EXHIBIT B

GARY KILDALL He saw the future and made it work. He was the true founder of the personal computer revolution and the father of PC software

1942–1994

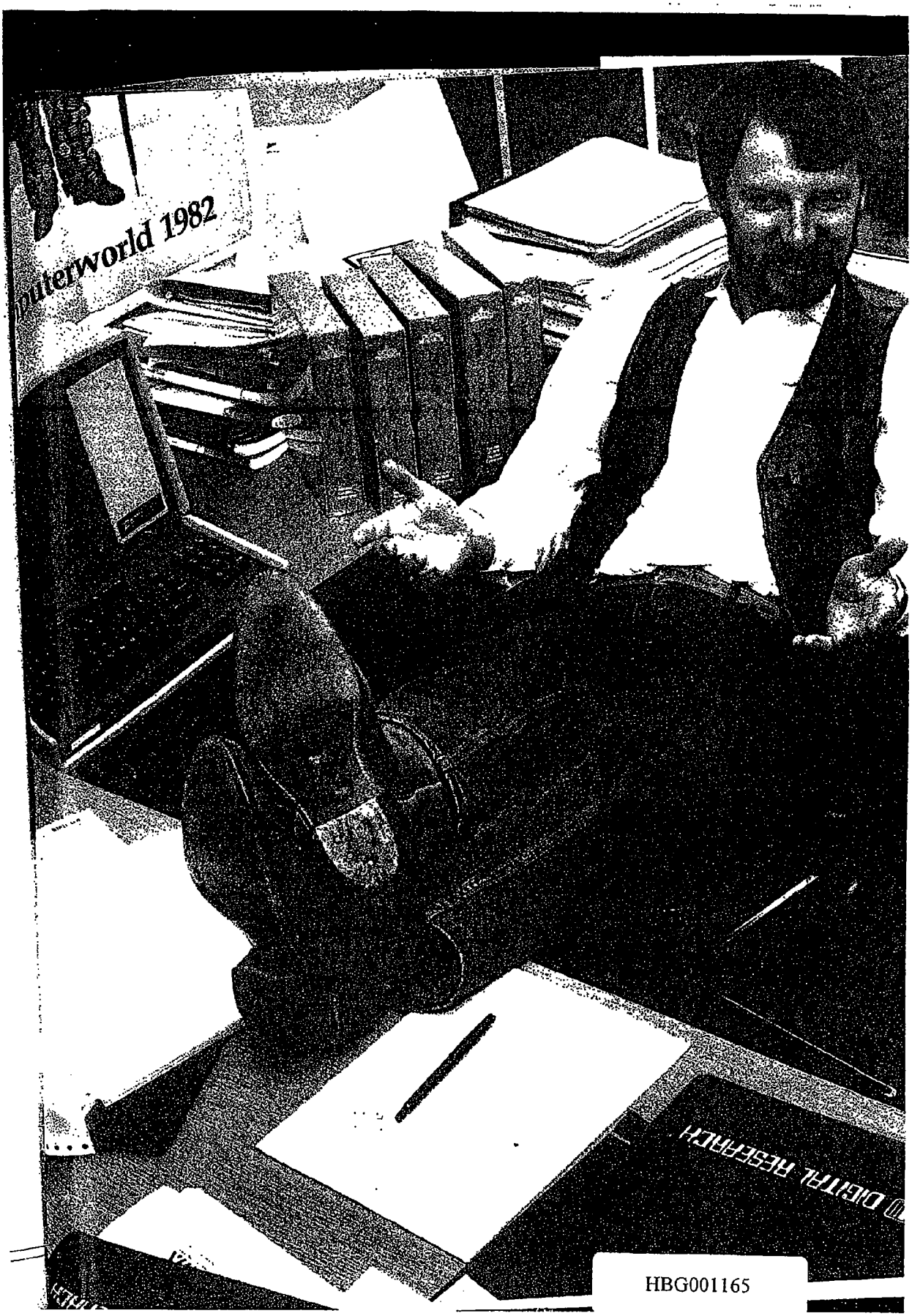
GARY KILDALL loved piloting his many aircraft, surfing his speedboats, roaring off on his motorcycles, riding the waves on his Jet Ski, racing his Lamborghini Countach S—at one time when he had more money than he knew what to do with he had the pick of 14 sports cars in his lakeside villa. But what Gary Kildall enjoyed most in his short life was sitting still for hours in a little office writing code for computers. "It's fun to sit at a terminal and let the code flow," he said. "It sounds strange, but it just comes out of my brain; once I'm started, I don't have to think about it." He would call colleagues in the middle of the night to tell them that a program had worked. "What a rush!" he'd shout. Author Robert Cringely's metaphor is apt: He wrote code as Mozart wrote concertos.

In the early '70s, he was utterly brilliant at programming—but that is an understatement of his crucial role in the personal computer revolution. He was the first person to realize that Intel's microprocessors could be used to build not just desk calculators, microwave ovens, traffic systems and digital watches but small personal computers with an unimaginable multiplicity of uses. Then, entirely out of his own head, without the backing of a research lab or anyone, he wrote the first language for a microcomputer operating system and the first floppy disk operating system before there was even a microcomputer, months before there was an Apple, years before IBM launched a personal computer. Kildall did it, moreover, in such a manner that programmers were no longer restricted by compatibility with the computer's hardware. In Kildall's system, anybody's application could run on anybody else's computer. It was the genesis of the whole third-party software industry. This alone would have been an astounding achievement.

SWEETHEARTS:
Photo booth self-portraits of Gary Kildall and classmate Dorothy McEwen

Kildall stayed ten years ahead of his time and never stopped pushing the boundaries of technology up to his untimely death just as the Internet was beginning to take hold. He pushed for preemptive multitasking, window capabilities and menu-driven user interfaces. He laid down the basis for PC networking. He created the first computer interface for videodiscs to allow nonlinear playback and search capability, presaging today's interactive multimedia. He built the first consumer CD-ROM filing system and data structures for a PC. With all this inventiveness, the "Edison of computers" was also a dedicated teacher; as his son, Scott, noted, it was his devotion to creating tools to help the world, rather than moneymaking, that led him to devote a great deal of time to a product called "Dr. Logo," an intuitive, nonabstract computer language program geared toward teaching kids to program, to use computers as learning tools, not merely game-playing machines. By the end of his life, he was working on wireless hardware connections. In all he did, he epitomized the openness of the early days of Silicon Valley, the zest for the next frontier, the conviction that the best technology would succeed in the marketplace on its own merits. He had the faith of the academic scientist that mankind advances less by the protection of knowledge than by its diffusion. Jacqui Morby, a venture capitalist, has an affectionate remembrance of his idealism from their first meeting. "He said to look for a red-bearded man in cowboy boots at San Joe airport, then he rolled up in a light plane and yelled from the cockpit for me to jump in for lunch at the Nut Tree. On a Nut Tree napkin he drew a visionary plan of an open industry in which the owner of the operating system would forswear going in for applications like word processing. He said that would create a dangerous monopoly and stifle innovation." Kildall was hardly a humorless missionary; he was unassuming, droll and generous. The bitterness that darkened the last decade of his life was similar to that inflicted on radio's Edwin Armstrong. Both men discovered that the sublime could come off a bad second to the mediocre, that misrepresentation and manipulation could prevail over truth and justice.

CODE KING: "It's fun to sit at a terminal and let the code flow. Once I'm started I don't have to think about it," writes Kildall, the endlessly innovative president of DRI, in 1982. Then he would put his feet up.



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"The day Gary went flying" has entered legend as the explanation of how IBM came to market an inferior operating system from Microsoft's Bill Gates that became the foundation of Gates's fortunes: Kildall, so it is said, preferred a joyride to a meeting with IBM and was too prickly to sign IBM's standard confidentiality agreement. The story is propagated by Bill Gates and others, and swallowed whole by computer historians. It is false. IBM tricked Kildall. And in the end it was not Kildall who missed an opportunity but the rest of us. Had IBM backed Kildall's system, the majority of computer users would have had multitasking and windows a decade earlier. By adopting MS-DOS, which was based on QDOS, a slapdash clone of Kildall's system, IBM and Microsoft forced users to endure more than a decade of crashes with incalculable economic cost in lost data and lost opportunities.

At the end of his life, Kildall wrote an autobiography, "Computer Connections," which has never been published. It is incisive, unaffected, moving and funny, suffused by Kildall's romance with technology. It informs part of the narrative that follows and is the source of the Kildall quotations, but nothing may ever be enough to drive a stake through the heart of the appealing myth of how Kildall missed becoming the richest man in the world. In his manuscript, Kildall writes, "I think I'll make a cassette tape of the 'IBM Flying Story.' I'll carry a few copies in my jacket to give out on occasion. There's only one problem. I tell this story, and after I'm done, the same person says, 'yeah, but did you go flying and blow IBM off?'"

GARY KILDALL's precise seafaring father, Joseph, long dreamt of building a simple machine to take the tedium out of finding just where a ship was on the face of the earth. Having taken a sexant reading and checked a chronometer, a navigator still had tedious calculations to do based on tables from the *Nautical Almanac* to correlate the exact time and date. Joe, who taught navigation at the family nautical college, envisaged just punching the data into his machine of cams and gears and turning a crank for the answer. "It wasn't until the microcomputer was invented," writes Kildall, "that the 'crank' was truly feasible," but his father's idea stayed in his mind.

Gary was a poor performer at Seattle's Queen Anne High School. He applied his technological gifts to rebuilding old cars and boats and carrying out pranks. He managed to rewire neighborhood phone lines so as to eavesdrop on his sister's conversations with her boyfriend. He invented and patented a type of Morse code device. But his English grades at Queen Anne were so bad he had to stay back a year. It turned out to be a stroke of luck: When he squeezed his lanky frame into the desk for his repeat year he found himself sitting next to a beguiling and witty young woman, Dorothy McEwen. His focus on irregular verbs suffered—they talked so much they had to be moved to different corners of the classroom—but she became his bride a few years later. Dorothy remembers, "He was inventive. He was like a little kid in a candy shop."

After high school, Gary followed his father, who had followed *his* father, Harold, in becoming a teacher at the Kildall Nautical School. Teenage Gary taught navigation and trigonometry for several years alongside his father and Harold, who did not stop teaching until the week before he died at 92. The family tradition was strong, so Gary's father did his best to sabotage Gary's plans when, at the age of 21, he announced he was abandoning ship to go to college. His ambition ran afoul of not only his father's protests but the fact that his grades at high school hadn't been good enough to qualify for the University of Washington. He petitioned the University regents to take into account his teaching at the Kildall Nautical School, and "by entirely too close a margin," he was admitted in 1963, the year of his marriage to Dorothy. She supported him while he studied—and study hard he now did. "The Kildall Nautical School," he writes, "taught me processes that high school hadn't. Such as the ability to do mathematics of a sort and, most important, the mental tools to dissect and solve complicated problems, and to work from the beginning to the end in an organized fashion." He got nothing but top grades.

Kildall found himself in a pivotal moment in the history of computers. The 1960s were a time of transition between mechanical and digital computing. He studied both; of the mechanicals, he dryly remarked that after a lot of complicated button pushing, "sometimes the resulting number was correct."

Kildall's deepest passion was for an important piece of the computer software called a compiler. Compilers are translators. They take computer languages understandable by people and turn them into the famous binary digits—ones and zeros—called "bits" for short, that the computer understands:

000011101010110000111110010100
0011010000001001, etc.

"They are sort of like natural language translators," writes Kildall, "who sit in a business conference and make English into Japanese. Compilers, when perfected, can be elegant to the point where you want to paste a printout on your wall, like artwork. OK, you have to be into writing compilers to get my meaning, but when your compiler works, you are very proud and want to show it off."

In 1966, the University of Washington bought a new Burroughs B5500, a computer powerful enough to run ALGOL, or Algorithmic Language—a series of procedures done by numbers. The computer follows algorithms to do mathematics much faster than people ever could. ALGOL was a precursor for today's PASCAL programming language. Kildall got himself a part-time job maintaining the Burroughs. He writes, "That old B5500 became my learning machine. I saw a ton of sunrises over that Computer Center." He became so gleeful having the computer to himself that at midnight he would put up a sign saying B5500 DOWN FOR MAINTENANCE. At 6 a.m. he would take down the sign after having played with the machine all night. "I learned from the architecture of the B5500 computer. In particular, I learned about data structures for organizing disk drive information."

His nocturnal exercises paid off. In 1967 he was accepted as one of 20 students in UW's first master's degree program in computer science. What the left hand of Providence bestowed, the right threatened to take away: He received a draft notice

consigning him to the army and the Vietnam War. "Damn, all of a sudden visions of rice paddies flew through my head. I know you're not supposed to use connections, but quite frankly, I didn't want to get shot at. Dad connected me with one of his [navy] buddies, and I got a repricve to finish my master's degree while I worked toward my commission as an officer." He spent two summers at the navy's Officer Candidate School in Newport, Rhode Island, in 1967 and 1968, became an ensign and, while waiting for assignment, taught data processing to sailors in Seattle. "It was a bummer. I was destined to become an officer on a destroyer tossing shells into the forests of Vietnam." Unbeknownst to Kildall, the president of the University of Washington, Dr. Charles Odegaard, had been impressed by Kildall's computer work in 1969 and arranged for him to have a decisive interview shortly before he was due to be posted (and he had graduated with honors). The navy captain he met with stared Kildall in the eye. "Mr. Kildall," he said, "you have a choice to make." He could become either an officer on a destroyer or an instructor in mathematics and computer science at the Naval Postgraduate School in Monterey, California. Kildall recalls: "This particular question made me understand the length of a microsecond. 'Well, sir,' I said, 'I would like dearly to serve my country in battle, but I think I shall take the second option, if you please.'" The captain warned him that if he taught at the Naval Postgraduate School, he would probably not reach the level of admiral. "I took a pensive stance for a moment and then told him that I would accept that risk."

He and Dorothy settled down to family life in the pleasantly sleepy town of Pacific Grove on the west edge of the Monterey peninsula. When his three-year tour of naval duty was up in 1972, Kildall kept a link with the school as an associate professor but returned to the University of Washington to pursue his Ph.D. His thesis topic was to optimize the translation of language into computer-readable form so as to reduce the amount of memory required. He called the project Global Flow Optimization. After several months, Kildall made a program that worked mathematically but he could not prove his process was more efficient. He slept little, struggling vainly for an answer. "I just sat and sat and sat in my UW grad student office, resting my head in both hands until my eyes shut by themselves late [one] evening. Nothing. Then, in an instant, the proof came to me. I wasn't even paying attention to it. I awoke in an instant and wrote the entire proof of my central theorem, not finishing until sunrise. I guess that's why they put lightbulbs over cartoon characters. The discovery of this proof was one of the grandest experiences of my life, except, of course, for the time I visited Niagara Falls."

KILDALL'S CHOICE: In a microsecond he lost the chance to be an admiral.

In 1972 a colleague showed him an ad in *Electronic Engineering Times* saying, "Intel Corporation offers a computer for $25." Actually, it was offering the four-bit computer chip, measuring approximately 0.8 to 0.3 inches, designed by Intel's young Ted Hoff for a Japanese desktop calculator but released for general sale at Hoff's urging. The cost was $25 only if you bought 10,000 of them; the price jumped to between $45 and $60 if you bought just one. But customers using the 4004 chip would first need to design a custom board-level or box-level system with memory, power suppliers, keyboard, display and cables. To help customers get started, Intel began selling various board-level "development systems" with enough memory to demonstrate chip operation and to run, test and design new programs. Still frustrated by the $3 million IBM mainframe, Kildall was intrigued. He had never heard of this "little chip company," but he sent for specifications for the first development system for the 4004. It was a little foot-square blue box called the SIM4-01, with 2,300 transistors on the chip and read-only memory (ROM), but the price was $1,000 plus $700 for a Teletype. He did not have enough money for both on his $20,000-a-year salary.

