The First 20 Years

A History of Data General

(1968-1988)

FOREWORD

None of us can rewrite history, even though we sometimes might like to. We can, however, learn from it.

Data General is probably the prototype 1960s high-tech startup company in the United States. We achieved so much of the success many young people dream of. We also made some of the blunders that keep managers awake at night. We have much to be proud of, and much to be humble about. All of us who lived through the years described here have a bond in that common experience that nothing will break.

Some of the people mentioned in this chronicle are no longer with Data General. They went on to start their own enterprises, partly because they had so much fun and frustration at Data General they had to do it all over again. Others took their experience to larger firms to bring a new vigor to more mature organizations. Still others have moved on to well-earned retirement. And many people and incidents are not included in this account that should be except for space.

However incomplete, the history of a corporation gives customers, stockholders, employees, vendors and competitors an opportunity to learn what happened and a way to interpret the future. The watershed events in the industry and the technology that we are all experiencing make this a fitting time to look back and reset our sights on the future.

Acknowledgements

The people of Data General wrote this book along with some help from Dick Brown, Peter McGowan, Ed McManus, Brad Stroup, Ray Thomas and many others.

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Anecdotes Along The Way

Prologue

In the beginning, there were three: Burkhardt, de Castro and Sogge – a programmer and two engineers working at Digital Equipment Corporation (DEC) – who had a bright idea.

But they found they needed a salesman, so they went to Herb Richman, a sales manager who had sold them Fairchild semiconductors. Richman discovered that they needed a legal and financial wizard, someone who knew the ropes and had the contacts for all the things the four did not have, so they found Fred Adler in New York, older than the others, who became an uncle and a "rabbi." And then there were five.

Richard Sogge dropped out early in 1971, burnt out at age 31. Henry Burkhardt III left four years later, burnt out at 30. And then there were three once more.

In a commencement address at the University of Lowell 10 years later, de Castro summed it up:

"I started a computer company along with several other people when we were not much older than most of you. Two engineers, a programmer, a salesman, and a lawyer got their heads together. The programmer was 23 and a Princeton drop-out. All of us were of trustworthy age, under 30, except for the lawyer. But being a Harvard man, he would have been suspect anyhow, regardless of his age.

"We were not close boyhood friends. We did not grow up together. We did not even know each other very well. We did not all like Bach or mathematical puzzles or Woody Allen or even the same jokes. Only one of us, the lawyer, had any money to speak of, but he had come from Brooklyn and was a skin-flint. We had different work habits, different tastes, different political preferences. We were Catholics, Protestants and Jews with Zen and yoga and doubts thrown in. And I doubt that we are any closer in personality today than we were 10 years ago.

"Only one of us made it through a university with distinction, and only one had gone on to graduate school. In those days in 1968, it was popular to talk of beating the system – the draft, the work ethic, racial discrimination, slum housing, academic grading, and so on. Martin Luther King was killed that year. Mark Rudd ruled Columbia. Pot and horse had nothing to do with cooking and riding.

"Maybe we thought we were trying to beat a business system when we founded Data General. We did have some things in common. We were willing to work hard and did – 70 to 80 hours a week, sometimes around the clock. We were competitive, that is, willing to try to beat the other guy, knowing well that someone else would lose if we won. And we were willing to run risks because we assumed there might be rewards for doing so."

Hard work, competitiveness and risk taking would characterize Data General people throughout the company's history. But other conditions in the late 1960s played a large part in determining the character of Data General and its basic strategies during its start-up years.

Start with the capital gains tax. It was 25 percent in 1968. The top marginal rate for ordinary income was 60 percent. That meant that you could keep 75 percent of a capital gain compared with only 40 percent of ordinary income – a major incentive to risk your savings by investing it rather than collecting five percent interest on a savings account.

Few venture capitalists existed in 1968. Ed de Castro, 29, had been an engineer and principal designer of Digital Equipment Corporation's PDP-8 minicomputer. Engineer Richard Sogge, 28, and programmer Henry Burkhardt III, 23, had both worked with de Castro on the PDP-8. Herbert J. Richman, 32, had been a sales manager for Fairchild Semiconductor Corporation and Frederick R. Adler, 42, was an attorney and early venture capitalist.

Richman was able to raise $800,000 initially. Adler restructured the deal among some 80 individuals who along with the five founders started the company. None of them had inherited wealth. Most of them had built their own capital through savings and investments during their own lifetime. They knew the risks of high-tech start-ups, that only one in 10 paid back the investment, that they could lose the whole stake within 12 months, but they were willing to take the gamble. They liked what they heard and saw. They knew that the rewards could also be also high, thanks partly to the capital gains tax.

But a lot of people with money knew the same thing and were taking similar risks. It was an explosive period of high-tech "go-go" start-ups with a frenzy of money chasing technology ideas. During this time, hundreds of high-tech firms were started. Over 200 such firms were established in 1968 alone. Most of them competed with Data General for customers, capital and employees.

In its wisdom, the United States Congress raised the capital gains tax beginning in 1969 through a three-year phase-in process that saw the rate reach 49 percent by 1971. Just about the time that most of these capital-hungry start-ups of 1968 were coming back to financial markets for second-stage financing to pay for manufacturing and selling the products they had just developed on a shoe-string, the financial doors began to close. The money available for high risks began to dry up after 1969 and so did many of the high-risk firms.

This was the environment that largely determined Data General's basic strategy and character. The industry was overcrowded with start-ups. The company's first strategy was to survive. Only those with the best products, the biggest bankroll, the lowest costs and the highest profitability would make it.

The late 1960s were also a period of rapid technological change. The days of the "data processing" experts in glass-walled, air-conditioned rooms were being shortened.

Scientists, engineers, academics and other highly sophisticated technical people had discovered the power and benefits of shaping computers for their own use, quite independent of large "business" data processing equipment which did its work in batches. They could not afford million-dollar computers, and had no interest in going through the bureaucracy of the data processing department. They wanted personal, hands-on experience with the computer.

A number of start-up companies had recognized this "underground" market for small, economical machines outside the mainstream of American business. The demand for such computers fueled the minicomputer market.

It was all too easy to chase after new electronic technologies and software. Too much of it was available from laboratories. Data General chose to do the only thing the founders knew how to do: build high-performance 16-bit minicomputers. They kept their overhead low and worked in low-rent districts. They avoided distractions and stuck to basics. The NOVA was the highest-performance system on the market. It was sold at the best price. It was simple and elegant in design, and highly reliable. It was also easy to copy, which would haunt the company later.

Data General avoided going after the customer directly through its own sales force, instead cultivating Original Equipment Manufacturers (OEM) and Value-Added Resellers (VAR). They chose not to lease computers, which would have siphoned off large amounts of capital to finance customers. This channel of distribution also made little demands for field engineering or product service, since the computer was often buried in a larger OEM system. This, in turn, sheltered sales and service expenses and gave the company extra cash flow to invest in research and development (R&D) to stay ahead.

The strategy was simple and it worked. The company shipped its first NOVA in February 1969, 11 months after its formation. Data General lost $268,000 in its 1969 fiscal year (ending September). It made a profit of $88,000 on $1.1 mil-

lion in sales in the December quarter, 1969. The first public offering of stock was made in November 1969 at $14 a share. The original investors and employees were suddenly worth several times what they had been. (Ten years later, their original stake in the company would be worth over $40 million.) Data General went off like a shot.

The Entrepreneurial Days (1968-1973)

A Product, a Name, a Show

In a rented 1,000-square-foot former beauty parlor in Hudson, Massachusetts, Burkhardt, de Castro and Sogge set to work building the industry's first commercial high-performance 16-bit computer. They also developed a detailed schedule for producing and marketing the system, targeting initial release at the Fall Joint Computer Conference, the industry's premiere event of the time, scheduled for mid-December in San Francisco.

The three engineers divided the work according to their strengths. Burkhardt designed the machine's instruction set, the repertoire of basic commands the hardware would execute. De Castro handled the complex internal timing and logic circuitry, while Sogge designed the power supply and mechanical packaging.

The machine they built had two crucial innovations. For one, it was the first general-purpose computer to use MSI, or medium-scale integration, the most advanced level of integrated circuitry then available. The pattern they followed would be the model for every new computer company since: unconstrained by the need to be compatible with an existing product line, they could exploit the capabilities of the newest technology. They could cram more functionality into a smaller, less-expensive machine, and could make it outperform anything else on the market.

The second major innovation was in packaging. Sogge wanted to build a simple, reliable, high-performance computer. Unlike the DEC PDP-8, which had dozens of small printed circuit boards, the Data General machine had only four large boards: a central processor composed of two 15-inch square boards, a 4,000-word core memory on the third board, and interfaces to external devices on the fourth. Thus, each major function in the machine resided on a single board or set of boards. The boards all stacked into a simple chassis

that allowed them to slide in and out easily. The result was a machine that had few parts, was reliable, and was easy to fix.

Richman's marketing strategy was to sell computers in volume to OEMs who in turn would plug the computers into systems designed to do specific jobs and then sell the systems to end users. These OEMs wanted a low-cost, high-performance computer "engine" with no frills. Data General's new machine would be that engine. At the time, the company could not offer them service or technical hand-holding, but this group of customers did not require such things: they did not want to pay for support, they could handle most of it themselves. Instead, OEMs and VARs sought high performance, low cost, and ease of repair – the fact that a broken computer could be fixed simply by pulling out one board and plugging in a replacement.

Introducing...NOVA

The computer designers were basically engineers building a technical product for other engineers. While they knew that price and performance would be most important, they also believed that people who bought technical products were influenced by "sex appeal" and proper market positioning, just as they were when they bought stereos. So, de Castro, Burkhardt and Sogge commissioned an industrial design firm in Los Angeles to build a special optional enclosure for the computer. This package was a sleek molded wedge shape instead of the metal box that people were used to seeing. In reality, nobody would ever buy anything but a regular metal box, yet the facts that the design was not really practical, that it was too expensive and that the boards could be barely crammed into it were all outweighed by "sexiness." The show package looked sexy, and they hoped it would draw the attention of trade magazine editors.

They also decided that Burkhardt should develop a demonstration program that would prove the power of the new machine. Burkhardt knew exactly what he wanted to do. At the Massachusetts Institute of Technology (MIT), people

were playing a rudimentary video game, called Space War, that let players maneuver rocket ships and shoot at each other.

The MIT game ran on a PDP-1, DEC's first machine, a room-size computer that cost more than $500,000. Between designing the computer and writing software, Burkhardt built a program to run Space War on the new Data General computer, a machine a fraction of the size and cost of the PDP-1. Nobody had ever run Space War on a small computer before.

The stage was nearly set for the Fall Joint Computer Conference. The design, the package, the demo were all prepared, but the machine still needed a name. *Electronics* magazine, one of the leading magazines in the industry, was ready to publish an article on the design innovations in Data General's first product and needed to include a name in the piece. But, time slipped by and no name was picked. Finally, the day before the deadline for the article, de Castro called a company-wide (all 26 people) meeting for 9:00 a.m. the next day. It was a brainstorming session, with everybody pitching in. By 11:30 a.m. they had a name. Everyone discarded numbers in favor of names. Burkhardt proposed NOVA,and it had seemed the least objectionable of the dozens of alternatives suggested during the morning meeting. They phoned *Electronics* and NOVA it was. "The amazing thing," recalls Burkhardt, "is that we picked the name with no trademark search, and we had virtually no infringement problems. We lucked out. Today, I wouldn't dare do that."

The NOVA was completed two days before the opening of the Fall Joint Computer Conference of 1968. The Conference was a smashing success for Data General. Their small, but flashy, booth was located just inside the door, directly opposite the IBM exhibit. Hundreds of people lined up to play Space War.

At the same time, the young entrepreneurs mounted an aggressive press relations program and a pugnacious advertising campaign that cast the shy de Castro as a grim-faced warrior boldly claiming to be president of "the richest new small com-

puter company ever." In the first 18 months after it was announced the new Data General computer appeared on the covers of at least a dozen trade magazines – the impractical, but sexy package helped. They were already staking out a claim as a major force in the small computer business by offering a powerful, general purpose, 16-bit computer with a Teletype interface and 8,000 words of memory for $7,350.

A product had been introduced, but more importantly, a new company with a unique culture had been launched, driven by a management team determined to succeed.

Companies Start with People

Building a new product was one challenge. But the entrepreneurs quickly learned that building a company involved much more.

While the rest of the team was building the NOVA, Richman spent the summer and fall of 1968 building a sales force. He spent an enormous amount of time in cars and planes, "beating the bushes" for manufacturing representatives (reps). He did not have a very clear model for the sort of experience these reps should have because there simply were no people selling small computers in 1968. However, he viewed minicomputers as system components not much different from those he had sold for Fairchild, so he extrapolated a profile based on his own experience. It called for people who were engineering-oriented, digitally-oriented, and who were regularly calling on customers who were already buying computers from other firms. By the time the NOVA was introduced, a coast-to-coast team of independent reps was in place, ready to go.

Richman's strategy was to start with reps and then switch to a direct sales force as business grew. This was the norm for technical companies like Data General, but Richman added an important concept. To back up the reps, he began putting in place a team of application engineers. The application engineers would give Data General a dimension it could not expect from the reps, who were basically freelance

The Long Journey of the First NOVA

When the Data General entrepreneurs returned from the Fall Joint Computer Conference in December 1968 they had orders to fill. The group was ready to start building NOVAs so they set up a production line (a couple of folding tables) in the tiny facility in Hudson, Massachusetts.

NOVA #1 was finally ready to ship in February 1969. It had been sold to the University of Texas by Bill Jobe, then an independent rep based in Dallas, who later became a sales manager for the company and ultimately its vice president of North American Sales. It went out the door of the plant one afternoon, headed for Logan Airport in Boston and then to Austin, Texas, for delivery to the University of Texas. There was a small send-off party before everybody went back to work. A milestone had been reached: the first customer shipment. . .they thought.

NOVA #1 never arrived in Austin. The machine simply never showed up. There was a major airline strike going on at that time, and that seemed to be the problem. Telephone calls went back and forth to Jobe. "But it was shipped. "What must these guys think? "Maybe Data General isn't for real after all. Embarrassed by what had happened, employees quickly shipped NOVA #3 to the University. It arrived safely.

