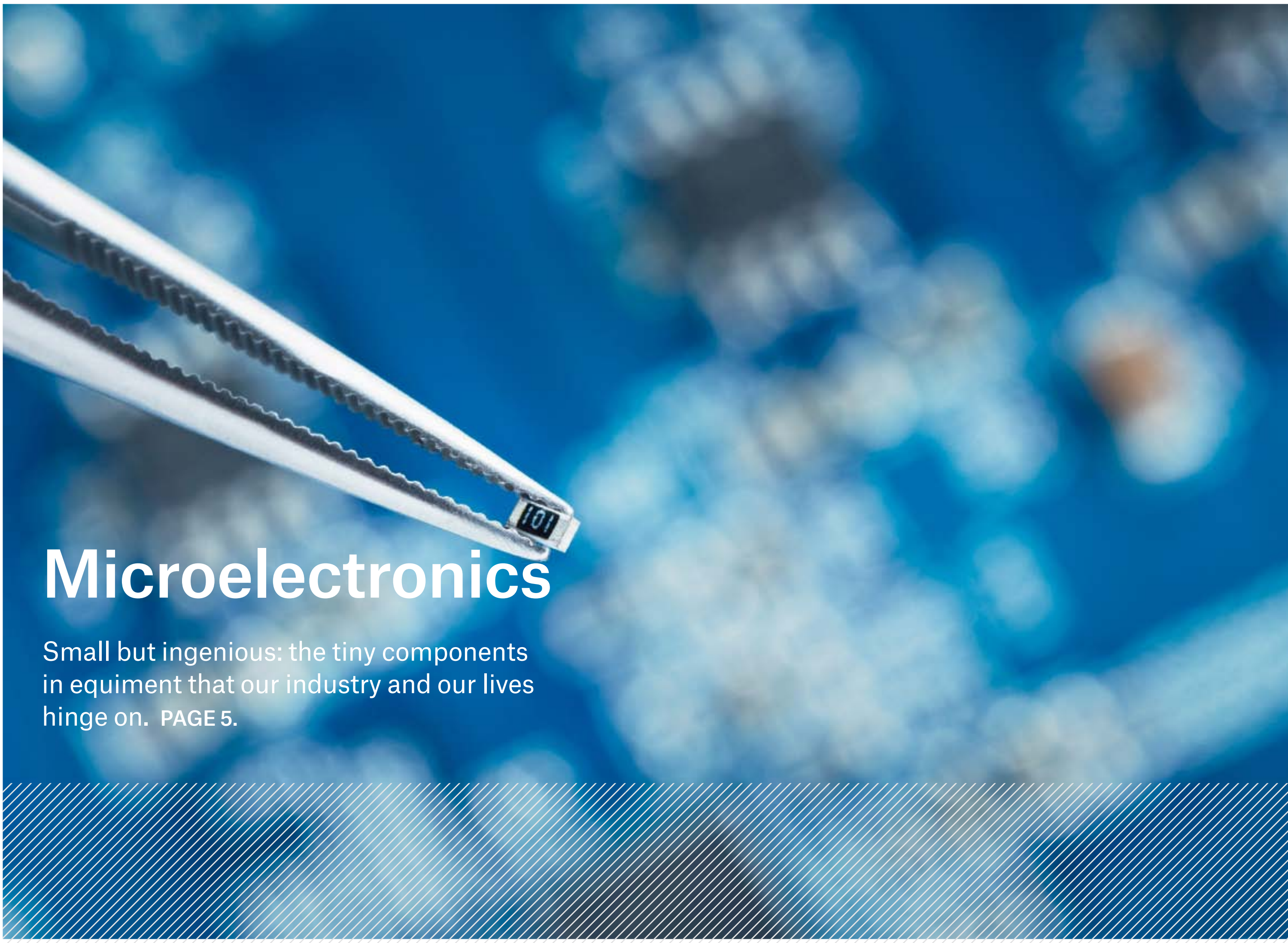
TOPICS
RISK SOLUTIONS

Insurance solutions for industry
Issue 1/2015



Microelectronics

Small but ingenious: the tiny components in equiment that our industry and our lives hinge on. PAGE 5.