He got around this by faking the operation of the little 4004 on the big IBM 370. As he programmed the simulator, the limitations of the chip drove him crazy, but he saw the potential of escaping from the room-size IBM mainframes (and the refrigerator-size minicomputers from Ken Olsen's Digital Equipment Corporation). "This [4004] was a very primitive computer by anyone's standard, but it foretold the possibility of one's own personal computer that need not be shared by anyone else. It may be hard to believe, but this little processor started the whole damn industry. . . . There, in 1972, my dad's navigation 'crank' had arrived in the Intel 4004, but there appeared to be some major programming work to get the crank to actually work."

The 4004 had no trigonometric functions, so Kildall spent months programming the chip to find sines and cosines. After debugging the program on his simulator, Kildall knew he had something that might interest Intel. He called a friend there and offered to swap the 4004 simulator for a real chip, a $1000 SIM4-01. The Intel engineer was less interested in the simulator than in the trigonometric functions Kildall had written. They made the trade, and Kildall had his own 4004.

There was a long and tedious year's journey to make anything of a machine that could be fed data only four bits at a time and had no monitor. Kildall describes the process: shining a UV light through a quartz window for 30 minutes to erase 256 bytes of space on the EPROM (erasable programmable read-only memory) so there was room for his own little program; feeding paper tape into a Teletype and then line by line typing a program written in hexadecimal code, known as machine language; fixing the typing errors by going back to the beginning; running the corrected code to load each EPROM. "We pioneers had to do all this stuff two decades ago so you can enjoy your sweet little laptop while cruising placidly over Colorado at 37,000 feet. . . . For reference, an average JFK to

SFO flight takes about six hours. That's the time it takes to program twelve EPROMs of 256 bytes each, or a total of 3,072 bytes of memory."

A laptop today does the same in a fraction of a second.

Nonetheless, Kildall built a briefcase computer—"it may have been the first personal computer"—and took it around for demos, lugging with him the 60-pound Teletype. He inspired hundreds, one of them a young engineering graduate at the University of Washington, Tom Rolander, who later became important in his life. Intel, too, was impressed by Kildall's bubbling imagination and engaged him as a part-time consultant, initially to build a simulator for the new microprocessor the company was working on, which was to be more sophisticated than the 4004 and ten times faster. Software applications were a low priority then at Intel; the software "group" Kildall joined part-time was only two people, tucked away in a space the size of a small kitchen. Kildall devised a *Star Wars* kind of video game for his briefcase computer based on a 1972 idea by Intel engineer Stan Mazor, a codeveloper of the microprocessor, and the pair of them showed it off to one of the founders of Intel, Bob Noyce, a gentle, smiling presence who occasionally walked encouragingly through the little software corner in his white lab coat. Kildall writes, "Noyce peered at the LEDs blinking away on my 4004. He looked at Stan and me and said, bluntly, that the future is in digital watches, not in computer games." Intel had just bought Microma, one of the first digital watch companies, which was not long afterward beaten into the ground by a flood of Japanese digital watches. Intel thus passed up an opportunity to lead the video game industry. Kildall, in a judgment that would reverberate for him, too, writes of Noyce: "He, like all of us, made some decisions that are right, and some that could have made the future unfold in a different manner." What mattered to Kildall was that in building an industry in microprocessors, "Bob treated his people with dignity."

IN THE COCKPIT: Kildall writes: "Tom Rolander (right) was co-pilot in flying and in life. Many evenings we'd fly across the United States, watching the stars in pitch-black background. We'd talk about the beauty of nature, the inner feelings of relationships between us and our wives."

Intel was abuzz in 1973 with the triumph of the 8008 chip, which doubled the power of its first microprocessor, and Kildall was drawn to spend more and more time there. After his "eyeballs gave way," he would spend the night sleeping in his Volkswagen van in the parking lot. He became a trader in an electronic bazaar, swapping his software skills for Intel's development hardware. One morning, he knocked on the door of Hank Smith, the manager of the little software group, and told him he could make a compiler for the Intel 8008 microprocessor so that his customers would not need to go through the drag of low-level assembly language. Smith did not know what Kildall meant. Kildall showed how a compiler would enable an 8008 user to write the simple equation $x = y + z$ instead of several lines of low-level assembly language. The manager called a customer he was courting, put the phone down and with a big smile uttered three words of great significance for the development of the personal computer: "Go for it!"

The new program, which Kildall called PL/M, or Programming Language for Microcomputers, wrote microprocessor applications such as operating systems and utility programs, and Intel used it for decades afterward. Kildall's reward was Intel's small new computer system, the Intellec-8. It must have been the first commercial personal computer, Kildall notes, though no one thought of it as that. He borrowed $1,700 to buy a printer and a video display. What irritated him was that he could not operate the Intellec independently of the expensive DEC PDP-10 minicomputer now installed in the navy's classroom at Monterey—unless he could contrive a way for the Intellec to store a great deal of data. As technology writer Al Fasoldt writes, without a disk operating system the computer is just too dumb to do anything useful.

Experiments with cassette tape did not work; then Memorex, just down the street from Intel, came up with an eight-inch floppy disk for mainframes. It held 250,000 characters, moved data at 10,000 characters a second (compared with ten characters a second with the Teletype paper reader) and in theory gave nearly instant access to any portion of the stored data without rewind or fast-forward. Wonderful—but the communication between Kildall's small computer and the disk drive needed a controller board to handle the complex electronics, and there was no such thing. "I sat and stared at that damned diskette drive for hours on end and played by turning the wheels by hand, trying to figure a way to make it fly. The absence of a controller for that floppy drive was the only thing between me and a self-hosted computer. It drove me nuts." The equipment sat in his office for a year, the software genius defeated by hardware. "I'd just look at it every once in a while. That didn't seem to work any better."

He went reluctantly back to his DEC minicomputer and built an operating system he called CP/M, or Control Program for Microcomputers, mimicking the name PL/M. (CP/M originally stood for control program/monitor.) He knew the program was sound, but he still could not get it to communicate with the disk. Desperate, he called his friend from the University of Washington, John Torode, who had a Ph.D. in electrical engineering. Torode worked on it for a few months and came up with a neat little microcontroller. Kildall held his breath: "We loaded my CP/M program from paper

tape to the diskette, and 'booted' CP/M from the diskette, and up came the prompt:

A>

"This may have been one of the most exciting days of my life, except, of course, when I visited Niagara Falls one day."

Kildall opened a file, stored it on the floppy and it appeared in the directory—commonplace stuff now but a dramatic achievement then, the world's first disk operating system for a microcomputer. Walking back to Kildall's home for a celebratory bottle of red wine, the programmer and the engineer told each other, "This is going to be a big thing." But where was the market? Ben Cooper, an entrepreneur from San Francisco, paid Kildall to write a program for an arcade astrology machine he was making: Put in a quarter, dial your birth date and out comes your future. Kildall built the software system in a small converted toolshed at the back of his home. When Ben mistakenly entered the command "del *.*" instead of "dir *.*" to get his files, he deleted all of the files on the diskette. And that is the origin of the prompt "Are you sure? (Y/N)."

Cooper finally got his machine installed on Fisherman's Wharf in San Francisco, and the entrepreneur and programmer sat on a bench one summer evening to see what would happen. A hand-in-hand couple put in a quarter, did not bother with the dial and walked off happily enough with someone else's horoscope. "Because of it," writes Kildall, "they are probably married with seven children to this day." But nobody wanted to buy the 200 machines Cooper had built.

Kildall's own happy marriage (with "two great kids, Scott and Kristin") hit a reef in 1974, but it was retrieved by Dorothy's willingness to help make a business out of the CP/M program. She had not had a formal college education, but she had worked in a phone company's customer service department and, as Kildall writes, often outsmarted the grads who came to him. Gary continued to teach at Monterey while Dorothy handled the early business, sending diskettes to customers responding to a $25 advertisement she and Gary had bought in the famous insider magazine *Dr. Dobbs' Journal of Computer Calisthenics and Orthodontia* at the suggestion of its founding editor, Jim Warren. Demand for the diskettes was slow at first; the market was made up of early computer enthusiasts. "We started in a corner of the bedroom," Dorothy told us. "There was no long-term plan. We put no money into the operation. We didn't have much savings. We lived off Visa and MasterCard."

The first big break was a sale of a word-processing program in 1975 to Omron, which made cathode ray tubes (CRTs) for newspaper editing. It was the first company to build hardware using CP/M. Kildall and Torode split the $25,000.

Earlier in the year, in Albuquerque, New Mexico, Ed Roberts had come out with a mail-order kit for hobbyists for the first commercially successful personal computer, the Altair, which sold for $500. It had an Intel 8008 microprocessor inside with toggle switches on the front panel. It was notoriously difficult to use, with only 256 bytes of memory and no screen or keyboard.

A new company with wider ambitions to sell to the general public was formed in San Rafael, across the Golden Gate Bridge from Silicon Valley, calling itself IMSAI. It had promised delivery of a diskette operating system and had not even begun to figure it out when Glenn Ewing, a former naval student of Kildall's, engaged as a consultant, told IMSAI about CP/M. "Glenn came to my toolshed computer room in 1975," writes Kildall, "so we could 'adapt' CP/M to the IMSAI hardware. What this means is that I would rewrite the parts of CP/M that manage things like diskette controllers and CRTs (screens). Well, come on, I'd already done this so many times that the tips of my fingers were wearing thin, so I designed a general interface, which I called the BIOS (basic input/output system) that a good programmer could change on the spot for their hardware. This little BIOS arrangement was the secret to the success of CP/M."

Kildall had in essence created a digital pancake. The underside could be adapted to fit different hardware configurations. But the top part was truly revolutionary; it did not have to be rewritten. Kildall developed an instruction originally dubbed "Call 5" and later called "Int 21"; any application program could interface with his operating system. This was a phenomenal advance. It liberated software from hardware. Any application could thereafter run on any computer.

According to Kildall, he and Ewing built the system on a lovely afternoon, sitting in the toolshed across from the house with its hummingbird feeders, a pastoral scene for a computer revolution, for that is what it portended. Kildall's friend and future partner, Tom Rolander, explains it well: "Think how horrible it was for the software vendors before that time. They would have to have different copies of their program configured to different pieces of hardware"—and there were scores of specialized pieces of hardware. Imagine a world where each model of car required a different kind of gasoline—that's what it was like for computer operators before Kildall's innovations. Kildall created the bedrock and subsoil out of which the PC software industry would grow. He licensed his system to IMSAI for $25,000 and felt rich.

Clearly, there was a business here, but Kildall found the transition from inventor to innovator wrenching.

He had fun with his classes at Monterey, where the graduates revved up on his enthusiasm and readiness to give everyone a chance. He led them through the steps to design a wristwatch computer that monitored a navy diver's nitrogen pressures at varying depths to avoid the "bends." His classroom, in the words of Michael Swaine, editor at large for *Dr. Dobbs' Journal*, was probably the world's first academic microcomputer lab. But it was time to move on.

"He just loved teaching," said Dorothy. "It was a hard decision for him to quit school full-time." But Dorothy encouraged the decision they made in 1976 to start a full-time mail-order business they called Intergalactic Digital Research—"intergalactic" only because someone else held claim to "Digital Research" for a couple of years. It happened—coincidentally says Kildall—that at this moment new management at Intel ended his consultancy. There is a story that he offered the whole system he was designing for $20,000 and that they missed a golden opportunity; the fact was, says Kildall, that Intel simply wanted to build their own operating system, and ultimately, that was a "godsend"

for him. But it is clear from his memoir he was also disenchanted with Intel. Recounting how marketing manager Jim Lally racked up the price of the Intel 8080 microprocessor with paper tape and floppy disk drive to $12,000, he writes: "I was dumbfounded. This was a direct attempt to block advancement in our society's technology for the profit of Intel. It was a good lesson for me. I protested. I wasn't even listened to or even considered. But Jim Lally is now a very successful venture capitalist."

Nevertheless, Kildall's ethics proved shrewd marketing. He initially proposed selling his system for $29.95 a disk, i.e., giving it away. At Dorothy's insistence, he asked $70—which was still absurdly cheap. She remembers going down to the post office in 1976 hoping to find checks that would keep the company alive a little while longer, but by 1978 it was a roaring success, leaving other proprietary systems in its wake. CP/M made the Intel operating system look like a scam; in addition to its being cheap, Kildall's system was small, it was fast, and it would run on all Intel computers and competing Zilog Z80s. "No other software product had been priced our way before," Kildall writes. "OK, CP/M's price came up to $100 per copy with version 1.4, but no one seemed to care." That denomination was in itself another Kildall invention: The first digit was a "major" revision and the decimal point indicated a minor revision for update. "You charge the manufacturers and customers a "minor" fee to get the minor revision and then issue a "major" revision, like CP/M 2.0 and charge a major fee. That became the way microcomputer software was labeled and for that purpose only."

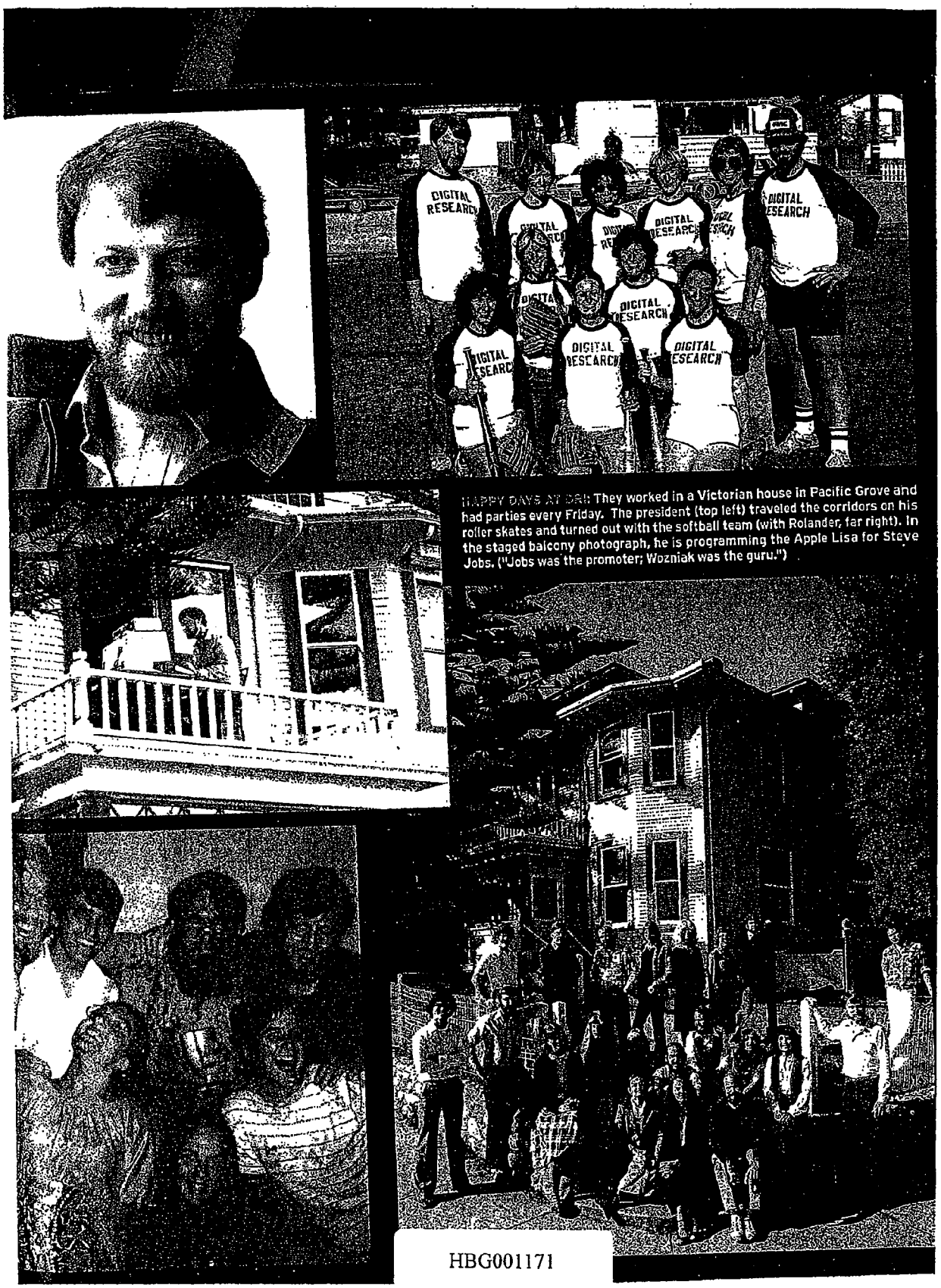
In 1978, when sales were $100,000 a month with a 57 percent profit margin, Gary and Dorothy moved into a spacious converted Victorian house in Pacific Grove overlooking the waves of Monterey Bay, where Gary worked under the cupola and Dorothy ran the business office on the ground floor, Dorothy abandoning the name Kildall for her maiden name, McEwen, to avoid the aroma of a mom-and-pop operation. "It was a very exciting time, and we were just very naive about everything, about starting a business, about the industry," Dorothy recalls. "We were young. The grown-ups hadn't come yet." They gradually recruited a young staff, students, professors and friends and installed the programmers out of sight on the second level of the house. The atmosphere was zany; as Kildall put it, a lot of marriages, a bunch of babies. People came to work barefoot, in shorts, and in hippie dresses; anyone in a suit was a visitor. One candidate for interview with the boss found herself talking technology with a red-bearded Roman emperor in a toga. Tom Rolander, visiting Kildall after three years working as an engineer at Intel, remarked that as a pilot he recognized the model airplane on Kildall's desk. Within minutes, Kildall bundled him into a sports car for a fast drive to the airport and a flight in the real plane, a Cherokee 180. Two days later Rolander was at work in Pacific Grove writing the multitasking version of CP/M.

