INTEL:

ARCHITECT

OF THE

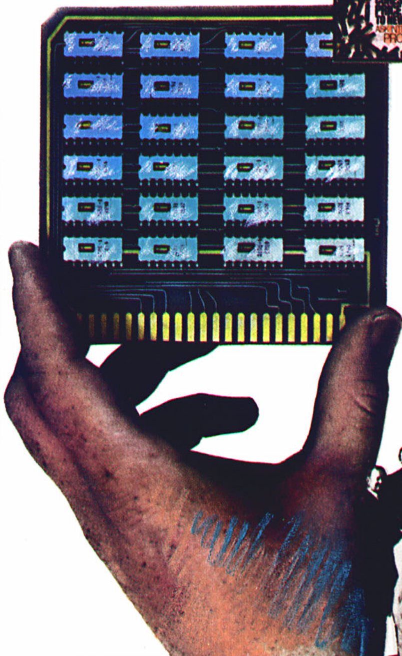
MICROCOMPUTER

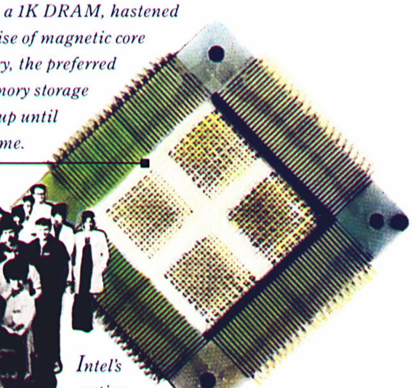
REVOLUTION

1968 ▪ 1969 ▪ 1970

INTEL AT 20
THE REVOLUTION CONTINUES

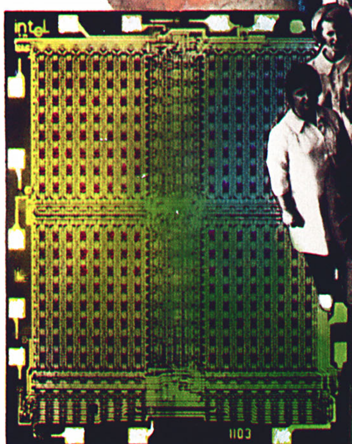
The "Intel Delivers" slogan was coined early on to alleviate engineers' fear of innovative computing products that sound terrific on paper but never make it to market.





The introduction of Intel's low-cost 1103, a 1K DRAM, hastened the demise of magnetic core memory, the preferred memory storage device up until that time.

Intel's entire workforce gathered for a group photo in 1970.



The 1103, a 1K DRAM.

Andy Grove (at right), who had worked with Noyce and Moore at Fairchild Semiconductor, joined Intel at its founding. He is currently the president and chief executive officer of Intel Corp.

Intel founders Gordon Moore and Bob Noyce inspect a memory board in the foreground of a photomicrograph of Intel's first product, the 3101 Schottky bipolar memory.

1968 was a year of revolution; reports of war, anti-war demonstrations, assassinations, riots and drugs filled the daily papers. Little-noted was the incorporation of a new company, Intel, that July in Mountain View, California.

The company started with 12 people in a single room and first-year revenues were $2672. This hardly seems the stuff of legends, and amid the tumult of 1968 one would had to have been a visionary to endorse Intel co-founder Gordon Moore's statement that "we are the true revolutionaries."

Twenty years later, that immodest claim rings much more true. Simply put, Intel's innovations have changed the world. Intel's microprocessor, erasable, programmable read-only memory (EPROM) and dynamic random access memory (DRAM) have transformed the way the world handles information. "Computers" are no longer huge, costly machines that take up entire air-conditioned rooms; rather they are tiny, inexpensive chips that can be tucked into personal computers, automated teller machines, automobile engines, laser printers, toys and assembly line robots. In the process, new industries have emerged and old ones have been transformed.

Intel too has been transformed. In 20 years it has blossomed into a multinational, Fortune 200 company with more than 20,000 employees.

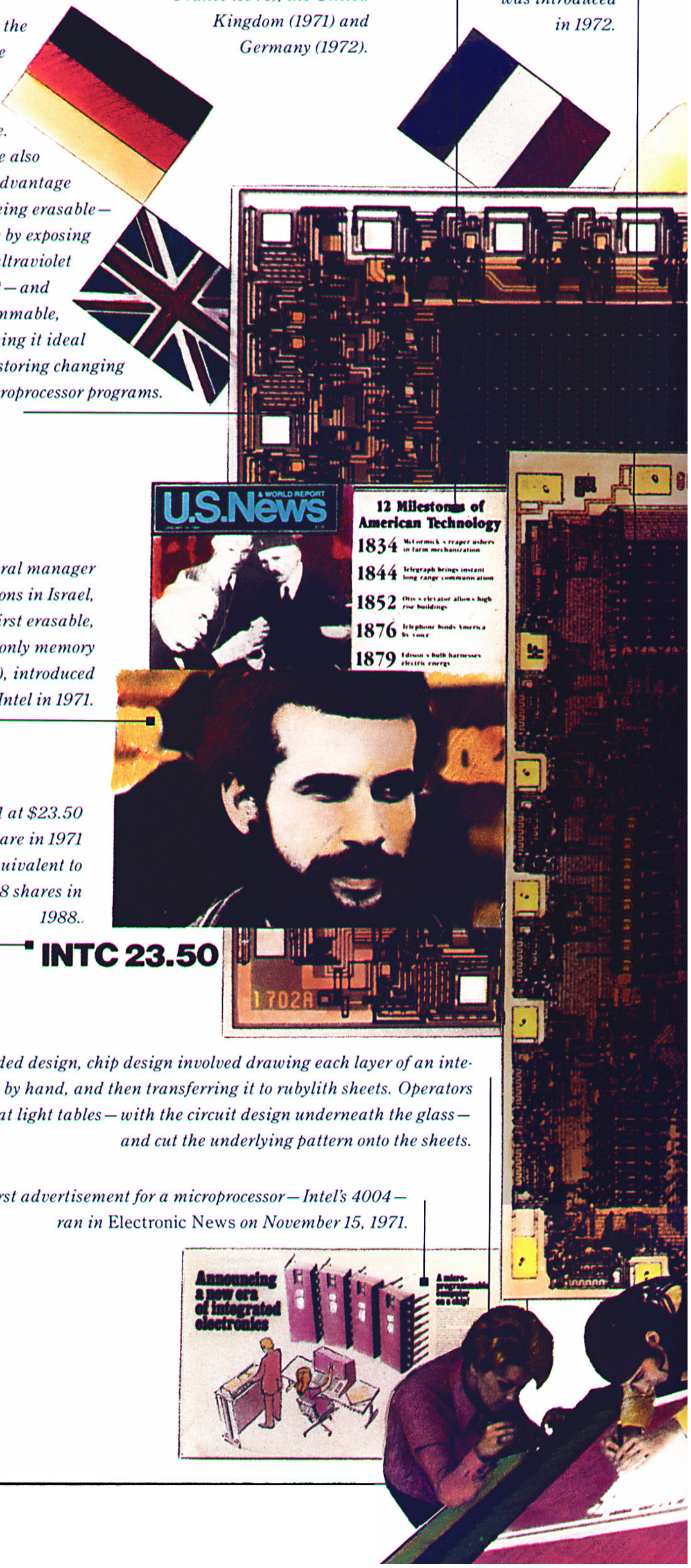
What has enabled the company to achieve so much in so little time? Perhaps it is a sort of high tech three R's: research, risk-taking and responsiveness. Through good times and bad, Intel has invested from 10 to 15 percent of its revenues on average on research and development, essential in an industry where yesterday's state-of-the-art can be tomorrow's obsolete. Fueling this is the fact that the entrepreneurial fervor ignited at Intel 20 years ago has continued. Taking risks—whether on a new product, a new market or even a new venture—is a requirement if you are going to be on the leading edge. Responding to *changing* market needs is also an imperative. The most dramatic example of Intel's shifting gears to respond to the marketplace has been the

The microprocessor was listed as one of "12 Milestones of American Technology" in U.S. News and World Report's *1982 ranking. Also gracing the list were the light bulb, the telephone and the airplane.*

Developed in tandem with the 4-bit 4004, Intel's 8-bit 8008 microprocessor was introduced in 1972.

Intel crossed the Atlantic early in the 1970s, opening offices in Switzerland (1969), Belgium (1970), France (1971), the United Kingdom (1971) and Germany (1972).

EPROMs like the 1702A could store charges permanently, even in the event of a power outage. The device also had the advantage of being erasable—simply by exposing it to ultraviolet light—and reprogrammable, making it ideal for storing changing microprocessor programs.

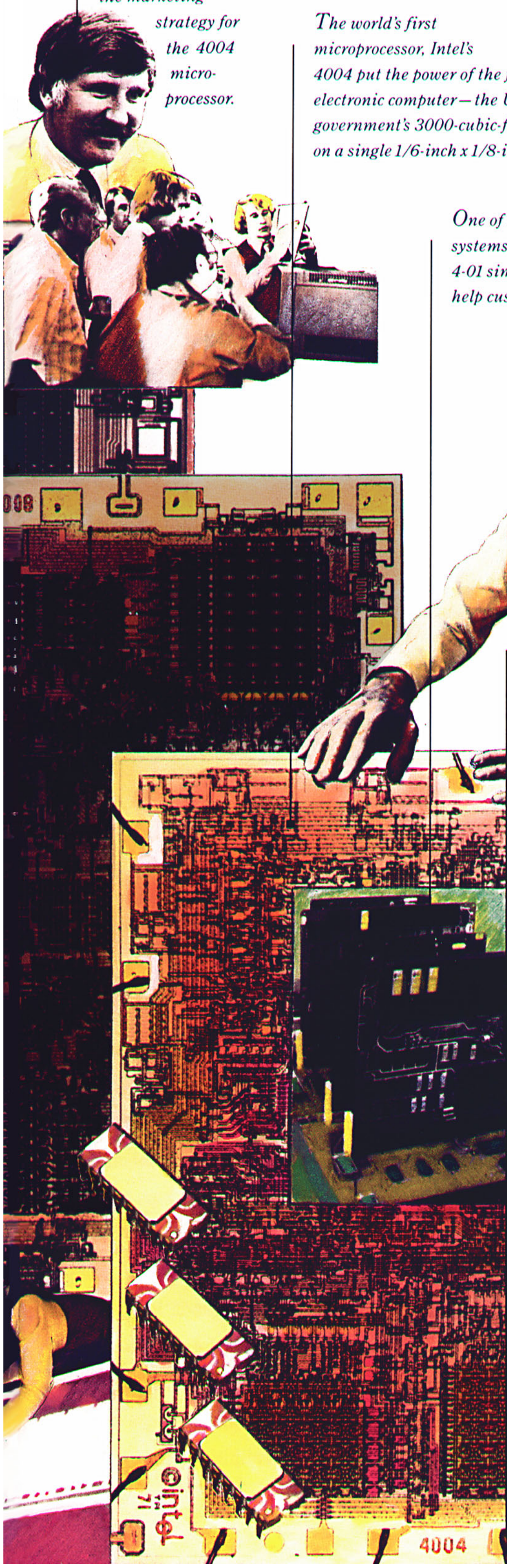


Dov Frohman, today general manager of Intel's operations in Israel, invented the world's first erasable, programmable read-only memory (EPROM), introduced by Intel in 1971.

