THE TORONTO STAR

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Monday, July 15, 2002 Section C

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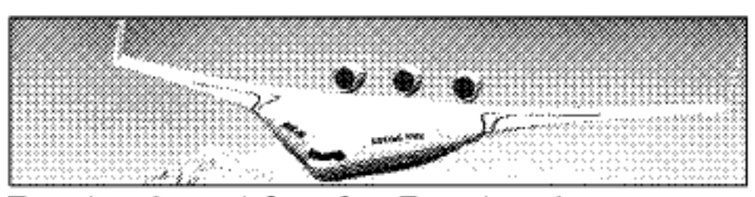
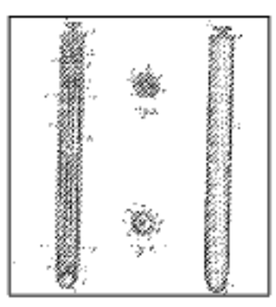
HIGH TECH C6
CLASSIFIED C8

Despite giant rivals, Handspring Inc. remains upbeat about its Treo handheld organizer and cellphone. C2



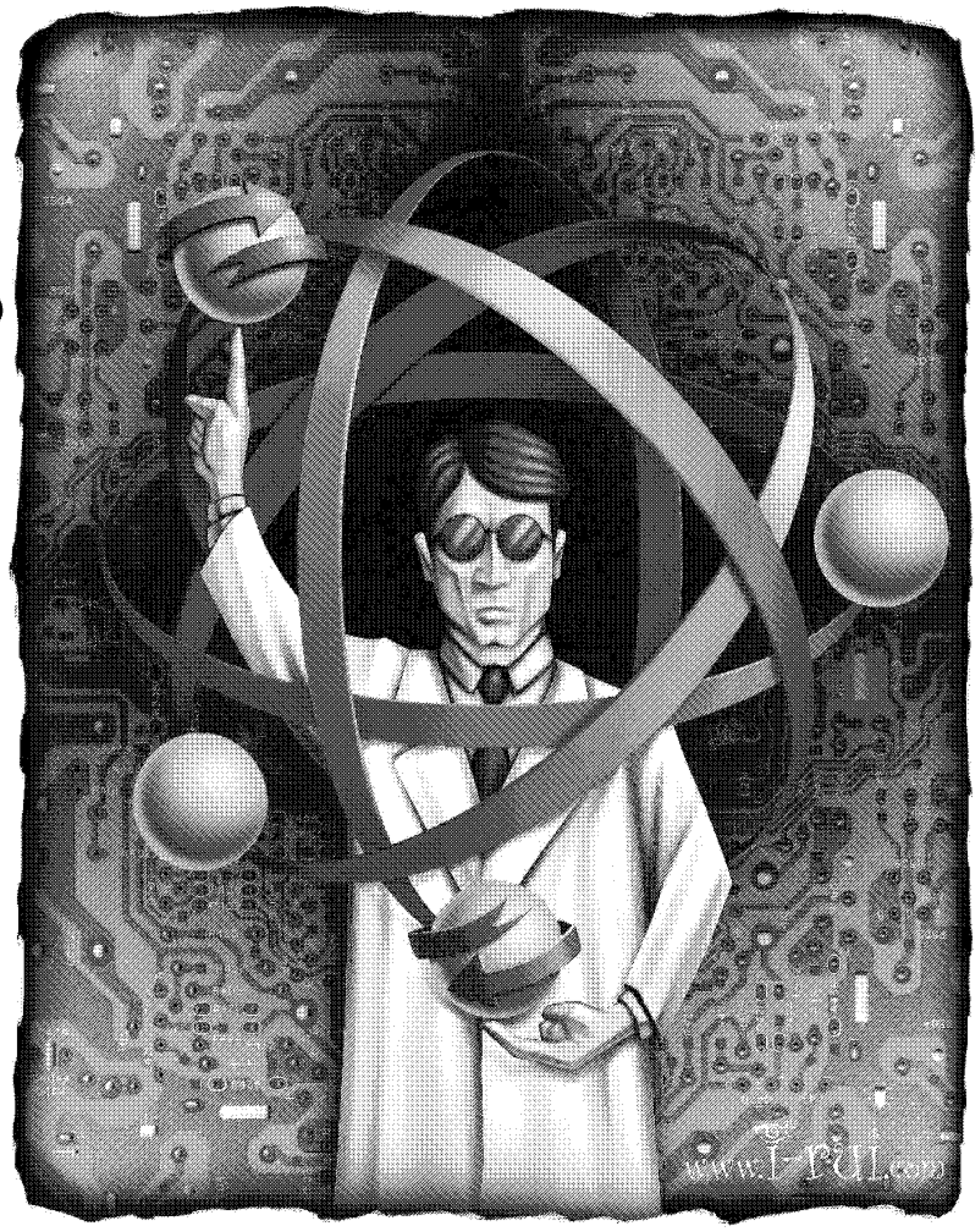
Boeing's pride, the Bat jet, is set to take off, but who wants to buy it? C2