Canada
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100 million transistors on the head of a pin

With circuitry thousands of times smaller than a human hair, when microelectronics stop working, the damage is often too tiny to see. In response, HSB is expanding its coverage with our new product HSB TechAdvantage™ Equipment Breakdown and Technology Coverage to stay ahead of today's equipment failures.

By Marc Saulsbury

Microelectronics has changed the way we live, work and do business. Now, with circuitry so small that 100 million transistors can fit on the head of a pin, insuring them is changing, too, making it easier to cover equipment losses when the damage is difficult to see.

Hartford Steam Boiler has taken a bold, but necessary, step in the evolution of equipment insurance, expanding its equipment breakdown coverage beyond the requirements of physical damage, to failures caused by accidents that cannot easily be traced.

Given that most equipment today uses microprocessors, this is a significant change. For decades, the trigger for equipment breakdown and other property insurance has been a loss due to physical damage that can be observed and identified. As more equipment breakdowns involve micro-circuitry, however, it is time to take a different approach.

The brains behind a business

Think of all the equipment that contains micro-circuitry today:

- Computers, laptops and mobile phones
- Elevators
- Retail sales and inventory systems
- Telecommunications
- Heating and cooling systems
- Household appliances
- Diagnostic testing equipment
- Production machinery
- Medical equipment
- Consumer electronics

If equipment uses electricity, it probably contains transistors and microprocessors. Microelectronics has become the brains behind a business. Our insurance claims data shows that equipment using micro-circuitry is likely to break down and is difficult to repair.

Only with the aid of a scanning electron microscope does the chip-to-chip interface become visible.

Electrons, silicon and "logic gates"

In simple terms, a transistor is a tiny electronic component used as a switch or gate to alter the flow of electrical current. Comparisons are sometimes made between transistors and neurons, the human brain cells that act as switches to help you think.