Intel went public in 1971 at $23.50 per share. One share in 1971 would be equivalent to 38 shares in 1988.

Before computer-aided design, chip design involved drawing each layer of an integrated circuit by hand, and then transferring it to rubylith sheets. Operators worked at light tables—with the circuit design underneath the glass—and cut the underlying pattern onto the sheets.

The first advertisement for a microprocessor—Intel's 4004—ran in Electronic News *on November 15, 1971.*



Intel's director of marketing Ed Gelbach developed the marketing strategy for the 4004 micro-processor.

The world's first microprocessor, Intel's 4004 put the power of the first electronic computer—the U.S. government's 3000-cubic-foot ENIAC—on a single 1/6-inch x 1/8-inch silicon chip.

One of Intel's first systems products, the SIM 4-01 simulator board was built to help customers design 4004-based products.

Asked to design a custom, multi-chip calculator solution for Japanese manufacturer Busicom, Intel engineer Marcian E. "Ted" Hoff instead invented the world's first, general-purpose microprocessor.

THE FIRST MICROPROCESSOR APPLICATION, THIS CALCULATOR FROM JAPANESE MANUFACTURER BUSICOM, USED INTEL'S 4-BIT 4004, THE WORLD'S FIRST MICROPROCESSOR. BUSICOM HAD INITIALLY CONTRACTED INTEL TO DEVELOP A CUSTOM, 12-CHIP SET FOR A FAMILY OF CALCULATORS. BUT INTEL ENGINEER TED HOFF HAD A BETTER SOLUTION: DESIGN A GENERAL-PURPOSE PROCESSOR THAT COULD BE PROGRAMMED FOR THOUSANDS OF DIFFERENT APPLICATIONS.

company's transformation from a semiconductor company to a microcomputer company, providing the component-, board- and system-level building blocks from which its original equipment manufacturer (OEM) customers can build their end-products.

In short, Intel has prospered by embracing change, a reasonable trait for a revolutionary.

HISTORY

By the time they founded Intel, Bob Noyce and Gordon Moore were already electronics veterans. They had met while working for William Shockley, co-inventor of the transistor, and had later co-founded Fairchild Semiconductor with six colleagues. At Fairchild, Noyce was co-inventor of the integrated circuit, and Moore managed the R&D team that brought the first chips into the commercial domain.

They were joined soon after Intel's incorporation by Andy Grove, a Hungarian emigre who had earned a doctorate in chemical engineering at U.C. Berkeley before joining Fairchild in the early 1960s.

Intel focused initially on making semiconductor computer memory practical. This was not a trivial challenge; at the time, magnetic core memory was 200 times cheaper than semiconductor memory. Intel's task was to drive down cost-per-bit by achieving dramatic increases in the number of bits that could be stored on a chip.

Talented people flocked to Intel, drawn by the founders'

There are no closed doors at Intel. Shoulder-high cubicles separate employees — even top management — from one another so that communication lines are always open. Openness is also the premise behind "constructive confrontation," otherwise known as "being direct." When practiced correctly, this philosophy is an effective way to get to the crux of a problem and prevents the build-up of unresolved tension among employees.

Intel opened its first international assembly plant on the small Malaysian island of Penang in 1973. What was initially a five-acre, 140-employee operation has burgeoned into a 27-acre, 2000-employee manufacturing machine.

reputations and a shirtsleeves, achievement-oriented atmosphere that valued hard work and good ideas.

Within a year, Intel had rolled out its first product — the 3101 Schottky bipolar 64-bit static random access memory (SRAM). Soon after, the company introduced the 1101, a 256-bit SRAM, developed on Intel's new silicon gate metal oxide semiconductor (MOS) process, which substituted a film of poly-crystalline silicon for the aluminum used previously. Both were moderately successful, but Intel's first really successful product — the 1103 DRAM — came in 1970. The DRAM, used to store a computer's instructions, received broad acceptance among mainframe manufacturers because of its low cost.

It wasn't long before the 1103 started to bury magnetic cores. Indeed, by the end of 1971, the 1103 was the world's largest selling semiconductor device. But 1971 was not only the year of the 1103, it was also when two of Intel's most significant contributions to microelectronics were unveiled.

1971: The Turning Point

1971 was a busy year at Intel. The company became a publicly held corporation and it was the first year in which revenue surpassed operating expenses. Intel also established sales offices in Paris and Tokyo in 1971.

In August 1971 Intel introduced the EPROM. The brainchild of Intel's Dov Frohman, the device was an industry first. The new memory could store data permanently, but could be erased simply by being zapped with a beam of ultraviolet light, unlike prior memory solutions which had to be replaced whenever new programming was needed.

Initially, the EPROM was viewed as a prototyping device for R&D. But with the invention of the microprocessor that same year, the full potential of the EPROM was realized — and vice versa. The EPROM gave OEMs a flexible, low-cost way to store microprocessor programs, and the market for both chips grew rapidly as a result.

The Microprocessor

The invention of the microprocessor forever changed Intel's course; it was the company's first real foray into the logic front, and a serendipitous one at that.

"Smart system designers use Intel microcomputers for almost everything," this 1973 Intel advertisement began. The ad went on to describe such diverse applications for Intel products as electronic scales, blood analyzers and video games.

The traffic light was one of the earliest and most pervasive applications for Intel microprocessors.

The 8-bit 8080 microprocessor featured roughly 10 times the performance of its predecessor, the 8008.

In 1972, as the digital watch craze was beginning, Intel acquired Microma, a small company. Price wars and the inability to add significant technological value to the product forced Intel to sell the business in 1978.

Intel's second international assembly plant opened in Manila, the Philippines, in 1974. A test facility followed in 1982. Today that Intel community numbers roughly 1500.

The development of the microprocessor actually began in 1969, when the now-defunct Japanese calculator-maker Busicom asked Intel to design a set of chips for a family of programmable calculators. The original design called for at least 12 custom chips, but Ted Hoff, the Intel engineer assigned to the project, thought the configuration was unduly complex. His solution was to develop a single-chip, general-purpose logic device which would retrieve its application instructions from semiconductor memory. Up until that time, every customer who had needed a complex logic chip wanted a custom-designed one. But, "If this continued," Noyce and Hoff wrote later, "the number of circuits needed would proliferate beyond the number of circuit designers." Hoff's solution would enable one off-the-shelf processor to handle a slew of different functions.

Hoff's vision was transformed into silicon in nine months by a team of engineers and designers led by Federico Faggin. Measuring 1/8-inch wide by 1/6-inch long and consisting of 2300 MOS transistors, the 4004 microprocessor had as much computing power as the first electronic computer, ENIAC, which filled 3000 cubic feet with 18,000 vacuum tubes when it was built in 1946. The 4004 could execute 60,000 operations in one second, primitive by today's standards, but a major breakthrough at the time.

There was only one minor problem with the device: Busicom owned the rights to it. At the outset, Busicom had paid Intel $60,000 to design the chip set. Now, Intel was uneasy about its decision to give up the rights. Cognizant of financial troubles at Busicom and sensing the market potential of the product, Intel offered to give them back their $60,000 investment if they would surrender their exclusive rights to the product. They accepted the offer, and the rest, as they say, is history.

The 4004 was formally introduced at the end of 1971, sold for $200, and was followed less than a year later by the 8-bit (processes 8 bits—a string of eight ones or zeroes—of information at a time) 8008. Soon after their introductions, both devices began to open up new markets for Intel products. For the first time, affordable computing power was available to designers of all types of products and they began using Intel's new devices in ways the company hadn't anticipated. Among the applications were traffic lights, scales and taxi meters.

The cash cows that funded these forays into computing were Intel's memory chips. At the time, no one could match the company's prowess in DRAMs, SRAMs or EPROMs. According to Gordon Moore, "We were fortunate in picking a technology sufficiently difficult that it took our competitors several years to catch on." In retrospect, the company's memory and logic technologies interacted with remarkable synergy: memory sales funded microprocessor development, which in turn created demand for more memory. And so on.

Born in 1974, the 8-bit 8080 has been called the first, true general-purpose microprocessor. It was much more highly integrated than its predecessors, and, executing 290,000 operations per second, offered roughly 10 times the performance of the 8008. While both the 4004 and 8008 used P-channel MOS technology, the 8080 used the innovative N-channel process, resulting in major gains in speed, power, capacity and density. The market response was enormous and the product soon became an industry standard.

But Motorola and Zilog responded to the 8080 with the 6809 and Z80 microprocessors, respectively, raising the competitive ante and driving Intel forward to the next generation of microprocessors. In fact, the company began pursuing two paths simultaneously. The 8086, a 16-bit microprocessor with 29,000 transistors and 10 times the performance of the 8080, was introduced in 1978. The iAPX 432, an architecturally innovative but slow 32-bit microprocessor, was introduced in 1981. Unfortunately, the process technology of the time couldn't deliver sufficient performance, so the 432 microprocessor never caught on despite its advanced design.

The 8086 was followed in 1979 by the 8088, an 8-bit bus version of the 8086. Orders for the new chips grew steadily, but, once again, the competition was close behind.

Serious competition developed in the form of the Motorola 68000, which crept up on the 8086 and beat it out for a number of key design wins. In response, Intel launched a company-wide campaign to squelch the onslaught and make the 8086/8088 architecture the industry standard. The objective was to generate 2000 new designs within a year and an aggressive Intel rose to the occasion. Aware that customers were increasingly looking to reduce their time to market, Intel stressed its ability to offer complete microcomputer solutions with software, peripherals and field support. Simultaneously, the company poured money and effort into advertising, seminars and technical documentation. The result? Intel beat its target by raking in nearly 2500 new design wins that year.

The IBM PC

The selection of Intel's 8088, in 1980, as the architecture for IBM's first personal computer was a terrific coup for Intel. IBM's strategy was to create an "open" system based on an industry-standard microprocessor. (Open, as opposed to closed or proprietary systems, are capable of providing an easy transition to the next generation of microprocessor technology. This is why software compatibility between microprocessor generations is so important.) The Intel 8086/8088 campaign had established the Intel architecture as the de facto 16-bit standard; later, the IBM PC* win clinched it. In addition to making the Intel 8088 the standard, the IBM PC also made the machine's software (Microsoft Corp.'s MS-DOS*) the standard, which led hordes of application software developers to start writing DOS-compatible programs. More important, however, it brought computing power to the office desktop.

While PC kits had been available ever since MITS' 8080-based Altair 8800 hit the streets in 1974, and Apple in 1977 had achieved success—mainly with hobbyists—with its Apple II personal computer, it was IBM that penetrated the office market. Workers jumped at the chance to increase productivity at their desks, and quickly embraced the small sampling of DOS-compatible word processing and spreadsheet programs on the market.