The original machine showed up months later, after the strike ended, in a terminal at Kennedy Airport in New York. Ultimately, the first NOVA did go to the University of Texas, but its strange odyssey continued for years afterward. It journeyed 15,000 feet up into the Chilean Andes on the back

of a burro, hauled there to help support a mountain-top astronomical observatory. It was the first "portable computer, traveling all over Europe on other astronomical missions, packed in a special crate that let it ride as luggage, security against new airfreight misadventures.

NOVA #1 eventually ended up back at Data General, for many years driving a display in the front lobby that tracked, in real-time, the worldwide birth rate of new Data General computers.

"gunslingers". The applications engineers would be articulate, presentable, literate, technically-oriented people located in the field. They would provide close sales support for the reps and some long-term leverage and control with the customers, as well as the ability to close a sale technically or at least identify what was needed to clinch the deal. They could also fix hardware, software, or political problems in the field.

The first field application engineer was Stan Booth. He was set up in California to support the reps in the western half of the U.S. Then Steve Gaal was signed up to support the eastern half of the country. Booth and Gaal were the prototypes. Richman called them the "blond-haired, blue-eyed, All-American engineers." They were both in fact, blond, attractive young men: Gaal, a Princeton grad with a couple of years at Bell Labs, and Booth, a Michigan grad with experience at DEC. They were followed quickly by Hubie Grush, an academically-inclined mid-westerner who was bald, not blond, and Ken Brandt, a slow-talking Texan with a strong technical background and "good-ole-boy" style. All of the pioneers would have long careers with the company and, more importantly, would form the backbone of the Data General sales force as it converted to a direct operation.

Data General's whole style was contrary to convention. One early recruit was John Henderson, a mid-westerner who had worked for Bell Laboratories. For Henderson and his pregnant wife, coming from Illinois, Massachusetts was as foreign as Timbuktu. He was interviewed at Herb Richman's apartment in an elegant old building in Boston's Back Bay. Impressed by the people he met, the young programmer accepted their job offer immediately, but did not see the real Data General until he and his wife were invited to the company Christmas party the night before he was to start work. They were shocked. The company was nothing more than a handful of kids and some folding tables in a storefront with un-painted walls.

To make matters worse, Henderson could not program because the only computer had been torn apart immediately

after its return from the San Francisco Computer Conference. So Burkhardt gave him a pile of rough technical data on the NOVA and some examples of other companies' software documentation and told him to go write some software manuals. It was a textbook example of how to mismanage a newly hired employee: assign a poorly defined, highly frustrating job, provide very little guidance, no well-thought-out schedule, and then ignore the "new hire" for weeks. But, Henderson loved it. He thrived in this atmosphere, and worked outrageous hours. Data General got a huge pay-off on its investment in giving a talented young person a chance to tackle challenging problems with very little bureaucratic interference. The process was to be repeated time and time again.

Data General's first employees were usually people the founders had worked with at DEC. Norm Perryman was the first employee beyond the founders. He was hired to lay out the printed circuit boards de Castro and Sogge designed. Then came Nancy Surveilas, a secretary from DEC. Jake Dias, de Castro's brother-in-law, who was with Price-Waterhouse in Boston, came in to go over the books once a month. Jim Austin, a friend of Sogge's, joined to handle the critical detail work of the mechanical packaging of the product. Allen Kluchman, who had been running advertising at DEC, also came on board to publicize the new company.

Soon, however, they needed to look for talent beyond their immediate area. Already they were building a legend that was a magnet for talented young people who liked the idea of working for an aggressive young company that looked like a winner. Among them was Ron Gruner, a 22 year-old who had worked at General Electric's (GE) Oklahoma City computer peripherals plant as a technician for two and a half years. Despite being one of the youngest design engineers at that company, Gruner was becoming discouraged with GE after several designs he proposed were turned down. He began researching companies where he might have a future, and Data General looked good. Gruner had worked on a circuit tester based on a PDP-8. He had heard Ed de Castro referred to as

the "father of the minicomputer." He figured he could learn from de Castro, so he arranged an interview.

Gruner paid for his own plane ticket. Arriving in Boston on a Friday, he rented a car and headed west on the Massachusetts Turnpike to Southboro, where Data General had just re-located. He expected to meet de Castro on Saturday, but he wanted to get a look at the company ahead of time. So, after checking into a motel, he drove down the road a few miles to Southboro Center. Publicity had convinced Gruner that Data General was a major corporation, but nobody in Southboro had heard of it. At about three o'clock that same afternoon, he called Data General to set up the meeting for Saturday. De Castro said to come out now.

When he arrived, Gruner was greeted by de Castro, Burkhardt, and Sogge. They sat down in the conference room and grilled him for three hours. "Have you ever designed a computer?," they asked; "no," he replied. Next, the three asked him if he'd ever designed an input/output (I/O) bus; again the answer "no." Had he ever designed a memory board? "No." Finally, they asked him, "how do we know you can design computers?" He told them that he had not designed all that "stuff", but he knew he *could* design it; "bring in the NOVA plans and I'll walk you through them," he claimed. They offered him a job. Gruner took it.

The Real Challenge: Do it Again...and Again!

Even as they were figuring out how to build NOVAs in enough volume to meet demand, Data General's young team was also sorting out how to meet the challenge of creating an encore to its brilliant first product. Early in 1969, they went to work on their second computer. The basic problem facing the team was that they simply did not know how to build a computer that would be significantly less expensive than NOVA. So they decided to build one that would be faster – much faster. They called it SUPERNOVA.

The SUPERNOVA

The principal designer of the SUPERNOVA was Larry Seligman, a 26-year old ex-DEC engineer who was splitting his time between Data General and MIT graduate school. Ron Gruner had been hired to be his understudy, and an experienced engineer named Joe Sutton was assigned to design the machine's core memory.

Seligman's theory for SUPERNOVA was to use the very fastest memory available, then design a processor that could keep pace. The designers took advantage of a new product, the semiconductor memory chip, in place of core memory. The NOVA was relatively fast for a small computer. Its "memory cycle time," the time it took to get one character of data out of core memory and into the processor, was 1.5 microseconds. With semiconductor memory, the SUPERNOVA would be five times faster, with a memory cycle time of only 0.3 microseconds, or 300 nanoseconds (300 billionths of a second).

The SUPERNOVA made its debut at the Fall Joint Computer Conference in Las Vegas in November 1969. Although there was a great deal of press interest in a little computer with such spectacular performance, sales never took off. The SUPERNOVA did, however, demonstrate that Data General was not a one-product company. To prospective customers, this meant that if they signed up as OEMs for Data General computers, they could count on the company to invest aggressively in new product development and not find themselves chained to an out-of-date product. SUPERNOVA may not have sold itself well, but its existence and what it represented helped sell Data General.

NOVA 1200 and 800

Weak sales of the SUPERNOVA did little to slow Data General's rapid growth. However, competition in the industry was intensifying. Consequently, immediately on the heels of the SUPERNOVA a new development effort was launched. Its goal was to expand the NOVA into a line of

compatible computers that would have as many parts as possible in common, and would offer more performance at lower price. They were going to now attempt what they had not thought was possible when SUPERNOVA was launched: build a cheaper, faster NOVA, the NOVA 1200. At the same time, build a faster, more expensive model, the NOVA 800. The plan was to develop the two machines in parallel and have them share everything but central processors. Seligman was to design the central processor for the NOVA 800, and Gruner, the sorcerer's apprentice, was to do the design for the NOVA 1200. The NOVA 800 and 1200 would give Data General a truly compatible line of products at different levels of price and capabilities, within which the customer could mix and match without fear of losing a large investment in software.

The result was a success. The NOVA 800 and 1200 were so compatible as to be virtually identical. In fact, in the process of re-configuring machines one day, a customer using a NOVA 800 and a NOVA 1200 side by side in a development lab removed the memory boards from both computers and stacked them up. To his horror, he realized that he could not tell the NOVA 800 memories from the NOVA 1200 memories, so he called Steve Gaal for help. Gaal knew he probably could not tell them apart either, but he did not want to admit it. He was quite sure that the 1200 memories would run just fine in the 800, and vice versa. The NOVA 800 would probably run a little slower than it should, but it should not be obvious. So he asked the customer to pick up the first board and describe certain features. The customer did as he asked, and after deliberating carefully, Gaal instructed him to install that board in the NOVA 800. They went through same process until all the memory boards had been re-installed. The customer turned on the machines, and lo and behold, they both ran fine. Gaal mentally uncrossed his fingers and said a silent prayer of thanks for a compatible line of computers. Later, he went to the customer's site with the proper test instruments and figured which boards really went with which machines.

Both the NOVA 1200 and the 800 were great successes for Data General. The NOVA 1200 quickly became the highest-selling minicomputer in history. The 800, offering more performance at higher cost, sold fewer units, but at far higher margins, making it a hefty contributor to profits. By the end of 1971 people in the company and the world at large could see that Data General was going to play a significant role in the booming minicomputer business. Sales topped $15 million, and the company had accumulated $17 million in cash. The pre-tax profits were $3.2 million.

Operating Systems and Other Products

In its early years, Data General was known primarily as a hardware company, an "iron vendor." But, software was equally important, although not as visible, as hardware. "We did a good job balancing hardware and software," recalls Burkhardt. As vice president of software development from the beginning, Burkhardt, more than anyone else, set software strategy. "The beauty of the NOVA was that it was a simple, easy-to-understand machine. We wanted to make the software just as easy to understand."

The initial software complement of the NOVA included the instruction set which was designed to offer more power and flexibility than previous minicomputers could provide. On top of this basic building block were a set of programming tools – assembler, debugger, editor, linking loader, mathematical routines, and BASIC, one of the most user-friendly and widely-used computer languages. The goal of the software was to provide tools, not for end-users, but for programmers, who would use them to develop application programs for end users.

The biggest drawback of the initial NOVA software was that it required a programmer to use a Teletype machine for input and paper tape for storage. Programming with paper tape was slow and cumbersome, This problem was overcome with the introduction in 1970 of DOS – the Disk Operating System. DOS let programmers create programs efficiently using much faster disk storage. From a programmer's point of view, DOS

changed the NOVA from a curious little toy into a real computer.

The next big step in software came in 1971, with the introduction of the Real-Time Operating System (RTOS). Only it was not clear whether RTOS was a step ahead, backward, or sideways.

RTOS came out of Datagen of Canada, Ltd., a small subsidiary created by Data General to help "crack" the Canadian market. RTOS had been written by Dick Farwell, a young Canadian programmer, to meet the requirements of a contract with the Regina Cancer Institute in Regina, Manitoba, for a Computer Aided Tomography (CAT) scan system. The system called for the ability to control multiple concurrent tasks in "real time" and to instantly establish priorities among tasks competing for computer access. Farwell had to develop a real-time operating system, something Data General had never done before. To complicate matters, Datagen had negotiated a fixed price contract, so development had to be done economically or the company would lose money on the job.

Farwell succeeded. RTOS, which was immediately added to the general product line, relieved programmers of the need to handle all the complexities of real-time applications. At the same time, it presented a basic problem. It was a paper-tape oriented system, and it had come, not from the company's software development group, but from an "outsider." "There were basic philosophical differences between RTOS and DOS, and that was probably a mistake," says Burkhardt. Things were out of synch. At one point, Farwell went to California to make a major RTOS presentation to a potentially large client, North American Rockwell. In a meeting not long after, a Rockwell engineer asked Gerry Clancy how the subject they were discussing fit in with RTOS. Clancy had to answer that he had never heard of RTOS.

For all the apparent confusion, RTOS allowed Data General to get into real time applications, including many medical

and industrial process control applications. The availability of RTOS also let customers develop programs on a large NOVA configuration equipped with a disk, but then run them under RTOS on a less expensive computer equipped only with paper-tape.

Fortunately, the next generation of operating systems solved the conflict between DOS and RTOS and eliminated most of the shortcomings of both systems. RDOS, for Real-time DISK Operating System, was introduced in 1972. While DOS was limited to supporting one job at a time, RDOS let the user run several programs at once, including real-time tasks, and it let the computer automatically work on a background task whenever it had idle time between foreground tasks. This was a tremendous boost in capability, allowing NOVAs to take on far more complex software applications.

Farwell, who moved to the U.S., was one of a select band of dedicated software specialists, putting in 12 to 14 hour days six and seven days a week for years. He held a number of positions in software marketing, then went to Paris where he worked for two years for Barry Fidelman as European Marketing Manager. When he left the company sixteen years later, he had done everything in a computer company a programmer could do, including regional systems engineering manager and systems support manager for the Distribution Division.

NOVA 840

Fiscal 1972 was an extraordinarily successful year for Data General. The NOVA 800 and NOVA 1200 were winners on the hardware side, as was RDOS in system software. Sales doubled to $34 million and the company had more than $20 million available in cash and short term investments. Pre-tax profits were $6.9 million.

In 1973, however, the competitive arena changed as DEC introduced its first 16-bit machine, the PDP-11/45. The NOVA 800 and 1200, which came first, were at heart very simple machines. The PDP-11/45 had a far more sophisticated in-

struction set and an advanced memory management capability that allowed it to operate with far more main memory than the NOVA's 32,000-word limit. As user applications became more complex they demanded more memory space; now DEC was in a position to exploit this weakness with a machine whose sophistication and power outclassed the NOVA. As soon as the 11/45 was announced, customers flocked to buy, and the backlog of orders suddenly stretched out to 12 months and then 18 months.

People at Data General were impressed with the 11/45, but they recognized that its popularity and resulting long delivery schedule were its Achilles heel, and they set out to exploit it. The NOVA 840 evolved, not in a straight line, but as the result of several simultaneous events that came together at the right time – a rare case of serendipity.

The development of RDOS had, in a way, forced the 840 into existence. RDOS developers recognized that background/foreground capability was needed. That is, the ability to allow one program to proceed in the foreground, receiving the highest priority, while a background task plods along on its own, automatically using up any spare time that the more critical foreground task does not need. However, this process required memory protection – the ability to protect user programs from each other and to protect the operating system from user programs. To build memory protection, the developers needed a memory segmentation scheme which required cooperation from the hardware engineers, who agreed to provide it only if the memory protection system were limited to the NOVA 800.

