

The Undead

By George Dyson
(Wired Magazine)

On a recent Saturday morning, Bob Swartz, founder of Cardamation Company Inc., showed me around his warehouse, a huge space where a once-mighty techno-dinosaur still roams, happily swishing its tail. Based in Phoenixville, Pennsylvania, Cardamation is the last establishment in the digital universe that can sell you a full line of new, off-the-shelf machines for processing punch cards - those bit-storing relics from days gone by, when computers usually meant IBM, and the cards themselves were seen to symbolize eerie, antihumanist agendas. ("Do not fold, spindle, or mutilate" and all that.) We're surrounded by piles of half-dismantled, half-assembled, strangely electromechanical stuff that looks more Victorian than Orwellian. In the age of desktop computing, we've been swept into a past where the machines are bigger than the desks.

Take, for instance, Swartz's Cardamation RP82, a nifty, clunky gizmo that reads, punches, prints, and duplicates punch cards - and weighs about 350 pounds. It's no museum piece, though. Swartz has sold several hundred of the line over the past 15 years, at prices ranging from \$12,000 to \$29,000.

"We're having a boom in punched cards!" he exclaims, using the more formal terminology for punch cards favored by technical types. "As fast as the machines get built they disappear."

These days, orders for punch-card processing equipment come in steadily to Cardamation, whose clients, mostly in the US, include a number of Fortune 500 outfits, among them the Ford Motor Company and several defense contractors. The mega-usages of yore - Social Security checks, income tax refunds - are history, but punch cards still cling to life. Though few companies rely on punch-card programming, many still maintain data - especially payrolls - on cards. Swartz's company produces new card readers and punches, keeps old machines running, and builds interfaces that allow old and new readers to communicate with modern PCs. Indeed, anyone who has vital data cut into punch cards will sooner or later wind up talking to Bob Swartz.

Swartz, now in his 70s, has been involved with computers for 40 years. In the '60s, he worked for Sperry Univac, a pioneer computer maker, where he delivered punch-card systems to Western Union and other customers starting to use computers for networked communication rather than data-processing alone.

"These were large communication nodes, with two football fields of computers each," he says, recalling that clerks on roller skates sometimes transferred strings of code, on punched paper tape, between incoming and outgoing lines.

After leaving Sperry in 1969, Swartz sold excess product lines for a company called Electronic Associates. "They wanted to go into new things, small computers," he says. The gear they ditched included a line of card punches and card readers that Swartz ended up buying. Cardamation, the company he founded in 1978, reached critical mass as other manufacturers - like Documation and Decision Data - abandoned the punch-card business. Swartz picked up the pieces.

For the most part, inertia is what keeps his company flush: Punch cards work just fine for many chores, so why upgrade? "The average person still using punch cards - and not panicking about it - will just sit thinking about the problem, philosophizing," says Swartz. "It's always next year, next quarter, they're going to get rid of them." But they usually don't.

"So," says Swartz with a smile, "they continue to need the equipment."

Punch cards were once the ultimate in high tech. They were introduced in the middle of the 18th century, when Jacques de Vaucanson, a Frenchman, invented a card-controlled automatic loom. With

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his device, patterns coded once on a sequence of cards could be executed repeatedly in silk. Later, in the early 1800s, Joseph Marie Jacquard improved on the punch-card technology of the original device. But it was the US Census Bureau that launched the business of punch-card information processing, providing the digital substrate upon which modern computing took hold. In 1889, on the eve of the 11th Census, a mechanical engineer named Herman Hollerith explained his plan for processing the American body count: He would store the Census info on cards rather than in ledgers, allowing for automatic processing of the results. "The records must be put in such shape that a machine could read them," he declared. "This is most readily done by punching holes in cards."

Then as now, punch cards are simple-looking things, rectangular pieces of stiff paper with a matrix of data positions defined by columns and rows. Modern cards are 80 columns by 12 rows, a total of 960 bits.

Hollerith counted 62 million people with some 50 million punch cards, delivering the Census for \$5 million below forecasts. He also developed electromechanical methods for reading, sorting, and tabulating the results. Relays and switches were arranged into rudimentary logic gates, using the same architecture that now pervades silicon devices at the submicron scale. Hollerith established the Tabulating Machine Company in 1896. Consolidated into the Computing-Tabulating-Recording Company in 1911, the outfit was renamed International Business Machines in 1924. IBM subsequently developed industry-dominating punch-card machines that were rented, not sold - until in 1956 the company was forced, under antitrust legislation, to make such devices generally available.