The IBM PC was a success, however in 1981-1982 overcapacity drove down prices on high-margin chips such as the 2716 EPROM. IBM, concerned about Intel's ability to keep investing in R&D and the advanced plants of the future, stepped forward in late 1982 to buy $250 million of stock. This infusion of capital and IBM's endorsement of the Intel architecture enabled Intel to solidify its position. In 1987 IBM sold the last of its shares in a strong Intel.

Intel invented the first EPROM microcontroller, the 8-bit 8748, in 1976. The microcontroller integrated a microprocessor, memory and an input/output device all on a single chip.

The next generation of the 8086 family—the 16-bit 80286—was introduced in 1982. While it maintained software compatibility with its predecessor, the chip, with 130,000 transistors, was far and away technologically superior. Aimed at the higher end of the 16-bit market, which was demanding more performance to accommodate everything from local area networking to color graphics, the 286 microprocessor featured multitasking (the ability to run two or more tasks simultaneously using one microprocessor), and an on-chip security function which ensured data would be protected. These features allowed it, for example, to be able to run both the MS-DOS and UNIX* operating systems.

Despite the fact that the personal computer was not even *mentioned* on a pre-introduction list describing every possible potential use for the product, it ultimately became the 286's largest application. While the 286 found its way into industrial auto-

An innovation in the area of development tools, Intel rolled out the ICE™-80 in-circuit emulator in 1975. This tool, used to emulate the performance of microprocessors while they are in an actual system, is still the most effective way to develop and debug microprocessor-based systems.

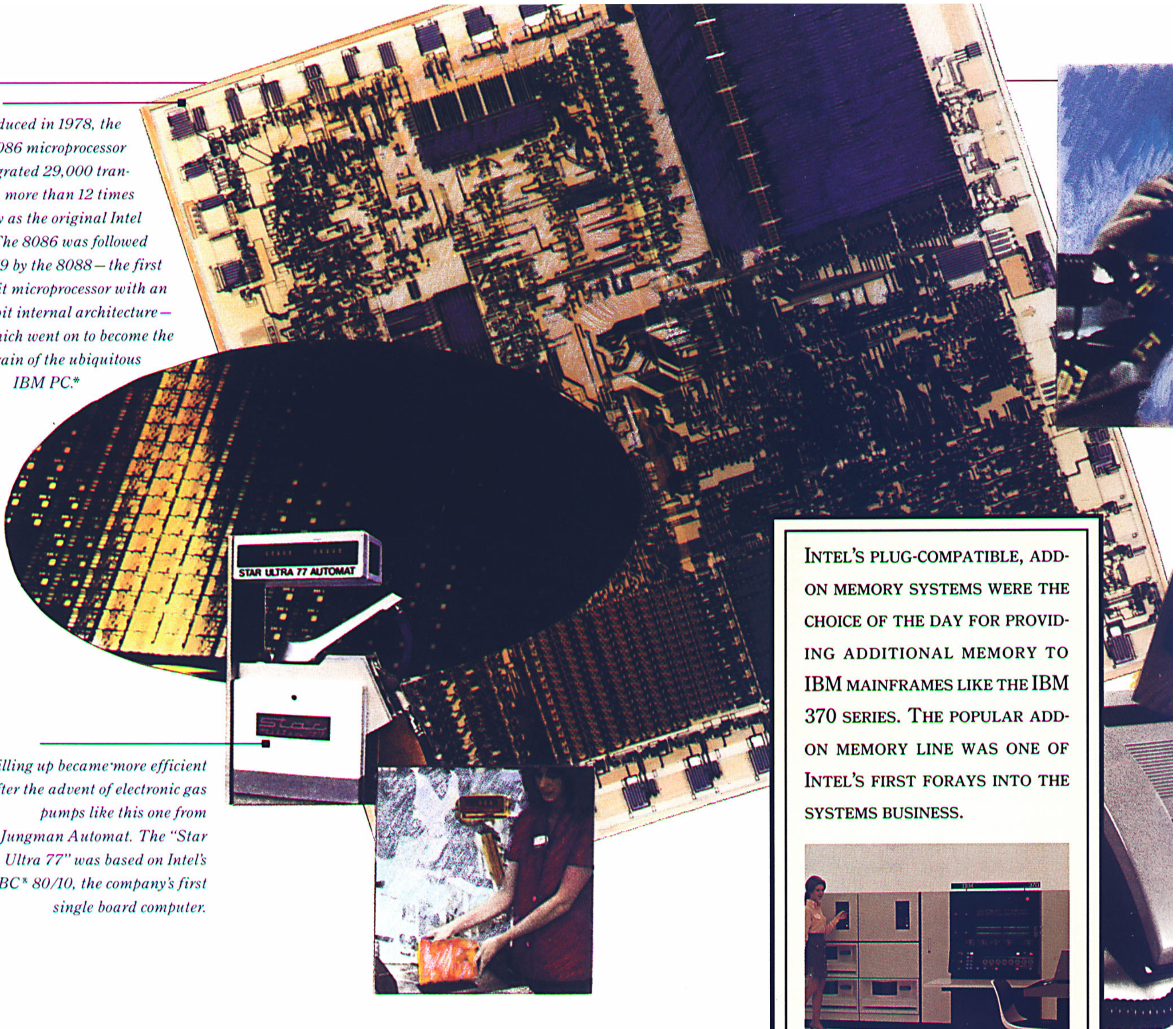
Few will forget the 1975 fire that destroyed the entire Penang assembly facility or the truly miraculous show of team effort that ensued. Operating out of rented space, the Penang team managed to ship 100,000 units less than two weeks after the disaster.

Intel began offering its customers single board computers in 1976 after OEMs began expressing interest in the "guts" of the Intellec® 8 development system.

mation, telecommunications, transaction processing and military applications, its most significant role was as the brain of the second-generation IBM PC—the PC AT*—and the compatible machines that followed. Hoping to replicate IBM's success and facilitated by the AT's open architecture, companies like Compaq, NEC and Tandy later brought out AT-compatible computers (clone-makers en masse had also introduced PC-compatible machines), so that by the end of 1988 there was an installed base of roughly 15 million 286-based personal computers worldwide.

Intel (written in Katakana on this button) first established a sales office in Tokyo in 1971, and expanded its Japanese operations in 1976.

Dick Pashley first led Intel into the high-performance MOS (HMOS) business. Initially applied to Intel static RAMs (SRAMs) and then DRAMs, the HMOS process ultimately led to denser, smaller and higher performance microprocessors.



*Introduced in 1978, the 16-bit 8086 microprocessor integrated 29,000 transistors, more than 12 times as many as the original Intel 4004. The 8086 was followed in 1979 by the 8088—the first 16-bit microprocessor with an 8-bit internal architecture—which went on to become the brain of the ubiquitous IBM PC.**

Filling up became more efficient after the advent of electronic gas pumps like this one from Jungman Automat. The "Star Ultra 77" was based on Intel's iSBC 80/10, the company's first single board computer.*

INTEL'S PLUG-COMPATIBLE, ADD-ON MEMORY SYSTEMS WERE THE CHOICE OF THE DAY FOR PROVIDING ADDITIONAL MEMORY TO IBM MAINFRAMES LIKE THE IBM 370 SERIES. THE POPULAR ADD-ON MEMORY LINE WAS ONE OF INTEL'S FIRST FORAYS INTO THE SYSTEMS BUSINESS.

Pressure From The Land Of The Rising Sun

Despite the success of the 286, Intel suffered—along with the rest of the semiconductor industry—through a severe recession in 1985-1986. The U.S. semiconductor industry as a whole lost money every quarter from the second quarter of 1985 through the fourth quarter of 1986 due to a combination of slumping demand and growing capacity. Concurrent with these developments, Japanese semiconductor manufacturers engaged in unfairly low pricing of both DRAMs and EPROMs. These developments led to the initiation of a number of formal trade cases in 1985.

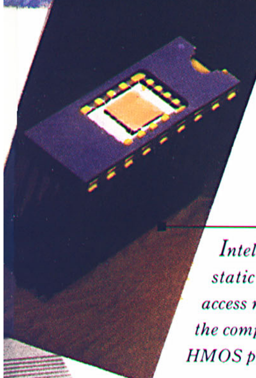
A Section 301 case, citing unfair pricing of Japanese semiconductors in the U.S. and restricted market access of American firms to the Japanese market, was filed with the U.S. Trade Representative in June 1985. Also that month, Boise, Idaho-based Micron Technology initiated a case against several Japanese DRAM manufacturers.

Soon after, Intel, Advanced Micro Devices and National Semiconductor filed their own case against the Japanese, this time for EPROM-dumping (i.e., selling below cost plus normal markup). Finally, the U.S. Department of Commerce initiated its own investigation of DRAM-dumping. In preliminary anti-dumping determinations in all of these cases, and final determinations in two, Japanese companies were found to be dumping.

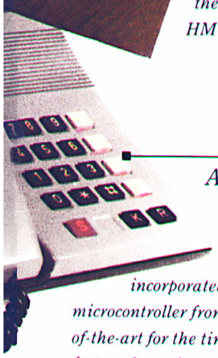
Yet, despite the seemingly promising outcomes of the cases, there was still devastating damage to the companies. In 1985, Intel was forced to resort to lay-

1977 ▪ 1978

Pictured here is an operator at Intel's first wafer fabrication facility (fab) in Oregon. Today Oregon is home to Intel's Systems Group, one of the company's technology development centers, a fab and a systems manufacturing facility.



Intel's 2147 4K static random access memory was the company's first HMOS product.



A telephone from Denmark's Kristian Kirks Telefonfabriker incorporated an 8-bit 8048 microcontroller from Intel. State-of-the-art for the time, the phone featured number recall and auto redial.

offs, plant closings, salary cuts and time off without pay. (Intel, however, still increased its R&D spending that year—to 14.3 percent of revenues). Perhaps worst of all, though, falling prices forced Intel in 1985 to abandon the DRAM business, a business it had created, although the company tenaciously hung on to its leadership in the EPROM business.

Largely the result of the unified semiconductor industry front and its persistent lobbying of the U.S. government, a Japanese/American trade agreement was signed in September 1986. In effect a settlement of the Section 301 investigation, it stipulated that all dumping of DRAMs and EPROMs in the U.S. and third-country markets must cease, and that full market access would be provided to foreign firms in Japan.

While dumping in the U.S. stopped fairly rapidly, dumping in third-country markets continued, as did the closed Japanese market. As a result, President Reagan in April 1987 imposed tariffs on $300 million worth of Japanese goods. Semiconductor imports were not targeted, however, to avoid hurting any U.S. manufacturers who depended on them for their end-products.

Enter The 386™ Microprocessor

Intel would probably just as soon erase 1985 from the history books, were it not for the introduction of the 386™ microprocessor. No longer producing DRAMs, struggling to keep its lead in EPROMs, and in the midst of the worst downturn in history, Intel needed a winner. The 32-bit 386 microprocessor turned out to be just that winner later in the decade.

With 275,000 transistors—a more than 100-fold increase in transistor count over the 4004—a top operating speed of 5 million instructions per second (MIPS) and the ability to run DOS software concurrently with UNIX programs—still the only microprocessor that can make this claim—the 386 microprocessor was embraced by the computer community. Upon its introduction, the chip was heralded as "the highest performance commercial microprocessor ever designed." The key word in that phrase was *commercial.* In other words, one might have been able to build a machine with higher performance by using exotic technologies, but you could not build it as small or as cost-effectively as the 386 microprocessor.