Rolander was with Kildall through all the emerging triumphs and crises. Kildall writes: "Tom and I had a knack about how we worked together. I would create new stuff, write programs, and he would clean things and make them products. Sometimes the products were good, and sometimes they weren't. But that's how this world works. You don't get a home run every time." Rolander, the son of a preacher, was described by one associate as Tom the Cannon. "What he meant is that you aim Tom in a particular direction and light the fuse. Tom really doesn't care what direction it is; he only wants to work 80 hours a week on an interesting software problem." He is today still a lean, focused man exuding fitness. Visitors to his office inclined to pick up his bicycle in a corridor find it impossible to move. Rolander loads it with heavy bricks to make sure he gets a proper workout. He might equally be called T-for-Thoroughness Tom. "Tom learned and practiced calligraphy," writes Kildall. "During our friendship, he wrote [out] *The Prophet* in calligraphy for me. I know it took him many, many hours to do this." The two men flew together, jogged the Asilomar Beach and confided in each other. Writes Kildall: "At the time he was my copilot in flying and in life." On one scary night flight, Rolander saved both of them. Kildall, distrusting his instruments, mistook a string of lights crossing Lake Ponchartrain outside New Orleans for the horizon. They were half a second from crashing when Rolander, looking out of the right window, yelled the alarm. "With the airplane now in a bank," writes Kildall, "I went back on the gauges. Righting that Aerostar to 'instrument level' may have been the hardest thing I've ever done in my lifetime."

Kildall was not a daredevil pilot. He was fully instrument rated. But on the ground, he relished risky fun. For his 39th birthday in 1981, he was given a pair of roller skates, "the kind that look like tennis shoes mounted on a Formula One car." When the party ran out of champagne, he sped downhill on them to get some more, stumbling over small acorns to everyone's merriment. He liked the skates so much he rolled around on them in the corridors of the office. Alan Cooper, who made an accounting system using CP/M on an IMSAI computer, says Kildall got frustrated only when the company didn't function like a college. "Employees would come to him expecting him to solve business problems, marketing problems, personnel problems. He didn't know the answers; didn't really want to think about the problems. What he wanted to do was write code."

There was nothing wild and woolly about that. Flying more than 1,000 hours on business trips with Kildall, Rolander came to appreciate Kildall's very methodical approach to flying, whether for a brief bit of acrobatics in his Pitts biplane or for a journey across the country in a twin-engined Aerostar. "While my own personality would have prompted more spontaneous departures, Gary's would always be done after detailed weather briefings, fuel loading, and weight and balance calculations.

"Gary's programming was just as methodical. It always began with complete and detailed sketches of data structures on large sheets of paper. The coding never started until he had visualized and comprehended the overall design. From the preflight to landing, Gary was a consummate professional in his flying, paying attention to every detail and never getting flustered. He was always calm, confident and equally demanding of detail from his copilot. He would have me rehearse my ATC transmissions over and over so that I would sound like a professional. After all, we were



HAPPY DAYS AT DRI: They worked in a Victorian house in Pacific Grove and had parties every Friday. The president (top left) traveled the corridors on his roller skates and turned out with the softball team (with Rolander, far right). In the staged balcony photograph, he is programming the Apple Lisa for Steve Jobs. ("Jobs was the promoter; Wozniak was the guru.")

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flying up at 25,000 feet, close to the big commercial jet traffic. Gary paid just as much attention to detail in his programming. Unlike other designers, who are often content to paint the broad picture and then let the more junior programmers fill in the details, Gary designed, implemented and debugged his products."

By 1980 Kildall had sold hundreds of thousands of copies of CP/M and had redesigned his system for the new hard drives. His was the standard operating system for most PCs. For the young couple, it was a heady time. Gerry Davis, who was then the Kildall attorney, remembers the bank calling to ask if DRI's profits were real. Davis said they were. "But they're making 85 percent profits. That's not possible." Davis assured the banker it was true. The Kildalls had a virtual monopoly. The natural question, then, is how Bill Gates got into the act.

Bill Gates was a 13-year-old hacker when Gary Kildall had already written his compiler and was pursuing his doctorate. Gates and Paul Allen famously simulated one of Ed Roberts's computers on the Harvard mainframe and installed on it a simple program invented at Dartmouth College by John Kemeny and Thomas Kurtz called "BASIC," meaning "Beginners' All-Purpose Symbolic Instruction Code." It was primitive, but it enabled hobbyists to write their own simple programs. Gates and Allen formed a company in 1975, originally called Microsoft, to sell this BASIC interpreter out of Albuquerque, not far from Roberts's factory, but two years into Microsoft, Gates wondered if Albuquerque was the right location for his little business.

Gates came to consult with Kildall, who drove him along the Central California coastline, and while commiserating about the speeding tickets they both routinely collected, they talked of merging their two companies. "We invited him to stay that night at our home. Dorothy fixed a nice roast chicken dinner," writes Kildall. But he adds, "For some reason I have always felt uneasy around Bill. I always kept my hand on my wallet, and the other on my program listings. I found his manner too abrasive and deterministic, although he mostly carried a smile through a discussion of any sort. Gates is more an opportunist than a technical type. . . ." David Kaplan, the author of the engaging *The Silicon Boys*, says there seemed to be a gentleman's agreement that neither would get involved in the other's business. "DRI would stay away from languages, and Microsoft would leave operating systems alone."

Around this time, Kildall was sought out by Data General Corporation, located outside Boston, to write a whole new compiler for IBM's PL/I, "a dinosaur every bit as well done as Disney could have produced." He thought the project would take him nine months, but it ended up taking two years. It was by far the best compiler built for the Intel chip set, enabling a host of new applications, but it held him up making CP/M-86, a 16-bit version to run on Intel's 8086 chip—a delay that gave Bill Gates the opportunity of a lifetime.

Gates settled his enterprise near Seattle, Washington, of course. His breakthrough, in 1978, was Allen's design of a "Microsoft Softcard." This was an add-in board to the Wozniak-Jobs Apple IIe so that it would run CP/M and Microsoft Basic. The addition of CP/M gave Apple II users access to a large software base from the CP/M application suppliers. "I wanted a royalty," writes Kildall, "but Bill wanted a buyout and was stuck on that point. I sold him 10,000 copies for $2.50 each." Kildall adds with emphasis: "He signed agreements to protect the CP/M design under this license."

It was a wise precaution. Many people were pirating Kildall's design in the late '70s: Hundreds of "clones" had been made. Gerry Davis would issue warning letters, but Kildall found the most effective way to stop the rip-offs, instead of suing, was to drop in on the infringer and try a little shame. Roger Mellon bought an operating system from the Palo Alto Computer Store and was assured it was original. He was astounded when Kildall used the machine's built-in debugger to view Mellon's memory storage and embedded there was the message: "Copyright 1978, Digital Research." Mellon promptly signed up for a license. Kildall writes, "I put the copyright message in the object code for exactly that purpose, and you had to be a very sophisticated programmer to remove that message. Not only that, if it was removed, CP/M would not run because the operating system checked to see if the message was there before starting, using an encryption scheme that worked quite well." (Kildall had learned the encryption techniques at the Naval Postgraduate School.) In the fall of 1979 Roger Billings was doing very well selling a computer system out of his company in Provo, Utah. Kildall and Rolander flew seven hours in single-engine Piper Archer, only to have Billings make them cool their heels in the waiting room. With nothing to do, Kildall played with a sample Billings computer in the waiting room. Using his debugger program, he quickly entered the innards of the computer operating system. There, again, was his copyright message. Kildall writes, "Roger became quite friendly all of a sudden."

Another participant in these little morality plays was Rod Brock, a neighbor of Bill Gates's in Redmond. Brock, who owned a small company called Seattle Computer Products (SCP), was impatient for the CP/M-86 Kildall was developing for the more powerful 8086 Intel chip. Brock's revenues were running down, so he hired Tim Paterson to fill the gap. Paterson did it by taking a ride on Kildall's system with a program he officially called "Seattle DOS," but which he also called QDOS, for Quick 'n' Dirty Operating System. Kildall writes: "Paterson's Seattle DOS was yet another one of the rip-offs of the CP/M design. The CP/M machine code was taken apart, using CP/M's own DDT [its debugger], to determine the internal workings of CP/M in order to make a clone of CP/M's operation." Paterson has denied using CP/M source code but admits making the two systems similar to help translate programs into QDOS. "Because of the completely different file-storage format, none of the internal workings has any corresponding relation to anything within CP/M," Paterson says. John Wharton, the former Intel engineer and computer specialist who became a friend of Kildall's, neatly sums up the ethics of that: "I can empathize somewhat with the bind in which SCP found itself: unable to sell its 8086 hardware for lack of software and unable to buy the software it wanted. But for Mr. Paterson to cite the unavailability of CP/M-86 as justification for appropriating the 'look and feel' of a competing operating system and its utilities seems to me

analogous to telling a judge, 'I needed the car, Your Honor, and the plaintiff wouldn't sell me his, so I was forced to take it.'"

This would have all been a bagatelle, soon disposed of by lawsuit or shame, but for the curious behavior of IBM. Everybody in the computer world knew that Kildall had created CP/M—everybody, it seems, except the biggest beast in the mainframe jungle, in which personal computers had hitherto been almost invisible. In July 1980, IBM's top managers in Armonk, New York, set up a task force in Boca Raton, Florida, to report on the feasibility of mass-producing and mass-marketing a desktop computer. Philip "Don" Estridge was given just one year to get the secret project, code-named Project Chess, into the marketplace by buying components and an operating system with open architecture to facilitate add-ons—exactly as Kildall had designed. IBM chose an Intel processor. For the operating system they called not on Kildall and DRI in California, but Bill Gates in Seattle on the lazy assumption that he owned CP/M: Microsoft was then a tiny 40-person company selling a programming language that ran on CP/M. A whole IBM team of five headed by Jack Sams and Pat Harrington flew cross-country into Seattle on a Wednesday in August. Having ensured that Gates and his partner, Steve Ballmer, signed a tight confidentiality agreement, and a consulting agreement, they opened negotiations to buy a license for CP/M from Microsoft. Hello? Gates had to say it was not his system to license. According to Rolander, Gates phoned Kildall only to say that a "big client" was going to contact DRI and that Kildall should "treat them well." Then IBM phoned to schedule a meeting with DRI two days later.

This is where the myth begins. In his memoir, Kildall is quite specific (and Rolander confirms) that he arranged to meet the Project Chess team on a Friday afternoon. Knowing and explaining that he had a previously scheduled business trip on Friday morning (visiting an important CP/M distributor, Bill Godbout, at his factory in Oakland), he arranged an initial meeting between the visitors and Dorothy, who negotiated contracts; that very Friday morning, she signed an agreement with Hewlett-Packard.

The IBM team showed up as scheduled at 10 a.m. and the lawyer, well-known for his aggressive style, presented Dorothy with a ludicrously far-reaching nondisclosure agreement. According to Kildall, it stated, "All Ideas, Inventions, or other Information become the property of IBM." Anything IBM said would be confidential, whereas anything DRI said was not. Dorothy balked and gave the IBM team DRI's standard licensing agreement, which more than 1,000 manufacturers had already signed. There was a stalemate for a few hours. Dorothy would not sign IBM's broad agreement without knowing what IBM wanted. IBM would not reveal what it wanted until DRI signed. Dorothy sought the advice of Gerry Davis, who joined the meeting. He agreed with her that the undertaking asked for was too broad but thought it might be modified. He says, "Bill (Gates) signed that agreement because he had nothing to lose, because he didn't have an operating system."

Dorothy decided not to negotiate further until Kildall came back for the afternoon session. In the meantime, it appears, the IBM team fumed. There is an exponential arc to the revisionism that was to so amaze and dismay Kildall. In an interview with the *Times* of London in 1982, Gates said, "Gary was out flying when IBM came to meet, and that's why they didn't get the contract." *Accidental Empires*, a 1992 book by Robert Cringely and one of the seminal works on Silicon Valley, states that Kildall never bothered to show up at all and that IBM left DRI in annoyance without ever revealing what it wanted. Wrong, wrong, wrong, and this is a standard book on the origin of the PC. The Long Island newspaper *Newsday* wrote, "In a story often told, the starched-shirt IBM guys, after CP/M long-hairs canceled an appointment, turned to an unknown company called Microsoft, headed by an unknown computer geek named Bill Gates." (On a smaller point of accuracy, Tom Rolander was quite bald by that time.) Maybe a source for the absent Kildall story is Jack Sams, who in 1992 told James Wallace and Jim Erikson that he was sure Kildall did not turn up for the meeting, "unless he was there pretending to be someone else." Alfred Chandler Jr., who does not doubt Kildall's presence, writes in his 2001 book *Inventing the Electronic Century:* "Kildall was unwilling to sign the standard nondisclosure agreements on which IBM insisted. . . . If Kildall had been willing to accept the nondisclosure clause, and if Motorola's chip had been the first choice over Intel's commercially unpopular one, the underlying history of the personal computer during the critical decade of the 1980s might have remained much the same. But the industry's two most powerful players in the 1990s might not have been Intel and Microsoft." David Kaplan explains the credulity: "That's the Microsoft, and popular, version—and since winners tend to write history, it's the prevailing one."