US consumption of punch cards peaked sometime around 1967, at approximately 200 billion per year - roughly 400,000 tons of paper. IBM closed the last of nine in-house card-manufacturing plants in 1984. The market has dwindled ever since, but there are still an amazing number of cards in play. Tiffin, Ohio-based US Card Corporation dominates the remaining market, selling some 5 million punchies per month.

Companies aren't eager to talk about their punch-card dependency.

"They said that the punched card as we know it now would be completely obsolete by the year 1975," says Mike Daughenbaugh, who heads the company, "but here we are in 1999!"

Who's using them all? That requires a little digging, since most companies aren't especially eager to talk about their card dependency. (Swartz, wanting to protect customer privacy, isn't much help, though he does tell the story of how a "well-known" entertainment conglomerate - not a client of his - recently had trouble getting out a payroll because the card reader bonked.)

One proud customer is Melville Clark Jr., a retired MIT nuclear engineering professor and Manhattan Project veteran. Now 77, Clark runs the Institute for Scientific Research in Music, a scholarly group that studies the physics and reproduction of sound. Not long ago, he rented a CT600 reader from Cardamation to read a pile of cards that contain digital "samples" of the sounds made by orchestral instruments. Clark had produced the cards back in the '50s and early '60s for use in his studies of sound properties and wanted to transfer the data to modern DC-120 cassette tapes.

"The cards were stacked on their sides, from floor to ceiling, across one complete wall in my house," Clark says. "We knew the day of being able to read those cards was passing. We finally panicked." It took nine weeks to read them all. "Now I can put the whole wall of cards in my pocket, on tapes," says Clark.

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Punch cards helped make the complexity of large factories manageable; remnants of this historical symbiosis can be found at the Ford Motor Company. Even now, when a dozen microprocessors are embedded in every new car, the punch card remains embedded in some of Ford's assembly lines.

"We're on the very last legs of using cards," says Larry Roguski, data processing manager at a Ford assembly plant in Saint Thomas, Ontario, a thrumming auto-hive about 150 miles northeast of Detroit. "We still have an IBM card reader, card punch, a couple of 083 sorters, and a couple of 129 keypunches." The data, which concerns the manufacturing status of each car, is sent electronically to headquarters by loading the cards in a mainframe and sending it out through a front-end processor to a mainframe in Detroit. "The cards themselves do not leave the plant," says Roguski.

Another punch-card user is the US Department of Agriculture's Cotton Division, in Memphis, Tennessee. "They have 14 card punches in operation that are used about five months out of the year," says Merritt Moon, a former head of automatic data processing. "We used to punch 15 to 18 million cards a year." Lately that's declined to roughly 400,000.

In the USDA operation, each card represents the "quality data" for one bale of cotton - a phrase that refers to cottony attributes like color and length of fibers. Each bale goes to a USDA classing office, gets graded, and then (somewhere else and sometime later) is sold. The USDA estimates that of the 18 million bales of cotton that will be classed in a typical season, about 1 or 2 percent will be recorded on punch cards. "We would have liked to get out of it," says Moon, sounding the "maybe next year" plaint. "But we still had a few customers who were holding on to these old punches."

On a much smaller scale, punch cards also remain popular among a handful of country clubs. "We're one of the last survivors, as far as I know," says Wayne English, an official with Club Technology in Irving, Texas, a company that provides software services for the private club industry. Some clubs still use punch cards as "chits" or "tickets" that are signed by the club member for dinner, drinks, and golf-course doodads. The cards are keypunched and read into a computer to produce a billing statement. "At the end of the month we sort the cards by account number and return the original," says English. "The signed tickets go back to the member with a statement."

Why does such a kludge-like system hang on? "It's your old-line clubs, your wealthier members-type clubs where dues are anywhere from \$200 to \$500 per month, and when members pay those kind of dues they want to get what they want. And these members want their ticket back with their statement."