In 1988 Intel rolled out the 386SX™ microprocessor, or "the 386 Lite," as *The New York Times'* Peter H. Lewis dubbed it. The chip is an entry-level addition to the Intel386™ family, which because it is priced competitively yet can execute 2.5 to 3 MIPS, is a natural upgrade from the 286. The chip also offers a distinct advantage in that, unlike the 286, it can run 32-bit software. Initial response to the chip was encouraging, and the first personal computers, from companies like Compaq and NEC, were well received.

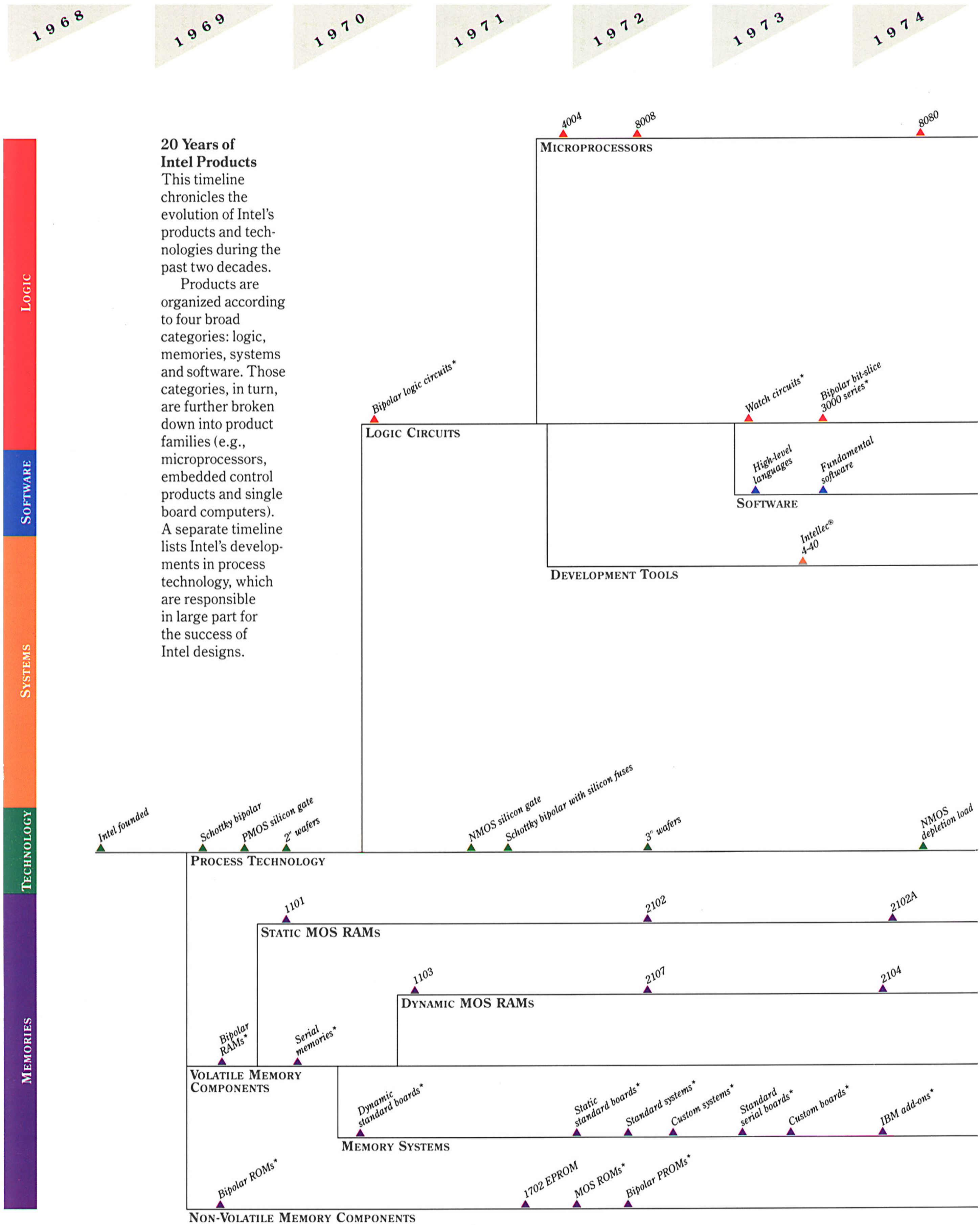
Peripherals—The Data Movers

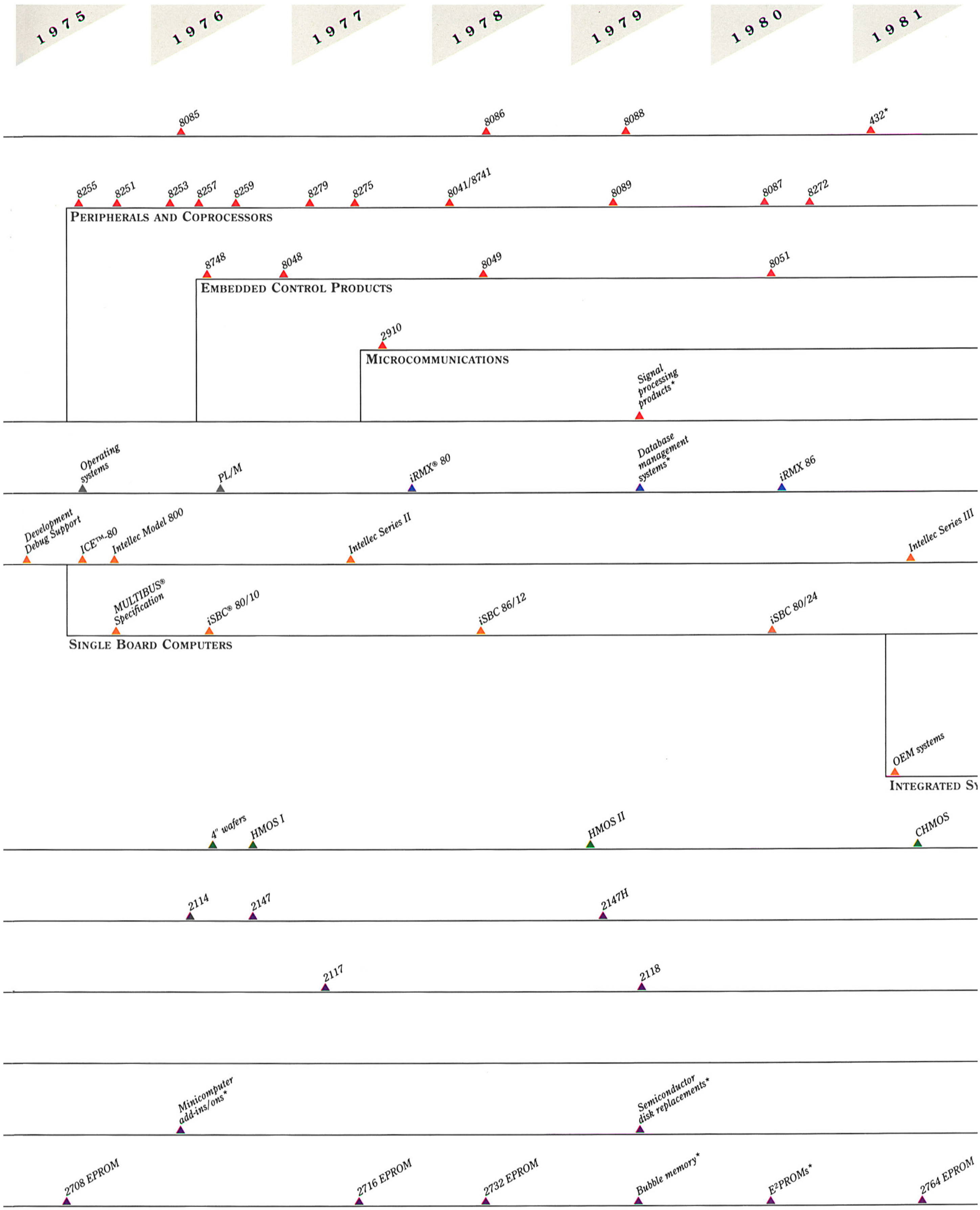
Soon after the introduction of the first version of the 386 microprocessor, Intel announced it would be offering three companion chips—part of a broad category of microcomputer products known as *peripherals*—to further enhance its performance. Peripheral components are specialized integrated circuits designed to reduce the load on a specific central processing unit (in this case, the 386 microprocessor). Typically, they are responsible for shuttling data internally, from the central processing unit (CPU) to the printer, for instance—or, in the case of telecommunications products, from machine to machine. Each of Intel's microprocessors has been supported by a full line of peripheral components. This particular trio consisted of the 387™ math coprocessor, the 82385 cache controller and the 82380 integrated system controller.

This commitment to providing complete hardware solutions finely tuned to Intel microprocessors surfaced in the late 1970s

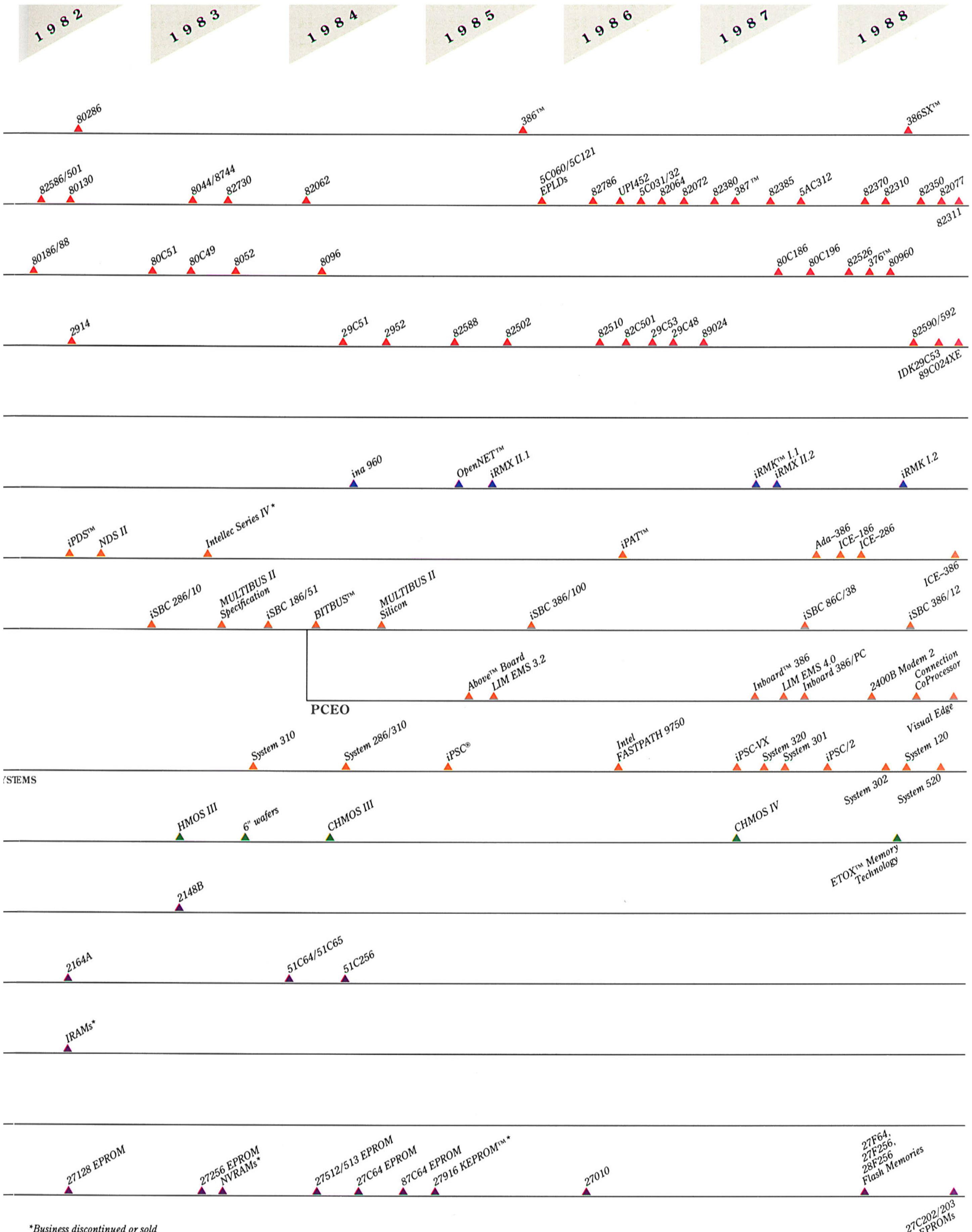
20 Years of Intel Products
This timeline chronicles the evolution of Intel's products and technologies during the past two decades.

