Future of computing may lie in a coffee cup

The Star-Ledger (Newark, New Jersey)

November 10, 1997 Monday

FINAL EDITION

Section: TECH; Pg. 39

Length: 764 words

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Dateline: CAMBRIDGE, Mass.

Body

You won't have to worry about spilling coffee onto the computers of the future. In fact, it may be necessary.

Professor Neil Gershenfeld of the Massachusetts Institute of Technology's Media Laboratory is happy to demonstrate, pouring a cup of muddy java into a thin, coil-wrapped cylinder.

He's illustrating his concept of ***quantum computing***. It's a bold idea, intended to take computing deep into the next millennium, after conventional methods for shrinking transistors reach their physical limits.

He has competition. Some of the country's brightest minds are looking 20 years down the road for new ways of computing. They contemplate chemical fabrication processes called nanotechnology, optical systems that transmit data with light pulses instead of electrical signals, and even organic methods for growing some sort of processor.

It's a worthy challenge for the Media Lab, a corporate-sponsored idea factory.

Gershenfeld says ***quantum computing*** can turn ordinary molecules into processors. He thinks developing this new breed of computers will be cheaper than trying to extend the limits of transistor manufacturing. He says the cost of building new and improved chip plants could exceed the gross national product of Planet Earth in just two decades.

Quantum computers would pack a number-crunching wallop unlike anything known today. In a single day, one quantum machine could solve problems that would tie up today's fastest computer for the lifetime of the universe - a pretty long time.

This quantum leap will bound into something called "Hilbert space," the "quantum part of the universe we don't use. It's the only untapped resource," says Gershenfeld.

For those who spent physics class in Hilbert space, here are the Cliff Notes:

Computers process information in strings of 1s and 0s stored in transistors. ***Quantum computers*** could store "qubits" in protons, where their "up" or "down" spin would correspond to 1s and 0s. Now for the weird part. According to quantum theory, protons lead a dual existence. They can be up and down at the same time. This translates to an exponential rise in the number of calculations they can perform simultaneously.

Any questions?

Liquids offer the most stable environment for this kind of programming, says Gershenfeld. Caffeine molecules just might work.

"All along, molecules have known how to compute. Ordinary molecules. Caffeine in coffee knew how. We just didn't know how to ask the right questions," says Gershenfeld, who has made a rudimentary ***quantum computer*** he compares to the Altair, forerunner of the PC. Though it may take decades to perfect, he is confident that, eventually, a computer "will be a container, where you pour in processor fluid."

Meantime, at the legendary Xerox PARC, the Palo Alto (Calif.) Research Center, Ralph Merkle is betting on nanotechnology, a chemical process for creating complex structures molecule by molecule.

"Think of rearranging atoms and molecules the way you might arrange and rearrange Lego blocks," Merkle says. "Whatever the technology and whatever we wish to build, we must build it with a great deal of precision."

Today's photochemical methods, which can print millions of transistors on a stamp- sized chip, are not precise enough to keep the Incredible Shrinking Transistor shrinking indefinitely. In today's process, atoms are sprayed "all over the place" (a process called doping) to produce the desired electrical qualities in a semiconductor chip.

"It's like firing screws, wrenches and tools at a car to build a car. It's not the best way to build a car," says Merkle.

But don't hold the phone for news on nanotechnology. Even synthesizing simple molecules is a painstaking task for modern chemists. Merkle says it may be decades before they can build structures with millions or billions of atoms. Moreover, research is scattered; he thinks it will take something akin to the Apollo project to move any of these concepts from science fiction to reality.

Nor is Merkle is optimistic about replacing electrical pulses with light waves, another grand strategy of the future. Although light works well for long-distance communications (the phone companies uses lots of lasers today), he says light wavelengths are too wide for advanced computing. "We want to build devices much smaller than that," he says.

William Brinkman of Bell Labs says all this talk of a sci-fi future is, well, premature.

"Silicon won't run out for another 15 years, and it will be pretty awesome at that stage," he says. "Nobody talks about replacing the light bulb. It's pretty much what it's always been."

Graphic

1. Professor Neil Gershenfeld of the Massachusetts Institute of Technology's Media Laboratory demonstrates one idea for ***quantum computers***, sort of a Mr. Fusion for the next millennium.

Classification

Language: ENGLISH

Publication-Type: Newspaper

Journal Code: nsl

Subject: NANOELECTRONICS (90%); ***QUANTUM COMPUTING*** (90%); QUANTUM MECHANICS (89%); SCIENCE & TECHNOLOGY (89%); PHYSICS (77%); MANUFACTURING FACILITIES (74%); NANOTECHNOLOGY (74%); RESEARCH INSTITUTES (72%); GROSS NATIONAL PRODUCT (70%)

Organization: MASSACHUSETTS INSTITUTE OF TECHNOLOGY (91%)

Industry: COMPUTER EQUIPMENT (90%); NANOELECTRONICS (90%); ***QUANTUM COMPUTING*** (90%); MANUFACTURING (79%); DATA TRANSMISSION (77%); SEMICONDUCTOR MFG (75%); MANUFACTURING FACILITIES (74%)

Geographic: NEWARK, NJ, USA (88%); EARTH (79%); MASSACHUSETTS, USA (74%); NEW JERSEY, USA (73%); CALIFORNIA, USA (66%)

Load-Date: April 18, 2007

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