The engineering team, headed by Gruner, developed the MAP (Memory Allocation and Protection) system on the NOVA 800 and demonstrated it at the Fall Joint Computer Conference in Anaheim, California in November 1972. MAP made it possible to expand the NOVA 800's memory beyond 32,000 words, meeting one of the challenges posed by the 11/45. Unfortunately, the MAP feature was offered only as an option on the NOVA 800, and very few customers picked it

up. The MAP option also presented a messy problem for manufacturing. In order to install the MAP unit as an add-on after an 800 had been built, manufacturing had to pull out some boards, do some re-work, then re-install and re-test the boards.

To solve the problem, Harvey Newquist, vice president of manufacturing, suggested that they make the 800, keeping MAP a separate product, so that orders could be identified from the outset, effectively eliminating much of the re-work. Lights snapped on in a lot of heads, and the idea of the NOVA 840 was born. More than an 800 with MAP, it was a "loaded NOVA," a basic 800 with a whole array of capabilities, including up to 128,000 words of main memory (made possible by the MAP feature), hard disk, magnetic tape, hardware floating point, high-speed hardware multiply/divide, as well as a long list of software capabilities.

What had evolved was a true "11/45 fighting machine." It had little of the technical elegance of the DEC machine, but it did what Data General always did well – it cut through extraneous issues and solved key problems: in this case, how to expand memory to support ever more demanding applications. It also had something the 11/45 couldn't match. The NOVA 840 was ready for delivery in less than 90 days, while 11/45 orders remained backlogged for many months.

The NOVA 840 had its debut in March 1973. It provided an important boost for sales; it was also the first Data General machine developed with any substantial input from marketing. And the 840 did indeed lead to new marketing ground. For the first time, it allowed Data General to build large minicomputer configurations. While its base price was under $17,000, the average selling price ranged from $40,000 to $70,000 and the 840 could be built into $100,000 configurations. The 840 also introduced Data General to an emerging new market. CAT scan machines were just being developed, and the 840 met their considerable needs very well. Early CAT scan developers like GE and EMI bought 840's and provided Data General with feedback on what they needed in

a computer. Eventually, the CAT scan market became a major business opportunity for Data General.

However, first and last, the 840 was a success at its basic mission: fighting off the challenge from DEC's PDP-11/45. The 840 helped keep Data General's growth booming, and it bought time for the development of Data General's next generation of computers, a true answer to the 11/45, the ECLIPSE.

The Manufacturing Story: From Folding Tables to Full Automation

Data General's manufacturing operations have come a long way since 1968 when the first NOVAs were assembled on folding tables in the beauty parlor in Hudson, Massachusetts. Getting the first NOVA built was not easy. Converting hardwired prototypes to clean printed circuit boards required a great deal of diligent detail work. "There was always a 'problem of the day,'" recalls de Castro.

The founders knew that they could not keep building computers in a beauty parlor, so while Richman was building a Sales force, Sogge began looking for a plant location. He found a developer who needed a first tenant for a big industrial park being built in Southboro, the next town over from Hudson. Sogge was a good negotiator, and worked out a deal that gave the new company a 10,000 square-foot building and options for long-term growth at good prices.

Building products at low cost was a goal from the outset. In manufacturing, this meant running a lean organization and using as much automation as possible. As early as 1970, investment analysts noted this method of operation in listing the positive attributes of Data General.

Core Operation

In a fast growing business, it was easy enough to identify what steps ought to be taken. The trick was to take them at

the right moment. Data General's tendency was to be conservative, put off taking a step until it was absolutely necessary, and then move fast. The company had always operated on a thin edge, always a few people short in every area, always with marginal facilities working at maximum capacity. While people and equipment ran flat-out all the time, profits were high.

Mike Schneider has been a premier technical trouble shooter since he joined the company in 1971. "I remember coming in one Saturday morning," he recalls, "All the purchasing department people were in. I asked what they were doing, and somebody told me they were buying aluminum wire and iron ferrite. I couldn't believe it. We were going into the core business. The decision had been prompted by the fact that RCA, one of our major core suppliers, had decided to get out of that business when they shut down their computer operation. They told us their plans one day that week. Literally within hours we had decided to build our own cores, and now these guys were on the phone buying the stuff we'd need. How many companies could decide to do anything that fast?"

Through the early 1970s, core memory was a major part of the cost of a computer. The tiny cores themselves were expensive, there was a large labor cost in stringing the cores into memory mats, and the drive electronics were complex. Data General believed that cutting core costs could be an important way to increase profit margin.

In 1971, Litton Industries, a major core supplier, decided to get out of the business. Data General considered buying the Litton core operation, but chose instead to invest in setting up a core stringing operation in Hong Kong. Then in 1972 RCA told Data General they too were quitting the business. This time, Data General was ready to move. De Castro and Burkhardt flew to New York and marched into RCA's corporate headquarters with an offer to buy the entire RCA core manufacturing operation. "They looked at our offer," recalls Burkhardt, "called it 'ridiculous' and terminated the meet-

ing. So instead of buying the business, we went out and hired Henry DiLuca and built our own." DEC also moved fast, buying most of RCA's core equipment and its facility in Marlboro, Massachusetts.

Henry DiLuca grew up in Italy during World War II, came to the United States shortly thereafter, and became one of the top people in the RCA core operation. At Data General he proved to be a masterful manager. He developed the a core operation in Southboro and had one of the world's most modern facilities up and running in months. Data General quickly became one of the world's largest and most efficient manufacturers of core memories. RCA had been producing cores at $1.50 per hundred. At Data General, DiLuca pushed it down to a mere *fifteen cents* per hundred. The payoff was enormous. At its height, the core operation accounted for about one-third of total revenue, and an even higher percentage of the profits that fueled the company's growth. The entire cost of the new core operation was written off in three months, so there would be no big write-off required when they decided to close it all down. DiLuca later set up another core facility in Hong Kong to take advantage of the lower labor rates. Everyone in Southboro referred to it as Henry's Hong Kong core house.

Sunnyvale Started

In 1972 Data General opened its own semiconductor division, a logical next step in the drive towards vertical integration. De Castro and Sogge believed that the new semiconductor devices coming into the market would have a huge impact on computers. They believed it was important for Data General to be a player in this part of the game. By building their own semiconductor capability, the company could control their own sources of supply, effectively avoiding delays and shortages. Developing special products needed to provide an edge in price and performance was another motivating factor behind the founders' decision to move west. They could keep abreast of developments in technology and they could maximize profit through vertical integration. They had plunged into the core memory business for some of

these same reasons, and the result had been an unqualified success. Perhaps they felt they could repeat that performance.

Deciding where to build this semiconductor operation was easy. Santa Clara County, California, was already the semiconductor capitol of the world. "Silicon Valley" was the birthplace of the leaders of the industry: National Semiconductor, Fairchild, Intel, Hewlett Packard, Advanced Micro Devices. There was a wealth of specialized talent in the area, and from here the company could keep an eye on developments in the field. By October 1972, Data General's Semiconductor Division opened its doors in a rented factory in Sunnyvale, California, in the heart of Silicon Valley.

Sunnyvale's first short-term goal was to immediately take over testing of a portion of the integrated circuits (IC) that the company was purchasing. An IC tester was quickly installed and that part of the job began. Sunnyvale's second goal was to identify products that they could gear up to build themselves, either as a second source or as developer and primary fabricator.

In its first year, the Sunnyvale operation made large investments in people and equipment. The percentage of purchased ICs inspected steadily increased and Sunnyvale eventually took over the majority of this testing. By July 1973 the operation had its own building and had installed its own fabricating facilities. With its own fabrication line in place, Sunnyvale began second sourcing a number of products, using the original developers masks to build bus drivers, registers, counters, and flip-flops, to name a few.

Yet, the real challenge remained: Sunnyvale had yet to develop its own products. By mid 1973, Sunnyvale began doing just that as the development of a 4K random access memory (RAM) chip was launched. The goal of the program was to develop a product that would be the mainstay of Data General's memory line.

Developing the 4K RAM turned out to be a long and painful learning experience. The company was not prepared for the magnitude of the investment required to keep even close to the state of the art in RAMs. The project constantly needed more money for better equipment. A talented engineer named Jeff Kalb was hired away from National Semiconductor in 1976 to manage Sunnyvale. Despite enhancements to the fabrication line and test capabilities, the facility was still unable to meet cost and reliability goals.

Eventually the 4K chips were used in the first generation of ECLIPSE computers and as add-on memory for older lines as core became obsolete. The 4K RAM chip was brought successfully into a full production mode as yield and quality improved dramatically. Over the years, however, the product never really succeeded. By 1978, Data General had populated only about 1,000 memory boards with its own 4K RAMs. By 1979, as 16K RAMs began to appear, the 4K RAM became obsolete and disappeared.

NOVA on a Chip

The microNOVA was the second major in-house development that Sunnyvale tackled. The program started early in 1973. Its goal was to develop a "NOVA on a chip" product that would let Data General attack the low end of the minicomputer market. The microNOVA would actually be a NOVA CPU shrunk from one 15 x 15 inch PC board to two IC chips. It was to be sold in three configurations: as a chip set, as a "computer on a board," and as a conventional computer in a box.

The microNOVA, like the 4K RAM, was not a great success, but for a different set of reasons. The 4K RAM suffered from escalating costs, unsatisfactory yields and reliability. MicroNOVA also had some yield problems, but technically it ran more smoothly than the 4K RAM, partly because the microNOVA was less ambitious. It was never on the leading edge of technology. It was barely state-of-the-art at its conception; and by the time it was introduced it was definitely *not* state-of-the-art.

The real problems with microNOVA lay in marketing. The product was introduced in 1975 at a press conference. A few months later it was a big hit at the Fall Joint Computer Conference, where a belly dancer performed with a microNOVA chip in her navel. But for all the hoopla, the introduction was handled clumsily. The announcement was not well coordinated with the "ramp-up" of production, so the chips were not available for delivery when the first sales were made. As a result, the sales force had little faith in the product and did not work to sell it. The sales force predicted it would not succeed and then proceeded to fulfil their own prophecy.

In the end, few chip sets were sold. The board and box level products did better – about 1,000 machines were sold – but the microNOVA never became a force in the marketplace. It did, however, have considerable internal impact. The microNOVA found lots of applications, not as a stand-alone central processor, but in other computers as a bus or peripheral controller. It was by no means a total flop.

Building an International Business

Data General took its first step outside the United States in 1969 when it hired engineer Don McDougall to provide customer support for Canada. The first major effort at developing business outside North American borders came the following year when Herb Richman made an exploratory trip to Europe.

The young management team concluded that England was the right place to start building its international business. The market was well established and growing; language was no barrier, and travel was relatively easy. So Richman ran an advertisement soliciting manufacturers' representatives, hoping to find someone capable of eventually becoming a direct employee who would run the operation. He wanted separate Data General operations in each country. But as in the U.S., he would start with representatives and switch slowly to direct people by creating a wholly-owned subsidiary in each country.

Richman was successful in the United Kingdom (U.K.) where he turned up Laurie Ashcroft, the manager of DEC's U.K. operation in Reading, who had written Data General a letter inquiring about employment possibilities before Richman's visit. Ashcroft was subsequently hired as Data General's U.K. country manager. He would become a model for future country managers: a proven manager with solid experience at one of the top competitors, but with a strong streak of restlessness and ambition.

Richman also was successful in Germany, where he hired an engineer from Schlumberger, a major conglomerate, who had bought that company's first NOVA computer. After establishing a base in Europe, Data General next turned to Australia. The "land down under" was fertile territory for American computer companies since, again, language presented no problems and Australians and Americans seemed culturally compatible. Fairchild's sales group in Australia had called to inquire about the possibility of representing Data General, and, since Richman was a former Fairchild employee with contacts in Australia, Fairchild was signed on as Data General's first international representative.

The strategy of hiring representatives and then converting to a direct sales force never worked as well internationally as it did in the U.S. One problem was that there was really no such thing as manufacturers' reps outside the U.S. Instead, there were independent sales organizations that acted more like distributors, buying products and reselling. They operated on short profit margins, severely limiting their growth potential. The most successful international operation turned out to be in the U.K. Data General sold direct there from the beginning, partly because of Laurie Ashcroft, but also because English distributors recognized that profits would be too tight and declined to take on the Data General product line.

However, even in England there were occasional rough spots. On August 8, 1970, for example, Frank Turner, a newly-hired Sales rep in London, put the only NOVA computer on

British soil into the back of his Triumph convertible and set out on his rounds. Wrapping up his day at 10:30 p.m., he came back to find that his brief case, golf clubs, Teletype terminal and computer had been stolen. Like "NOVA #1," lost on its way to Texas, the "U.K. NOVA #1" was missing in action. Fortunately, London police turned up the missing computer two days later, considerably worse for wear. It took police another three days to figure out what they had found so they could return it to somebody. Turner's golf clubs, considerably more valuable to the thief, were never recovered.

International Operations Expand

In fiscal 1972, international operations accounted for sales of $9 million, or 26 percent of the company's total sales of $34 million. The subsidiaries in the U.K. and Germany had each sold more than 100 computers, and distributors in the other major European markets were being added. With the momentum on Data General's side, Barry Fidelman, who came to the company in 1969 and managed the northeastern United States sales activity, went to Europe to pick up where Richman had left off, signing up distributors, establishing subsidiaries and building the organization.

Fidelman wanted to establish a European headquarters in a continental city, because he believed Data General needed a strong presence on the continent. For various business, competitive and cultural reasons, the choice came down to Amsterdam and Paris. Fidelman was familiar with Amsterdam, and knew that it was easy to get work permits there. So Fidelman set up temporary headquarters in Amsterdam until a permanent decision was made.