Products are organized according to four broad categories: logic, memories, systems and software. Those categories, in turn, are further broken down into product families (e.g., microprocessors, embedded control products and single board computers). A separate timeline lists Intel's developments in process technology, which are responsible in large part for the success of Intel designs.





1975
1976
1977
1978
1979
1980
1981
8085
8086
8088
432*
8255
8251
8253
8257
8259
8279
8275
8041/8741
8089
8087
8272
PERIPHERALS AND COPROCESSORS
8748
8048
8049
8051
EMBEDDED CONTROL PRODUCTS
2910
MICROCOMMUNICATIONS
Signal processing products*
Operating systems
PL/M
iRMX® 80
Database management systems*
iRMX 86
Development Debug Support
ICE™-80
Intellec Model 800
Intellec Series II
Intellec Series III
MULTIBUS® Specification
iSBC® 80/10
iSBC 86/12
iSBC 80/24
SINGLE BOARD COMPUTERS
OEM systems
INTEGRATED SY
4" wafers
HMOS I
HMOS II
CHMOS
2114
2147
2147H
2117
2118
Minicomputer add-ins/ons*
Semiconductor disk replacements*
2708 EPROM
2716 EPROM
2732 EPROM
Bubble memory*
E²PROMs*
2764 EPROM



*Business discontinued or sold

MAJOR OPERATIONS
- *Santa Clara Microcomputer Division*
  Santa Clara, California, U.S.
- *Folsom Microcomputer Division*
  Folsom, California, U.S.
- *Memory Components Division*
  Folsom, California, U.S.
- *Chandler Microcomputer Division*
  Chandler, Arizona, U.S.
- *Systems Group*
  Hillsboro, Oregon, U.S.

REGIONAL HEADQUARTERS
- *Paris, France*
- *Munich, W. Germany*
- *Hong Kong*
- *Tsukuba, Japan*
- *Swindon, United Kingdom*

WAFER FABRICATION
- *Chandler, Arizona, U.S.*
- *Livermore, California, U.S.*
- *Santa Clara, California, U.S.*
- *Albuquerque, New Mexico, U.S.*
- *Aloha, Oregon, U.S.*
- *Jerusalem, Israel*

SYSTEMS MANUFACTURING
- *Hillsboro, Oregon, U.S.*
- *Las Piedras, Puerto Rico*
- *Singapore*

COMPONENTS ASSEMBLY & TEST
- *Chandler, Arizona, U.S.*
- *Penang, Malaysia*
- *Manila, Philippines*

U.S. SALES OFFICES
Huntsville, Alabama
Phoenix, Arizona
Tucson, Arizona
Canoga Park, California
El Segundo, California
Sacramento, California
San Diego, California
Santa Ana, California
Santa Clara, California
Colorado Springs, Colorado
Denver, Colorado
Danbury, Connecticut
Ft. Lauderdale, Florida
Orlando, Florida
St. Petersburg, Florida
Norcross, Georgia
Schaumburg, Illinois
Indianapolis, Indiana
Cedar Rapids, Iowa
Overland Park, Kansas
Hanover, Maryland
Greenbelt, Maryland
Westford, Massachusetts
W. Bloomfield, Michigan
Bloomington, Minnesota
Earth City, Missouri
Red Bank, New Jersey
Roseland, New Jersey
Albuquerque, New Mexico
Fairport, New York
Fishkill, New York
Islandia, New York
Charlotte, North Carolina
Raleigh, North Carolina
Beachwood, Ohio
Dayton, Ohio
Oklahoma City, Oklahoma
Beaverton, Oregon
Fort Washington, Pennsylvania
Pittsburgh, Pennsylvania
Las Piedras, Puerto Rico
Austin, Texas
Dallas, Texas
Houston, Texas
Murray, Utah
Richmond, Virginia
Bellevue, Washington
Spokane, Washington
Brookfield, Wisconsin

CANADIAN SALES OFFICES
Burnaby, British Columbia
Ottawa, Ontario
Rexdale, Ontario
Pointe Claire, Quebec

EUROPEAN SALES OFFICES
Copenhagen, Denmark
Helsinki, Finland
Lyon, France
Paris (St. Quentin-en-Yvelines), France
Hannover, W. Germany
Munich (Feldkirchen), W. Germany
Stuttgart, W. Germany
Wiesbaden, W. Germany
Tel Aviv, Israel
Milan, Italy
Rotterdam, Netherlands
Skjetten, Norway
Madrid, Spain
Solna, Sweden
Zurich, Switzerland
Swindon, United Kingdom

INTERNATIONAL SALES OFFICES
Crow's Nest, Australia
Sao Paulo, Brazil
Beijing, China
Hong Kong
Kanagawa, Japan
Nagoya-shi-Aichi, Japan
Osaka, Japan
Saitama, Japan
Tokyo, Japan
Tsukuba, Japan
Seoul, Korea
Singapore
Taipei, Taiwan

INTERNATIONAL CUSTOMER TRAINING
St. Quentin-en-Yvelines, France
Feldkirchen, W. Germany
Hong Kong
Tel Aviv, Israel
Milan, Italy
Tokyo, Japan
Rotterdam, Netherlands
Solna, Sweden
Swindon, United Kingdom

U.S. CUSTOMER TRAINING
Westford, Massachusetts
Schaumburg, Illinois
Santa Clara, California
Greenbelt, Maryland

TOLEDO SCALE RECOGNIZED EARLY ON THAT ELECTRONICS COULD OUTPERFORM MECHANICS. THUS, IN THE LATE SEVENTIES THE COMPANY ABANDONED ITS MECHANICAL GROCERY SCALES AND REPLACED THEM WITH ONE OF THE WORLD'S FIRST MICROPROCESSOR CONTROLLED SCALES. FUELED BY 8039 MICROCONTROLLERS FROM INTEL, TOLEDO'S MODEL 8404 SCALE COULD READ AN OBJECT'S WEIGHT, MULTIPLY THAT BY A UNIT PRICE, AND CALCULATE THE TOTAL PRICE.

Describing it as "Unique in the semiconductor industry, not only because it excelled at technological innovation, but because it demonstrated that it is equally astute in marketing, organization and every other measure of management excellence," Dun's Review *selected Intel as one of "The Five Best Managed Companies of 1980."*

Intel joined the ranks of the "Fortune 500" in 1979. Fortune *further shone on Intel that year when it named the company one of the "Business Triumphs of the Seventies."*

Determined to secure industry-standard status for Intel's 8086/8088 microprocessors, Bill Davidow directed an effective marketing campaign against the Motorola 68000.

Intel opened a sales office in Hong Kong in 1979. A burgeoning market for Intel products, revenues generated from the company's Asia-Pacific Operation nearly quadrupled from 1986 to 1988.

A pioneer in local area network technology, Intel implemented Xerox Corp.'s Ethernet communications protocol in silicon. An IEEE standard, Ethernet enables different computers to be linked, and thus communicate with one another.

1979 ▪ 1980

and was a very successful strategy for the company. Intel's peripheral product portfolio was weak in the early eighties which allowed a number of smaller start-ups to beat it to market with chip sets for its own microprocessors. The companies were wildly successful at first and Intel was forced to play catch-up. It did, and in so doing a fundamental business principle became crystal clear: time-to-market is everything.

Because Intel chip sets are now developed in tandem with the company's microprocessors, time-to-market is considerably shorter than third-party chip sets. Furthermore, Intel chip sets are developed *specifically* for Intel chips by designers working with the microprocessor design teams.

Hidden Intelligence

An outgrowth of the microprocessor, the EPROM microcontroller was invented by Intel in 1976. The device combined a microprocessor, memory and an input/output mechanism on a single chip.

Differing from the microprocessor, microcontrollers are preprogrammed by product designers to perform the same function—whether it's controlling Ford Motor Company's automotive engines or a robotic arm from Cincinnati Milacron—and are then embedded in the application. Because of this, users often don't even know they're there. But there they are, and in huge numbers.

Indeed, microcontrollers are actually far more pervasive than general-purpose microprocessors. In 1988 microcontrollers outsold microprocessors by more than five times—with an estimated 486 million units, compared with 89 million microprocessors, according to Dataquest, a San Jose, California-based market research firm.

The first entry in Intel's microcontroller line was the 8-bit 8748, followed closely by the 8-bit 8048 and then the 8-bit 8051 in 1980. The latter two went on to become industry standards; in fact, today they account for roughly one-third of the 8-bit microcontroller market. Then in 1984, Intel unveiled the industry's first 16-bit microcontroller, the 8096. Two years earlier, Intel had introduced the 80186, which was initially developed to be used in traditional microprocessor applications, but also found broad acceptance in the embedded control market.

While the 8-bit 8048 and 8051 and the 16-bit 8096 became leading architectures, the controller market proved to be intensely competitive, and over time Intel found itself with a declining market position.

To capture market share, Intel had to convince customers of its commitment to their specialized needs. The stage was set for another major Intel campaign. Launched in 1987, the embedded control campaign, like the 8086 drive nearly a decade before, was a tremendous success. Intel's energetic and enterprising field sales and applications engineers came to the rescue, raking in more than 5500 new designs, 2500 more than their target. Not only were they offering Intel's existing products in standard or application-specific configurations, they also had an enhanced lineup of new embedded control products.