The 1888 ballpoint pen design, at right, revolutionized writing instruments. C3



Spin doctors

Physicists are pursuing a science called spintronics that could create a new generation of computers and other electronic devices



RUI RAMALHEIRO FOR THE TORONTO STAR

BY RACHEL ROSS
TECHNOLOGY REPORTER

We've gotten a charge out of the electron for years in all kinds of digital devices. Now it's time to take the electron for a spin.

Spin-based electronics — a.k.a. spintronics — is a growing field of science that seeks to use the spin of electrons to create a new generation of computers and a host of new microelectronic devices that will be smaller, faster and more robust than their predecessors.

"Ideally, if the plans unfold, spintronics will render classical computers obsolete," said Henry van Driel, chair of the physics department at the University of Toronto. "It's almost mind-boggling when you think about what some of the capabilities might be."

Van Driel has been working on spintronics research for the past two years, slowly watching those plans unfold through his own research and the work of countless other physicists around the world.

At first glance, Van Driel's spintronics lab looks like the backroom of an insane optometrist's office. There are lenses on black and silver stands, seemingly scattered all over a couple of metal tables and a couple of glowing, green beams of light.

But their placement is far from haphazard. Each lens is actually screwed into the table and angled just so. This is not a place for small children. Move one of those lenses just ever so slightly and nothing will work.

The lights and lenses are all part of an elaborate spintronics experiment, in which each of the lenses plays a critical role in getting just the right kind of light to shine on the electrons and control their spin.

Thinking back to your high school science, you'll probably remember that electrons — those subatomic particles that are sometimes found orbiting the nucleus of an atom — are negatively charged. That negative charge makes up the electric current that runs through the circuit boards of your Walkman or VCR.

"All electronics today is based on using electrons for their charge, but the fact is that electrons don't have only charge, they also have spin," said Peter Nemec, a visiting physics professor at the University of Toronto, who is part of the spintronics team.

Spin is what's called a quantum property, something that governs the way the parts of atoms interact with each another. Electrons don't really spin in the normal sense of the word, but it's a decent analogy for their angular momentum.

There are two basic states of spin: spin up and spin down. This is akin to spinning a top clockwise or counter-clockwise. In a normal electronic circuit, the electron's spin doesn't have any effect on the circuit because the different spins are randomly distributed. The trick to spintronics is to be able to organize electrons according to their spin and get them to move from one place to another.

"In future, new devices may be purely based on the spin properties of electrons, but most likely there will be a hybrid phase where in some cases it's the electrical properties that are used and in some cases it will be the spin properties," said van Driel.

Why do we need to use spin, when we've already got the charge to play with? Researchers say there's a limit to what can be done using an electron's charge alone.

"Electronics based on charge is hitting a technology barrier," said Andrew Sachrajda, a physicist and spintronics researcher for the National Research Council (NRC) of Canada.

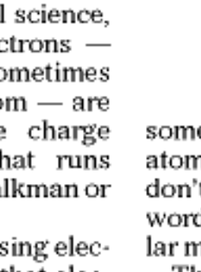
At some point, using traditional electronics, we will hit the end of Moore's Law, which states that computer performance will double

☛ Please see Spintronics, C3

Regulatory look at Nortel is long overdue

Where it's @

TYLER HAMILTON



One by one, the corporate dominoes are falling, a seemingly endless chain of fools linked together by accounting improprieties and executive greed.

Enron, Global Crossing, Xerox, Tyco International, WorldCom, Qwest — who would have thought two years ago that these respectable giants of American business would become implicated in such scandal? Or that the situation would deteriorate so much that it demanded the personal attention of a U.S. president fighting a war on terrorism?