In 1973, Fidelman was made vice president for Europe, and headquarters were moved to Paris. It was the best location in Europe for many reasons. People from every country were willing to move there. Taxes were reasonable. Weather was good. Perhaps most convincing was the fact that only one other computer company had its European headquarters in Paris and that company was IBM. On the assumption that IBM had probably spent a lot of money coming up with some

good reasons for choosing Paris, Data General followed its lead and moved there in 1973. In Paris, an effort to hire people of all nationalities also proved successful.

The Data General they sold in Europe, not only to customers but also to recruits, was different from the Data General that sold itself in the U.S. where the company was a stock market star and had a reputation as the tough-talking, somewhat abrasive "new kid" on the block. In Europe, considerably more money was spent on making offices attractive in a necessary cultural adaptation.

Data General developed a "killer team" approach to setting up subsidiaries in Europe. The first step was to choose a country manager. They were usually technically oriented, successful, probably from DEC or Hewlett-Packard (HP) and blocked in their career path. He made a few initial sales to break the ice and then hired the rest of the crew: a sales representative, an applications engineer, a field service engineer and a secretary.

In Italy, for example, things went well from the start. The Italian subsidiary was formed in 1973 under the leadership of a former HP manager, and the business grew steadily. In Spain, a reliable distributor was found who handled the business well until it went direct in 1981. The new subsidiary, based on the foundation the distributor had established, was able to immediately accelerate growth. Each country had its own peculiar history, but a pattern was apparent: once a sound country manager was in place, the enterprise would thrive.

When a new subsidiary was formed, the members of the team were technical people. One of the first places they looked for initial sales was in the universities where employees had previously studied. There, in the technical departments, they could follow the classic Data General pattern: sell price and performance to other "techies" who did not need a lot of hand-holding. Yet, if a subsidiary were to really grow, it

needed better credentials in a wider market. The best way to get them was to make a large sale to a prestigious customer.

One early example came in Sweden. In 1974, Data General was able to sell the city of Malmo, second largest in Sweden, on the concept of computerizing all municipal operations using Data General computers – everything from garbage collection to tax collection. The program was a huge success. Over the years, dozens of Data General computers were installed in Malmo. More importantly, the whole Swedish subsidiary was able to grow dramatically, partly as a direct result of the revenues generated from Malmo, but also because of the indirect impact it had on other business.

Similar success was found in Italy. The Italian equivalent of the Internal Revenue Service collects taxes through banks. When a consortium of banks bought Data General computers to help process taxes, sales went up, employment quadrupled, and the door was open to move into prestigious commercial accounts in banking and insurance.

By the early 1970s, Data General was making progress outside Europe, as well. In 1973 Wayne Fitzsimmons, the top man at Fairchild, the company's Australian distributor, came to Data General and established a new Australian subsidiary. Here, an early customer was Broken Hill Proprietary Company, Ltd., one of the largest mining operations in the world.

However, the early advances were not without surprises. Datagen of Canada, for example, was the only North American computer company invited to a trade fair in Beijing (Peking, at that time) in 1972. It got a tantalizing glimpse of the Chinese computer market, and also got something of a shock; there were already NOVA computers, or copies of NOVA computers in China. How they got there was a mystery, but their existence was undeniable.

A Brazilian subsidiary was set up in 1975. Brazil was a market of vast potential. A team of six people was set up under Ken Brandt, one of the company's first applications en-

gineers. However, shortly after the subsidiary was formed, Brazil closed its doors to sales of computers manufactured outside its borders.

Some Early Lessons

Data General's fortunes seemed to go straight up through the first two years. They delivered the one hundredth NOVA in September 1969. In November of that same year, during the Fall Joint Computer Conference in Las Vegas, the company went public, raising $3 million in the initial public offering. The stock opened at $14 and went as high as $50 the first day. By the end of 1970 more than 700 NOVAs had been installed. To the outside world, it was a rocket ride. But inside, some tough lessons were being learned.

Data General sales for 1969 had been a little over a million dollars. For 1970, sales were projected to grow to $10 million. As a publicly held company with very ambitious growth plans, attaining these outrageous goals was crucial to their ability to raise capital. However, early in 1970 it became clear that they were not going to hit their numbers. The $10 million figure shrank to $7 million. The entrepreneurs learned a stern lesson. To win the high risk game they were playing, they had to have financial discipline. They learned very early that if sales slowed down, they had to stop spending money immediately. That discipline carried the young group through this minor crisis and equipped them for the rigors of the spectacular growth ahead.

Founder Burkhardt, who became the company's first treasurer by default, believes that Data General was able to build a billion dollar company on an $800,000 investment, while so many others failed to flourish in the same fertile ground, because "we used money better than everybody else by a factor of two." By 1972, there were almost 100 companies in the minicomputer business, 50 of them start-up firms like Data General.

Fifteen years later, only Data General and one other such company from this period remained as independent companies. Not because the others did not know how to design and build minicomputers, but because they did not have the financial discipline that let Data General operate at a high profit, which in turn allowed it to raise large amounts of capital at low cost, even when the capital gains tax rates were high – an absolute essential for growth and survival.

Growing Pains (1974-1980)

Data General's highly focussed start-up strategy worked well, and the company had the results to prove it: a high-performance product (the 16-bit NOVA); rapid product cycles (four NOVA generations in six years); one major market channel in OEMs that sheltered direct sales and service expense; tight cost controls and lean management to keep profitability high (operating margins of more than 20 percent) and bureaucracy low. But, times were changing, and Data General's strategy was changing, too. In order to continue growing, and to build a more permanent company, Data General clearly needed to diversify the markets it served. And, the NOVA architecture was already stretching its limit.

The plan during the last half of the decade was to broaden the product offerings, the markets served, and the manufacturing resources, while holding tight reins on costs and management in order to sustain the record of steady, high profitability. All this was undertaken in 1975 amid an economic recession that flattened Data General orders and shipments for the first time in its seven-year history and resulted in the slowest annual company growth rate to date – a mere 29 percent.

These strategies resulted in the introduction of the ECLIPSE family of systems, repeated (but thwarted) efforts at winning end-user customers, a concerted build-up in the European sales/service organizations and diversification of manufacturing and engineering plants outside Massachusetts. It was also a period punctuated by Data General's highest level of vertical integration of design and manufacturing of total products.

The Politics of Expansion

As the company grew, it became an active participant in public policy debates both in Massachusetts and at the national level. Data General's continuous need for capital, due to

rapid revenue, inventory and receivables growth during the period, prompted the company to engage in efforts to reduce the capital gains tax in Washington, D.C. In Massachusetts, Data General's corporate expansion (employment was up 71 percent or 1,100 new employees in 1974) collided with the State's social welfare policies and high tax rates.

During this period, Massachusetts held the dubious honor of having one of the highest tax burdens for individuals in the U.S. The property tax in many communities had reached three to four percent of fair market value. Income, excise, and sales taxes, combined with a variety of user fees to create a personal tax burden 17 percent above the average for other industrial states. Auto insurance, although not a tax, was also among the highest in the country, and was usually included in this burden package. The tax burden continued to grow during this period. One of newly-elected Governor Michael Dukakis' first actions in 1974 was to raise personal income taxes (known as a "temporary" surtax of seven and a half percent which was finally repealed by the State legislature in 1987.) The high personal tax burden became a major barrier to recruiting and retaining employees at Data General and at other growing firms in Massachusetts. The problem, to which the State's elected officials seemed oblivious, was that there already existed full employment in Massachusetts among the types of people Data General and its high technology counterparts wished to hire. Recruiting non-residents was the only way to fill these jobs. Unfortunately, the well-publicized personal tax burden made Massachusetts a particularly "hard-sell" for Data General personnel recruiters.

At the same time, the Dukakis administration was searching for funds to support the high unemployment rate (10-12 percent) in other sectors of the State's economy and to pay for social welfare programs. Funds were transferred from other state budgets earmarked to support an infrastructure already strained by the growing high-technology sector of the economy – the budgets for new or improved highways, bridges, water (quantity and quality), sewer systems, rubbish disposal (land fills), electric power, and airports.

A Red Light in Southboro

Between 1974 and 1977, Data General employment at its Southboro headquarters and manufacturing site increased by more than 80 percent. In 1974, approximately 1,100 automobiles entered and left the site daily. By 1977, the number climbed to over 2,000. Traffic on Rt. 9 was getting really bad.

The problem was that the Commonwealth of Massachusetts was still in a maintenance/no-growth mode, a holdover from the 1960s. It was totally unprepared to handle the growth in jobs and commuting autos on its highways.

The company had requested that a traffic signal be installed on Route 9 several hundred yards from the Data General facility in order to somehow control the ever-increasing flow of cars. That was 1974; by 1976, Brad Stroup, in the Public Affairs department, began writing the Massachusetts Department of Public Works (DPW) urgent letters. A year later, major accidents began to occur, one involving five Data General employees. Although none were seriously injured, the cars were totally destroyed and people began to wonder if they wanted to risk their necks getting to work at Data General.

After dozens of meetings, and a mountain of correspondence, Stroup finally worked out a deal with the Town of Southboro and the DPW. If Data General would foot the bill, the Town would hire an engineering firm to design the red light (in conformance with DPW specifications). When approved by the DPW, the design would be let out to bid by the Town (in conformance with DPW regulations), and the contractor selected would construct the red light (in conformance with DPW specifica-

tions). The DPW's attitude was that the problem was too minor for them to bother with. Since it benefited only one company, they took the position that the company ought to pay for it anyhow, especially since DPW's budget was tight at that time.

In 1977, the engineering firm designed the light and the intersection. Data General donated the necessary land on Rt. 9 to install the light. The Town selected a contractor, (his bid was just over $35,000) and everything seemed to be going just fine. It turned out, however, that the Massachusetts DPW did not have a standard specification for the "strain poles" that hold red lights out over roads. So the engineering firm used the specs of the Connecticut DPW, which looked adequate to them and had been used for years in Connecticut.

And that is where everything began to come unraveled. The Massachusetts DPW would have nothing to do with Connecticut and its strain poles. They wanted their own. They demanded that strain poles be specially designed for this intersection. And the manufacturer in Canton, Ohio, said it would take six months (or longer) to make them. In addition, the DPW required additional engineering designs be prepared on other parts of the system that the engineering firm would not perform without additional charges. More meetings; more correspondence (letters to and from the Governor); things dragged on into the winter of 1977-78.

By September of 1978, nothing had happened except for correspondence and promises. Stroup was between a rock and a hard-place. De Castro and many employees were pounding on him for the red light. The Town and the DPW were still feuding and promising. He had commiserated with Jim Campbell, vice president of human resources, over the problem several times. Finally, Campbell hit on a wacky idea: what if you erected a bogus red light on the side of the road, and made a public spectacle of it? Stroup said hungrily, "Where do I find a red light?"

The next week, Stroup and Steve Daniels, the investor relations manager, passed by an antique/junk shop in Southboro. They walked through it and Daniels' eyes lit upon a rusty red light standing in a corner of the shop. It was the real thing, only 30 years old. It had the red/yellow/green lights shielded by dark green visors, and stood about three feet high. Stroup's prayers were answered. On his expense account sent to de Castro that week was a receipt for "one used red light: $20.00."

The ceremony was on September 15. Data General maintenance people affixed the red light on a 10 foot pole, and painted a sign to go next to it. It read: "REAL TRAFFIC LIGHT REQUESTED 1974; ESTIMATED INSTALLATION MARCH 1979." The media was invited, especially local television stations. Employees were invited. DPW and Town officials were invited (none showed up). There, during the worst of the afternoon rush-hour traffic along Rt. 9 for all to see, employees raised the red light like the flag on Mt. Suribatchi. The cameras clicked and whirred. The local television news loved it. The headlines in the Boston Globe and the local papers delivered the message the next day. The real red light was installed five months later.

Just to show there were no hard feelings, Stroup held another ceremony on Rt. 9 after the real light was installed. George McClelland, Treasurer of Data General presented Tom McAuliffe, chairman of the Southboro Board of Selectmen, a check for $35,766.25. Only Mini News, Data General's employee newsletter, ran the photo.

The Southboro Selectmen were a determined bunch. They requested that the DPW reimburse Data General. The DPW refused. In 1980, however, the Town received the extra funds through the State-aid disbursement. And on November 7, 1980, an astonished George McClelland received a check from the Town for $37,886.55, which included the original $35,766.25 plus interest of $2120.30. As for the rusty old red light – it was stolen from the Rt. 9 site about two weeks after it was "installed."

During this time Data General was also hit with a firestorm of infrastructure problems that threatened to block the company's growth or to add major new costs of doing business in Massachusetts.

The DPW refused to install red lights on Rt. 9 to protect employees from accidents crossing traffic on the grounds that it would impede through traffic.

The Southboro land fill was abruptly closed to industrial rubbish in 1975 without notice and without recourse, causing Data General an emergency search for a commercial hauler to carry its rubbish (mostly paper) out of state at considerably higher expense.

A ballot initiative supported by the State would have required industrial employers to pay a higher electric rate than residences, as a measure to encourage conservation and lower rates to consumers. It was defeated only after intense lobbying by high-tech companies and other industries.

Data General's Southboro septic tanks permanently flooded out in 1978. Southboro had no capacity to handle the sewerage for 3,500 employees. After protracted negotiations with the Town of Westboro, a sewer pipe was laid up Rt. 9 and a pumping station installed at the company's expense. The Southboro manufacturing facility tapped into Westboro's already overburdened sewerage system, which, incidentally, the State had blocked further expansion of, pending formation of a regional system five years later that would be more efficient.

In addition, the State paid out the most generous unemployment compensation benefits to laid-off workers in the country from a fund to which each employer was required to pay an annual per-employee fee. This penalized employers who created jobs, and rewarded those who laid them off even temporarily or seasonally (as in the case of tourism or the automobile companies). To make matters worse, the unemployment compensation fee was increased over the years as

the combination of generous benefits and high unemployment bankrupted the fund.

All of these factors resulted in a collision of high technology company expansion and the political agenda of the Governor. This situation lay the groundwork for the formation of the Massachusetts High Technology Council (MHTC) in 1977, in which Data General played a major role. It culminated in 1979 with a ballot initiative to reduce property taxes to two and one half percent of evaluation, known as Proposition 2 1/2, which passed by a two to one margin, thanks in part to MHTC and other advocacy groups.