In 1988 Intel rolled out the 80960, a 32-bit controller architecture offering outstanding features and performance. To meet varied customer needs, the 80960 was offered initially in three configurations, with more to follow.

In conjunction with the 80960, Intel launched the 376™ embedded processor, a lower-priced, lower-performance entry based on the Intel386 architecture. Finally, Intel introduced its flash memory device, a chip targeted at those who may want to *update* their embedded programs. Affordable and easily manufacturable like EPROMs, but easier and faster to update, flash memories don't have to be taken out of their application in order to be reprogrammed. This capability facilitates program updates in such hard-to-reach places as automobiles and assembly lines. By the end of 1988 there were nearly 200 flash memory designs in the works.

Systems

Intel's systems business, like its embedded control business, is also somewhat overshadowed by the high-profile microprocessor. The Systems Group—headquartered outside Portland, Oregon—develops, manufactures and markets microcomputer boards, systems and software for original equipment manufacturers, the retail market and the end-user.

Interestingly, Intel's systems business followed roughly the same evolutionary path as the company's components business. While the first product offerings were memory-related, the majority of subsequent products were microprocessor-based.

When Intel introduced the world's first DRAM in 1970, many customers initially had difficulty designing systems around the part—"It was probably the most difficult-to-use semiconductor device ever created by man," Gordon Moore once reflected. To help customers, and thus speed the acceptance of the product in the marketplace, a number of Intel engineers put together boards to show customers how the DRAM could be used. As casually as that, Intel's systems business was on its way.

In 1971 Intel formalized its systems focus and formed a Memory Systems Operation (MSO), a separate group dedicated to building and selling memory circuit boards and memory systems. The operation's first product was the IN-10, a moderately successful memory board that also incorporated peripheral support components. Then in 1972 Intel began selling plug-compatible, add-on memories for IBM mainframes, a business which continued until the late seventies. In 1983, due to shrinking demand for this and other memory systems products, MSO was phased out.

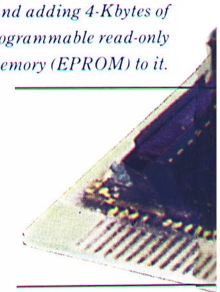
About the same time DRAM customers were crying for help, a similar situation was arising on the microprocessor front. When the first microprocessor (the 4004) came out in 1971, Ted Hoff and several other Intel engineers had to go on the road to tell engineers how to use the new chip. Hoff had made up a simulator board, aptly called the SIM-4, to demonstrate how customers could develop 4004 products. At first there was a difference of opinion as to whether the boards should be given away free or sold to customers. But when it became clear how eager customers were for them, Intel opted for the latter choice. This move launched Intel into the development tools business.

Microcomputer development tools have been an important part of Intel's product offerings ever since. In 1973, Intel introduced its first complete development system: the Intellec® 4-40. Used to develop both the hardware and the software for new products incorporating Intel microprocessors, the turnkey system considerably reduced customer product design cycles and was, consequently, extremely popular. In essence, the Intellec machine was the first engineering workstation, created because engineers really had no host machines on which to develop software. The advent of industry-standard hosts, like PC- and AT-compatible machines and the DEC VAX* minicomputer, facilitated a shift away from dedicated hosts like the Intellec development system.

Intel's next step in development tools—and an industry first—was its introduction of the ICE™-80 in-circuit emulator in 1975. The ICE module could be substituted for the microprocessors that were actually used in a customer's system, providing an effective way to develop and debug microprocessor-based systems. The in-circuit emulator has since become the industry-standard solution for this activity.

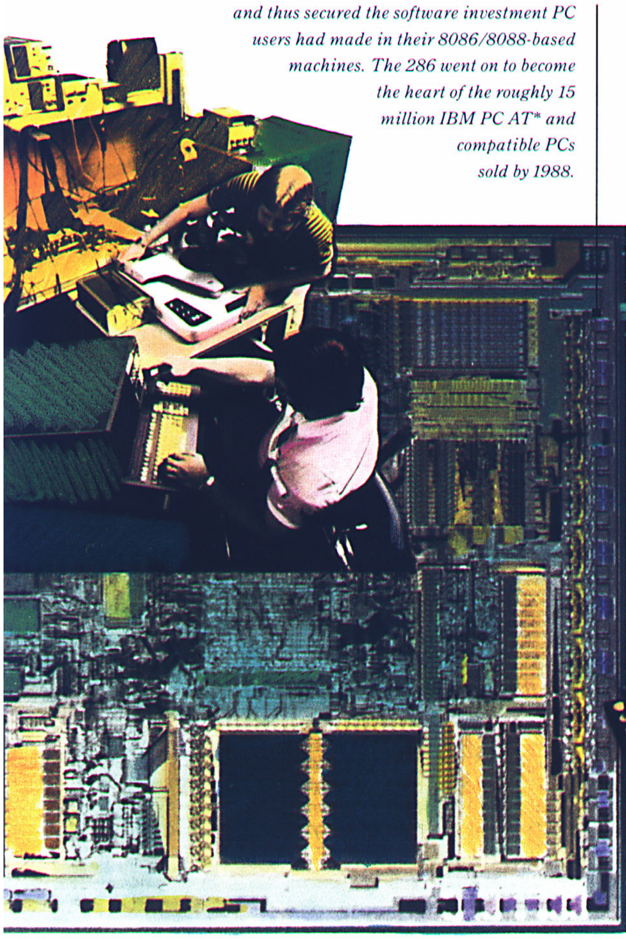
The year after the ICE development tool was introduced, Intel branched out in yet another systems direction. Up until that point, if customers wanted to build systems based on Intel components, they had to do it themselves. This meant that customers faced the task of integrating the microprocessor, peripherals, memories and other circuits onto printed circuit boards, and then adding the other elements needed to make a complete system.

OEM memory boards, like the 2164A DRAM board shown here, were one of Intel's first forays into the systems world.



The 8-bit 8751 microcontroller, an example of an application-specific standard product, was made by taking a standard 8051 part and adding 4-Kbytes of erasable, programmable read-only memory (EPROM) to it.

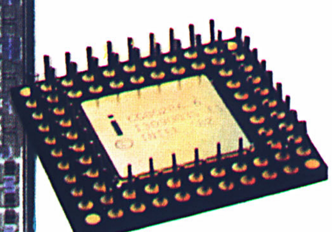
Automated teller machines (ATMs) have made bank interiors foreign terrain to many of us. ATM manufacturer Diebold supplied Bank of America with this machine, which was based on Intel single board computers.



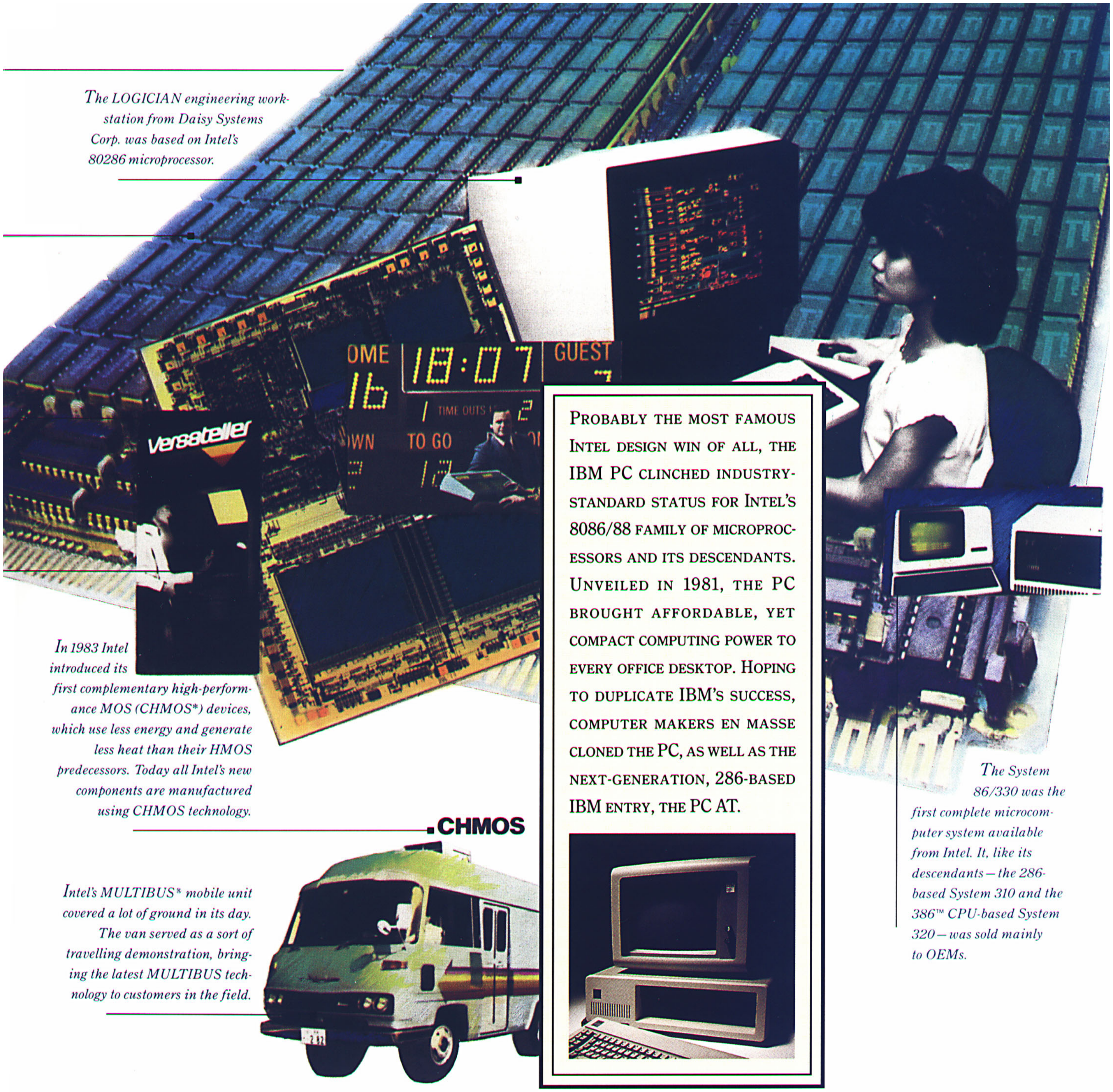
The second-generation microprocessor in the 86 family, the 16-bit 80286 was compatible with its predecessor and thus secured the software investment PC users had made in their 8086/8088-based machines. The 286 went on to become the heart of the roughly 15 million IBM PC AT and compatible PCs sold by 1988.*

IBM

During the industry downturn of 1981-1982, IBM bought $250 million of Intel stock. The infusion of capital and IBM's endorsement of the Intel 8086 architecture helped Intel weather the storm. IBM sold the last of its shares in a strong Intel in 1987.



1981 • 1982



The LOGICIAN engineering workstation from Daisy Systems Corp. was based on Intel's 80286 microprocessor.

