it can slide down the helix. Carmakers no longer have to mold a dozen or so brass inserts into their plastic intake manifolds to accept screws, at six cents per fastener. A BosScrew costing a penny will go directly into the plastic--and save money by cutting out the inserts.

"These threads address major issues that have plagued assemblers," says Charles Wilson, the director of engineering at the Industrial Fasteners Institute, an industry-funded standards organization. "And it seems to have a universal application for all plastics. It's a very important development."

ITW's Parker says that the next application, finely threaded machine screws, could be the biggest of all. The machine screw is supposed to fit perfectly because it is screwed into a socket expressly designed to accept it. But invariably there is play between the threads of the bolt and the female insert because the teeth don't fit perfectly. Screwmakers add nylon inserts to keep fasteners tight, but this adds 7% to 10%to the cost of a screw. ITW's new model works better at no extra cost; it debuts later this year.

LeVey already has moved on to other projects, chief among them a capless refueling system for autos that could banish forever the plague of gas caps left dangling from cars. "Luckily,"he says, "I am given freedom to sit and ponder."