In fact, when Kildall and Rolander arrived at Pacific Grove—on schedule—they met the IBM men in the early afternoon along with Dorothy and Davis. Once the nondisclosure agreement had been argued and agreed, with Kildall signing, IBM revealed its plans. Rolander demonstrated DRI's new MP/M-86, the brilliant new multitasking operating system that worked for Intel's 16-bit computers. (Gates long believed he persuaded IBM to adopt a 16-bit chip, but IBM had already decided on the 16-bit model according to Gates's biographers Stephen Manes and Paul Andrews.) In multitasking, Kildall was years ahead of anyone else. Rolander also discussed CP/M-86, the newest version of CP/M, which would be used to transition customers buying the new Intel chips. Ultimately, though, Kildall and Rolander wanted MP/M-86 to become the new standard. Kildall writes, "The new MP/M-86 was the operating system for the future, because it had built-in multitasking that supported the existing software base. It had built-in networking. Only today [1994] are we even considering these prospects. Clearly, the PC industry would be much more advanced if DRI had been allowed to introduce these products a decade ago."

Negotiations began over how much IBM would pay. According to Rolander, Kildall felt uncomfortable around the stiff, overdressed (by California standards) IBM men. They probably saw him as a hippie. DRI's earnings then were $5 million a year, mostly from CP/M. Kildall writes, "IBM offered to buy out CP/M-86 for its new PC

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for $250,000. You might be saying, 'Hey, Gary, sell the whole damn thing to IBM, then just wrap MP/M on top of that, say, hey?' That strategy may have worked, but our entire customer base wanted a smooth transition into 16-bit machines and we'd have lost them in a heartbeat. So I countered with an ongoing $10 per copy royalty for CP/M as was paid by all other manufacturers." Davis points out that DRI had contracts with "most favored nation" clauses, meaning that to sell CP/M to IBM for a flat fee might have caused DRI to be sued by its other customers. Kildall had to try to negotiate a contract similar to the ones signed by other customers.

IBM jibbed at this—it even insisted on renaming the Kildall system PC-DOS—but Kildall still believed they could strike a deal. As far as he knew, no one else had an operating system IBM could use. Kildall writes, "We broke from discussions, but nevertheless handshaking in general agreement on making a deal." Kildall and his family left that evening to vacation in the Caribbean. On the flight to Florida, they ran into the IBM team returning to Boca Raton. Kildall spent much of the flight discussing how he would adapt CP/M to IBM's needs. Dorothy describes the team as "friendly." "One of them kissed me on the cheek," she says. (Sams, the author of the "invisible Kildall" story, says she must have kissed one of his team going back to Boca Raton, but not him, because he went to Seattle, presumably to meet Gates again.)

The Kildalls were back in Monterey a week later. Kildall straightaway put in a call to the Boca Raton team—and another, and another. IBM had gone off the air; they'd gone back to Microsoft. Davis said DRI caught wind later that IBM was talking to Gates, but Kildall told him, "Bill's a friend of mine. He wouldn't cut my throat." But that is precisely what Bill did.

When IBM revisited Gates with news of the encounter with Kildall, Gates jumped in with the observation that Kildall had not yet finished designing CP/M for a 16-bit machine and that Microsoft could itself meet IBM's requirements. As soon as the IBM visitors went back to Boca Raton, Gates called Rod Brock and bought Tim Paterson's system for $75,000—an initial $25,000 plus another $50,000 on closing the deal—without telling Brock why he wanted it so much (he later cited the nondisclosure agreement with IBM).

Gates was taking two gambles. The first was that Paterson's adaptation of Kildall's system risked a damaging legal suit: Gates never told IBM how close QDOS was to CP/M. The second was that IBM might pull out. They had done that before; back in 1974, IBM had made a $10,000 PC, the IBM 1500, which ran on Intel chips and failed to sell. "They seriously talked about canceling the project up until the last minute," says Gates, "and we had put so many of the company resources into this thing." But Gates was willing to bet everything. At the end of September, he and Ballmer flew to Boca Raton to present a proposal, much of it written by Kay Nishi, a Japanese employee, for using Paterson's version of Kildall's program—now renamed Microsoft DOS—and asking almost nothing in royalties. On the drive from the airport to the meeting, Gates panicked when he realized he had forgotten a tie. (They stopped at a department store on the way in.) Gates understood how to behave around IBM. His culture meshed with theirs far more than Kildall's did. Estridge, who died in a plane crash in 1985, told Gates over lunch that when IBM's new chief executive, John Opel, heard Microsoft might be involved with the PC, he enthused, "Oh, is that Mary Gates's boy's company?" Opel and Gates's mother served together on the board of the United Way. Gates signed an agreement with IBM in November 1980. He believes his mother's connection helped land him the contract for the new PC, which was code-named Acorn.

Kildall was relaxed about IBM's silence. He shared Silicon Valley's view of IBM as a dinosaur. "A lot of us in the microcomputer world in the early days," says Rolander, "saw IBM as all fluff and marketing, big, lumbering, slow, uninteresting, not clean, exciting, fast." In 1981 Kildall's CP/M ran on 90 percent of the roughly 500,000 or so Intel-chip-based personal computers in existence. (Apple was the exception, using chips made by MOS Technology and later Motorola.) Where else could IBM go? But about half a year later, Andy Johnson-Laird, a friend of his who was a savvy consultant, showed Kildall a list of the PC-DOS API (application program interface) function calls for an IBM computer—the specifications for the software. These specifications had to be published so that programmers would know how to write new software for the upcoming IBM personal computer. Kildall was astonished to find how much of CP/M's proprietary list had been copied. He writes: "The first twenty-six function calls of the API in Gates's PC-DOS are identical to and taken directly from the CP/M proprietary documents [CP/M manuals]." He was irate, and with good cause. What Paterson essentially had done was rewrite the bottom part of the software—improving the way files were stored and adapting the program to a 16-bit machine—while copying most of the top part of Kildall's operating system (the Int 21 commands that allowed the operating system to interact with the application program). Even if QDOS and CP/M were 80 percent different, as Paterson has said, he took almost unaltered Kildall's Int-21 mechanism—the heart of his innovation. An independent examination of the two systems shows some blatant copies, some slight alterations. For instance, CP/M began each new line with:

A:

The DOS prompt was:

A>

Paterson copied Kildall's first 36 Int-21 functions into QDOS. He did rename Kildall's "Read Sequential" function "Sequential Read"; "write sequential" became "sequential write"; "Read Random" was called "Random Read." And so on.

In addition, CP/M's ED program was almost the same as PC-DOS's EDLIN editor program. Rolander says that "what Tim did was very clever. Ironically, an invention of Gary's was used against him." Gary's design was so good that he actually made it fairly simple for Paterson to "rip off" CP/M. Paterson in effect validated the significance of Gary's design. Applications were not tied to an implementation of an operating system (CP/M versus QDOS) or physical computer hardware (BIOS), but rather to a logical interface. Paterson's file

system, Rolander acknowledges, was better for the larger disk, but he adds that mistakes were made in cloning Kildall's work. "QDOS didn't operate the way CP/M did just because of misunderstandings." John Wharton was an engineer at Intel when Gates visited Santa Clara to persuade Intel to abandon a joint development project with Kildall. "It was I who first informed Gates that the software he just bought was not, in fact, fully compatible with CP/M 2.2. At the time I had the distinct impression that, until then, he'd thought the entire operating system had been cloned." Wharton says that "the strong impression" he got of Microsoft programmers at the time was that they were "untrained, undisciplined, and content merely to replicate other people's ideas and that they did not seem to appreciate the importance of defining operating systems and user interfaces with an eye to the future. In the end, it was the latter vision, I feel, that set Gary Kildall so far apart from his peers." What Kildall saw, and what Paterson, Gates and IBM did not, is that CP/M-86 itself would soon be antiquated. The real problem was not that QDOS was similar to CP/M, but that it did not have the stable multitasking capabilities that Kildall was planning.

Kildall lost his traditional cool. This time he furiously got through to IBM. They immediately dispatched a manager and an attorney to Pacific Grove. "I showed the IBM attorney definitive evidence that PC-DOS was a clone of CP/M and immediately threatened a lawsuit for copyright infringement. The IBM attorney compared the API interface, and I can say clearly that he fairly blanched at the comparison and stated that he was not aware of the similarity. I told him that he should take note and become aware at the earliest opportunity, or else he should face a major lawsuit."

IBM knew it had to appease Kildall in some way since a lawsuit for "injunctive relief" could delay its entire secret venture, which was due to be launched in four months, in August 1981. They invited Kildall to fly to Boca Raton with Gerry Davis and there and then offered to market CP/M-86 alongside Microsoft's PC-DOS in similar packaging on the condition that Kildall would not sue IBM for infringement of CP/M copyrights. He accepted that but did not agree to an undertaking to refrain from suing Microsoft. "We discussed pricing issues," writes Kildall, "but setting a price level, according to IBM, 'was a violation of antitrust.'" Pricing could not be set. Kildall thought he was getting exactly what he wanted. CP/M would not be changed to PC-DOS, and IBM accepted that it would pay DRI a standard royalty rate. Both PC-DOS, Microsoft's operating system, and CP/M would be released. Both operating systems would be sold in different boxes next to the new IBM. The marketplace would decide the victor. Gates was furious his old friend had been allowed back in the game, insisting that IBM had been "blackmailed into it."

IBM at least seemed to take DRI's involvement seriously. Kildall had never seen such strict security precautions. The prototype IBM loaned to DRI had to be chained to a desk in a locked room. No phone was allowed nearby. Any document printed out had to be shredded and burned. Several times, IBM technicians appeared on nearby roofs armed with special meters to detect if anyone was able to eavesdrop on the electromagnetic signals emitted by the new computer's keyboard.

In August 1981, IBM's PC finally came out. Rolander remembers driving with Kildall to the nearest store in the Bay Area, both of them brimming with excitement. They knew a knife had been plunged in their backs the moment they saw the labels on the software boxes: Microsoft's price advantage was a multiple of six. IBM asked $240 for CP/M-86 and only $40 for Microsoft's PC-DOS. Rolander says seeing the price difference was probably the biggest shock of his life. "It was just as if I were to reach across the table right now and give you a slap across the face, something completely off the wall. Looking at the price and knowing you had been completely screwed, that there was no intention whatsoever on their part to sell CP/M-86. No intention at all. There was such a trusting nature, especially in the academic world that was collegial. This was so big-business, aggressive, killer." He and Kildall felt so naive. They called IBM to demand the company reduce the price of CP/M, but no one called back. Davis says, "IBM clearly betrayed the impression they gave Gary and me."

Kildall writes: "The pricing difference set by IBM killed CP/M-86. I believe, to this day, the entire scenario was contrived by IBM to garner the existing standard at almost no cost. Fundamental to this conspiracy was the plan to obtain the waiver for their own PC-DOS produced by Microsoft." As psychiatrists like to say, even paranoids are persecuted. Kildall clearly was.

Gates continued the revisionism begun in the London *Times* in 1982. In an interview with *PC Magazine* in 1997, he said, "The IBM guys flew down there and they couldn't get the nondisclosure signed. Because IBM nondisclosures are pretty unreasonable. It's very one-sided. And we just went ahead and signed the thing. But they didn't. Subsequently, Digital Research woke up to the fact that this was a pretty important project and convinced IBM to also offer their product. But they priced it very high." There are, of course, two problems with these two sentences. The implication that DRI itself priced the retail product is untrue; and Kildall did sign agreements with IBM in both Pacific Grove and Boca Raton.

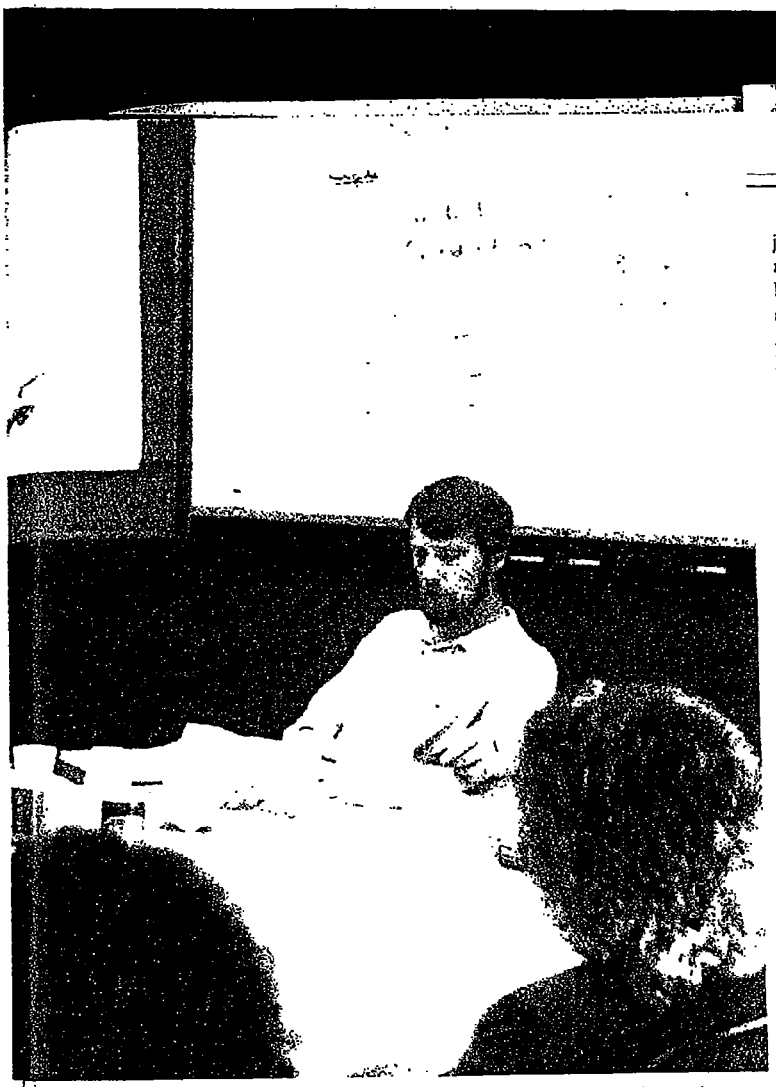
The obvious question is why Kildall did not sue Microsoft as he was free to do. Kildall flew to Seattle in August with his marketing vice president, John Katsaros, to confront Gates and Allen. He writes: "Allen was worried about a lawsuit and asked if DRI had ever sued anyone over copying CP/M. I said I hadn't. I was telling the truth. Paul is a gentle person, but he saw my chink and said that we were now engaged in OS-Wars."

The decision not to sue was a disastrous error. In the same year of 1981 venture capitalists invested in DRI—the attractive Jacqui Morby of TA Associates in Boston and the venture capital companies Hambrecht and Quist and Venrock Associates—and they helped DRI move into the big time with a bright new president, John Rowley, relieving Kildall of management. But the new board also dithered about suing as time ran out under the statute of limitations. At the time, no one had ever filed a lawsuit over the infringement of computer software copyright. The copyright law of 1976 was not amended until 1981, specifically to cover the look and feel

of software. Gerry Davis himself won one of the first cases, putting a Bay Area infringer of CP/M out of business, but he had to advise the board and Kildall of the risks—the ignorance of judges at the time, the deep pockets of IBM. Was it a mistake to hold back? "Yeah," says Davis now, "what we should have done in retrospect was gone in and sued Microsoft very early on, even with the uncertainty of the law, because it would have stopped the development of a competitor. And if we had stopped them to begin with, they would never have gotten the foothold they have." Jacqui Morby agrees. "We could have won the first look and feel case and held up IBM." She recalls that the new board was not aware that during this period, while IBM and Gates kept very quiet, Microsoft's Steve Balmer was nonetheless continually on the telephone to DRI's project manager, Kathy Strutynski, asking for guidance on the internal engineering of the CPM operating system. "That was pure thievery." But aggression ran contrary to Kildall's character. Davis remembers him saying, "It's not nice to sue people, and we're going to succeed anyway." Everybody in the company was in denial for a couple of years, says Davis. "There was a lot of naïveté on the part of a lot of us, the board, me, and then the venture capital people."