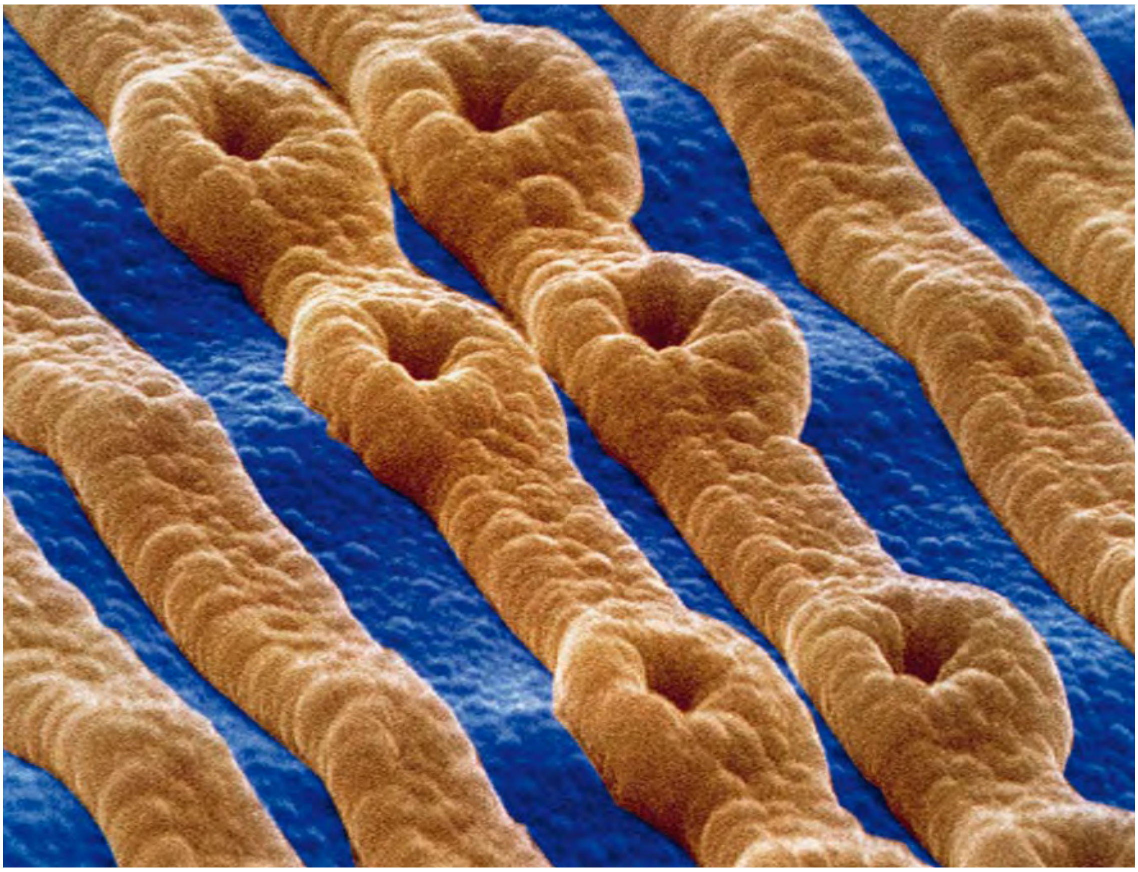
A transistor is a "silicon sandwich", three layers of the element silicon, which is present in sand and glass. Silicon is a semiconductor that can act as both a conductor and an insulator. This means that a transistor can permit the flow of electrons, in the way copper wire conducts electricity, or inhibit it, like the plastic insulation wrapped around the wire. When a transistor works as a switch, turning current quickly on and off, it stores the numbers zero and one.

When individual transistors are connected, they can create a "logic gate," allowing computers to add up and compare the binary numbers zero and one. This is the basic foundation of computer programmes – those series of instructions that make computers and programmable equipment operate.

Transistors are the building blocks of integrated circuits, which have extremely large numbers of transistors interconnected with circuitry and baked into a single microchip. Using a single or very few integrated circuits, a microprocessor incorporates the functions of a computer's central processing unit (CPU). A CPU is a programmable device, with one or more microprocessors, used in everything from the smallest embedded systems to supercomputers.

Before microprocessors existed, small computers often had racks of circuit boards with many small- and medium-scale integrated circuits. Microprocessors combine large-scale integrated circuits to boost processing power and enable the programming of any devices and systems, such as building controls, automated machinery and other equipment.

Integrated circuits on a microprocessor – only visible with the aid of a scanning electron microscope.



How small is "small"?

The original transistor built by Bell Labs in 1947 was big enough to be assembled by hand. Today, Intel Corporation reports that more than 100 million of its 22 nanometre tri-gate transistors could fit onto the head of a pin; more than 6 million transistors would fit in the full stop at the end of this sentence.

The gates on the transistors are so small that you could fit 4,000 of them across the width of a human hair. Each transistor can switch on and off more than 100 billion times in one second. It would take you about 2,000 years to flick a light switch on and off that many times.

A nanometre is one-billionth of a metre. As the US government's National Nanotechnology Initiative points out, it is difficult to grasp just how small that is, so it lists a number of examples on its website www.nano.gov.

A sheet of paper is about 100,000 nanometres thick. A strand of human DNA is 2.5 nanometres in diameter. There are 25,400,000 nanometres in one inch, and a human hair is approximately 80,000 to 100,000 nanometres wide. Looked at another way: if the diameter of a marble was one nanometre, the diameter of the Earth would be about one metre. If a typical house shrank as much as transistors have, you would not be able to see it without a microscope.

Motors and gears the size of an atom

With each invention and innovation, technology becomes faster and smaller.