Gremlins: Punch Cards and Y2K

One legacy of punch cards is 1999's infamous global headache: the Y2K problem. Y2K happened, in large part, because the space restrictions of a typical 80-column punch card put a premium on digital thriftiness, inspiring programmers to economize wherever they could. The fatal space-saver, of course, was the widespread decision to represent years using two digits instead of four - the binary poison pill at the heart of Y2K. Ironically, Y2K may help punch cards survive into the 21st century. Bob Swartz believes many companies that would like to abandon punch cards are now unable to hire the old-school programmers who could help them make the switch. Why? Because they're all busy working on Y2K.

As a student of technology less tantalized by the software (the cards) than the hardware (the machines), I return to Cardamation for a longer tour of the factory innards. I'm taken around by Bill Nagle, an energetic hardware-and-software virtuoso who has worked at the place nearly 20 years. As we roam wide corridors stacked high and deep with equipment, I'm reminded of childhood visits to the

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American Museum of Natural History in New York. Here, too, we have entered the hall of large reptiles, full of mighty machines enamel-skinned in dark green or gray.

Nagle stops to admire a really sizable piece of equipment. "An IBM collator, just sitting here, in case someone needs parts," he says. "Over here's an IBM 129 - the classic."

The IBM 129 is the workhorse of keypunches - the machines at the front lines of the digital revolution, cutting those perfectly rectangular holes in punch cards, translating everything from tax returns to poetry into ASCII text. Nagle hands me a spare punching head from the RP series, a unit that combines the heft of a machine tool with the precision of a watch. "A carborundum wheel slides the card, keeps the card tight and moving through there," he says, explaining how the card is fed through the punch station. Then he points to a set of razor-sharp blades. "There's the knives, quite a work of art. Made to keep on going."

Nearby, at a well-equipped workbench, a 26-year-old technician named Chris Wojakowski is assembling a CF300 card reader. "I've been in electronics since high school, went to tech school right up the road," Wojakowski tells me. "I went into the Navy, worked on F-14s, from radar to bombs. When I came here I remember walking in and thinking, 'Man, people still use this stuff!' I had seen a special on the Discovery Channel about the dawn of the computer age, and here it was."

Wojakowski's refurbishing job begins with him selecting any one of dozens of rebuildable machines stacked in back. "You've got to strip it all the way down," he says. "All the belts and rollers get replaced, new rubber, modifications to the plate under here because these rollers are not exactly the same. This is day four of this machine."

Wojakowski starts the card reader. "Oh, that's quiet!" he coos. "You don't get them like that a lot. That's nice!"

Elsewhere, James Alvord, who has been at Cardamation since 1983, is running diagnostics on a partially assembled sorter. Alvord, a no-nonsense man, is the master of all things electromechanical. He knows every machine down to its most inaccessible parts. He is the card whisperer.

He introduces me to a series of machines, starting with an IBM 084 sorter. "This will do 2,000 cards per minute. Now, this here is the CR300. It can run up to 600 cards per minute. I probably built 100 to 200 of these in my day, from scratch, piece by piece, part by part. I had that thing memorized, part numbers and everything."

We return to a sorter that Alvord is repairing. It sorts cards one column at a time, delivering them to 11 individual trays. "If the cards aren't perfectly flat," says Alvord, "it'll cause a lot of jams. Even the humidity in the air will affect the cards. You can have it running perfectly now, and then by the third day it just goes down hard."

Alvord is preparing for a major sorting job - a shipment of 70,000 cards from an East Coast metropolitan housing authority. He figures the sort will probably take a week or two, nonstop.

Now, he's ready to test the sorter. He loads it with a deck of cards and lets it run. Watching the machine is like watching a Las Vegas card dealer, vastly speeded up. The cards come shooting down the belt and flutter, effortlessly, into place, and it dawns on me that this is precisely the image I've conjured to visualize modern packet-switching. When you send a mes-sage over the Internet, it's broken up into a deck of separate packets that are reshuffled independently throughout the network

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and then resorted at the other end. As I watch the cards fly, I know that this is exactly what is happening - at megacycles-per-second rather than cards-per-minute - to billions of information packets all over the world.

Later, I mention this notion to Paul Baran, the telecommunications pioneer who developed high-speed packet switching at Rand. He likes the analogy, and recalls the role cards played when he was writing programs back in the '60s. "When I was exploring how a distributed network would behave under stress," he says, "the programs' characters were transcribed by an operator at a keypunch machine that punched out the requisite holes in the 80-column IBM cards."

It's a nice way to visualize it. Punch cards and packets involve twin processes - separated at birth, but related to the end.