But consumed by this unfolding U.S. drama, as we often are, it's too easy to forget about the spectacular rise and fall of Nortel Networks and its devastating impact on the millions of Canadian shareholders who held its stock.

Star reader David Brown, in a recent letter, says more than ever we should remember Nortel and other Canadian examples of epic corporate misadventures.

Applauding Star business columnist David Olive and his story, "Bush's war on greed highly suspect," Brown highlights the lack of attention given to Canadian corporate scandals in today's post-Enron fallout.

Why, he asks, has there not been a similar level of outrage and political leadership against companies such as Nortel, whose story of hubris and excess now seems a distant memory? (The Ontario Securities Commission has never acknowledged any investigation into Nortel.)

It doesn't seem to matter that Nortel executives, most of them long gone from the company, walked away with hundreds of millions of dollars after watching $300 billion in stock value vanish into thin air. It doesn't matter that millions of Canadians were directly hurt by this earth-bound plunge, despite promises from then CEO John Roth that all was well and healthy — when in fact there were strong internal and external indications to the contrary.

There's nothing new about these points, but does that make them any less important? To this day, there has been no closure on Nortel's fall from grace as a handful of class-action lawsuits, all alleging some degree of personal and accounting improprieties, move at a snail's pace through the courts.

On the other hand, the U.S. Securities Commission has been much more attentive to the corporate accounting fiascos that have sucked investor confidence from our already anemic markets. Earlier this month, the U.S. regulator declared that the chief executives and chief financial officers of the 950 largest U.S. companies must now personally vouch for the truth and completeness of their most recent financial results.

It's a start. I say go further, and make such certification retroactive to the past five years of financial reports.

But this is a moot point with respect to Nortel. As much as it acts like a U.S. company, the faded Canadian gem still keeps its headquarters in Brampton, where it remains sheltered from the SEC's latest call. And while the OSC claims to be reviewing whether it should implement similar measures here in Canada, you probably have a safer bet these days investing in high-tech equities.

There's a temptation by some to leave Nortel alone so it can quietly pull up its bootstraps and get on with business. Sure, there may be a witchhunt going on south of the border, but why tie Nortel to a burning stake when its already suffering? We'll get more detail of this suffering when the company releases its second-quarter results on Thursday.

It's sometimes difficult not to feel sorry for Nortel. It's stock is languishing below $2.50 on the Toronto Stock Exchange (down 98 per cent from its high two years ago of $123.10). It's been booted off of the S&P 100 and 500 indices. Its projected revenues this year will be less than $12 billion (U.S.), having fallen a jaw-dropping 60 per cent from two years ago.

It's also running low on cash, and risks violating its bank cov-

☛ Please see Let, C6

@BIZ

Ballpoint pen still on a roll

John Loud patented a device to improve on the fountain pen but failed to cash in on his vital invention

Rediscovery

RACHEL ROSS

John Loud must be rolling in his grave. He patented one of the most ubiquitous devices of the 20th century, but he didn't know it.

His invention: the ballpoint pen. His problem: He never thought to use it on paper.

Loud patented his ballpoint pen as a set of "improvements" to the fountain pen in 1888, but it really was a complete overhaul. Instead of a pointed tip at the end, Loud's model used a ball that would roll around in all directions so that the ink could freely run out.

Loud saw it as a tool for writing on "rough surfaces" such as wood or coarse paper boxes. What he failed to realize was that it could — eventually — be made to work like a charm on perfectly smooth paper, too, and outshine the fountain pen completely.

His failure to realize the full potential of his own great idea meant he lost out on a lot of money and, perhaps more important, the world had to go on using fountain pens for another 50 years.

It wasn't until 1935 when two Hungarian brothers "invented" the ballpoint pen — again! Fortunately, Ladislo Biro was smart enough to recognize the commercial demand for such a device, in part because he was a journalist.

According to the legend of the Biro brothers, Ladislo was sick of filling fountain pens, with their smudgy ink and pointy tip that would sometimes rip the paper. He and brother George developed a pen, which like today's ballpoints, worked much like roll-on deodorant, only on a much smaller scale.

You might not realize it, but there's actually a very tiny metal ball right at the tip of your pen. You can't see it, but it's there — under a little glob of ink. The ball fits into a hole just slightly larger than its size, so that it is still held in place but free to rotate. As the metal ball at the end of the pen rolls around, ink sticks to the ball and rolls on to the paper. By 1938, the Biro brothers had patented their handy-dandy writing tool.