Some employees thought, at the time, that Data General's expansion outside Massachusetts was due to a personal feud between de Castro and Dukakis. But, there was considerable business evidence to justify expanding elsewhere. With high-technology full employment in Massachusetts, high personal taxes, a deteriorating infrastructure, high unemployment compensation fees, and a conscious anti-business political environment, the company had no choice but to locate new plants outside the state. Most other high-tech firms did the same during this period. The second non-Massachusetts location was Westbrook, Maine in 1975 (Sunnyvale was the first in 1972); third was Portsmouth, New Hampshire in 1976; Clayton, North Carolina and Research Triangle Park in the same state came next in 1977; Apex, North Carolina opened a year later. Company headquarters were also moved in 1977 to Westboro. Not coincidentally, Dukakis was defeated in his first re-election attempt in 1978.

The Next Generation

As good as the NOVA 840 was, it was only a place holder in the Data General product line until, in October 1974, the company officially answered the PDP-11/45 with the introduction of the ECLIPSE. The ECLIPSE was the first new family of Data General computers since the NOVA five years earlier. It was the culmination of the most extensive development effort the company had ever mounted.

The ECLIPSE was born at a critical moment for Data General. 1974 was a poor year for business worldwide. Inflation appeared an unstoppable force, slowly crippling world business. Data General had done well in 1974, sales up 56% to $83.2 million and pre-tax income up to $19.5 million; but in the past, company performance seemed to lag behind that of the economy by six months or a year. At the same time, competition, in the form of DEC's PDP-11/45, was getting stiffer. NOVA sales began to slip. Against this backdrop, many people believed that the success of the ECLIPSE was essential for the survival of the company.

Developing ECLIPSE

The development of the ECLIPSE may have been the "most extensive" effort in Data General's history, but it relied just as heavily as all projects on individual contributions. A team, led by Ron Gruner, was gathered for ECLIPSE development. The team was small; backed up by a few people from Honeywell's defunct "3Cs division" (Computer Controls Corporation, acquired earlier by Honeywell) and a couple of engineers right out of college. Badly undermanned, the team was powered by Gruner's vision and a great deal of dedication.

Tom West became a part of the team by accident. Hired into an application engineering group, he arrived at Data General from RCA late in 1972. When he reported for work the manager who hired him was out of town, but left word for West that Ron Gruner was having some problems and that he should help him out temporarily. The "problem" turned out to be the ECLIPSE, and West never ended up with the group that hired him.

The goal of the ECLIPSE development team was to build a new machine that would address the basic memory limitations of the NOVA family. At the same time, the ECLIPSE had to be compatible with the NOVA family so that it would not effectively render obsolete the huge investment Data General's OEM customers had made in NOVA software. ECLIPSE had to offer a graceful transition to the new machines or risk losing them.

Sparks of Justice

On a cold day in January 1975, everyone in Southboro was greeted by headlines in the Wall Street Journal claiming that company officers were charged with setting fire to a competitor's offices in Santa Monica, California. The report went on to say that a federal grand jury was investigating a case of arson involving Data General and Keronix, Inc., a small, privately-owned maker of "knock-off" memories for minicomputers, including Data General's own products. It also reported that Keronix had filed a $55-million civil suit a month before charging Data General with conspiracy to commit arson at its facility in hopes to put them out of business.

The Journal reporter had not contacted Data General for comment before filing the story; it contained, therefore, no response from the company – Data General simply stood accused. Confusion and concern reigned in Southboro. Initially, most employess thought it was a hoax. There were jokes about "Eddie the Torch," "Freddie the Flame" and "Smokin' Henry", but it was not funny to investors or customers.

The telephone lines to company headquarters were jammed with calls. Brad Stroup, manager of investor and public relations at the time, accumulated a stack of 300 messages from investors and dozens of calls from reporters the first day alone. Fred Adler, who was close to many of Data General's largest investors, received at least as many calls at his office in New York City. Data General stock was traded heavily and its price fell from $19 a share to under $9 a share after the story was reported.

It took weeks to do it, but each call was returned. Some wanted interviews with company officers, others wanted copies of court filings and other documents immediately; everyone wanted the facts, simple and quick. The problem was there weren't any answers. Nobody had heard of the Keronix civil suit; Data General had never received a copy, and no one knew anything about the grand jury investigation. While Federal attorneys had contacted company officers about the grand jury investigation, this information could not be disclosed because all such inquiries are strictly confidential under federal law.

At the Data General annual meeting held one week after the reports were published, de Castro issued a categoric denial: "Putting it bluntly, the charges are preposterous, the allegations are without substance and the law suit is without merit." Civil suits and countersuits, which the company would file later in this case, are routine in the computer industry and, generally, taken in stride by investors and customers – criminal charges of arson are another matter altogether.

As the weeks passed a convoluted story began to come out. Private investigators had been used by both parties. It was later discovered that a convicted felon had committed the arson, but at whose bidding, no one could find out. The situation did not make sense. Some speculated that the fire and lawsuits were an elaborate stunt aimed at obtaining a quick financial settlement from Data General.

The incident was a cloud over the company. Customers did not want to buy computers or anything else from "arsonists;" employees do not like to work for them either.

As for investors, regulations governing pension fund managers forbid investments in firms whose principals are criminals. Fund managers can be held criminally liable. When one large Boston mutual fund company held its Monday morning investment review meeting just after the Keronix story broke, the house legal counsel asked: "Do you know that you hold 300,000 shares of a firm whose officers may be indicted for arson?" Without further ado, the firm dumped its Data General stock. Since 30,000 shares a day was normal trading volume for Data General at the time, the stock went on a stampede for several days. Another firm just across the street in Boston's financial district still smiles when they remember buying most of the 300,000 shares dumped by their competitor that week at $9 a share. By the following year, Data General stock was trading for $60.

The grand jury completed its investigation a few months later, found nothing to indict on, turned the file over to the City of Los Angeles where it lies today gathering dust. Years later, the Keronix civil suit was thrown out of court for lack of evidence.

It was an early lesson in frustration in dealing with litigation and the courts that Data General was to go through later several times. And it was especially hard to explain to employees who were mostly engineers, programmers, business and marketing people.

The computer industry is especially vulnerable to litigation because ownership of technology is the foundation of the individual competitor's strength and success. The only way to protect rights of ownership is to sue those who gain unfair or illegal access to it. Data General was particularly vulnerable during its first decade since most of its most valuable technology was not protected by patents. The Fairchild and Digidyne litigation, which was initiated by the mid-1970s but resolved only in the mid-1980s, centered around Data General ownership and control of its technology. Today, most of the company's proprietary technology is protected by patents.

Gruner's team labored through 1974 to complete the new machine. The NOVA 840 system bought them time so they could get things right rather than sloppily pushing out a product. It was a complex task. For example, ECLIPSE was to run both 800 nanosecond core memory and 200 nanosecond semiconductor memory. Each type of memory was to include circuitry that would both locate and correct errors "on the fly. Designing this circuitry for the core memory was not impossible, but it was extremely complex. "It was a lot different from the way it's done today, when you just plug in a memory chip," recalls Tom West. "Anybody who has never designed a core memory board doesn't know what designing a computer is."

The ECLIPSE was also an incredibly flexible machine that could be configured and re-configured practically endlessly. But this configurability – a crucial long-term capability – was won at the cost of seemingly endless re-designs. And the ECLIPSE also included a number of ambitious architectural features that had previously been available only on much larger, more costly computers.

Gruner fretted over the fact that the project was taking so long. De Castro was on his back about the slipping deadline, too, and one day he exploded after listening to Gruner explain further delays. "Sogge and I built the NOVA in two months. What the hell's taking you so long?" The answer, Gruner knew, was that "the Bird" as the new machine was called, was a vastly more complex machine than the NOVA. He believed de Castro and Sogge probably could not build it any faster (or even as fast) as he could. But believing that did not get the thing built, so he just shut up and took the heat. Soon "the Bird" became "the Elusive Bird."

At last the Elusive Bird was caught. In October 1974, the ECLIPSE was introduced. The ECLIPSE could manage large amounts of physical memory (up to 256,000 words). It did "right" the MAP concepts that had been first built into the NOVA 840. It could challenge the PDP-11/45 in the marketplace. And, slow in development or not, it was in posi-

tion soon enough to shore up sales before the slippage in NOVA sales became visible to the outside world.

S200 Opens CAT Scan Market

The first ECLIPSE machines introduced in the fall of 1974 were two "S" or Scientific models, the S100 and S200, aimed at Data General's traditional engineering/scientific markets. The S100 was the smaller machine and, as is often the case, sold very few units. The S200, on the other hand, was a major success.

The S200 was equipped with a performance feature called "writable control store," a special cache memory that increased performance in certain scientific applications. This capability fit precisely the needs of the emerging CAT scan technology. The largest CAT scan machine manufacturers, including General Electric and EMI, soon became important consumers of S200 computers. The S200 helped create the CAT scan industry.

$100,000 Systems

Increasing the value of systems had been one of the objectives of the ECLIPSE, and it was achieved. For the first time, Data General was selling computer systems worth more than $100,000. Another objective had been to re-direct Data General's sales effort away from its traditional scientific/engineering OEMs and toward a more systems-oriented end-user customer. But that simply did not happen. Data General's salesmen were famous for their aggressiveness and tenacity, and they certainly were not going to let an evolving product line deflect them from a path where they knew they could succeed, OEM sales. "We simply didn't do a very good job of moving toward end-user sales," admitted de Castro. It was a failure which would continue to haunt the company for years to come.

Commercial ECLIPSE

In March 1975, less than six months after the introduction of the scientific ECLIPSE machines, Data General brought out the first "C" Series ECLIPSE, the C/300.

The C/300 was equipped with a specially designed commercial instruction set, different from that of the "S" Series machines and more like the instruction set of an IBM 360 mainframe. This gave it a character more suited to business applications. Its goal was to bring interactive, on-line minicomputer technology to bear on business data processing tasks. The idea was not to supplant IBM mainframes, but to supplement them. C/300s were priced from $70,000 to $200,000, again breaking new ground in pricing.

Besides its commercial instruction set, the C/300 had a complement of business-oriented software, in addition to the scientific software supplied with "S" Series machines. But the business software offering was thin. Its major pieces were Report Program Generator (RPG) and INFOS. INFOS was one of the keys to the initial success of the commercial ECLIPSE systems.

INFOS, or at least its roots, came to Data General from TAC BASIC, an Atlanta-based software firm Data General acquired in 1974. INFOS was a powerful tool that exactly fit the needs of Data General's new commercial customers. It resembled a data base management system, or DBMS, in that it allowed users to build large data bases and retrieve information from them in a variety of ways. INFOS competed with traditional DBMS packages, although it was not actually a DBMS, but a "file manager." It was not an end-user product, but an "expert system," a high-performance product that expert programmers, whether they were OEMs or worked in the end-user organizations, could use to build commercial application programs. It was exactly the kind of "tool" that was Data General's traditional strength. INFOS quickly became one of the strengths of the "C" Series machines, and remained so for many years. "The number of INFOS licenses out there," says Tom West, "is astounding."

A Lunch at Morgan Guaranty

In the 1970s, Data General was considered one of the "hot" stocks on Wall Street. It doubled, then tripled in value in only a few years. Institutional money managers from the largest banks and investment firms were always asking to meet with Data General representatives to try to understand what made the company go.

Morgan Guaranty Bank in New York, one of the largest banks managing investments in the country (at the time they held about $23 billion in investments) invited Data General to lunch in order to learn more about "an interesting new little company". The lunch at Morgan was a way of formally introducing Data General officers to Morgan's senior investment committee. If they liked what they saw and heard, they could take a full position, that is, purchase five percent of Data General's outstanding shares as part of its investment portfolio. The company stock was trading at $25-$30 a share during this period.

The big day arrived. Ed de Castro, Henry Burkhardt and Brad Stroup flew to New York City early that morning. The group met Fred Adler in the lobby of Morgan Guaranty's huge new building on West 52nd Street, then proceeded up to the lunch meeting.

De Castro was dressed in a plaid suit; Burkhardt in chino pants and windbreaker, hair, as usual, down to his shoulders; Adler and Stroup wore suits. The Morgan group appeared in uniform, wearing conservative dark blue suits.

The Data General group was ushered into a mahagony walled-room to where a massive oak table, elegantly set with fine china, awaited their conversation. The talk was light and social over much

of the lunch; occasionally, it turned to computers and Data General's business. Promply at 2:00 p.m. the head of the investment committee thanked the Data General group for coming, shook hands and began to stroll out. As they were leaving, Stroup asked one of the Morgan people how he thought everything went. The senior Morgan official, grey at the temples with matching moustache in a pin-stripped blue suit, smiled pleasantly and said: "It is all very interesting. There are possibilities. Perhaps when you get to be a $40 stock, we should take a position, but not now."

Stroup reported the comment to de Castro, Burkhardt and Adler as they walked out of the Morgan building. Burkhardt, who was then serving as treasurer of the company as well as head of manufacturing and R&D, commented, "Remind me, if we ever have a pension fund, not to let them manage it." Ironically, when Data General did establish a pension fund years later, its first fund manager was Morgan Guaranty. By then, however, Burkhardt had long since left the company.

AOS Operating System

The first "S" Series and "C" Series ECLIPSE computers were introduced in late 1974 and early 1975, respectively. Within a few months they were making major contributions to sales, picking up the slack caused by slumping NOVA sales. As a result, even though the world economy had serious problems in 1975, Data General moved ahead. Sales went from $83 million in 1974 to $108 million in 1975. Pre-tax profits were $19.5 million and $26.0 million respectively. Growth was strong, if not as rapid as in the past, and ECLIPSE sales were fueling that growth.

There was also a problem lurking behind the success of ECLIPSE. The expectations of an OEM or end-user customer buying a minicomputer for $75,000 or $200,000 were very different from those buying a $10,000 or $20,000 system. They were paying a lot of money, and they expected performance. Data General delivered hardware performance, but in 1975 and 1976 the software products to meet rising customer expectations generated by ECLIPSE were not available. ECLIPSE lacked a true multi-user operating system. DOS was only a two-user system. In reality, RDOS was simply an extension of DOS. RDOS was a typical Data General product – simple, straightforward, and fast. But now the world needed something more sophisticated.