The complacency at DRI is understandable. DRI seemed unstoppable. In 1981, CP/M was used worldwide in close to 200,000 installations with over 3,000 different hardware configurations. There were nearly 500 software products in the shops. The company doubled its space, moving from the Victorian house to offices on Central Avenue, and bought Gordon Eubanks's Compiler Systems, which produced CBASIC, a more commercial version of BASIC directly competitive with Microsoft. By the end of 1982, DRI employed more than 500 people and had operations in Europe and Asia. Revenues skyrocketed from $6 million in 1981 to $44.6 million in 1983. Everyone was confident because they knew that DRI's technology was superior, so it must surely prevail in the marketplace. Kildall and Rolander had moved beyond CP/M and MS-DOS, which was based on it, and they had a poor view of the IBM machine itself. "That machine was a piece of crap," says Rolander, "compared to other machines. I would defy you to find anyone else who was around the industry 20 years ago who would have thought the IBM would be successful." When the IBM machine came out, Kildall and Rolander were working on an operating system that offered multitasking, multiprogramming and multiaccess. These are things computer users take for granted now, such as the ability to print a file while editing a spreadsheet, or cut and paste between spreadsheet and text. The IBM-Microsoft operating system, being single-tasking, yielded nothing like this. Only two months after the launch of the IBM machine, DRI began to ship MP/M-86, the multitasking 16-bit version of CP/M, and MP/M II, the 8-bit version. The key feature of MP/M-86 was that the application program interface (API) was compatible with programs written for the eight-bit architecture, thus allowing programmers to easily adapt their applications.

But Kildall remained frustrated. The tensions reflected themselves in his personal life. He and Dorothy separated and then divorced after 18 good years together; she opened a lovely guest ranch in Carmel Valley. How utterly maddening it must have been. With Microsoft and IBM controlling the market, he could not push MP/M-86 with its multitasking capabilities. "I was competing with an operating system clone, MS-DOS, of my original design, and both operating systems were by this time completely out of date." Multitasking was thus delayed in America for a decade by the IBM-Microsoft hegemony. In Europe at least Kildall could push multitasking, which



TENSER DAYS AT DRI: John Rowley (left) came in as president, recruited by venture capitalists backing DRI, including Jacqui Morby, Venrock Associates, Hambrecht and Quist and Intel's Bob Noyce. "I call John a Boy Scout," writes Kildall (head of table). "He could talk so fast about products that your ears would flap."

is now of course the standard everywhere in the world. Digital Research had four European offices, two in England, not far from London, one in Paris and one in Munich. Foreign operations did better in many respects than DRI's American operations since IBM and Microsoft had much less market clout abroad. DRI's European operations kept the company afloat during the mid-80s. Paul Bailey, DRI's head of UK operations, beat out Microsoft for big accounts like Siemens and Nixdorf. DRI software was used to automate industry in Europe; Microsoft still could do only single-tasking. DRI's software allowed manufacturers to track multiple pieces of data.

While the salesmen fought the battle over operating systems, Kildall just could not stop inventing and innovating. Videodiscs were still new—they were the beginning of "multimedia"—and he and Rolander pushed the boundaries to fashion interactive videodisc hardware and software for the Commodore 64 computer. They labeled the system VidLink. Kildall astonished Grolier Publishing by storing Grolier's entire nine-million-word encyclopedia on a single videodisc. Grolier gave the go-ahead for Kildall to develop a commercial version of their *Academic American Encyclopedia* on videodisc. Ironically, the new management of DRI didn't take the job, so Kildall and Rolander independently made the first encyclopedia videodisc in Kildall's garage. In 1984, Kildall set up a new company with Rolander called Activenture; the name later changed to KnowledgeSet. It was small, just like the early Digital Research, with Kildall and Rolander doing the engineering, and Kildall's new wife, Karen, doing the bookkeeping.

Kildall, ever prescient, set out in 1985 to build a CD-ROM version of the encyclopedia, called the *Grolier Electronic Encyclopedia*. Rolander remarks, "This was in June of '85. Here we are seventeen years later. At that point in time, we said, absolutely, every new computer will have a CD-ROM drive. You will not be able to buy a new computer without a CD-ROM drive. And it took at least ten years to get to the point where they were commonplace and twelve or thirteen before they were a standard device." Rolander's daughter, Kari, so astounded the teachers with her knowledge of Costa Rica from the CD-ROM searches she got an A+ on her paper.

Bill Gates, not realizing who KnowledgeSet really was, wrote the company a letter saying Microsoft might be interested in acquiring a CD-ROM firm. When he discovered that Kildall was the man behind it, he wrote him what Kildall describes as "a fine letter." It is not clear whether Kildall is paraphrasing, but he says it went like this: "Dear Gary, it has been a long time since we have been together. Next time you are in Seattle, maybe we can get together and go water-skiing, and talk about CD-ROMs." In the spring of 1985 Kildall visited Seattle to see his family and met Gates in a suite at the Olympic Four Seasons Hotel. The ever-generous Kildall writes that the meeting was pleasurable "and for some reason I opened up to Bill. I told him about the CD-ROM work that I was doing. We talked of standards. We talked for hours." Kildall mentioned his intention to hold a CD-ROM seminar at the Asilomar Conference Center, in Monterey, for publishers and was somewhat taken aback shortly afterward when Gates invited him to be the (unpaid) keynote speaker at a $1,000-a-head Microsoft CD-ROM conference. Only when he had given his speech did he hear from a Microsoft friend in the

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audience that Gates had come straight back to his office from the Four Seasons meeting to order a conference to preempt Kildall's. Kildall writes: "It was clever. It was divisive. It was manipulative. It is Bill Gates's nature. I must give him credit for being a very opportunistic person." Among other projects, KnowledgeSet worked closely with Sony to develop a Knowledge Retrieval System affording instantaneous searches of large databases. They made CD-ROMs containing the entire maintenance manual, complete with vector drawings for the Boeing 767.

By 1984 DRI was enabling PC users to link their computers through its Concurrent DOS program and Star Link software. You could buy one single IBM-compatible PC to serve as a hub to other PCs. Cables would connect all of the computers. Kildall writes, "The difference between multiple PCs and Concurrent with Star Link is that all workstations can share a common database. And that's what made it work. Take a typical VAR [value-added reseller] application such as a doctor's office. Patient records are stored at the hub and are made available to each authorized secretary for billing at a station or two. A nurse at the same time enters patient transactions, like drug dosage or the time spent with a doctor in the clinic. None of these tasks are difficult for even the most ancient IBM PC to perform. The issue was not speed, but simply sharing of common data in the office. If every workstation had a different PC, then the data for each patient could not be shared. And that, quite simply, just didn't work. But this need for common databases fostered PC networking."

Again, Kildall was a decade ahead with his Concurrent DOS.

By the middle of the decade, for all these innovations, for all the superior systems, for all the killer marketing efforts of John Rowley, DRI was losing its principal business against the muscle of IBM in alliance with Microsoft. The board fired Rowley and authorized Kildall to sell the company. Recognizing his responsibility to shareholders, he gritted his teeth and called Gates. Kildall flew his airplane to the San Francisco airport and met Gates in the United Red Carpet Room. "This is a very sticky situation," he writes. "Bill, although once a good friend, had taken advantage of me at least twice. Bill appeared nearly on time at 2:00 in the afternoon. I learned what 'eating crow' means." No doubt fearing he might be taken advantage of again, Kildall gave Gates only public information and suggested $26 million would be a fair price. Gates replied that DRI was probably worth only $10 million. "We parted friends for some reason I don't understand today. However, this rejection by Bill was one of his big business mistakes."

Kildall made one deal with Atari's Jack Tramiel for its graphic display technology and another with Kay Nishi, the Japanese programmer and entrepreneur who had fallen out with Gates. Many people, like Nishi, wanted DRI to create an MS-DOS direct competitor. DRI was the only company that could legally parallel DOS, Kildall believed, because DRI had not forced suit; DOS was simply "a derived work of CP/M." Microsoft seemed vulnerable because it had not improved its operating system, had done nothing to support the new larger disk drives until Compaq moved in to do that and had failed to improve memory management for the larger applications programs (such as desktop publishing).

When DRI's first version of DR-DOS was released, Kildall must have loved the irony that the company he founded was now selling a clone of MS-DOS. The new single-tasking operating system was MS-DOS compatible and gave Microsoft a run for its money. On August 6, 1989, Bill Gates wrote in an e-mail to Steve Ballmer: "DOS being cloned has had a dramatic impact on our pricing for DOS. I wonder if we would have it around 30-40% higher if it wasn't cloned. I bet we would!" This was a loss of millions of dollars. Users started calling DRI's new operating system "Doctor Dos," not "Dee Are Dos," since it cured so many of the bugs found in MS-DOS. The August 1990 *Byte* magazine commented, "The latest incarnation of DR-DOS, Digital Research's MS-DOS clone, is an innovative and intriguing operating system that's thoughtfully designed. Version 5.0 is also packed with the extra features that Microsoft's own operating system should have (and might eventually have if the long-rumored MS-DOS 5.0 becomes a reality)."

Microsoft responded by announcing in May 1990 that within a few months it would issue a new release of MS-DOS, to be called MS-DOS 5.0, that would catch up on the DRI system. Industry experience indicates that it would have been near impossible for Microsoft to so soon develop and release a commercial version. Nonetheless, Microsoft repeated this vaporware announcement throughout the summer and into the fall of 1990. In fact, MS-DOS 5.0 was not released until June 1991, and when finally released, it did not offer the features Microsoft had promised.

On July 17, 1991, Ray Noorda, the founder of Novell, announced that his company was acquiring DRI—not for the $26 million Kildall had asked or the $10 million Gates had offered, but for $120 million. Using DR-DOS and its networking software, Novell became one of Microsoft's biggest rivals. Now Gates was up against a tougher opponent than Kildall. Noorda devoted himself to fighting Microsoft by acquiring a small start-up called Caldera, which employed the Linux system, and he used Caldera as a battering ram to sue Microsoft for monopolistic practices. He did not attempt to challenge the original cloning of CP/M, but focused exclusively on the "predatory" way Microsoft had cut DR-DOS sales by 91 percent. "This action," said Caldera's claim, "challenges illegal conduct by Microsoft calculated and intended to prevent and destroy competition in the computer software industry." Caldera alleged Microsoft would falsely announce new software that didn't exist, engage in exclusionary licensing, create false warning messages, criticize DR-DOS, use product tying, and threaten customers who used DR-DOS with retaliation. According to Judge Dee Benson, who oversaw the lawsuit, "On September 23, 1991, IBM officially endorsed DR-DOS 6.0, which was scheduled to be released to the public in September or October of the same year. Plaintiff alleges that in response to IBM's endorsement and in anticipation of an IBM/Novell alliance, Bill Gates publicly threatened retaliation against IBM should it choose DR-DOS. Caldera claims that as a result of the threatened retaliation and intense FUD [Fear, Uncertainty, Doubt campaign] concerning DR-DOS incom-

patibility with Windows, IBM withdrew its consideration of DR-DOS."

The lawsuit stretched on three and a half years. On January 10, 2000, just weeks before the case was to go to a jury, Caldera and Microsoft settled. The deal was secret, but Microsoft announced a one-time charge against earnings of three cents per share. Observers of the case quickly noted that since there were over five billion shares of Microsoft stock, that came to over $150 million. Many think the amount paid to Caldera was higher; the *Wall Street Journal* estimated it at $275 million, but some estimates go up to half a billion.

Kildall and his second wife, Karen, had moved to Austin, Texas, in 1991 after the sale to Novell. Again, Kildall was ahead of his time, provoked by technical conundrums encountered even by an undaunted computer wizard. His son, Scott, created a desktop publishing system using the Apple Macintosh, impressing Kildall enough to want to give it a try himself. He found setting up his own Macintosh "one of the worst (experiences) of my life, except for the day I visited Philadelphia." Then he wrestled with a Murata F-50 fax machine and found it "a switch-o-manic's nightmare," with 17 switches and such confusing instructions he ended up finding that his fax machine rang his personal phone day and night.

"OK," he writes, "so I am complaining about switches. How about proposing a solution to this stuff. I mean, plugging in a stereo these days seems to require a degree in electrical engineering. But there seems be something on the horizon that may help. It's called digital wireless." Kildall set up a company called Prometheus Light and Sound, working closely with Japanese company DDI, to exploit the fact that the $1 chips for cordless phones communicating at 32KB in a frequency range around 1.9 GHz, could also be used for stereos, VCRs, security systems, heating "and you-name it, because for the local area you need no wires. . . . Buy a stereo at Macy's. Plug a unit into the wall and turn it on. No speaker connections. No CD player connections. No tuner connections. It just works. . . . It just works."

He predicted: "Switches, cables, wiring. We can't live with it in the future because of the complexity of the interconnections. Wireless will solve part of this. Some 'switch standards' will solve the rest." He might have made another fortune. But making money was never what drove him. He had a beautiful lakeside ranch in the West Lake Hills suburb of Austin, a mansion with a splendid sea view in Pebble Beach, California, and all his fast toys, but his second marriage was heading toward divorce. He got some satisfaction from charitable work for pediatric AIDS, but the continual anointment of Bill Gates as the founder of the PC revolution finally got to him. Rolander said, "The more the fortune and influence of Bill Gates grew, the more he became obsessed. Day and night, the film of that day played in his head. It wasn't a question of money. What really hurt him was the myth. Gary felt no one accorded any importance to what he had accomplished." Everywhere he went people would ask why he had "gone flying" the day IBM came. Cruelly, the University of Washington triggered an emotional decline. It invited Kildall—surely its most lustrous graduate—to attend the 25th anniversary celebration of UW's computer science program; he was mortified to hear that they had asked Bill Gates—"a generous donor"—to be the speaker that evening. When Kildall rang to question that, the chairman of the computer science department hung up on him. Kildall writes, "The UW Computer Science Department educated me so that I could produce compilers, like PL/M. Then, I made CP/M a success through millions of copies sold throughout the world, again using my knowledge gained through education at the UW. Gates takes my work and makes it his own through divisive measures, at best. He made his 'cash cow,' MS-DOS, from CP/M. So, Gates, representing wealth and being proud of the fact that he is a Harvard dropout, without requirement for an education, delivers a lecture at the twenty-fifth reunion of the computer science class. Well, it seems to me that he did have an education to get there. It happened to be mine, not his."

So Kildall ends his manuscript.

His health deteriorated. When he was afflicted with arrhythmia of the heart, his doctor banned him from flying. Kildall gave Rolander his pilot's helmet. It was a bittersweet moment. He had so loved flying. Now one of his last refuges was taken away from him.

During the summer of 1994, he returned to Monterey for a visit. Shortly before midnight on Friday July 8, 1994, he stumbled and hit his head inside the Franklin Street Bar and Grill in downtown Monterey. The place was packed, and he was found on the floor next to a video game. He went to the hospital twice over the weekend but was released. Doctors saw nothing wrong. Three days later, on July 11, he died of a cerebral hemorrhage. A blood clot had formed between his brain and skull.

He was 52. Three hundred people came to his memorial service at the Naval Postgraduate School. Bill Gates was not among them. Microsoft issued a statement that Kildall's passing was "a loss to the industry." Kildall's ashes were returned to Seattle to be buried not far from the lakefront where Gates was building his $60 million home.