In a stroke of luck so good it sounds like a script from *The Three Stooges*, the Biro brothers happened to run into the president of Argentina while on vacation. The president was so impressed with the pen that he helped them set up a factory there. The pens took off with the England's Royal Air Force, which appreciated that the pen's thick ink wouldn't leak out at high altitudes.

The only problem was that the pen didn't work very well back on earth. The ink was just too thick and gloppy for everyday use.

But that didn't stop the copycats and elaborate marketing schemes.

You see, the Biro brothers were not the only inventors who vacationed in Argentina at the time. Milton Reynolds, a businessman from Chicago, spotted the Biro pen while visiting, brought a few back with him and quickly copied the whole idea. He rushed his product to the U.S. market so fast that he actually beat the Biro brothers at their own game.

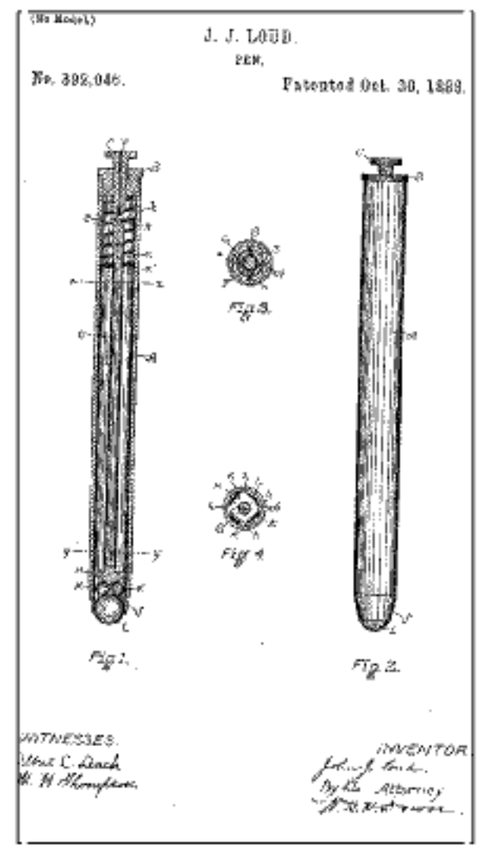
This was bad news not only for the Biro brothers but also for their licensees. The Eversharp Co. had bought the rights to sell the Biro pen in America, but was slow to get the product on the shelves. And it cost them a lot.

Reynolds captured the public's imagination with a big ballpoint pen launch at the Gimbals Department store in New York City. He claimed the pen wouldn't leak, and would write for two years, even under water.

He called his pen the Reynolds Rocket — an appropriate name given how fast he got the product on store shelves.

By the time shoppers realized that their prized pens were shoddy, Reynolds had already made a bundle. An estimated 10,000 Reynolds Rockets were sold on the first day for $12.50 (U.S.) each.

Despite the fact that Eversharp took its time before bringing its product to market, the company's ballpoint pens weren't much better. The crazy ad campaigns continued but consumers complained about the leaking, smearing ink.



LOUD'S DESIGN: An early design of John Loud's ballpoint pen as shown in this 1888 patent.

By the late 1940s people were basically fed up with the whole idea. Both Reynolds and Eversharp ultimately folded.

The whole idea didn't really catch on again until Bic pens — named after the French Baron Marcel Bich — and Parker Pens introduced reliable models in the 1950s. Both companies had been making fountain pens for years, but held off on releasing a ballpoint version until they were sure they had products that worked.