Data General responded to this demand by placing greater emphasis on software. This signalled a major shift for the company. The specific response was an entirely new product called the Advanced Operating System, or AOS.

Work on AOS started late in 1974. In spite of the growing emphasis on software, the effort was initially supported by a team of just two of the company's best young software developers, Jerry Clancy and George Franson, the "Clancy/Franson Gang." They started with a clean sheet of paper and a charter to address fundamental issues and came up with a whole new class of software, a UNIX-style multi-user, multiprogramming operating system.

AOS was a long-term project. The product was not introduced until November 1976. AOS was far more complex and slower than RDOS, carried much more overhead, and was more cumbersome. But, it also had vastly more capability and greater functionality. It was a true multi-user, resource management system, allowing users access to multiple peripheral devices simultaneously and still keep out of each other's hair. It could also manage very large amounts of memory, and it had INFOS, a smart file system. And AOS was largely, although not perfectly, compatible with its predecessor, RDOS, thus preserving customers' software investment. The combination made AOS a winner.

In the course of AOS development the software group added many more people. Finally, they had to be re-located to a new building, a mile or so down the road from their previous quarters. They certainly needed the room, and while the move was a sign of a growing vigorous organization, it also marked a departure from the informal and usually very effective way in which hardware and software had always been integrated. "It was only down the road," recalls Clancy, "but the move cut off casual interaction with hardware." That turned out to be a real negative.

While the AOS operating system was highly successful, many customers still preferred RDOS, because it could be faster and more responsive, and they did not want to go to the effort of moving their applications programs. RDOS was a link to Data General's one-user, real-time, OEM past, and, although it was threatened by the bigger AOS, it survived. The transition to broader markets was not easy. "Data General," says Clancy, "was being dragged kicking and screaming into new markets."

But the die was cast toward expanding markets, and ECLIPSE and AOS marked a major change in direction. "AOS," recalled Henry Burkhardt later, "kept us going in the mid- and late-seventies even when we didn't have a new hardware product."

Fountainhead Project

In 1976, sales rebounded from the recession of the previous year and grew again in 1977. Then, in 1978, sales were up an incredible 49 percent, to $380 million, and earnings were up 39 percent. It was a truly spectacular three year run. Yet in his 1978 Annual Report letter, de Castro said that the company was "somewhat cautious" about growth for the near term.

Some of the concern was based on a belief that the economic growth that had followed the 1975 recession was losing steam. But another cause for concern was that, while Data General had been introducing new products at a tremendous rate, the company had made no fundamental leaps ahead since the ECLIPSE family was introduced late in 1974. And it could be argued that, since the ECLIPSE was really an upgraded NOVA, Data General was actually still relying on a 10-year-old architecture.

The same could not be said of the competition. In 1977 Digital Equipment Corporation introduced its new VAX family of 32-bit computers. After an initially slow start, the VAX became the standard for large-scale minicomputers, and its backlog stretched a year out. There were new competitors, too. Prime Computer, ten miles down the road from Data General in Framingham, Massachusetts, was enjoying remarkable success with its large-scale, 32-bit minicomputers for traditional data processing applications.

Data General did not have a competitive 32-bit product, but it was not for lack of trying. Immediately after ECLIPSE was introduced in 1974, Ron Gruner started to work on a next generation product. It was called the "Segmented ECLIPSE." It was an ECLIPSE-type machine, but it attacked the address space problem of the NOVA architecture in a more fundamental way than ECLIPSE had. The ECLIPSE, for all its success, was really only a patch on the address space problem. With the ECLIPSE and its sophisticated memory mapping system, instead of being limited to a total of 32,000 words of storage for all functions, each user had 32,000 words.

Taking a Tip

In 1977, the Massachusetts high-technology industry was just getting itself together. The Mass. High Technology Council was founded in 1977, made up mostly of CEOs who found they had to have a voice in state public policy issues.

By getting together, they found they also had several major national issues in common, principally the high capital gains tax rate. The U. S. marginal rate had begun a phased-in increase starting in 1969 that brought it to 46 percent in 1972 and 49 percent by 1976. It had choked off most start-ups by 1972. Two hundred high-technology firms were formed in Massachusetts between 1964 and 1969; less than 50 have been formed since then. And firms started during the late 1960s were having trouble with second financings or public offerings.

The tax represented a threat to the availabiliy of capital to grow capital-intensive firms. If someone was foolish enough to risk money investing in Prime or Analog Devices or Data General and the investment increased in value, the Federal Government now took 49 percent of the gain. If someone lost money on the investment, which occurred nine times out of 10 among young high-technology companies, none of the losses could be deducted from other income.

Data General was growing at an annual compound rate of 40 to 50 percent during this period. Prime was growing at 30 percent; Analog Devices at 25 percent; Ionics Inc., a small startup maker of advanced water-purifying systems based in Watertown, Massachusetts, at 70 percent. Such growth rates meant that these companies were spending capital faster for expansion and jobs than they could produce profits to pay for it. They were capital-short most of the time.

The cost of capital in the U. S. was higher than in most industrial nations. Japan and West Germany had no capital gains tax at all. The economic problem was that the industries that could keep the U. S. growing and competitive were starving for money, while very large firms and industries (steel, oil, autos) were stagnating and increasingly non-competitive.

Massachusetts high-technology companies banded together with the American Electronics Association to make their problem known to the Congress and President Carter. A bill was introduced in the House Ways & Means Committee by an unknown young representative named William Steiger from Wisconsin. It dramatically called for cutting the capital gains tax to zero. Because of the strong backing of the new high-technology industry and many minority business groups, including Jesse Jackson, it threw the Congress into an uproar and made a national hero (or villain) of Bill Steiger.

President Carter called the bill "welfare for the rich." Both senators from Massachusetts (Kennedy and Tsongas) agreed and gave speeches against "the give-away," despite the testimony of Data General and other companies that the job-creating and tax revenue-creating potential of cutting capital gains taxes far offset the loss to the Treasury of the tax cut.

The key to the long and complex lobbying efforts to get the bill passed ultimately turned out to be Thomas P. "Tip" O'Neill, Speaker of the House, from Massachusetts, whose motto was "all politics is local." Tip could make sure the Steiger bill (or its amended version reducing the tax to 28 percent) got to the House floor for a vote or see that it never got there. Such is the power of the Speaker of the House, that a nod from Tip could change the course of tax history. His support would almost assure passage.

The task of reaching O'Neill fell to the fledgling Massachusetts-based companies, who had never lobbied in Washington, never contributed money to a political campaign, never formed political action committees (PACs), and none of whom were sure how legislation got written or changed. And only one firm, Bolt, Beranek and Newman, was located in Tip O'Neill's district.

Getting to see O'Neill in his Speaker's office in the Capitol is no ordinary feat. Brad Stroup (director of public affairs) negotiated for four months in setting up the meeting. The group wanted as many CEOs to attend as possible; O'Neill's aides kept stalling, trying to see which way the bill was going in committee, and which way public opinion was drifting.

Finally, with help from Congressman Joe Moakley, also representing Massachusetts and a close friend of O'Neill, a meeting was set for July 18, 1978, shortly before the bill was to be reported out of committee. Seven CEOs were available to make the meeting. Stroup wrote out briefing sheets for each person and obtained agreement among the seven on who was to speak and what they were to say. Since there would not be time or Tip's patience to hear from all seven, offical spokesmen for the group were chosen to be Ed de Castro, the fastest growing; Ray Stata, hurting most for capital; and Art Goldstein, the smallest company; the others would chime in when appropriate. And a summary of the arguments supporting H.R.12111 and S.3065 was forwarded to O'Neill's office in advance.

On Tuesday, July 18, George Berman of Unitrode, de Castro, Ken Fisher from Prime, Arthur Goldstein of Ionics, Andy Knowles from DEC,

Sam Labate of Bolt, Beranek & Newman and Ray Stata of Analog Devices went to Washington. After waiting for 15 minutes in an ornate antechamber with 18-foot ceilings, the group was ushered into Tip's office with Joe Moakley.

Tip talked about what was the matter with the Boston Red Sox baseball team, about the rainy weather, about his wife, Milly's, dislike of Washington heat, about how tough it was to keep the House on a schedule in order to finish up by the recess in late August. De Castro introduced the subject of the meeting and described its importance to DG's future. Ray Stata followed by pointing out that Analog Devices had a booming market for its products but he had no cash and couldn't raise any through the financial markets. Art Golstein finished by telling Tip how hard it had been for Ionics to raise funds and remain independent. Ken Fisher, Sam Labate and George Berman added short supporting comments while the conversation flowed over Tip like water over a beach.

O'Neill listened for a few minutes, looked at Moakley, looked out the window, fiddled with a cigar, scratched his ear and rubbed his big red nose. Sometimes his eyelids appeared to droop. Finally, Tip had heard enough, held up his hands, and said: "OK, fellas, I hear what you're saying. But an awful lot of people out there really need help. It seems to me that you fellas are doing pretty well. My God, you're all growing at tremendous rates. Everybody loves your products. You're making lots of money. I don't know what you've really got to complain about."

It was Ed de Castro who responded first. "But many firms are not here because they could not get started." Ken Fisher added: "And some companies have already died." And Art Goldstein, representing the smallest company in the room, finished: "And some of us won't be here much longer if something isn't done."

Tip's eyes lit up in understanding. "OK, fellas," he said again, " I hear you, I hear you. I'll do what I can." And the meeting was over. H.R. 12111 and S. 3065 were passed in September of 1978 and reluctantly signed by President Carter soon thereafter.

The second explosion of start-ups in Massachusetts and elsewhere began in 1979. The new tax revenues from these and existing high-technology firms and their employees directly attributable to the capital gains tax reduction of 1978 has been estimated in the $30-40 billion range annually.

U.S. Senator Paul Tsongas from Massachusetts said in 1983 when he resigned from his seat in the Congress for health reasons that the biggest mistake he made in his Senate career was opposing the cut in the capital gains tax.

The tax was reduced again in 1981 to 20 percent and there it stayed until 1986 when it was raised to 33% and its differential with income tax rates eliminated.

Bill Steiger, age 41, died suddenly in 1979 of a heart attack. Over 300 companies, mostly from Massachusetts and California, including Data General, established a trust fund providing college educations for his three children.

But now people were frequently writing individual programs that required *more* than 32,000 words of storage. The "Segmented ECLIPSE" would solve that problem using a "virtual memory" approach that would give each user practically unlimited memory space.

Gruner believed strongly in the Segmented ECLIPSE. He began designing it alone and only came into the plant on Wednesday afternoons. While Gruner was still the titular as well as spiritual head of the engineering group, Tom West soon found himself running the day-to-day business of pushing the first ECLIPSE out the door and designing the next level of conventional ECLIPSE machines.

Although Gruner internally promoted the Segmented ECLIPSE project heavily, he did not get unqualified support from de Castro. He also ran into formidable resistance from the software group. The pendulum of power at the company was swinging to software. Software had its own building, lots of new people, and a new head man in Earl Gilmore. The current philosophy in the industry was that the real cost of any project did not lie in hardware development but in software development. So when Gilmore argued against the Segmented ECLIPSE by saying it would take 200 to 250 man years to upgrade AOS so it could run on the Segmented ECLIPSE, the project was doomed.

Gruner was bitter about losing the fight. He believed he had lost not on technical merit, but because software wanted the upper hand and because Gilmore was a better politician than he was. The software team believed that Segmented ECLIPSE was simply a "band-aid" on the address issue, and they wanted to launch an even more ambitious project. So it was software, and specifically Jerry Clancy, who began to define the shape of the next machine.

Meanwhile, Gruner was determined to "do" the next machine, so a team was formed. It was called the "Fountainhead Project" (so named because intially work was done in a suite of offices at the Fountainhead Apartments five miles

west of Data General's Southboro headquarters). The original six-member team, including Clancy, Gruner, Franson, Steve Wallach, Craig Mundie and Steve Schleimer, started work in July 1975. They met with de Castro, Burkhardt, and Gilmore and came away with a charter to do something "fundamental," to build a "supercomputer," to start from scratch, with a blank sheet, no preconceptions, no limits, no concerns about compatibility with past machines. Just build a great computer. The goal was lofty, but it was vague, and vagueness would haunt it to the grave.

Eventually, it became clear that the Fountainhead Project was too ambitious, tried to do too much. But at the time it seemed like the ideal move to make. And its lack of direction was not really apparent. In fact, it seemed like business as usual at Data General. All the successes of the past had been achieved by letting individuals or small teams go off and do their own thing with little or no interference/guidance. And Fountainhead was the future of the company, something bigger than they had ever done before.

The Fountainhead Project was allowed to pluck stars from groups around the company and to go outside for special talent not available in house. As a result, they built a talented team, but they also generated a good deal of resentment among the second team who had been relegated to working on less glamorous projects.

Fountainhead Moves to North Carolina

DEC's introduction of VAX in 1977 put new pressure on the Fountainhead Project. Initially, Data General people were not impressed with VAX. Their perception of VAX was similar to their initial view of the PDP-11/45. When the 11/45 came out, some people at Data General had scoffed because they thought nobody would want a minicomputer with half a million words (usually referred to as a million bytes, or a megabyte) of memory. All that memory was too expensive and there was no real use for it, they argued. Keep it simple and balanced, like the NOVA. But very quickly the megabyte

machine became the standard, and people found plenty of use for all that space.

Data General employees reacted similarly to the VAX. Sure, the 32-bit architecture let you increase total addressable physical memory from 64,000 to 16 *million* bytes, but who could find a use for it? There was some merit to their argument, because very sophisticated programmers could build elegant code that ran faster and used less space. With more space, however, less talented programmers could be sloppier and still do the job cheaper and faster, and the only loss would be memory space, which was now suddenly very plentiful and very cheap. It was not long before VAX became the dominant computer in the large-scale minicomputer field, and there was some pressure to make Fountainhead a "VAX-fighting machine."