In 1983 Intel introduced its first complementary high-performance MOS (CHMOS) devices, which use less energy and generate less heat than their HMOS predecessors. Today all Intel's new components are manufactured using CHMOS technology.*

Intel's MULTIBUS mobile unit covered a lot of ground in its day. The van served as a sort of travelling demonstration, bringing the latest MULTIBUS technology to customers in the field.*

PROBABLY THE MOST FAMOUS INTEL DESIGN WIN OF ALL, THE IBM PC CLINCHED INDUSTRY-STANDARD STATUS FOR INTEL'S 8086/88 FAMILY OF MICROPROCESSORS AND ITS DESCENDANTS. UNVEILED IN 1981, THE PC BROUGHT AFFORDABLE, YET COMPACT COMPUTING POWER TO EVERY OFFICE DESKTOP. HOPING TO DUPLICATE IBM'S SUCCESS, COMPUTER MAKERS EN MASSE CLONED THE PC, AS WELL AS THE NEXT-GENERATION, 286-BASED IBM ENTRY, THE PC AT.

The System 86/330 was the first complete microcomputer system available from Intel. It, like its descendants — the 286-based System 310 and the 386™ CPU-based System 320 — was sold mainly to OEMs.

Behind this new systems thrust, ironically, was the Intellec system. The development system had become extremely popular with OEMs, many of whom expressed interest in its individual contents: namely the CPU and memory boards. Recognizing another business opportunity, Intel in 1976 began offering its customers single board computers. These modules, utilizing Intel's general-purpose processors, were compatible with Intel's now-industry-standard MULTIBUS* architecture, designed for mid-range computing applications. By 1988 Intel had shipped more than one million MULTIBUS boards.

After Intel rolled out its first single board computer, the company found it needed a new operating system for it. Unlike DOS or UNIX, the first iRMX* real-time operating system was geared strictly for applications that needed a guaranteed response within a strict time deadline. More than 500,000 CPUs were running iRMX by 1988, making it the most widely used real-time operating system in the world.

In 1981, the company took the next step forward in system integration when it introduced the first microcomputer in its System 300 series. The System 86/330 came complete with

MULTIBUS-compatible single board computers, disk drives, software interfaces, power supply and chassis, and was sold mainly to OEMs, who had only to add their own application software in order to have a complete system. Intel replaced the System 86/330 a few years later with the System 310, a 286-based machine that found its home in, among other things, a system that keeps a close watch on the status of the water levels in Venice, Italy, and one which monitors the trading levels on the New York Stock Exchange. At the end of 1987, Intel rolled out the latest System 300 series machine, the 386 microprocessor-based System 320. And in 1988 Intel introduced the System 520, its first system to employ MULTIBUS II, the next-generation MULTIBUS architecture featuring multiprocessing capabilities ideal for both real-time and minicomputer-class applications.

While the System 520 is likely to be found controlling the activities on a factory floor, Intel's 386 microprocessor-based System 302 is more apt to be taking care of business at the office. Introduced in 1988, the System 302 is a microcomputer designed for OEMs who want to offer desktop systems but don't want to invest time and money developing hardware. The AT-compatible system comes complete with all the essentials save for a monitor, keyboard and applications software; it must, therefore, be configured by the OEM.

Using the APPLICON graphics design system, Intel engineers could easily generate and revise circuit designs on-screen.

"If you want to work in a tough, demanding environment where you are constantly being pushed to your limits, Intel is the place for you," read the entry about Intel in the 1984 bestseller, The 100 Best Companies to Work for in America.

Intel's ICE™-286 in-circuit emulator, a microprocessor development tool introduced in 1984, emulates the behavior of the 80286 in a system design, providing engineers with an excellent way to develop and debug 286 systems.

In 1984 Gene Meieran followed microprocessor inventor Ted Hoff to become the second Intel Fellow, the corporation's most honored technical position. Intel Fellows are free to explore new technologies and to choose their own research projects. Meieran is currently concentrating on integrating artificial intelligence techniques with the mainstream computer technology found in today's semiconductor manufacturing facilities.

Intel's iSBC 286/10 single board computer features Intel's 80286 microprocessor and is compatible with the company's MULTIBUS* system bus architecture. By 1988 Intel had shipped more than one million MULTIBUS boards based on the 86 family of microprocessors.*

1983 ▪ 1984

In 1983 Intel became the first semiconductor company to produce chips from six-inch silicon wafers. A six-inch wafer can yield more than twice the number of chips as a four-inch wafer.

Systems manufacturing began in Singapore in 1984. More than 200 employees today work at the highly automated Singapore facility, where processes like surface mount technology are completed without any human handling.

Based on Intel's 16-bit 80286 microprocessor, the Foxboro Company's SPECTRUM* Command Center controls industrial processes in real time. Seated at the console, an operator can quickly access data from the factory floor and respond to changing conditions in the plant.

Living On The Edge

The systems products discussed thus far are all sold to OEMs, who customize them before they are sold as end-products. Intel also, however, sells some systems products through the retail channel, as well as directly to the end-user. These products are all the result of Intel's internal venturing activities.

In 1984 Intel stepped up its efforts to explore new businesses of potential strategic importance to the company. These Intel "start-ups" have the freedom to pursue new product ideas while retaining the ability to tap into the corporation's many resources. All inspired by enterprising Intel employees, they operate as separate businesses designing, manufacturing, marketing, selling and supporting their own products.

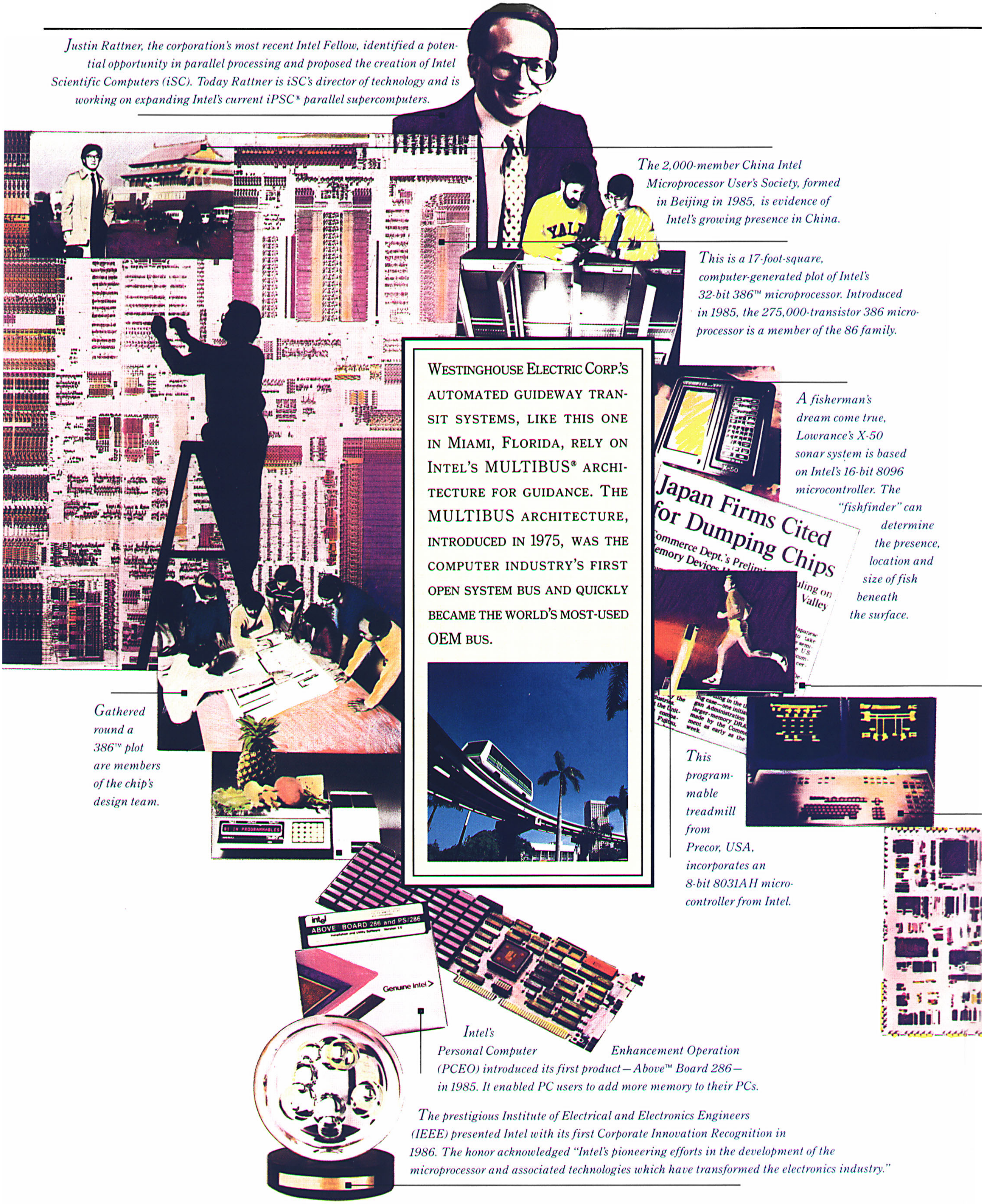
The Systems Interconnect Operation was formed in 1986 to develop and market FASTPATH, a system sold through an end-user sales force. It is used to connect IBM System/370-class mainframes with other computers and networks in factory, laboratory and office environments.

Intel Scientific Computers (iSC) produces concurrent supercomputers which solve complex problems by putting as many as 128 standard Intel microprocessors to work on different parts of the problem at the same time. Intel's iPSC® machines can match the performance levels of certain Cray supercomputers, but are a fraction of the cost because they use off-the-shelf microprocessor technology. Originally viewed as a machine just for researchers, the iPSC is now used in such high-end applications as drug modelling, fluid dynamics and oil exploration. Intel had shipped more than 100 iPSCs by the end of 1988.

The Personal Computer Enhancement Operation (PCEO) sells boards used to enhance the performance of personal computers through more than 2000 retail outlets. The Above™ Board product line offers PC users a way to add more memory to their existing PCs, while Inboard™ products enable users to upgrade their machines to the next generation of microprocessor technology. In 1988, PCEO became the first group to become large enough, as well as profitable enough, to no longer be considered a new venture. PCEO is now an operation within Intel's Systems Group.

Products like FASTPATH, Inboard and the iPSC concurrent supercomputer are evidence of Intel's continued commitment to exploring new technologies, as well as new markets. Naturally, not all of Intel's programs have paid off. Unsuccessful ventures included Intel's acquisition of the Microma watch company in 1972, which it sold off in 1978, its bubble memory business and the 432 microprocessor. In each case, the company cut losses and moved on.

Not a company to get hung up on past disappointments, Intel continues to investigate new



Justin Rattner, the corporation's most recent Intel Fellow, identified a potential opportunity in parallel processing and proposed the creation of Intel Scientific Computers (iSC). Today Rattner is iSC's director of technology and is working on expanding Intel's current iPSC® parallel supercomputers.

The 2,000-member China Intel Microprocessor User's Society, formed in Beijing in 1985, is evidence of Intel's growing presence in China.

This is a 17-foot-square, computer-generated plot of Intel's 32-bit 386™ microprocessor. Introduced in 1985, the 275,000-transistor 386 microprocessor is a member of the 86 family.