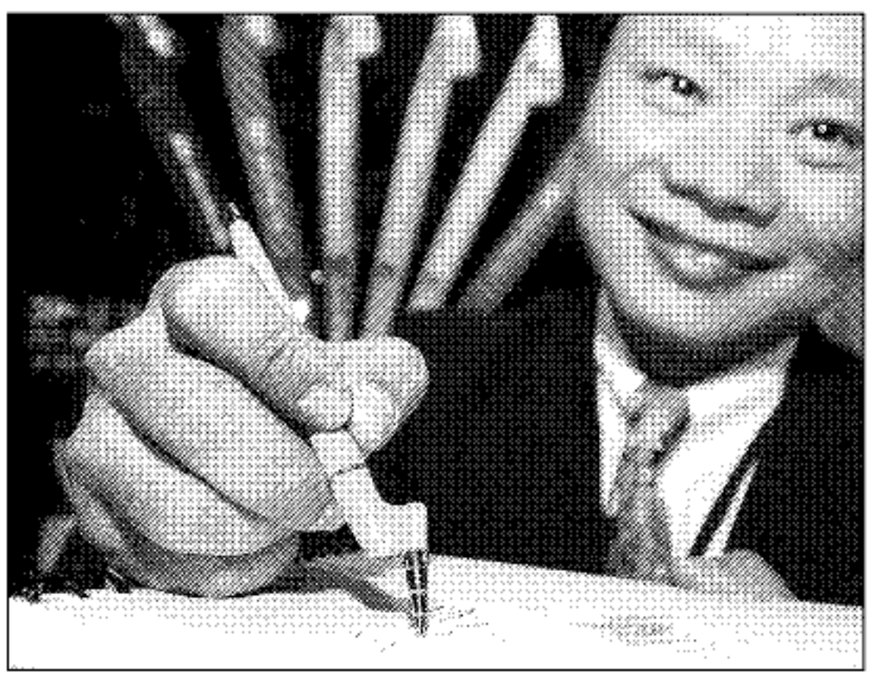
Basic business logic might suggest that getting to market first counts most. But all the marketing in the world didn't keep the pen makers in business until their product lived up to the hype.

Sure, Bic and Parker missed the heyday of high pen prices. By the early 1950s the price of ballpoints had already dropped to a fraction of the price of the first Reynolds Rockets, but consumers were finally switching over from the fountain pen.

Today, the ballpoint pens are a staple product in every home and office.

John Loud would be proud. Bitter . . . but proud.

Rachel Ross can be reached by e-mail at rross@thestar.ca



3-D PEN: Chinese Bao-Shen demonstrates his invention, a 3-D Yoropen, which can write at different angles.

Of pens and inks

■ Bette Nesmith, mother of the Monkees guitarist Michael Nesmith, invented white correction fluid using her blender at home. She was sick of having to retype documents every time she made a typo. She called it Mistake Out and made up little bottles for some of the other receptionists in her office before starting her own company.

Her correction fluid is still on the shelves today, as Liquid Paper.

■ In the days before ballpoints, insurance salesman Lewis Waterman decided to develop his own fountain pen after he destroyed some paperwork with the ink from a leaky pen.

■ The Vacumatic, by Parker Pens, was one of many novel approaches to make refilling a fountain pen easier.

The Vacumatic used a plunger and rubber diaphragm to draw ink out of a jar.

■ All Sir Arthur Conan Doyle ever wanted was a good pen. In a 1931 advertisement for Parker Pens, he stated that the Parker ballpoint was so good it didn't distract from his flow of thought.

Spintronics opens new vistas in computing

Continued from C1

every 18 months. That increase is based on our ability to pack more and more transistors in the same space.

While Sachrajda notes that Moore's Law has held true for about three decades, there are limits to just how small we can make traditional electronic components. When we get down to making things really small, there are new laws that govern how particles interact. These are the laws of quantum mechanics. So, to really make things work on a small scale, we need to work with the quantum properties of the electron, such as spin.

Working with spin has other potential advantages. Researchers believe that one day the up and down states of spin could be used to represent encoded information — like the ones and zeros that make up the binary computer language.

Spin was actually discovered about 80 years ago, but it's only recently that it really seemed like something that humans could harness for their own use.

In the late 1980s, it was discovered that when electron spins were organized so that they were all spin up or all spin down, a magnetic effect called giant magnetoresistance (GMR) was produced. Magnetoresistance had been used in computer hard disks to access data, but this newly discovered variety was 200 times stronger. In practical terms, it meant that far more data could be crammed into a hard disk if it was read using materials with GMR.

"That's what made laptops so small," said Sankar Das Sarma, a University of Maryland professor, who researches spintronics.

Das Sarma calls this kind of spintronics — which works in metals — the first generation of spintronic devices. But he said that's only a small part of the future of spintronics. While the first generation of spintronics devices made computer memory more efficient, the next generation will combine memory with the computer processor.

The two parts of today's computer — the hard disk memory and the central processing unit — are separate. Second-generation spintronics would bring the logic and memory functions together in a single semiconductor chip.

"As a trivial benefit, imagine your computer switching on almost immediately instead of waiting during that annoying, long booting-up time," said Sachrajda of the NRC.