Even earlier, in 1976, Fountainhead had started what would prove to be a pattern of changing direction. That year Bill Foster replaced Earl Gilmore as head of software development. Foster, who came from Hewlett-Packard, was an outsider, and a lot more of a team player than most of the old hands at Data General. He tried to manage using conventional tools like memos and meetings, while the veterans liked to run a lot looser, finding their way by sense of smell.

Foster tried hard to change the direction of Fountainhead. Instead of a strategic machine, a leap forward in fundamental technology, they should build a tactical machine to compete with VAX. "Build an HP9000," he said, "go look at what Tandem did." The Fountainhead Project people dug in their heels and said, "we can't do an HP9000 or a Tandem. We're doing a strategic machine." The basic conflict between science and VAX-fighting was never resolved.

Early in 1977 another fateful step was taken. Fountainhead was to move even farther off campus, all the way to Research Triangle Park, an up-and-coming-technology center in North Carolina. The idea was to take advantage of the large academic community and attractive environment of the

Raleigh/Durham area to lure and hold talented technical people.

The move was costly. As many as fifty percent of the Fountainhead team elected not to move to North Carolina; those who did re-locate lost six months of productive work, from March through September 1977, simply grappling with the logistics of moving the operation, building the facility, and hiring a new staff.

Fountainhead marched ahead in North Carolina for several more years. In 1979 Steve Gaal, who had been with the company eleven years, took over as vice president of software, replacing Foster who left Data General to establish Stratus Computer, Inc. Gaal was immediately faced with the lack of direction at Research Triangle Park. Foster had told them to stop building a strategic machine and start building a VAX-fighting machine. Now there was a new guy on top, and he had a different view. Back in Westboro, Tom West was telling Gaal that the Fountainhead gang could not turn a VAX-fighting machine around anywhere near fast enough, but that he and his "junior varsity team" could. Gaal believed West was correct, so he told the Fountainhead Project, "Now stop building a VAX-fighting machine and go back to building a strategic machine." Gaal could not help feeling that, while the decision might be right, the process that had allowed the company's best talent to be bounced back and forth was terribly wrong.

microECLIPSE and 16K RAM

The semiconductor operation in Sunnyvale reached a crossroads in 1979, at least in the main memory business. By 1978 the 4K RAM was becoming obsolete. If Data General wanted to continue in the memory business, the next step was to build a 16K RAM. To do that, the company would have to make a major investment to set up a 4-inch wafer fabrication facility. On the other hand, Data General was prepared for the 16K RAM, thanks in part to a cooperative development deal with Intel which launched work on the 4-inch fabrication line.

Despite this progress, nagging questions remained. Even with Intel's help, could Data General really compete in this market? Companies entirely dedicated to semiconductors were making huge investments in capital equipment to build 16K RAMs. The investment drain appeared as if it would never stop; in order to keep up, Data General would have to double its capital equipment investment. And when that was finished, the new equipment would already be obsolete. Lots of semiconductor companies were bucking under the investment demand, and even the Japanese competitors were feeling the pressure as prices dropped.

In 1979 Sunnyvale managers met with de Castro and Jeff Kalb, then vice president of engineering. In the face of the massive investment demands it imposed, the 16K RAM project was dropped.

The microECLIPSE was considerably more successful than the memory products or the microNOVA, the previous microprocessor. Development started in 1979. The goal was to provide a low-end ECLIPSE product, a three-chip set that could execute the entire ECLIPSE instruction set. The microECLIPSE was introduced in 1982 as the CPU for the ECLIPSE S/20 and ECLIPSE S/120 computers, and later migrated to the DESKTOP GENERATION computers.

The greater success of the microECLIPSE project was largely a result of fixing things that had gone wrong with the microNOVA. While the microNOVA was plagued by clumsy coordination and scheduling, the microECLIPSE was much better orchestrated. A far better job was done coordinating the product announcement with production ramp-up. While there were early problems in bringing yields up to a satisfactory level, good planning minimized the impact of the problems. Most important, the product did not get bogged down, as the microNOVA had, in second-guessing from the sales force. Top managers did a good job of selling microECLIPSE to the sales force, and the sales force, in turn, went out and sold the product enthusiastically. MicroECLIPSE was also better integrated with the company's

broader strategy. Goals and expectations were established and understood early.

Technically it was a better product, also, with the loose ends tidied up far better than they had been on microNOVA. There was a dramatic increase in staffing for microECLIPSE, with more people being managed better. And they had advanced computer-aided design tools that were not available for microNOVA. Finally, Data General had learned a lesson from microNOVA and had made microECLIPSE more in tune with established industry standards.

With microECLIPSE, Sunnyvale's efforts looked less like quixotic tilting at technological windmills and more like a rational investment in vertical integration.

Fixing Manufacturing

The incredibly rapid pace of change and growth throughout the 1970s placed heavy strains on every part of the enterprise. Through the early years of the company, one of the steadiest anchors to the whole structure was Harvey Newquist, vice president of manufacturing from 1969 to 1973. Early in 1973, however, Newquist left Data General to become a consultant. At the same time, a whole new generation of products was coming into production, including a new line of small OEM computers, the NOVA 2, and several peripherals. Under that pressure, things began to fall apart.

Henry Burkhardt was alarmed about the situation. He could see that inputs to manufacturing – people, space, equipment, and parts – were up significantly, but output of finished machines was declining. Burkhardt identified the situation as a real threat to Data General's survival. Even though sales were growing, DEC was making gains in the 16-bit world with the PDP-11, and Data General was losing customers to them. Looking more closely into the situation, he began to view Data General's manufacturing operation as one that was full of talented, hard-working people, but who were handcuffed

McManus on Burkhardt

"Henry Burkhardt III was probably the brightest individual I had ever met," recalls Ed McManus, who has had a long career in sales support at Data General. "Although surprisingly narrow in breadth beyond his field, his logic and insight were awesome. Also, he could educate himself, seemingly overnight, in any new field he chose to explore. He was also a nervous wreck who lived on the Maalox he stashed in his credenza.

"Henry once told me that people were put off by his listening skills and he didn't know why. I had pitched him and I knew why: when you began the pitch Henry sensed where you were going, logically raced ahead, got there before you, and gave you his answer - often when you were only half through! People felt they weren't being heard and went away sulking.

"When I told him this, his eyes widened, and suddenly he understood. Later, he told me, 'I still do the same thing, but now I lightly tune them out and go on to some other project while they finish their pitch. Then,' he chuckled, 'Then, I tell them no!'

"I had the first portable calculator at Data General: a $99 Bowmar – a personal expense, and a status symbol. A day later Burkhardt came in to play with it. 'This would drive me crazy,' he said, punching the keys. 'How do you stand it?' 'Stand what?' I asked. 'There's a few microseconds delay before the answer flashes on the screen!' (I hadn't noticed any delay.) 'I live with it,' I mumbled. 'Not me,' said Henry, 'not me!'"

by a lack of *systems*. When new products came on line, they simply could not accelerate output to meet the new demand.

In 1974, Burkhardt volunteered to "fix" manufacturing. He took over the vice president of manufacturing slot in addition to his roles as vice president of software and treasurer. It was a daunting load, but Burkhardt had built a reputation as a hardworking genius who could get results. For the next 18 months, with Burkhardt providing the leadership, Data General's manufacturing operations were wrenched up by their bootstraps to a whole different plateau in terms of size, capability, and most importantly, automation.

Burkhardt felt that there were hundreds of problems in manufacturing, but that the solutions to the problems were also there in a cadre of dedicated workers. So they set out to attack the problems. A veritable laundry list of changes were made. The physical environment in plants was upgraded. Plants were expanded. An entire manufacturing engineering department was built from scratch. They began installing a Materials Requirements Planning (MRP) system. They created formal training programs for workers and supervisors. They went to college campuses to recruit new graduates and fill manufacturing slots. They brought in a few key management people from outside the company. They installed a complete order entry system. Henry Burkhardt wrote the order entry software himself, working at night, after he had finished a day juggling his duties as three company officers in one. He had never written a COBOL program before, so before he could even start he had to teach himself COBOL programming. Yet the order entry program was written and installed, worked well, and was, in fact, used by Data General until 1981 when a more comprehensive and sophisticated system called SPIRIT took its place. A distributed field network called COMET was added in 1987. However, one part of Burkhardt's software – a program called the assembly configuration system – was ported to newer hardware in 1984 and is still used by the company to convert models ordered into piece parts for manufacturing purposes. Dave Whitworth, a 17-year Data General manufacturing veteran who now manages

Being Tough, Being Fair, and Building Trucks

The worldwide economy was in bad shape in 1975 and not showing many signs of getting better. Yet in the face of this, Data General managed to revamp its entire manufacturing operation, continue aggressive product development on several fronts, and still keep after-tax profit at a healthy 10 percent, one of the highest figures in all of American industry.

However, Data General did not escape entirely untouched by the 1975 downturn. Co-founder Henry Burkhardt was, at that time, serving as vice president of manufacturing; he was determined to hold the line on costs so the company could maintain vital profit margins even though sales were flattening out. It was not always easy.

"We had to do terrible things in 1974 and 1975. We had to control costs, so we had to 'ramp down' a number of vendors in a hurry. We had built into our agreements with these vendors the right to cut back on orders, but a lot of them never thought that would happen. So it really hurt them when it happened. I think that's when we got an undeserved reputation for being tough on our vendors. We were tough, but we were also fair."

Even more painful, Burkhardt also had to cut back some Data General employment. The Hong Kong core-stringing facility was using labor at the rate of 60,000 hours a week, and Burkhardt wanted to pull a major chunk of that time back into U.S. operations to keep the main domestic plants at full capacity as other work shrank. So he called Jay Trepannier, an American who headed the Hong Kong operation. Burkhardt did not mince words – he told Trepannier he would have to cut back to 30,000 hours a week.

Trepannier asked, "Can we accept alternative work?" Burkhardt replied, yes, but that the work would have to be contracted in no more than 14 days.

Ten days later, Trepannier called back. "Henry," he asked, "do you mind if we build toys? We've got 20,000 hours a week for ten weeks assembling toys."

So for a while in the mid-1970s Data General became one of the world's largest toy manufacturers, building Tonka trucks.

corporate order distribution, believes Burkhardt's programming was way ahead of its time. "He had hooks built into the system that allowed us to use new fields and produce new reports years later. Some of Henry's concepts are key determining factors in planning customer shipments to this day."

Probably the most important change in this period was the conversion of Data General from a one-plant operation to a multi-plant, worldwide manufacturing company. Of course it was not all smooth going. Right in the middle of this tremendous expansion effort, business was slowing down, so there was a constant struggle to upgrade facilities while cutting costs. The plant in Westbrook, Maine, had 135,000 square feet when it opened in 1975, but there was not any work for it to do. Burkhardt was certainly not going to divert work from existing plants to the new plant, since he was struggling to avoid layoffs in the old plants as it was. So, the Westbrook plant sat there for months. The six people who were up there in the big empty shell called Burkhardt constantly to ask for work. He was both hopeful and brusque, telling them to hold on, things were going to get better, or, sometimes, to shut up and stop complaining, because with business as bad as it was, they were lucky he did not just pick up the phone and sell the building.

Burkhardt spent 18 months heading up manufacturing, software, and the treasurer's operation. He did indeed "fix" manufacturing, but the price was high. By the summer of 1975 he told de Castro he would have to take a long leave or maybe even quit entirely. In his place, three vice presidents were hired including a new vice president of manufacturing, Paul Stein, who came from Burroughs. By early 1976, Burkhardt had left the company. At the age of 32 he had built a major computer company, made himself rich, and he was, at least for the moment, burned out.

A Moving Train

With strong growth resuming in 1976 after two relatively slow years, manufacturing moved quickly to keep pace. As stated in the 1976 Annual Report, "To catch a moving train, you have to move faster than it does. So we did in 1976."

While revenues grew by 49 percent, facilities grew by 80 percent, and the number of employees by 76 percent. Manufacturing space was doubled in Westbrook, Maine, where most peripheral products and metal frames for computers are assembled; a new facility was acquired in Portsmouth, New Hampshire, where printed circuit boards would be assembled, and the company leased a 55,000 square-foot facility in Framingham, Massachusetts, to serve as the field engineering, repair and spare parts headquarters for the company.

The movement of administrative functions to the new Westboro headquarters in 1977 opened up additional systems integration space in Southboro. That same year PCB assembly operations took off in North Carolina, and additional expansion began in Westbrook. Over 100,000 more printed circuit boards were assembled in Portsmouth than in the previous year.

In all, during 1978 and 1979, even more capacity was added around the world. The company was prepared for continued growth in a booming industry. A business recession in the United States, however, would soon affect profitability while a new strategy would impact manufacturing operations as the next decade began.

Keeping Pace

International business growth kept pace with Data General's rapid overall growth through the mid seventies. In 1977, for example, international sales were U.S.$81 million, or 32 percent of the worldwide total of U.S.$255 million. In 1978 sales outside the U.S. increased 46 percent, to U.S.$118 million, or

a little more than the entire company sold only three years earlier. The company had 2,000 international employees, and international sales accounted for 31 percent of the company's revenues.

Moving East and South

The company also began developing strategies to penetrate Central and South American markets as well as the Far East in the mid-1970s. In 1978 Americas/Far East was well established only in Australia and New Zealand. Other than that, the operation included only a small subsidiary in Costa Rica and the former Brazilian subsidiary, which had been effectively frozen out of this lucrative market by the Brazilian government-imposed trade restrictions. Data General's first priority was to identify areas where subsidiaries could succeed. Some of the successes seemed unlikely.

Although Chile is not a wealthy country, it has high-quality universities and an abundance of well educated people, many of whom could not find jobs to match their qualifications. When Data General ran an employment advertisement in Chile, one interviewee, Rudolfo Luttges, arrived accompanied by two co-workers. Luttges was, at that time, heading up the local Texas Instruments distributorship. Along wth the salesman and the software engineer who came to the interview they formed a "ready-to-go" team. Meanwhile, in another South American country, Venezuela, a major sale to Petroleos de Venezuela S.A., the government-owned oil company, got Data General off to a fast start.