The first transistors were used in the 1950s for hearing aids, radios and experimental computers. During the 1960s and 1970s, transistors were incorporated into integrated circuits, in which many components, including diodes, resistors and capacitors, are formed on a single chip of semiconductor material.

As transistors replaced vacuum tubes in computers, memory chips and microprocessors led to space flight systems, personal computers, MRI machines, video consoles, digital cameras and controls, CNC lathes, flat screen displays, MP3s and industrial robots. The Global Positioning System (GPS), a satellite navigation system created by the US military, was adapted for business and is now used in a host of consumer devices.

Nanotechnology is helping to build new transistor structures and interconnections for even faster and more advanced computer chips, perhaps with materials that are superior to silicon. Some researchers also hope that someday nanotechnology will allow the programmable assembly of mechanical components, such as motors and gears, at the atomic level.

Through the use of nanotechnology, it may soon be possible to store your computer's entire memory on a single tiny chip, according to the National Nanotechnology Initiative. Magnetic random access memory (MRAM), enabled by nanometre-scale magnetic tunnel junctions, will quickly save encrypted data during a shutdown or crash.

Five billion new transistors every second

Moore's Law, a computing term originated in 1965, stated that the number of transistors on an affordable computer processing unit would double every two years. The most popular formulation of the law is the doubling of the number of transistors in a dense integrated circuit every two years, and that has generally remained true.

The easiest way for most people to understand how far digital technology has advanced is to compare the speed and power of today's personal computers with earlier models.

The Commodore 64 desktop, which sold millions in the 1980s, had a 1.023 megahertz (one MHz is a million cycles per second) processor and 64 kilobytes (KB, here, 64,000 characters) of random access memory (RAM), which holds all the data and instructions while a computer is running. The Commodore used slow-loading floppy disk or cassette tape drives.

The latest business PCs have at least a 3.5 gigahertz (GHz) 6-core processor, 16 gigabytes (GB) of memory and a 1 terabyte (TB) internal hard drive. By comparison, 3.5 GHz is 3.5 billion cycles per second, or 3,500 MHz; 16 GB of RAM is 16 billion characters, or 16 million KB; and 1 TB of memory is one trillion bytes (1 billion KB, or 1,000 GB).

Mobile phones, meanwhile, have become minicomputers, with multi-core processors having up to 2.5 GHz and 128 GB of storage capacity. Smart phones feature autofocussing megapixel cameras, video recorders, accelerometers, voice recognition, high-definition displays and other features that would have been inconceivable not so long ago.

The world's no. 1 chip maker Intel says that its factories produce more than 5 billion transistors every second. Forbes magazine, combining industry data, some assumptions, and a bit of "whimsy", estimates that 2.9 sextillion transistors (2,913,276,327,576,980,000,000) were made worldwide between 1947, when the technology was invented, and early 2014. To put that in perspective, there are "only" 200 billion stars in the Milky Way and 100 trillion cells in the human body.

What are the limits of microelectronics?

As impressive as the numbers seem, they soon will be outdated, probably by the time you read these words. Technology is advancing so rapidly that it is hard for most people to keep up with the changes. Futurists say that the pace of change will become instantaneous, with continuous technical development. In essence, some scientists predict, equipment will almost become obsolete as soon as it is developed and deployed.

Many scientists and researchers believe that Moore's Law is nearing its limits. Once transistors are created as small as atomic particles, they say, it will no longer be possible to double the speed of computer processors. Yet, manufacturers continue to find new ways to etch smaller and smaller transistors onto silicon chips. Intel has announced a new process to manufacture chips with features as small as 14 nanometres.

Quantum computers are one invention that may lead to another breakthrough. Quantum computers would not be limited to zeros and ones; they could encode information as quantum bits, or qubits, which could exist as zero or one, zero and one simultaneously, or somewhere in between. They would use transistors small enough to operate with only one electron; exceptionally small, yet theoretically possible.