He and his colleagues recently announced they have created a spintronic transistor. It's a landmark finding, but it's still far from ready for commercial use. It's really just a prototype to show what can be done, once some of the other issues with spintronics have been solved.

A critical issue in advancing spintronics is finding the right materials for the job. For a long time, the trouble with this second-generation spintronics research was finding a semiconductor with magnetic properties. Then about six years ago, it was discovered that a common semiconductor had magnetic properties at low temperatures. That brought new hope to the field and research in the area took off. But for researchers such as Das Sarma, the hunt is still on for semiconductors that have magnetic properties at room temperature.

Van Driel's lens-ridden experiments get around this problem by avoiding the use of magnetism. Instead, van Driel used polarized light waves that vibrate in a very specific way to generate electrons with a certain spin state, and make them move in a certain direction, thus producing a spin current.

"If you're going to make any kind of a device, then you have to be able to transport those electrons," van Driel said.

While researchers focused on magnetism deal largely with up and down spins, this all-optical solution is also concerned with the full range of spin states in between. Van Driel is actually trying to generate these mixed spin states (a.k.a. superpositions) in electrons because they will be able to represent even more information.

"With respect to new ways of processing and storing information, the key is to take advantage of these in-between states," he said. "This provides extra information-carrying capacity."

Just how these mixed states can represent extra data is a bit confusing. Like much of quantum physics, the logic behind this theory sounds like it comes from the Wonderland. Everything is so different behind the looking glass. Similarly, the laws of physics seem to change into something beyond our everyday experience when it comes to the very small.

But the basic, though seemingly unbelievable reason is that mixed spins actually represent several different spin states. It's like one object that's really two.

'Viable technology based on spintronics will be available in the next five years. Of that I'm absolutely confident.'

– SANKAR DAS SARMA
professor and researcher at the University of Maryland

As electrons in a mixed spin state interact with other particles, they tend to fall back into either a spin-up or spin-down state in a fraction of a second. But van Driel said that's likely long enough to use them to briefly hold data used in rapid computer processing.

Right now, the University of Toronto team is verifying its work, checking the strength of the currents and seeing how long they will retain certain spin characteristics.

"This is a very pioneering area and there is an awful lot of fundamental work that has to be done before one can talk about devices," van Driel said.

Spintronics will also be an important part of the much-hyped, though far from realized, quantum computer. Such a computer would use the laws of quantum physics to achieve significant improvements in processing power. But Das Sarma said such a machine is at least 50 years away because it would require reading the spin of individual electrons.

"You can think of each spin as a little bar magnet, but it's also an incredibly weak bar magnet, so measuring it is a very tall order," he said. "And for quantum applications, that needs to be done."

Fortunately, there are simpler spintronics applications that will be perfected much sooner. Both van Driel and Das Sarma are confident that other spintronics technologies will emerge in the next couple of years.

"Viable technology based on spintronics will be available in the next five years. Of that I'm absolutely confident," said Das Sarma. "Whether that will actually go into any consumer applications or not, I simply don't know. That involves a business model."

And Das Sarma admits he's no expert on profit models. But there's a growing sense that the technology will prove valuable. The Institute of Physics, an international professional association, estimates that the potential market for spintronics will be worth hundreds of billions of dollars a year.

Das Sarma's own work is funded in large part by the U.S. military. He said he gets about 80 per cent of his $1 million budget from the U.S. Department of Defence.

"The big word within the Department of Defence now is multi-functional," he said. "You have one device that can do 50 different things. It needs to be small, robust and flexible."

And he believes that spintronics will likely be able to meet those needs, by combining traditional electronics, magnetics and optics. It would be like having your electronic central processing unit, magnetic hard drive and optical CD player all in one piece, on one medium — instead of the current computer system which connects separate devices that lose precious processing time sending and converting data between one unit and the next.

It might sound like a fanciful idea, but Das Sarma notes that much of science seemed ridiculous at some point. When lasers first came out, he said, no one thought they would have any use at all. They were big and cumbersome and took a lot of time and effort to operate. Today, they are used in all kinds of home electronics and medical applications.

"Just look at the history of technology," he said. "When a new fundamental aspect of nature is conquered, invariably there are applications. And often those applications come from a direction that nobody knows of."

RICK MADONIK/TORONTO STAR

NEW SPIN : Henry van Driel, chair of the U of T's physics department, does spintronics research using polarized light waves.