Etched on Kildall's tombstone is a simple image: a floppy disk.

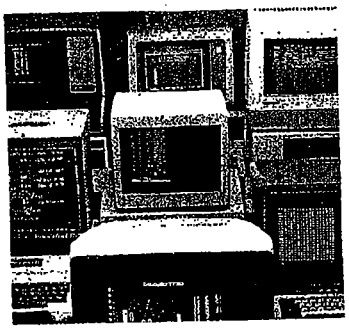

EXHIBIT C

Gary Kildall, 52, Crucial Player In Computer Development, Dies

By JOHN MARKOFF

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Founding Digital Research

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Success with CP/M, but losing a crucial contract with I.B.M.

[illegible]

Hoarding What I.B.M. ...

[illegible]

Max F. Baer, 81, Longtime Leader At B'nai B'rith

By WOLFGANG SAXON

[illegible]

Max Frank Baer

Earned Advanced Degrees

[illegible]

Jean F. Ingrao

Labor Official, 63

[illegible]

Lars-Eric Lindblad, 67, Pioneer Of Tours to Exotic Destinations

By JANET FIORINO

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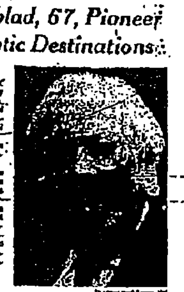

Lars-Eric Lindblad

[illegible]

Charles Burr Lamar

Architectural Designer, 68

[illegible]

R. J. Reynolds 3d, Tobacco Heir, 60

[illegible]

Daniel L. Blum

Newspaperman, 80

[illegible]

Mary Anna Meyer, Charity Official, 74

[illegible]

Carl Barnett

Newspaper Foreman, 74

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MAKE A CHILD SMILE GIVE TO THE FRESH AIR FUND

Deaths | Deaths | Deaths | Deaths | Deaths

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In Memoriam

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PAYTON 2007

EXHIBIT NO. 35

1-18-07

C. HAMMER

Gary Kildall, 52, Crucial Player In Computer Development, Dies

By JOHN MARKOFF

Gary Kildall, a pioneering computer scientist who created the first popular operating system for personal computers, died on Monday at the Community Hospital of the Monterey Peninsula in Monterey, Calif. He was 52.

An autopsy performed yesterday failed to determine the cause of death, said John DiCarlo, Monterey County's deputy coroner.

While teaching computer science at the United States Naval Postgraduate School in Monterey in 1973, Mr. Kildall wrote a personal computer operating system, a fundamental program that controlled the way the central processing unit stored and retrieved information from a floppy disk drive. He named the program Control Program/Monitor, or CP/M.

Before his program was available, inexpensive hobbyist microcomputers were generally programmed with a punched paper tape reader or by laboriously entering information by setting combinations of on-off switches to encode each byte.

Founding Digital Research

With his wife, Dorothy McEwen, Mr. Kildall founded a company to sell the CP/M operating system from their home in 1974. At first they called the company Intergalactic Digital Research, but the name was quickly shortened to Digital Research.

In 1977 Digital Research licensed CP/M to IMSAI, one of the early makers of personal computers. In the years afterward the program became the standard operating system for the first generation of 8-bit microcomputers.

Even before the invention of the electronic spreadsheet, these machines quickly became useful for business applications like word processing and relational databases, and by the early 1980's Digital Research's yearly revenues were $5 million.

Despite his business success, Mr. Kildall stayed on for several years as a professor at the Naval Postgraduate School because he enjoyed teaching.

Meeting With I.B.M.

In one of the most controversial events in the history of personal computing, Mr. Kildall was approached by I.B.M. in 1980 to develop a 16-bit version of CP/M for its new personal computer.

There is a legend in the computer industry that Mr. Kildall ignored the I.B.M. representatives who had arrived for a meeting and went flying in his airplane instead. But Mr. Kildall has said that in fact he attended the meeting and left believing that he had struck a deal with I.B.M.

In any case, I.B.M. executives later met with a small software company, the Microsoft Corporation, then located in Bellevue, Wash., founded by William Gates to sell his version of the BASIC computer language. Upon learning that I.B.M. was designing a personal computer, Mr. Gates, who at the time did not sell an operating system, rushed to buy one from a small Seattle company.

Eventually I.B.M. offered both Digital Research's CP/M-16 and Microsoft's MS-DOS operating systems with the I.B.M. PC. But it priced its version of the Microsoft operating system, PC-DOS, at $40 and the Digital Research operating system at $240.

PC-DOS quickly became the standard operating system for the I.B.M. PC, and when Compaq produced the first I.B.M.-compatible personal computer, MS-DOS became the industry standard. Microsoft eventually became the leading supplier of all kinds of personal computer software, and eventually broke with I.B.M. in a dispute over MS-DOS's successor operating system, OS2.

Many people in the computer industry argued that Microsoft's MS-DOS infringed on CP/M patents, but Mr. Kildall decided not to sue.

"In those days everyone was imitating everyone else," he said in a magazine interview several years ago. "That's why I didn't do anything about CP/M; it never occurred to me."

Mr. Kildall was widely viewed as a creative innovator in software design who disliked the cut-throat aspects of business and avoided many of the more aggressive tactics employed by his competitors in the computer industry.

Thomas Rolander, who was director of engineering for Digital Research when the company was approached by I.B.M., said he had flown with Mr. Kildall on the day of the I.B.M. meeting. He said he and Mr. Kildall arrived late at the meeting and refused to sign a nondisclosure document from the computer maker after the I.B.M. executives refused to sign a similar document presented by Digital Research.

Success with CP/M, but losing a crucial contract with I.B.M.

Mr. Rolander said that several months later I.B.M. returned with an offer that included a royalty, but that I.B.M. had made the decision to price the two competing programs differently.

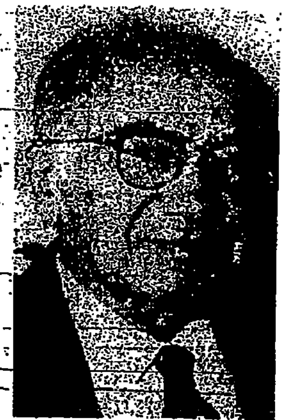
Mr. Kildall remained involved as chairman of Digital Research until the company was sold to Novell in 1991. He founded a second company in 1985 called Knowledge-Set to develop one of the first consumer applications for CD-ROM, a disc-based version of the Grolier Encyclopedia.

More recently, he moved to Austin, Tex., to found Prometheus Light and Sound, which is developing a "home PBX system."

Several years ago, he moved back to the Monterey area, where he began working on a book titled Computer Connections, a history of the computer industry. Mr. Kildall self-published the book earlier this year.

Mr. Kildall was born in Seattle and received his Ph.D. in computer science from the University of Washington. He and Ms. McEwen were married in 1962 and divorced in 1983. He is also survived by two children, Scott, of San Francisco, and Kristin, of Seattle, and by his mother, Emma, and sister, Patricia Guberlet, both of Seattle.

Max F. Baer, 81, Longtime Leader At B'nai B'rith


Max Frank Baer

By WOLFGANG SAXON

Dr. Max Frank Baer, who was associated with B'nai B'rith for 65 years — 43 of them in staff and leadership positions — died on Monday at his home in Washington. He was 81.

The cause was a heart attack, the organization reported.

Dr. Baer was trained as an educator and vocational specialist. He retired in 1977 as the international director of the B'nai B'rith Youth Organization, which he had run since 1948.

After retirement, he remained a consultant to B'nai B'rith, the world's oldest and largest Jewish service organization. He also continued to act as a consultant to the United States Department of Labor and the Social Security Administration.

Earned Advanced Degrees

Born in Frankfurt, Germany, he was brought to this country while in his youth and was reared in Indiana, where he became a member of the B'nai B'rith Youth Organization in 1929. He graduated from the University of Arizona and earned a doctor of laws degree at Creighton University in Omaha, a master's degree in education at Columbia University and a doctorate in education at George Washington University.

He joined the B'nai B'rith staff in 1934 in Omaha as the assistant executive secretary of its boys' division. Four years later he moved to Washington to start the B'nai B'rith Vocational Service Bureau and then served as its national director for six years.

As head of the international youth organization, he was credited with bringing in professional social workers as field directors and building the group into the world's largest Jewish youth movement. He developed leadership programs, including a Summer Institute, as the organization expanded to Israel and other nations.

In the late 1930's, he helped thousands of refugees from Austria and Czechoslovakia to resettle in this country. After World War II, he initiated a national survey to expose and end the quota systems that barred returning Jewish G.I.'s from colleges and universities of their choice.

He wrote the first code of personnel policies for B'nai B'rith, as well as books on vocational guidance. He also served as a visiting lecturer at Catholic University, George Washin[...] University, Bucknell University [...] Marquette University.

Dr. Baer's survivors include [...] wife of 27 years, Gertrude S[...] Baer, and two stepchildren, Ric[...] Rosenbaum of Orlando, Fla., [...] Randye Low of Manhattan.

Jean F. Ingrao

Labor Official, 63

Jean Fredette Ingrao, one of [...] first women elected to high offic[e ...] the A.F.L.-C.I.O., died on Thursd[ay ...] her home in Falls Church, Va. [...] was 63.

She died of cancer, said Mic[...] Byrne, a spokesman for the [...] federation.

Mrs. Ingrao (pronounced GRAY-oh) was elected in 197[...] executive secretary-treasurer o[f ...] A.F.L.-C.I.O. Maritime Trades [De]partment, which represents wor[kers] in 42 unions in the shipbuilding [...] seafaring trades and in other fi[...] She retired in 1993.

Mrs. Ingrao, who was born [...] Washington and attended sc[...] there, began her career in 1950 [...] aide to George Meany, then presi[dent] of the American Federation of L[...] She later served as administr[ative] assistant to the federation's ex[ecu]tive secretary-treasurer.

She is survived by her husb[and] Leonard; two sons, Michael, of [...] Church, and Mark, of Alexan[dria] Va.; two sisters, Barbara Leona[...] McLean, Va., and Mary Schmel[...] Gaithersburg, Md., and two gr[and]children.

Deaths

ALLEN—Dr. Kenneth P., former Foreign Service Officer, teacher in the New York Public Schools died at age 56 at his home in Manhattan after a long illness. He is survived by his wife Mariette Pathy Allen, his daughters Cordelia and Julia, his mother Lillian Allen and a sister Mary Lou Flood. Funeral 11 AM, on Thursday, July 14 at the Church of the Heavenly Rest, 5th Ave. at 90 Street. Visiting at Frank E. Campbell, Madison Avenue at 81 Street, Wednesday, 6-9 PM. In lieu of flowers, contributions to the Kenneth P. Allen Memorial Fund would be appreciated.

BERMUDEZ—Juan J. 66, on July 12, 1994, of Rio Piedras, P.R. The employees and the Board of Directors of the Federal Home Loan Bank of New York mourn the [...]

Deaths

FRIEND—Howard L. The Board of Governors and members of Fairview Country Club, with profound sorrow, mourn the passing of its beloved member, Howard. On behalf of all Fairview members we wish to express our deepest condolences to his family.

Ralph M. Freydberg, President
Howard A. Reed, Secretary

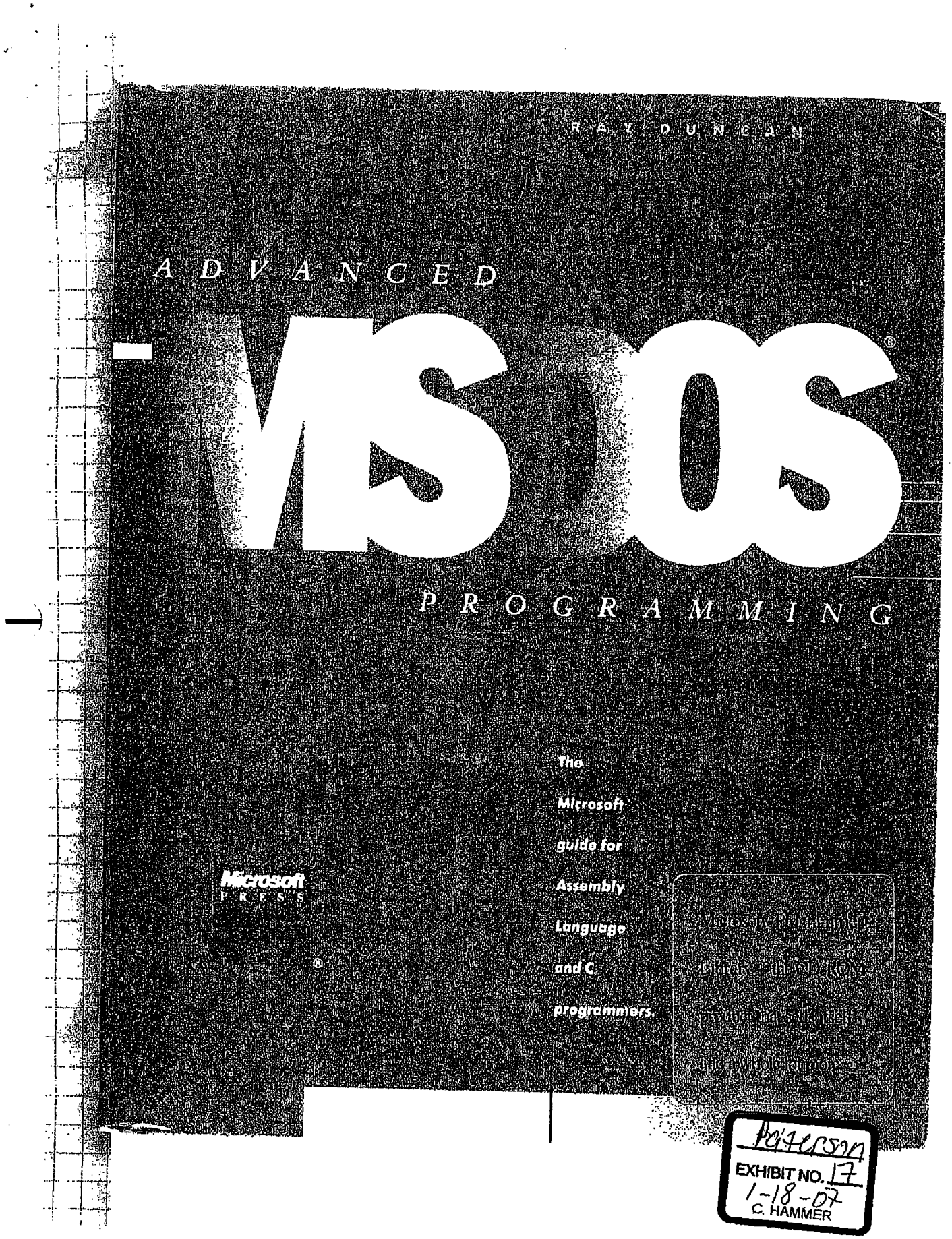
GIBNEY—Paul B. Jr., of Montclair, NJ, on July 10, 1994. Beloved husband of Deborah Pierce, devoted father of Paul W., Thomas, Matthew and stepfather of Zachary, loving brother of Barbara Phillips. A funeral Mass will be offered on Thursday at 10AM in Immaculate Conception Church, Montclair, NJ. Interment Gate of Heaven Cemetery, Valhalla, NY. Visiting hours 2-4 & 7-9PM, Wednesday at the Hugh M. Moriarty Funeral Home, 76 Park St., Montclair, NJ. In lieu [...]