Computing at such an infinitesimal level would be carried out according to the unpredictable laws of quantum mechanics. When applied to electronic equipment, it could be difficult or impossible to determine the cause of an equipment failure.

As technology gets smaller, the risks get bigger

And that is the challenge for business and industry. In the marketplace, new technology is not about theory and experimentation – it is about improving the bottom line. Equipment is an investment, and equipment breakdown loss can be costly and disruptive.

The evolution of equipment using computer chips and circuit board technology is causing that equipment to fail differently than did earlier technology. Microelectronics makes equipment more vulnerable to a breakdown, especially when the device is portable and fragile. Because equipment with micro-circuitry is more complex, it can fail in new and different ways.

We know this because we have tracked and analysed equipment breakdown claims data from among the more than five million commercial locations that HSB insures, and we have seen an increase in losses involving electronics.

Yet, while traditional equipment breakdown insurance policies require evidence of physical damage for coverage to apply, increasingly, microelectronic damage is not detectable and sometimes not even physical.

Damage at the molecular level

Equipment may stop functioning for no obvious reason, with no apparent physical damage. Integrated circuitry is constructed at a molecular level. If a wire one micron wide breaks, the break is virtually undetectable. Only time-consuming, costly forensic failure analysis can find the microelectronic impairment.

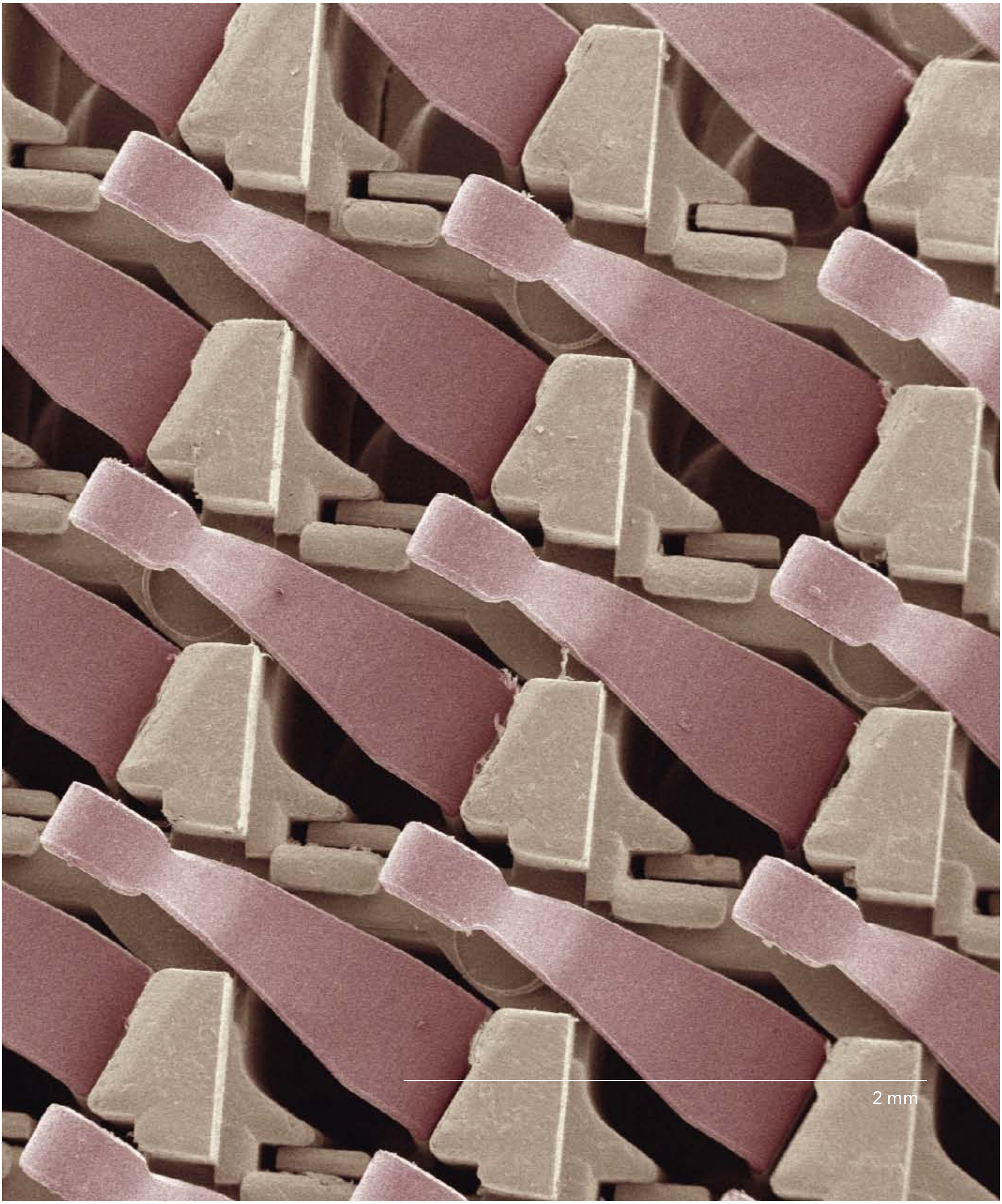
Virtually all electronic equipment requires firmware, embedded software instructions essential to its operation. Firmware updates can be used to add features and functions, fix bugs and add compatibility with other devices. Yet when firmware becomes corrupted, the equipment stops operating. This is damage, but it is not physical damage.

