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Heroes of manufacturing

These innovators sail against the prevailing winds, discovering whole new worlds in biotech and software. by Gene Bylinsky

Dan Dodge and Gordon Bell:

When software really, really has to work

Is software hopeless? Ask anyone whose computer has just confessed to an illegal operation or whose screen has locked up. Despite decades of effort, a wisecrack from the software industry's early days still stings: "If builders constructed buildings the way programmers write software, the first woodpecker to come along would cause the collapse of civilization."

There's one notable exception. As far as anyone can tell, software created by a Canadian company called QNX Software Systems simply doesn't crash. QNX's software has run nonstop without mishaps at some customer sites since it was installed more than a decade ago. As a delighted user has put it, "The only way to make this software malfunction is to fire a bullet into the computer running it."

Like Windows or Linux, QNX's program is an operating system, the traffic cop that organizes and runs a computer's many functions. But this operating system is used mostly in highly specialized, real-time industrial applications. QNX software directs "extreme" manufacturing, such as guiding the flawless grinding of optical lenses—a process in which the slightest software glitch can ruin a product worth $100,000. It's also used to control facilities such as nuclear power plants and other critical installations where any software funny business could be catastrophic.

QNX's software is the brainchild of Dan Dodge, 48, the company's CEO, and Gordon Bell, 47, its president (they swap titles every year). They're subdued, low-key fellows—until you ask about their technology. Then they grow animated and even passionate. They're friends who drive basic cars no different from those of their employees and live in modest houses. Tucked away in a nondescript industrial park in Kanata, Ontario, an Ottawa suburb 2,400 miles from the hubbub of Silicon Valley, QNX has been called a "stealth company," its founders say.

It may not be on many radar screens, but it's hardly stealthy to smart manufacturing and process-control engineers, who have installed more than one million QNX systems around the world—and beyond. Cisco uses QNX to power some of its network equipment; Siemens uses it to run its medical systems. QNX enables the high-speed French TGV passenger trains to round curves without tilting too far; it runs U.S. Postal Service mail-sorting machines, directs GE-built locomotives, and will soon control all of New York City's traffic lights. The Federal Aviation Administration (FAA) has purchased 250 copies of QNX for air-traffic control. And the system operates the Canadian-built robotic arm on both the space shuttle and the international space station.

From the earliest days, Dodge and Bell chose to focus on such industrial-strength applications for their software. But QNX was designed to run on PCs, and its latest version, Neutrino, features an easy-to-use graphical interface, e-mail, web browsers, and the like. The company says tens of thousands of users, mostly computer whizzes, have downloaded a free version of Neutrino from its website. And QNX software may soon become known to more than just plant managers and aficionados. Versions of the ultra-reliable system are beginning to push out Microsoft and other competitors in new, smaller-scale applications. QNX powers some new laser eye-surgery devices, portable home-dialysis machines, and computerized casino games, for example.

Some car owners will soon be steering to directions from QNX. IBM has chosen the software for an advanced automobile-navigation system that integrates traffic updates, weather data, and emergency service information on the fly. The system, which automatically re-computes routes to bypass accidents, traffic jams, or dangerous road conditions, will appear in luxury models in the U.S. in the next year or so, and more broadly soon after. "We'll be shipping 20 million systems to the automakers

in 2004," Dodge says. QNX expects to dominate the software part of this new market, which UBS Warburg predicts will be worth $9.3 billion by 2005 (with software alone accounting for 25% of that total).

Dodge and Bell both grew up engrossed by electronics. The son of a Nortel engineer and a housewife, Dodge built circuit-boards and even a laser in high school, and in 12th grade he was programming the mainframe at the community college in Belleville, Ontario. To understand electronics, he majored in physics in college but continued to spend most of his time in the computer lab.

Bell was the oldest of four children of a Toronto electronics technician and a secretary at an R&D firm. His father worked for a chipmaker, so Bell "got tons of electronic parts to play with," he says. In high school he was already building computer peripherals such as tape readers and audio systems, and he had built his first computer by the time he went to college—winning one of three provincial scholarships for high-school superachievers. Dodge and Bell met at the University of Waterloo near Toronto, when a friend who knew that both built computers in their dorm rooms introduced them. They've been friends ever since.

Dodge and Bell were long entranced by the idea of creating an operating system that would work without failures. Most programmers have organized their operating systems in the so-called monolithic fashion, in which both the "kernel," or the code that directs the OS, and the various internal computer functions such as file systems and graphic displays, are all assigned a common memory space. The problem with this approach, still followed in widely used operating systems such as Windows and Linux, is that a trivial error in any one of the many functions that share the same memory space can shut down the whole system. The monolithic system, as Dodge and Bell describe it, is like an orchestra in which the conductor, or kernel, and all the players, or functions, are confined to a single room where any problem quickly becomes contagious. "If a horn player dies," says Dodge, "the orchestra stops playing."

Aiming for absolute reliability, Dodge and Bell decided to take a different route. Their OS would contain a "microkernel," a tightly written piece of software only a tiny fraction of the size of the big kernel. Instead of taking up megabytes of memory, the microkernel could be squeezed onto a single 40K chip. All the components of their OS were isolated from the microkernel and from one another in their own protected memory spaces. That makes QNX a "distributed system"—one in which the orchestra is not confined to a single space. And thanks to the program's "self-healing" feature, a dead player is automatically replaced or resurrected in millionths of a second without affecting the rest of the band. QNX has been the only company so far to commercialize a microkernel OS.

The microkernel enables QNX to run at blinding speeds. QNX also ranks functions, giving priority to the most critical, deadline-driven ones. Those features give it an unmatched ability to operate in "hard real time," responding to vast amounts of incoming signals in a few hundred nanoseconds (billionths of a second) and performing the right tasks at exactly the right moment. The capacity to "juggle ten billion balls a second without dropping one," as Bell puts it, is what makes QNX ideal for extreme manufacturing and other critical control operations. A QNX OS that runs materials-handling and assembly lines at the Siemens Dematic plant in Grand Rapids, for example, has been operating without failure for 13 years.

To pursue their dream, Dodge and Bell founded QNX in 1980 in a small office next to a shoe store in a shopping center in Kanata. They never looked for venture capital, and QNX is still privately held. Today the company has annual revenues of around $30 million, but at first the founders barely made it; Dodge was supported by his working wife, and Bell, then single, lived with his parents to save money.

Because of their industrial focus, Dodge and Bell managed to escape Microsoft's notice for most of their company's history. In recent years, though, Gates & Co. have made inroads into manufacturing markets; Microsoft has recruited outside software firms to adapt its NT operating system for use in less demanding manufacturing applications, such as running standard milling machines and lathes. And Microsoft's Windows CE is a sort of mini-operating system that can easily be adapted to run things such as machine tools. After that program was introduced in 1996, Dodge and Bell say, Microsoft executives told them they would run QNX out of business in two years.

Nothing of the sort has happened, obviously. Instead, new markets are opening up for the sort of dependability and versatility that QNX offers. And the company has found a powerful ally in IBM (not to mention other new partners, such as Intel, Motorola, and Toyota). Big Blue's Skip McGaughey, who has worked on making QNX the software behind IBM's new automotive computer systems, says the company chose QNX because it represents the "very best" of real-time operating system technology. "The typical automotive end user would have no patience with a unit that freezes up or experiences systems errors," he says. Wonder which archrival company's software he's thinking of. F