Deaths

KATZ—Benjamin. On July [...] Beloved longtime New [...] principal. Devoted husba[nd ...] late Helyn. Loved father [...] and Arthur Rosengarte[n ...] lished grandfather of C[...] Sharon, Amy Esq. and Ro[...] heartfelt thanks to Brook[...] aice for an easy pain free [...] table passing which he [...] served. Services We[...] 12:30PM "Boulevard-R[...] Chapel, 312 Coney Islan[d ...] (at Prospect Park).

KATZ—Daniel. On July [...] Loving husband of [...] Mildred "Sis" Katz. Belov[ed ...] er and uncle, cherished [...] Matthew and father-in-la[w ...] rie. Funeral service Fri[...] 15, 1994, at "Schwartz Br[...] Memorial Chapels" at 1[...] ens Blvd and 76 Rd. Fo[...] Interment Beth Israel Ce[...]

EXHIBIT D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Microsoft PRESS®
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MS-DOS is an operating system that is rapidly evolving. A new major or minor version has been released at least once a year for the last three years (Figure 1-1), and more versions are known to be on the way. Due largely to its adoption by IBM, and to the enormous wave of third-party software that followed the success of the IBM PC, MS-DOS has become the dominant operating system for personal computers that use the Intel 8086 family of microprocessors. With several million licensed copies in use, the number of users of MS-DOS dwarfs the total number of users of all of its competitors (CP/M-86, Concurrent DOS, P-system, iRMX-86, XENIX, and UNIX).

From the programmer's point of view, the current versions of MS-DOS (versions 2 and 3) are robust, rich, and powerful development environments. A broad selection of high-quality programming tools is available from both Microsoft and other software houses. Porting existing applications into the MS-DOS environment is relatively simple, since the programmer can choose to view MS-DOS as either a superset of CP/M or a subset of UNIX.

The progenitor of MS-DOS was an operating system called 86-DOS, which was written by Tim Paterson for Seattle Computer Products in mid-1980. At that time, Digital Research's CP/M-80 was the operating system most commonly used on microcomputers, and a decent though not extensive range of application software (word processors, database managers, and so forth) was available for use with it. In order to ease the process of porting 8-bit CP/M-80 applications into the new 16-bit environment, 86-DOS was originally designed to mimic CP/M-80 in both functions available and style of operation. Consequently, the structures of 86-DOS's file control blocks, program segment prefixes, and executable files were nearly identical to those of CP/M-80. Existing CP/M programs could be converted mechanically (by processing their source-code files through a special translator program) and, after conversion, would run under 86-DOS either immediately or with very little hand editing.

Because 86-DOS was marketed as a proprietary operating system for Seattle Computer Products' line of S-100 bus, 8086-based microcomputers, it made very little impact on the microcomputer world in general. Other vendors of 8086-based microcomputers were understandably reluctant to adopt a competitor's operating system, and continued to wait impatiently for the release of Digital Research's CP/M-86.

In October 1980, IBM approached the major microcomputer-software houses in search of an operating system for the new line of personal computers it was designing. Microsoft had no operating system of its own to offer (other than a stand-alone version of Microsoft BASIC), but paid a fee to Seattle Computer Products for the right to sell Paterson's 86-DOS.

(At that time, Seattle Computer Products received a license to use and sell Microsoft's languages and all 8086 versions of Microsoft's operating system.) In July 1981, Microsoft purchased all rights to 86-DOS, made substantial alterations to it, and renamed it MS-DOS. When the first IBM PC was released in the fall of 1981, IBM offered MS-DOS (referred to as PC-DOS 1.0) as its primary operating system.

IBM also selected Digital Research's CP/M-86 and Softech's P-system as alternative operating systems for the PC. However, they were both very slow to appear at IBM PC dealers, and suffered the additional disadvantages of higher prices and lack of available programming languages. IBM threw its considerable weight behind PC-DOS by releasing all the IBM-logo PC application software and development tools to run under it. Consequently, most third-party software developers targeted their products for PC-DOS from the start, and CP/M-86 and P-system never became significant factors in the IBM PC-compatible market.

In spite of some superficial similarities to its ancestor CP/M-80, MS-DOS version 1.0 contained a number of improvements over CP/M, including:

- An improved disk-directory structure that included information about a file's attributes (such as whether it was a system or hidden file), its exact size in bytes, and the date that the file was created or last modified
- A superior disk-space allocation and management method, allowing extremely fast sequential or random record access and program loading
- An expanded set of operating-system services, including hardware-independent function calls to set or read the date and time, a filename parser, multiple-block record I/O, and variable record sizes
- An AUTOEXEC batch file to perform a user-defined series of commands when the system was powered up or reset

IBM was the only major computer manufacturer (sometimes referred to as OEM, for *original equipment manufacturer*) to ship MS-DOS version 1.0 (as PC-DOS 1.0) with its products. MS-DOS version 1.25 (equivalent to IBM PC-DOS 1.1) was released in June 1982 to fix a number of bugs, and also to support double-sided disks and improved hardware independence in the DOS kernel. This version was shipped by several vendors besides IBM, including Texas Instruments, Compaq, and Columbia, who all entered the personal-computer market early. Today, due mainly to the increasing prevalence of hard-disk-based systems, MS-DOS version 1 is no longer in common use.

MS-DOS version 2.0 (equivalent to PC-DOS 2.0) was first released in March 1983. It was, in retrospect, a totally new operating system (though great care was taken to maintain compatibility with MS-DOS version 1). It contained many significant innovations and enhanced features, including:

- Support for both larger-capacity flexible disks and hard disks
- Many UNIX-like features, including a hierarchical file structure, file handles, I/O redirection, pipes, and filters
- Background printing (print spooling)
- Volume labels, plus additional file attributes
- Installable device drivers
- A user-customizable system-configuration file that controlled the loading of additional device drivers, the number of system disk buffers, and so forth
- Maintenance of program environment blocks that could be used to pass information between programs
- An optional ANSI display driver that allowed programs to position the cursor and control display characteristics in a hardware-independent manner
- Support for the dynamic allocation, modification, and release of memory blocks by application programs
- Support for customized user command interpreters (shells)
- System tables to assist application software in modifying its currency, time, and date formats (known as *international support*)

MS-DOS version 2.11 was subsequently released to improve international support (table-driven currency symbols, date formats, decimal-point symbols, currency separators, and so forth), to add support for 16-bit Kanji characters throughout, and to fix a few minor bugs.

As this book is being written, MS-DOS version 2.11 is the base version being shipped for 8086/8088-based personal computers by nearly all major OEMs, including Hewlett-Packard, Wang, DEC, Texas Instruments, Compaq, and Tandy. It is therefore the version that applications should be designed to run with.

In MS-DOS version 2.25, released in October 1985, the international support was extended even further for Japanese and Korean character sets, additional bugs were repaired, and many of the system utilities were made compatible with MS-DOS version 3.0.

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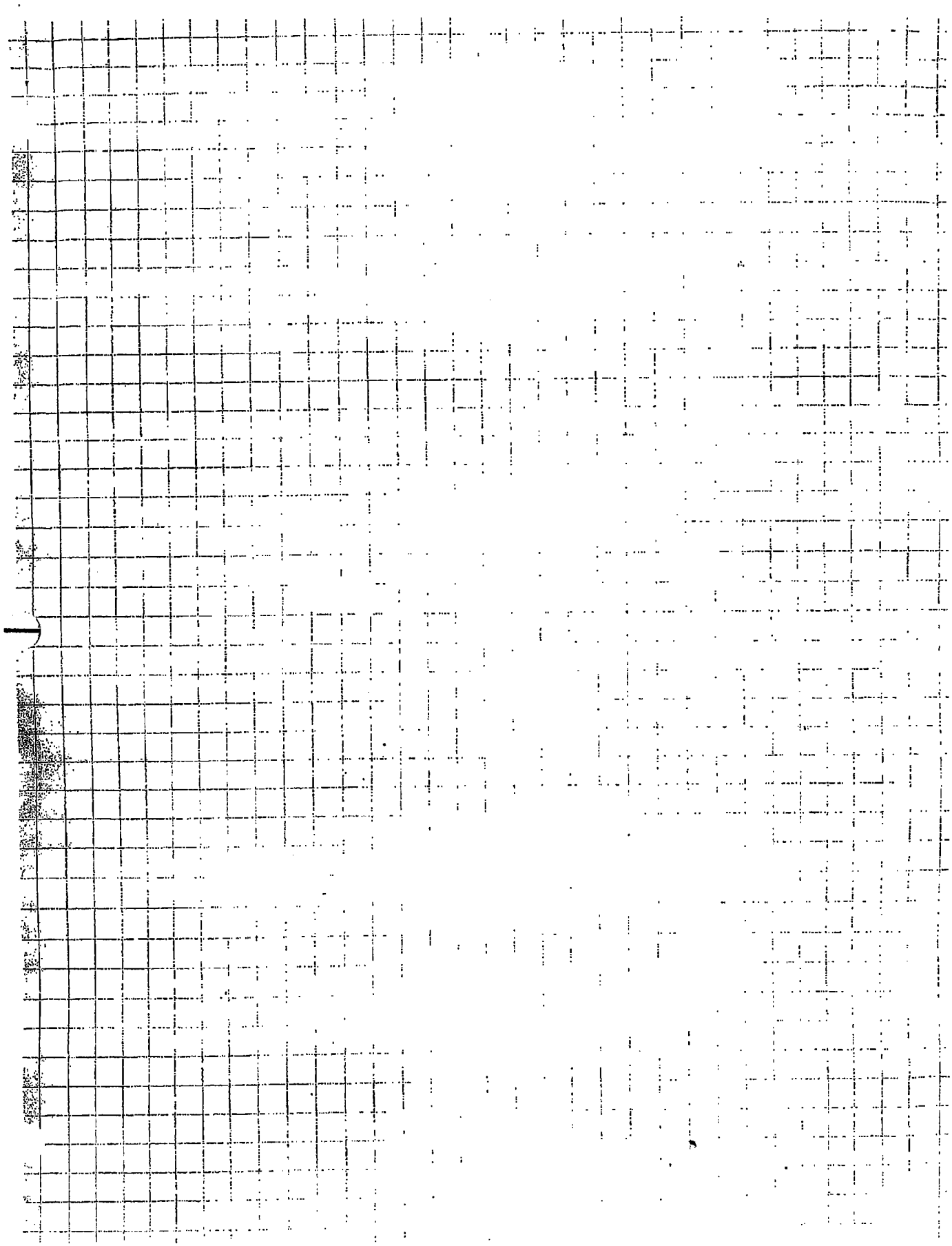

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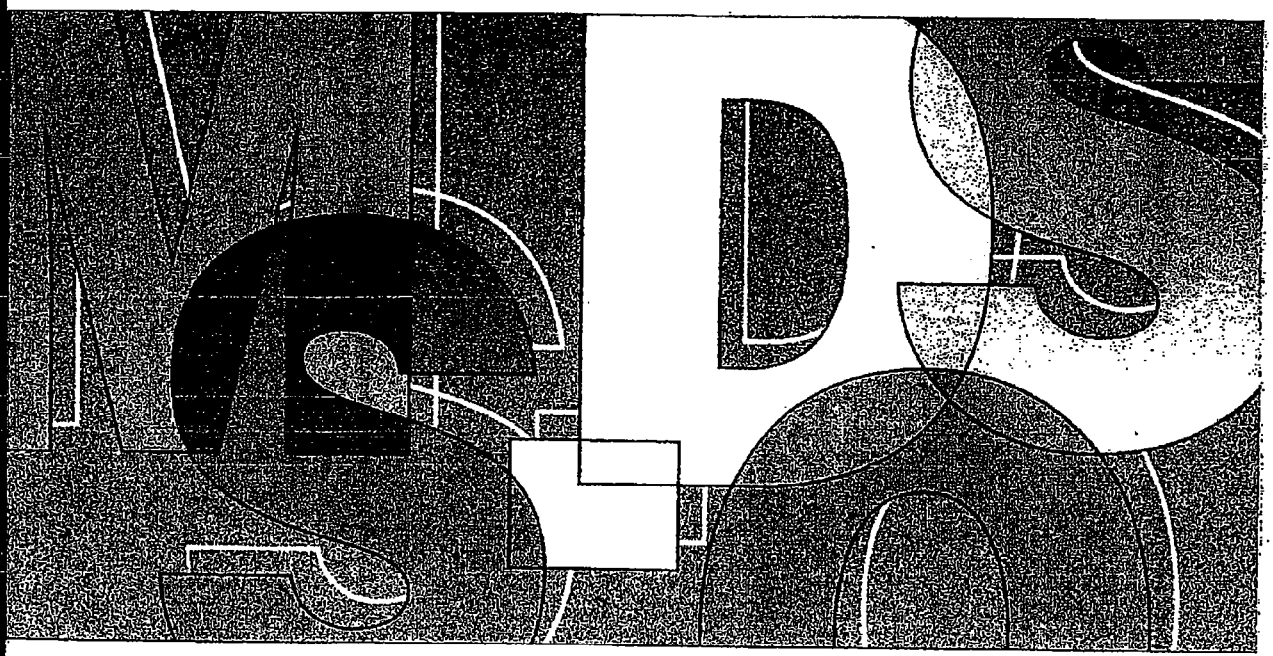
Complete and Unabridged

The MS-DOS® Encyclopedia



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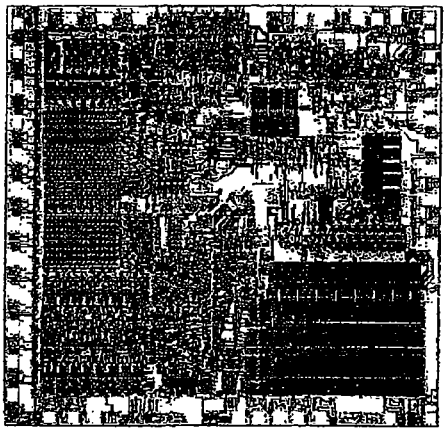
The January 1975 cover of Popular Electronics *magazine, featuring the machine that caught the imaginations of thousands of like-minded electronics enthusiasts — among them, Paul Allen and Bill Gates.*

Although it was too limited to serve as the central processor for a general-purpose computer, the 8008 was undeniably the ancestor of the 8080 as far as its architecture and instruction set were concerned. Thus Traf-O-Data's work with the 8008 gave Gates and Allen a head start when they later developed their version of BASIC for the Altair.

Paul Allen learned of the Altair from the cover story in the January 1975 issue of *Popular Electronics* magazine. Allen, then an employee of Honeywell in Boston, convinced Gates, a student at Harvard University, to develop a BASIC for the new computer. The two wrote their version of BASIC for the 8080 in six weeks, and Allen flew to New Mexico to demonstrate the language for MITS. The developers gave themselves the company name of Microsoft and licensed their BASIC to MITS as Microsoft's first product.

Though not a direct forerunner of MS-DOS, Altair BASIC, like the machine for which it was developed, was a landmark product in the history of personal computing. On another level, Altair BASIC was also the first link in a chain that led, somewhat circuitously, to Tim Paterson and the disk operating system he developed for Seattle Computer Products for the 8086 chip.

From



The 16-bit Intel 8086 chip, introduced in 1978. Much faster and far more powerful than its 8-bit predecessor the 8080, the 8086 had the ability to address one megabyte of memory.

The 8086

When Intel released the 8-bit 8080 chip in 1974, the Altair was still a year in the future. The 8080 was designed not to make computing a part of everyday life but to make household appliances and industrial machines more intelligent. By 1978, when Intel introduced the 16-bit 8086, the microcomputer was a reality and the new chip represented a major step ahead in performance and memory capacity. The 8086's full 16-bit buses made it faster than the 8080, and its ability to address one megabyte of random-access memory was a giant step beyond the 8080's 64 KB limit. Although the 8086 was not compatible with the 8080, it was architecturally similar to its predecessor and 8080 source code could be mechanically translated to run on it. This translation capability, in fact, was a major influence on the design of Tim Paterson's operating system for the 8086 and, through Paterson's work, on the first released version of MS-DOS.