In addition to the risk of equipment failure, cyber thieves can program malware to overwrite firmware and take control of electronic devices, from computers to industrial equipment. For instance, a fundamental flaw was uncovered in the design of USB drives, which are used in PCs, keyboards, thumb drives, and many other applications.

Breakdown on the road or in the cloud

Microtechnology has spawned another trend: fragile electronic equipment is more portable and frequently used off premises, where it is exposed to greater risk of damage.

A medical services company may set up mobile diagnostic centres, moving sensitive equipment from town to town. Building contractors use portable X-ray machines to identify areas where repairs are needed. With so much mobile equipment at risk, it can be difficult, costly and take more time to recover, when equipment fails to operate at a remote location.



A coloured computer chip – not visible
to the human eye.

With the internet and cloud computing, losses may also be virtual

Studies show that the majority of US businesses use the cloud, with some estimating that up to 75% or more use some type of cloud services. The number of smaller businesses using the cloud is expected to more than double to 80% in six years. Although the internet and the cloud are creating a new era of opportunity for businesses, loss of broadband service or cloud connectivity can cripple many operations.

In a survey of small and mid-size business conducted by HSB and the Ponemon Institute, 48% said they had experienced an interruption of cloud services. Of those businesses, 56% reported that at least one such interruption prevented their company from functioning. Other studies show that cloud data centres experience many unplanned outages, which expose users to business interruptions and data loss.

Keep in mind that the cloud resides and operates within physical buildings and equipment. That equipment can fail. Picture the cloud as remote data centres or warehouses, where businesses store and access their electronic files and applications. These data centres number in the thousands and do not have to be anywhere near a client business. Some of the biggest are Google and Amazon, although there are many smaller cloud providers.

Physical limits and the "Internet of Things"

Many observers say the cloud and the "Internet of Things" mean that the physical limitations of transistors and integrated circuits no longer matter. Networks and cloud computing, they argue, make computers and equipment run faster and better by connecting the devices to bigger, faster, more complex systems on remote servers.

With new markets developing for tablets and remote sensors, and older machines increasing computing power, these analysts suggest that chip designers should focus less on big advances in processing power. Incremental improvements to chips for simpler devices such as smart thermostats and monitors may become more important.