WESTINGHOUSE ELECTRIC CORP.'S AUTOMATED GUIDEWAY TRANSIT SYSTEMS, LIKE THIS ONE IN MIAMI, FLORIDA, RELY ON INTEL'S MULTIBUS® ARCHITECTURE FOR GUIDANCE. THE MULTIBUS ARCHITECTURE, INTRODUCED IN 1975, WAS THE COMPUTER INDUSTRY'S FIRST OPEN SYSTEM BUS AND QUICKLY BECAME THE WORLD'S MOST-USED OEM BUS.

A fisherman's dream come true, Lowrance's X-50 sonar system is based on Intel's 16-bit 8096 microcontroller. The "fishfinder" can determine the presence, location and size of fish beneath the surface.

Gathered round a 386™ plot are members of the chip's design team.

This programmable treadmill from Precor, USA, incorporates an 8-bit 8031AH microcontroller from Intel.

Intel's Personal Computer Enhancement Operation (PCEO) introduced its first product—Above™ Board 286—in 1985. It enabled PC users to add more memory to their PCs.

The prestigious Institute of Electrical and Electronics Engineers (IEEE) presented Intel with its first Corporate Innovation Recognition in 1986. The honor acknowledged "Intel's pioneering efforts in the development of the microprocessor and associated technologies which have transformed the electronics industry."

possibilities. In fact, two new ventures were announced in 1988: BiiN™ and the acquisition of Digital Video Interactive (DVI) technology. Formed by Intel and Siemens A.G. in 1988, BiiN is a 50-50 joint venture providing systems for applications which require continuous operation, high security and fault tolerance. BiiN announced its first two products in late 1988.

DVI is a technology Intel acquired from General Electric/RCA. Developed at the David Sarnoff Research Laboratory in Princeton, New Jersey, the technology brings full-screen, full-motion video with stereo sound, as well as interactive capabilities, to personal computers.

When EPROM prices dropped precipitously in 1985, Intel joined AMD and National Semiconductor in a successful dumping complaint against Japanese competitors.

The RANGER Energy Management System, developed by Ferranti International Controls Corp., incorporated several Intel products, including iSBC 286/12 single board computers and 80186 embedded processors.*

The Methods Behind The Magic

Revolutionary ideas alone cannot lead to success—a company needs to be able to quickly turn those ideas into viable products. In order to achieve this, Intel must keep improving the methods used to develop its products, namely through state-of-the-art design and manufacturing capabilities.

Intel's sophisticated computer-aided design (CAD) tools are making product design faster than ever before. The 82385 cache controller, for instance, went from product plan to sample in only 34 weeks. One way Intel is reducing design cycles is by reusing proven parts from past circuits. Computerized circuit "libraries" store previously designed circuits in the hope that parts of those chips can be used to design other chips. With a mere stroke on the keyboard, a proven feature of a chip can be copied and used in the design of a new chip. And not only are the products being made faster, they're being made better. A modern chip might have thousands of elements to check; verification without a computer would make for a very painstaking manual operation. So too would simulation. Today's design engineers can enter a representation of a chip into a computer and simulate its operation on-screen. By identifying any bugs and correcting them on the computer, engineers can get functional samples on the first try.

Better chips in less time is also the rationale behind "designing for manufacturability," whereby Intel's design and process engineers work together from the concept stage to ensure Intel products are designed with manufacturing in mind. This has led to significant improvements in time to market.

Long considered the poor stepchild of design, manufacturing has assumed a new importance at Intel, prompted by customers' demands and by increased competition from top-notch Japanese manufacturing machines. Today, Intel puts manufacturing high on its priority list, on par with technological leadership, customer service and concern for employees.

Intel manufacturing begins at the company's technology development centers. D1 in Oregon is devoted to exploring new manufacturing techniques for producing logic chips, while D2, a 200,000-square-foot facility nearing completion in Santa Clara, California, will be the proving ground for memory and microcontroller process technologies. Once these processes are perfected, they are transferred to one of Intel's production wafer fabrication facilities.

Manufacturing at Intel means computer-integrated manufacturing, driven by human engineering. Within the super-clean confines of Intel's futuristic fabs—Albuquerque's Fab 9 Class 1 clean room is 1000 times more sterile than an operating room—automatic guided vehicles shuttle wafers from station to station while a centralized computer system keeps track of where everything is at any given time. Statistical process control methods, ensuring any defects on the line are identified and corrected immediately at the source of the problem, are employed at all Intel fabs. In addition, Intel fab workers are trained to perform several different tasks so that a replacement can jump in should a particular worker be called away from his station. The result of all this effort? Production yields have risen, revenue-per-manufacturing employee jumped from $100,000 in 1984 to more than $200,000 in 1988 and units per manufacturing employee doubled during this period.

This attention to quality, in the form of methods like statistical process control, has enabled Intel to reduce its defects per million components rate from several thousand at the beginning of the decade to less than 200 today. It has also allowed Intel to narrow the line width—the distance between gates on a chip—to one micron, or roughly one 25-thousandth of an inch—a distance 1/150th the width of a human hair. This translates into smaller, faster chips, and thus smaller, faster, more cost-effective end-products from our customers.

The Revolution Continues

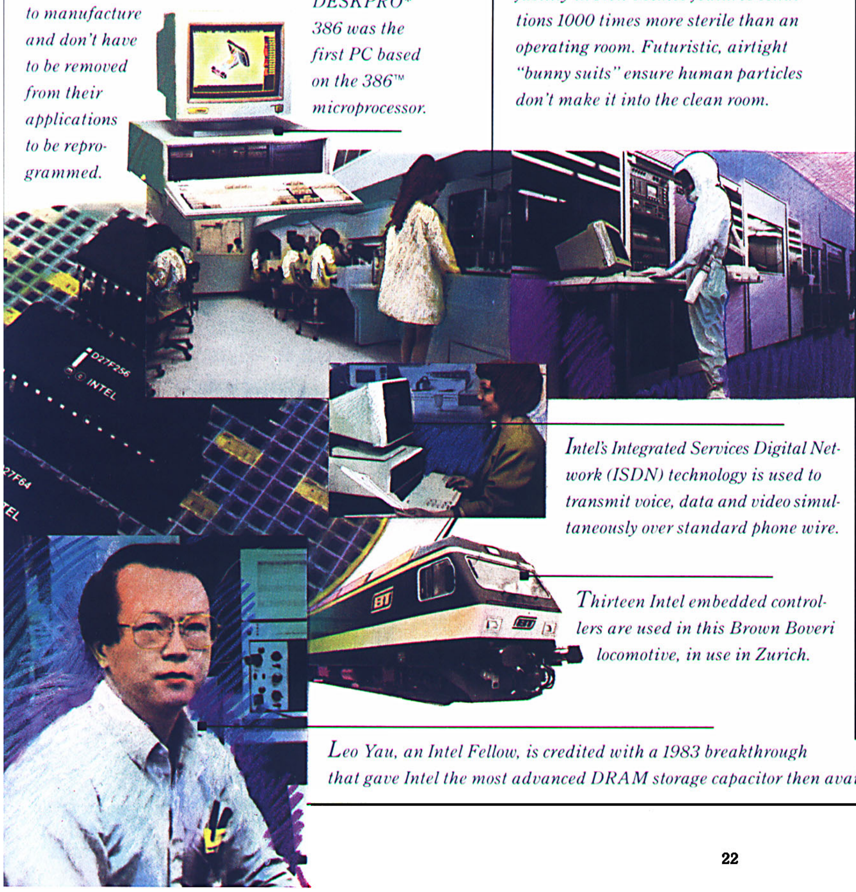
The trend toward smaller, faster chips will continue, as will a number of other promising trends. Intel's increasingly global nature, for one. Intel initially ventured beyond the U.S. border, as many companies did, to take advantage of dramatic savings in manufacturing costs. By 1988, the company had a wafer fab in Israel, component assembly and test facilities in the Philippines and Malaysia, and systems assembly facilities in Puerto Rico and Singapore. Due to the increasingly global nature of today's business climate, the ***consumption*** of Intel products abroad, and consequently the resources needed to handle the demand, also began to climb. The result has been an ever stronger European operation—responsible in 1988 for nearly a quarter of the company's sales—and a growing presence in the Far East. In 1987 Intel was ranked as the 35th largest industrial exporter in a study conducted by *Fortune* magazine.

The trend of powerful, yet affordable, off-the-shelf processors finding a home in high-end computers once solely dependent on highly complex and costly custom chips will continue. The 386 microprocessor, for instance, is present in PCs like Compaq's DESKPRO 386 and IBM's top-of-the-line PS/2 series, yet it is also the brain of Sun Microsystems' 386i engineering workstation, Prime Computer's EXL 316 minicomputer and Intel's iPSC/2 concurrent supercomputer. The next generation of Intel technology will most likely be targeted at the higher end of the computing spectrum. Over time, however, it, like its forebears, will be replaced in the most challenging applications of the day by even higher performance designs.

You can bet Intel engineers are working on those innovations right now. Two decades later, the revolution at Intel lives on.

- * IBM PC, AT, Micro Channel Architecture and PS/2 are trademarks of International Business Machines Corp.
- * MS-DOS is a trademark of Microsoft Corp.
- * UNIX is a trademark of AT&T.
- * VAX is a trademark of Digital Equipment Corp.
- * CHMOS is a patented process of Intel Corp.
- * SPECTRUM is a trademark of the Foxboro Company.
- * DESKPRO is a trademark of Compaq Computer Corp.

This cellular telephone from NovAtel CARCOM, Inc. depends on Intel's 80C51BH microcontroller to process all commands and communications.



Introduced in 1988, flash memories are affordable, easy to manufacture and don't have to be removed from their applications to be reprogrammed.

Unveiled in September 1986, the Compaq DESKPRO 386 was the first PC based on the 386™ microprocessor.*

The mini smock was in in 1968, but way out in 1988. In an environment where a microscopic speck of dust can ruin an entire integrated circuit, keeping clean (and thus covered) is mandatory. Intel's newest facility in New Mexico features conditions 1000 times more sterile than an operating room. Futuristic, airtight "bunny suits" ensure human particles don't make it into the clean room.

Intel's Integrated Services Digital Network (ISDN) technology is used to transmit voice, data and video simultaneously over standard phone wire.

Thirteen Intel embedded controllers are used in this Brown Boveri locomotive, in use in Zurich.

Leo Yau, an Intel Fellow, is credited with a 1983 breakthrough that gave Intel the most advanced DRAM storage capacitor then available.

THE ENGINE IN THIS FORD TAURUS IS CONTROLLED BY INTEL PRODUCTS. FORD BEGAN INCORPORATING THE EEC-IV ENGINE CONTROL MODULE IN ITS CARS IN 1984. BASED ON A CUSTOM MICROCONTROLLER AND EPROM FROM INTEL, THE EEC-IV MODULE IS PRESENT IN EVERY FORD CAR AND LIGHT TRUCK IN NORTH AMERICA. TEN MILLION OF EACH OF THE TWO PARTS HAD BEEN SHIPPED TO FORD BY 1988.

1987 ▪ 1988

Printed in U.S.A./289/65K/AL/PP
Order Number: 240447-001