When the 8086 arrived on the scene, Microsoft, like other developers, was confronted with two choices: continue working in the familiar 8-bit world or turn to the broader horizons offered by the new 16-bit technology. For a time, Microsoft did both. Acting on Paul Allen's suggestion, the company developed the SoftCard for the popular Apple II, which was based on the 8-bit 6502 microprocessor. The SoftCard included a Z80 microprocessor and a copy of CP/M-80 licensed from Digital Research. With the SoftCard, Apple II users could run any program or language designed to run on a CP/M machine.

It was 16-bit technology, however, that held the most interest for Gates and Allen, who believed that this would soon become the standard for microcomputers. Their optimism was not universal—more than one voice in the trade press warned that industry investment in 8-bit equipment and software was too great to successfully introduce a new standard. Microsoft, however, disregarded these forecasts and entered the 16-bit arena as it had with the Altair: by developing a stand-alone version of BASIC for the 8086.

At the same time and, coincidentally, a few miles south in Tukwila, Washington, a major contribution to MS-DOS was taking place. Tim Paterson, working at Seattle Computer Products, a company that built memory boards, was developing an 8086 CPU card for use in an S-100 bus machine.

86-DOS

Paterson was introduced to the 8086 chip at a seminar held by Intel in June 1978. He had attended the seminar at the suggestion of his employer, Rod Brock of Seattle Computer Products. The new chip sparked his interest because, as he recalls, "all its instructions worked on both 8 and 16 bits, and you didn't have to do everything through the accumulator. It was also real fast—it could do a 16-bit ADD in three clocks."

After the seminar, Paterson—again with Brock's support—began work with the 8086. He finished the design of his first 8086 CPU board in January 1979 and by late spring had developed a working CPU, as well as an assembler and an 8086 monitor. In June, Paterson took his system to Microsoft to try it with Stand-alone BASIC, and soon after, Microsoft BASIC was running on Seattle Computer's new board.

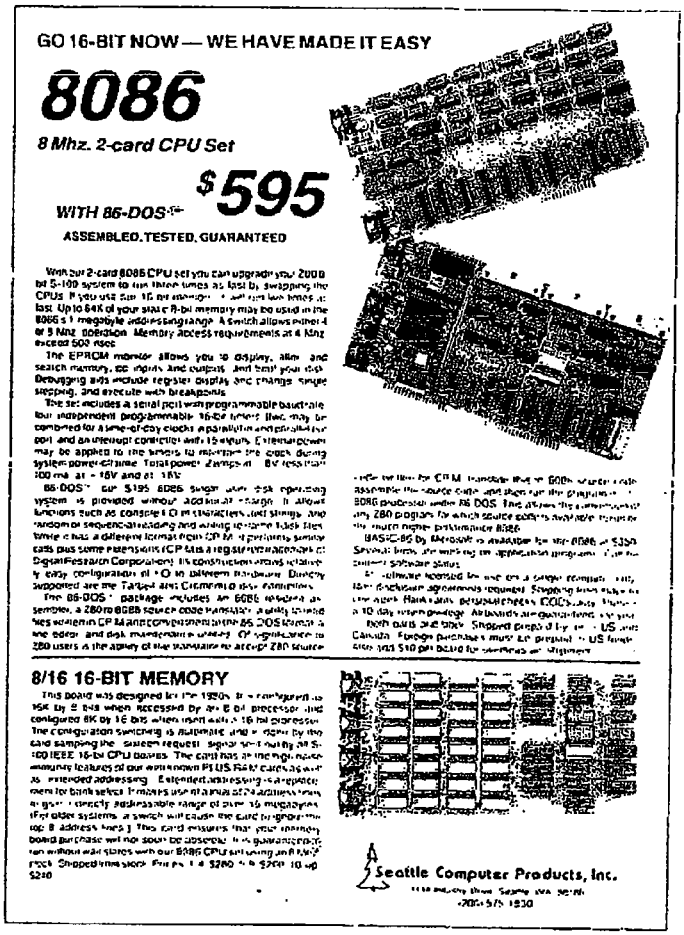
During this period, Paterson also received a call from Digital Research asking whether they could borrow the new board for developing CP/M-86. Though Seattle Computer did not have a board to loan, Paterson asked when CP/M-86 would be ready. Digital's representative said December 1979, which meant, according to Paterson's diary, "we'll have to live with Stand-alone BASIC for a few months after we start shipping the CPU, but then we'll be able to switch to a real operating system."

Early in June, Microsoft and Tim Paterson attended the National Computer Conference in New York. Microsoft had been invited to share Lifeboat Associates' ten-by-ten foot booth, and Paterson had been invited by Paul Allen to show BASIC running on an S-100 8086 system. At that meeting, Paterson was introduced to Microsoft's M-DOS, which he found interesting because it used a system for keeping track of disk files—the FAT developed for Stand-alone BASIC—that was different from anything he had encountered.

After this meeting, Paterson continued working on the 8086 board, and by the end of the year, Seattle Computer Products began shipping the CPU with a BASIC option.

When CP/M-86 had still not become available by April 1980, Seattle Computer Products decided to develop a 16-bit operating system of its own. Originally, three operating systems were planned: a single-user system, a multiuser version, and a small interim product soon informally christened QDOS (for Quick and Dirty Operating System) by Paterson.

Both Paterson (working on QDOS) and Rod Brock knew that a standard operating system for the 8086 was mandatory if users were to be assured of a wide range of application software and languages. CP/M had become the standard for 8-bit machines, so the ability to mechanically translate existing CP/M applications to run on a 16-bit system became one of Paterson's major goals for the new operating system. To achieve this compatibility, the system he developed mimicked CP/M-80's functions and command structure, including its use of file control blocks (FCBs) and its approach to executable files.



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The EPROM monitor allows you to display, alter and search memory, do inputs and outputs, and boot your disk. Debugging aids include register display and change, single stepping, and execute with breakpoints.

The set includes a serial port with programmable baud rate, four independent programmable 16-bit timers (two may be combined for a time-of-day clock), a parallel input and output port, and an interrupt controller with 15 inputs. External power may be applied to the boards to maintain the clock during system power-down time. Total power: 2 amps at 8V (less than 200 ma at +16V and at 16V).

86-DOS™ our $195 8086 single user disk operating system is provided without additional charge. It allows functions such as console I/O of characters, text strings, and random or sequential reading and writing to named files. While it has a different format than CP/M, it performs similar calls plus some extensions (CP/M is a registered trademark of Digital Research Corporation). Its construction allows relatively easy configuration of I/O to different hardware. Directly supported are the Tarbell and Cromemco disk controllers.

The 86-DOS™ package includes an 8086 relocating assembler, a Z80 to 8086 source code translator, a utility to take files written in CP/M and computer printer 86-DOS format, a line editor, and disk management utilities. Of significance to Z80 users is the ability of the translator to accept Z80 source ... 8086 processor under 86-DOS. This allows the ... any Z80 programs for which source code is available to ... the much higher performance 8086.

BASIC-86 by Microsoft is available for the 8086 at $350. Several ... are working on application programs ... the customer's software status.

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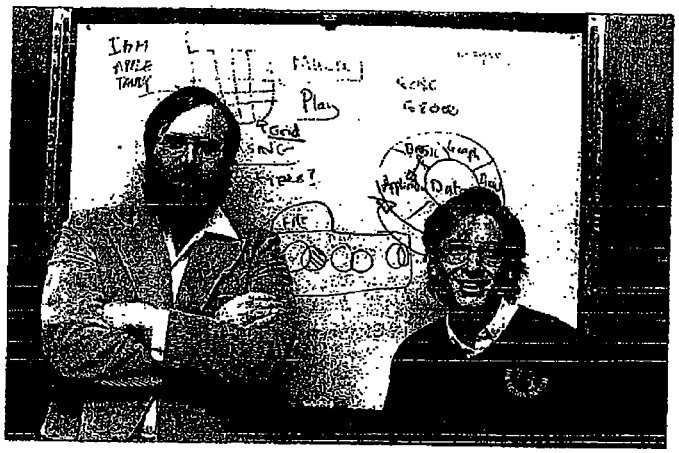
Seattle Computer Products, Inc.

An advertisement for the Seattle Computer Products 8086 CPU, with 86-DOS, published in the December 1980 issue of Byte

At the same time, however, Paterson was dissatisfied with certain elements of CP/M, one of them being its file-allocation system, which he considered inefficient in the use of disk space and too slow in operation. So for fast, efficient file handling, he used a file allocation table, as Microsoft had done with Stand-alone Disk BASIC and M-DOS. He also wrote a translator to translate 8080 code to 8086 code, and he then wrote an assembler in Z80 assembly language and used the translator to translate it.

Four months after beginning work, Paterson had a functioning 6 KB operating system, officially renamed 86-DOS, and in September 1980 he contacted Microsoft again, this time to ask the company to write a version of BASIC to run on his system.



Paul Allen and Bill Gates (1982).

This work, handled by O'Rear, fell into a series of steps. First, he moved a section of code from the 8-inch disk and compiled it. Then, he converted the code to Intel hexadecimal format. Next, he uploaded it to a DEC-2020 and from there downloaded it to a large Intel fixed-disk development system with an In-Circuit Emulator. The DEC-2020 used for this task was also used in developing the BIOS, so there was additional work in downloading the BIOS to the Intel machine, converting it to hexadecimal format, moving it to an IBM development system, and then crossloading it to the IBM prototype.

Defining and implementing the MS-DOS disk format—different from Paterson's 8-inch format—was an added challenge. Paterson's ultimate goal for 86-DOS was logical device independence, but during this first stage of development, the operating system simply had to be converted to handle logical records that were independent of the physical record size.

Paterson, still with Seattle Computer Products, continued to work on 86-DOS and by the end of 1980 had improved its logical device independence by adding functions that streamlined reading and writing multiple sectors and records, as well as records of variable size. In addition to making such refinements of his own, Paterson also worked on dozens of changes requested by Microsoft, from modifications to the operating system's startup messages to changes in EDLIN, the line editor he had written for his own use. Throughout this process, IBM's security restrictions meant that Paterson was never told the name of the OEM and never shown the prototype machines until he left Seattle Computer Products and joined Microsoft in May 1981.

And of course, throughout the process the developers encountered the myriad loose ends, momentary puzzles, bugs, and unforeseen details without which no project is complete. There were, for example, the serial card interrupts that occurred when they should not and, frustratingly, a hardware constraint that the BIOS could not accommodate at first and that resulted in sporadic crashes during early MS-DOS operations.

were needed for file-header information, the MS-DOS programmers decided to use some of the remaining 16 bytes to record the date and time of creation or update (and the size of the file) as well.

Batch processing was originally added to MS-DOS to help IBM. IBM wanted to run scripts—sequences of commands or other operations—one after the other to test various functions of the system. To do this, the testers needed an automated method of calling routines sequentially. The result was the batch processor, which later also provided users with the convenience of saving and running MS-DOS commands as batch files.

Finally, MS-DOS increased the options available to a program when it terminated. For example, in less sophisticated operating systems, applications and other programs remained in memory only as long as they were active; when terminated, they were removed from memory. MS-DOS, however, added a terminate-and-stay-resident function that enabled a program to be locked into memory and, in effect, become part of the operating-system environment until the computer system itself was shut down or restarted.

The Marketplace

When IBM announced the Personal Computer, it said that the new machine would run three operating systems: MS-DOS, CP/M-86, and SofTech Microsystem's p-System. Of the three, only MS-DOS was available when the IBM PC shipped. Nevertheless, when MS-DOS was released, nine out of ten programs on the *InfoWorld* bestseller list for 1981 ran under CP/M-80, and CP/M-86, which became available about six months later, was the operating system of choice to most writers and reviewers in the trade press.

Understandably, MS-DOS was compared with CP/M-80 and, later, CP/M-86. The main concern was compatibility: To what extent was Microsoft's new operating system compatible with the existing standard? No one could have foreseen that MS-DOS would not only catch up with but supersede CP/M. Even Bill Gates now recalls that "our most optimistic view of the number of machines using MS-DOS wouldn't have matched what really ended up happening."

To begin with, the success of the IBM PC itself surprised many industry watchers. Within a year, IBM was selling 30,000 PCs per month, thanks in large part to a business community that was already comfortable with IBM's name and reputation and, at least in retrospect, was ready for the leap to personal computing. MS-DOS, of course, benefited enormously from the success of the IBM PC—in large part because IBM supplied all its languages and applications in MS-DOS format.

But, at first, writers in the trade press still believed in CP/M and questioned the viability of a new operating system in a world dominated by CP/M-80. Many assumed, incorrectly, that a CP/M-86 machine could run CP/M-80 applications. Even before CP/M-86 was available, *Future Computing* referred to the IBM PC as the "CP/M Record Player"—presumably in anticipation of a vast inventory of CP/M applications for the new computer—and led its readers to assume that the PC was actually a CP/M machine.

Microsoft, meanwhile, held to the belief that the success of IBM's machine or any other 16-bit microcomputer depended ultimately on the emergence of an industry standard for a 16-bit operating system. Software developers could not afford to develop software for even two or three different operating systems, and users could (or would) not pay the prices the developers would have to charge if they did. Furthermore, users would almost certainly rebel against the inconvenience of sharing data stored under different operating-system formats. There had to be one operating system, and Microsoft wanted MS-DOS to be the one.

The company had already taken the first step toward a standard by choosing hardware independent designs wherever possible. Machine independence meant portability, and portability meant that Microsoft could sell one version of MS-DOS to different hardware manufacturers who, in turn, could adapt it to their own equipment. Portability alone, however, was no guarantee of industry-wide acceptance. To make MS-DOS the standard, Microsoft needed to convince software developers to write programs for MS-DOS. And in 1981, these developers were a little confused about IBM's new operating system.

An operating system by any other name...

A tangle of names gave rise to one point of confusion about MS-DOS. Tim Paterson's "Quick and Dirty Operating System" for the 8086 was originally shipped by Seattle Computer Products as 86-DOS. After Microsoft purchased 86-DOS, the name remained for a while, but by the time the PC was ready for release, the new system was known as MS-DOS. Then, after the IBM PC reached the market, IBM began to refer to the operating system as the IBM Personal Computer DOS, which the trade press soon shortened to PC-DOS. IBM's version contained some utilities, such as DISKCOPY and DISKCOMP, that were not included in MS-DOS, the generic version available for license by other manufacturers. By calling attention to these differences, publications added to the confusion about the distinction between the Microsoft and IBM releases of MS-DOS.

Further complications arose when Lifeboat Associates agreed to help promote MS-DOS but decided to call the operating system Software Bus 86. MS-DOS thus became one of a line of trademarked Software Bus products, another of which was a product called SB-80, Lifeboat's version of CP/M-80.

Finally, some of the first hardware companies to license MS-DOS also wanted to use their own names for the operating system. Out of this situation came such additional names as COMPAQ-DOS and Zenith's Z-DOS.

Given this confusing host of names for a product it believed could become the industry standard, Microsoft finally took the lead and, as developer, insisted that the operating system was to be called MS-DOS. Eventually, everyone but IBM complied.

Developers and MS-DOS

Early in its career, MS-DOS represented just a small fraction of Microsoft's business—much larger revenues were generated by BASIC and other languages. In addition, in the first two years after the introduction of the IBM PC, the growth of CP/M-86 and other

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