Gartner Incorporated, the information technology research and advisory company, estimates there will be 26 billion connected devices performing such basic tasks by 2020. Already, wi-fi connections and radio-frequency identification enable the remote management of everything from retail business inventories to home washers and dryers.

What does this really mean for a business?

Think about the exposures, with so many functions digitised and interconnected.

Imagine that a retail store loses power and, once power is restored, the store's point-of-sale registers and telephones no longer work. Attempts to reboot the system fail, and technicians cannot find any physical problem. Even though there is no obvious damage, the hard drives are replaced and the system is restored.

In another example, machinery breaks down when the coding embedded in microcircuits is corrupted. There is no visual source of physical damage, but technicians eventually replace the affected components and reboot the machines. Contracted work is far behind schedule, however, and the company must pay overtime and outsource production.

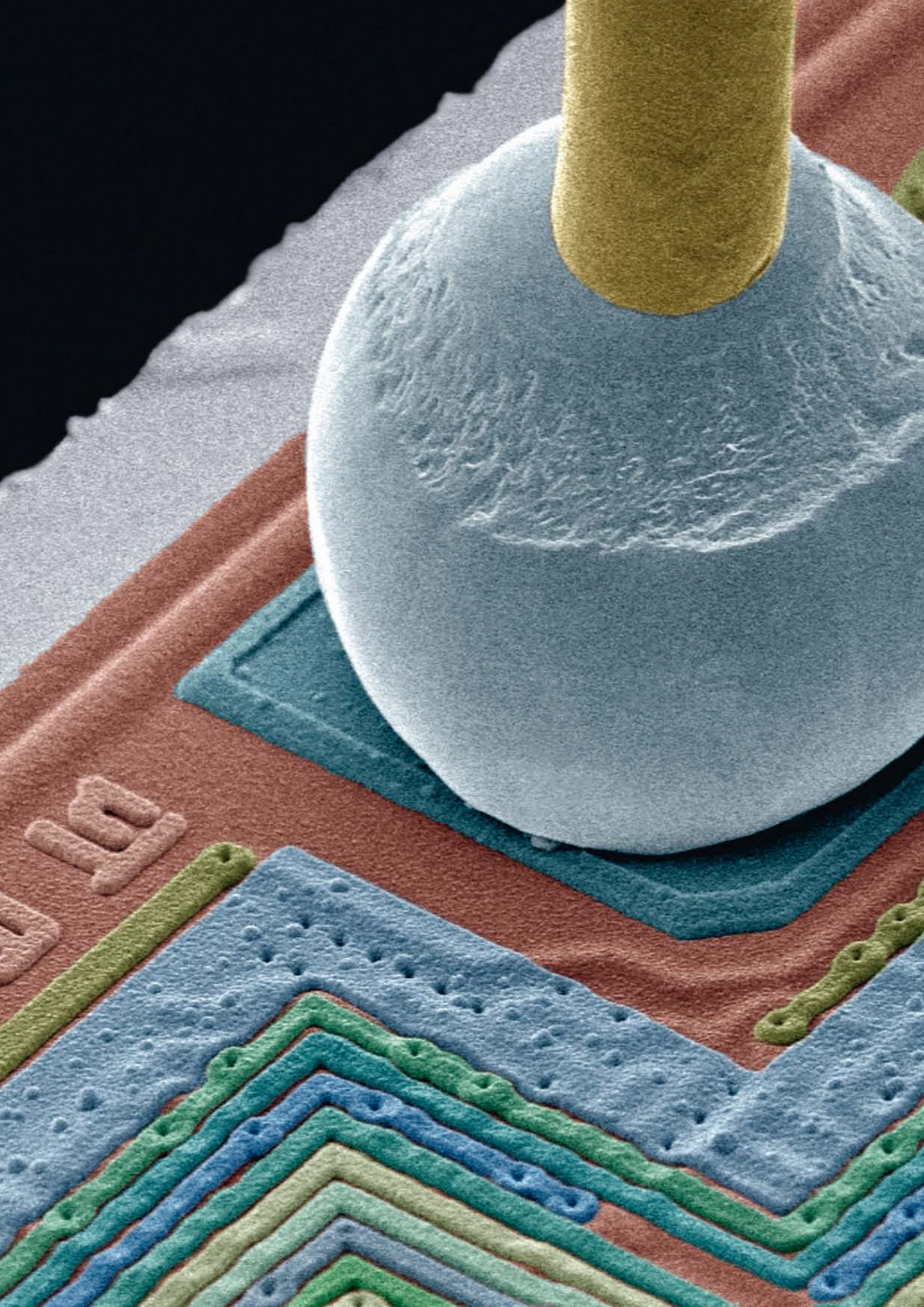
Often a business will keep replacing electronic components until the equipment starts working again, or it becomes obvious that it would be less expensive to replace everything. With no definite idea of what is causing the damage, it is hard to make efficient repairs. This is not a practical claims approach for a business or its insurance carrier.

HSB's new equipment breakdown insurance will pay to replace failed electronic equipment, even when physical damage is not evident. It pays to restore data, replace lost income and other related expenses. Enhanced coverage for cloud service interruptions and portable equipment is also included.

Stronger than steel, harder than diamonds

It is difficult to predict when the next leap will come in new microelectronic technology. Will the improvements be incremental, or revolutionary? Can the tech sector maintain the exponential growth of computing power and speed of the previous decades? Indications are that we may be poised for another technical transformation.

Advanced nanotechnology is used in computing, communications and other electronic applications, providing faster, smaller and more portable systems. Scientists are working to discover a replacement for today's transistors that moves beyond the limitations of current silicon semiconductor technology.



In what seems like science fiction, some researchers are even aiming to break through the limits of conventional electronics by integrating biological and nanoelectrical systems. The scientists hope that by mimicking biological networks with sub-threshold electronics, they can discover new high-performance electrical circuit designs.

Also of interest are nanocrystals, at least 1,000 times smaller than the diameter of a human hair, for use in engineering new materials for applications including electronic components. Other studies backed by hundreds of millions of dollars of funding are focusing on nanoelectronics platforms using exotic materials.

An exciting new "miracle material" called graphene is currently the subject of extensive research. The thinnest materrial on earth, graphene is made of a single layer of carbon atoms. It is highly flexible, stronger than steel, harder than diamonds, and conducts electricity faster than silicon, over long distances, without electrons scattering.

Several hurdles exist – graphene is not a true semiconductor – but scientists are convinced they can add switching properties to make graphene transistors and computer chips thousands of times more efficient than existing ones. Other uses with equipment applications will include batteries, solar energy panels and LCD screens.

Connecting is what really counts

It is a challenge to keep up with so much change. What new technologies will emerge in the future? How will breakthroughs in microelectronics shape the equipment and systems that are used every day by business, industry and the public?

New technologies may shake up business and consumer markets. Electronic equipment also consumes a tremendous amount of expensive energy. But as technology continues to shrink, it will improve the efficiency and capabilities of equipment. That will help drive down energy and operating costs, increase productivity, and support innovation.

In a digital world, we live and work online. Technology connects us and provides us with the tools to communicate, create products and deliver services. Data is what drives a successful business in the age of internet shopping and social media marketing. And connecting is what counts when it comes to equipment and getting closer to customers.

As a result, some of the old concepts of property insurance, developed over a century ago, may no longer serve businesses as well. Today's technology is too complex. Nanoelectronics. Moore's Law. Quantum mechanics. It almost seems like one needs to be a scientist or engineer to understand the technology of tomorrow.

We do not think that it has to be that complicated. When equipment stops working, it should be covered by insurance. It is as simple as that.

>> More at
www.hsb.com/HSBGroup/hsb-techadvantage.aspx

OUR EXPERT

Marc Saulsbury,
Vice President,
Strategic Products
HSB
marc_saulsbury@hsb.com