Sales subsidiaries also were established in Singapore with Hong Kong serving as the Far East headquarters. Suprisingly, the fact that Data General had extensive manufacturing facilities in Hong Kong as well as in Singapore, did very little to help sales in these countries. Accessing the market in Japan was handled through Nippon Mini-Computer, now known as Nippon-Data General.

The Story of Nippon Data General

In 1971 Data General entered a royalty-bearing licensing agreement with the Nippon Mini-Computer Company, a firm created with the help of the Japanese Ministry of International Trade and Industry (MITI) by a group of Japanese industrial and banking companies expressly to import minicomputer technology. The deal exchanged Data General's NOVA technology including its manufacturing and sales rights for a clear window into the world's second largest computer market.

For the next seven years, this arrangement made steady, if unspectacular progress. By 1978, Nippon Mini-Computer was selling more than $20 million worth of NOVA computers. It had 300 employees engaged in manufacturing, sales, customer support and development of products needed specifically for the native market. At the same time, Nippon Mini-Computer recognized the need to provide its customers with Data General's new ECLIPSE computers, for which the Japan-based company had no manufacturing or sales agreement. If it was unable to sell ECLIPSE, its Japanese customers would be cut off from future development and would soon find themselves in a technological backwater. Nippon Mini-Computer had to do something.

After a series of negotiations, an agreement was reached. In exchange for a 50 percent ownership of Nippon Mini-Computer, Data General gave the Japanese firm a 10-year license to build and sell NOVA as well as ECLIPSE computers in Japan. At the same time, Data General formed its own Japanese Business Development group whose goal was to coordinate U.S.-Japanese efforts in general and, in particular, the introduction of new products into the Japanese market.

As a "50/50" partner, Data General was now in a position to put more people on the board of directors of the Japanese company. Some of the seats were filled by Data General's officers, but, even more significantly, Japanese executives were hired and placed on the board. This was a powerful incentive for a Japanese executive to leave a prestigious job with

another company to join Nippon Mini-Computer. In Japan, where position and prestige go with age, a young executive had no hope of being appointed to a board of directors. At Nippon Mini-Computer, however, this was possible, and it brought tremendous prominence to the Japanese officers who were appointed.

The company's name was changed to Nippon•Data General in 1980. In 1981, sales were up to $34 million and the company had 600 employees in ten locations throughout Japan. At this point, Nippon•Data General (NDG) now manufactured the majority of Data General products. NDG also imported from the U.S. many of the peripherals that it did not build. Its development efforts were growing more ambitious. For example, it developed an interactive system that allowed customers to use NOVA and ECLIPSE computers to manage and store information in the Kanji language that consists of more than 8,000 characters.

Once again, however, NDG found itself at a crossroad. Continued expansion would require large infusions of capital; however, Japanese investors were not willing to put large amounts of capital into a venture they no longer controlled. Similarly, while Data General was willing to give NDG extensive support and favorable terms for purchasing Data General products, it was unwilling to pump more money into a company it did not control.

The impasse was solved in 1982 when Data General acquired another 35 percent of Nippon•Data General, bringing its total interest to 85 percent in exchange for access to all future Data General technology. This change led to a much closer working relationship between the two companies. In the past, the Japanese company had made changes in product design as it saw fit for its market, as long as the changes did not violate its agreement with Data General. Now the Japanese were asked to submit any design changes for review in the United States. In a way, its freedom was reduced. On the other hand, suggested changes that were adopted could have an impact on *all* of Data General's business worldwide, not just in Japan.

Slowly the Japanese company was evolving from taking U.S. products and manufacturing them for Japan, to developing and manufacturing new products for Japan, and, finally, to developing new products for worldwide markets, including the U.S. NDG, for example, developed a large part of the cartridge tape drive used in the DESKTOP GENERATION computer. In 1983, NDG played a major part in the implementation of the advanced gate array technology used in the ECLIPSE MV/8000C, a very compact, sturdy ECLIPSE MV/Family computer designed for industrial applications in harsh environments. Much of the circuit design technology used in this project was available only in Japan, therefore, NDG's role was important.

Closer ties with NDG allowed Data General to become the first foreign-owned company to receive subsidized financing from the Japanese Long Term Development Bank. With an "okay" from MITI, the bank loaned, at seven and one-half percent for 10 years, the funds to build a new, highly automated plant for manufacturing a totally new product – the DATA GENERAL/One laptop computer – a product that was designed jointly by Data General and Nippon•Data General.

Data General had become one of the very few American computer companies to be viewed by the Japanese as a Japanese company. When Hishashi Tomino was elected an officer of Data General in 1984, he was also one of the first Japanese executives elected to an officer's position in an U.S. company. This became an important advantage for the company in 1987 when Nippon Telegraph and Telephone (NTT) Corporation chose Data General for a joint development project aimed at providing integrated telecommunications systems for NTT's customers in Japan and worldwide.

The End of an Era

While business growth slowed in the U.S. in 1980, international sales continued to grow rapidly, rising from U.S.$162 million in 1979 to U.S.$247 million in 1980, an increase of 52 percent, compared with total revenue growth of 29 percent.

As a result, the contribution of international sales to the whole loomed even larger, increasing to a record 38 percent. Soon, however, the economic trends that were dragging down the computer industry in the U.S. affected the European market. By 1981 this economic slow-down, combined with high inflation, began to sink in around the world. International sales were hit hard that year: growth over the previous year was up a mere five percent. Things were tough all over.

Here Come the Cowboys

Two factors led to Data General's remarkable success during the 1970s – a resourceful engineering team that repeatedly brought advanced product to market fast; and the most aggressive sales force in the industry. The sales force built in the early 1970s became the archetype of the high-technology sales force for the decade. They were highly-commissioned, independent, hard-driving, high-energy "cowboys on the range." The commission structure was the envy of the industry. Although, most computer companies had sales commissions, Data General's was highly progressive – the more orders a salesperson brought in, the greater the share of the revenue paid in commissions once the computer was installed and accepted by the customer. And, most important, there were no caps at the high end. It was not unusual for a Data General salesman to receive commissions in excess of $300,000 annually. In 1976, de Castro's salary was $75,000, Richman's was $70,000.

This gave the salesperson and his manager unparalleled independence from senior managers and the "home office" as long as they met their goals. They could organize their territory and target their accounts as they wished, selling opportunistically. Whatever won, worked. The commission system rewarded drive, innovation and assertiveness in the self-starters. There was no "right" set of credentials, no formula background from which Data General sales people were drawn. The only common denominator among them was performance.

Such a system also penalized losers quickly and everybody generally when the products were competitively weak or the market turned sour, as it occasionally did during the decade. Turnover was inevitably high, running 30 to 40 percent in tough times. Even in good times, the weak performers were pushed over the side of the boat annually, creating a universal tension and pressure on everyone. The low U.S. region for the quarter was awarded "The Tail Ender" award with great ceremony – a horse's rear end, that the manager was required to keep on his desk until another region won it next quarter.

Finally, the system created an independent organism hard to manage or redirect. And since commissions were paid quarterly on hardware accepted by the customers, the sales people were strictly short-term focused. A sales situation that developed slowly over many months, requiring repeated calls on the customer, was often quickly lost. This presented repeated problems in developing large end-user accounts among Fortune 500 customers. But as long as the products were "hot," and customers knew what they wanted, the Data General sales force could move faster than any other.

Richman ruled over the cowboys with raucous humor, high jinks and impossible demands for winning – all focused on beating the competition and making customers happy. Bill Jobe, the original rep in Dallas that sold the first NOVA to the University of Texas, became the prototype high-tech cowboy. Thin, casual, drawling, intense and demanding, Jobe built up his Southwestern territory after joining the company, later repeated his success on the west coast, recruiting a hard-core of regional cowboys throughout the country known as the "Texas Mafia" before he came to Westboro as national sales manager, then Vice President of North American Sales.

The U.S. sales managers, recruited and trained by Jobe and Richman over many years, developed a driving intensity toward the selling process that the computer market had not seen before. Among the leaders were Ralph Wertheimer (New York), Chris Robert (Boston), Chuck Presto (Atlanta), Jim Morrissey (Chicago), Bill Adams (Los Angeles), Mark Les-

lie (San Francisco) and Stan Joseph (Washington). The "Texas Mafia," led by Jobe, became the longest-playing sales force in the industry during the 1970s.

By the early 1980s, they were all gone. Ed McManus, head of U.S. Sales Planning for the whole time, characterized the passing of the era: "The preachers came to town, the bawdy houses closed, it was a lot more respectable but, oh, so dull." Richman expressed the theory that "we can be both British and Yiddish," but it did not work out that way. It became a cultural thing. Some refused to go through the transition to three-piece suits walking mahogany halls to end-users. Some could not stomach the larger, more bureaucratic organization the company had become. Others had so much excitement and challenge during the early Data General days that the experience had become addictive. They had to go elsewhere to recreate the same experience in the start-up situation. But in 10 years they moved the company's revenues from $15 million (1971) to $737 million (1981), a record few companies have ever matched.

Pain and Strain (1981-1984)

Despite efforts to broaden its product lines and markets during the late 1970s, Data General by 1980 was still a maker of high-performance 16-bit minicomputers used largely for engineering and technical applications by product OEMs and VARs. The plan to leapfrog the industry into the new world of 32-bit systems – Fountainhead – had failed. The Eagle, Tom West's remarkable catch-up project, had landed three years after DEC's VAX took off.

But, in the ECLIPSE MV/8000 the company finally possessed the vehicle to broaden its product line and go after new markets. That made implementing the strategies formulated in the 1970s possible. To build a broad-based, permanent company the firm's business had to be balanced between commercial end-user markets and traditional OEM markets.

Data General recognized that to accomplish this broader strategy a sacrifice of short-term profitability would be required since major investments would have to be made over a number of years. The 16 percent operating margin of 1980 (the lowest in Data General's history) would not be seen again.

The logic behind the plan was not complex; it was just expensive. In order to serve commercial end-users (business applications with Fortune 1,000 accounts and smaller businesses) an extensive investment in product service (field engineering) resources had to be made. This meant new offices, repair centers, diagnostic centers and field inventories of spare parts, all to be paid back via service contracts over several years. The faster service revenue grew, the greater the investment needed to support it.

Massive re-training of the sales force, which was still largely engineering and OEM-focused, also had to be initiated. In many cases, new business-oriented end-user sales people

would have to be recruited, since the traditional Data General technical sales people would not make the transition either by choice or by capability. The side effects of this transition meant turnover in the sales force and a loss of productivity while major investments in training programs were being made.

The technology of the MV/Family systems required a significant overhaul and automation of manufacturing resources on two continents. It was simply no longer possible to build these new machines using the processes developed for NOVAs or the early ECLIPSEs, much less keep the costs down to the levels necessary to keep the product price-competitive. Heightened customer demands for hardware reliability could not be met without highly automated manufacturing processes either.

Meeting strategic goals also entailed broadening the senior management cadre. No one at Data General had ever worked with a large Fortune 500 customer at an executive level. Only a few Data General officers had ever worked for a Fortune 500 company at a senior level.

All of these plans were achieved. With the advent of the Comprehensive Electronic Office (CEO), a pioneering integrated office automation software platform, Data General penetrated the office of the larger, commercial customer for the first time. Having missed the word-processing explosion precipitated by Wang in the early 1980s, Data General soon outdistanced traditional wordprocessing with its own concept of integrated office automation. By 1985, over $400 million in revenues were produced by CEO-related systems sold directly to larger business customers primarily by a retrained, overhauled sales force .

At the same time, Field Engineering was built into a worldwide organization of 2,400 engineers in hundreds of offices, producing revenues of more than $300 million. Service revenues grew from 16 percent to 26 percent of the total business revenue. This segment of Data General's business

became highly profitable while customer satisfaction reached record levels.

The automation of the company's factories, called the "Cornfield" project, transformed facilities in Portsmouth, New Hampshire, Apex and Clayton, North Carolina, and put Singapore on the Data General map. As a result, capital expenditures during these years reached their highest levels – $130 million in 1984; $167 million in 1985 – but, the results were impressive: accelerated shipments of ECLIPSE MV/Family systems (up 48 percent in 1984) with the highest levels of quality and reliability in the company's history which, in turn, contributed to a high level of customer satisfaction.

Finally, top company managers were joined by senior people drawn from other Fortune 500 firms, mostly IBM – the head of North American Sales Division (Frank Keaney), of Corporate Marketing (Bob Miller), Field Engineering (Frank Silkman), Manufacturing (Dave Chapman), as well as the Information Systems Group (Dave Lyons) were all recruited from the ranks of "Big Blue." At the same time, three product divisions were established in order to serve the major vertical markets that had emerged: business automation, industrial automation and personal automation.

Over this five-year period, an organizational structure and manufacturing capacity had been built to handle business volumes in the $3-4 billion range. Profit margins dropped to 10 percent, then 8.7 percent while the capital expenditures surged as did costs of sales and R&D. The number of Data General employees reached 17,600 worldwide, the highest point for the decade. The broadening of Data General into a solid force in the computer industry appeared within reach.

Landing the "Eagle"

While Fountainhead slogged along looking for an identity, the pressure from VAX grew heavier. Data General needed a "VAX-fighting machine."

Tom West's approach was pragmatic and, where Fountainhead was attempting to be revolutionary, entirely *evolutionary*. He reasoned that Data General's last big step ahead, the ECLIPSE, was successful in part because it was a result of an effort to "fix" the NOVA. It was "doing the NOVA 840 right." Therefore, for the next generation, let's "fix ECLIPSE, give it a 32-bit architecture, but build that architecture on the ECLIPSE foundation."

With a charter to build a VAX-fighting machine, West put together a team of veterans and neophytes. In a 24-month blitz effort from April 1978 through April 1980, they built the computer that was code-named "Eagle." The Eagle was both a huge step forward and a bridge between old and new. It was a powerful 32-bit computer, the first of a new generation of 32-bit superminicomputers for Data General. Yet it was closely enough related to the 16-bit ECLIPSE family that all the ECLIPSE AOS software could run on the new machine. That meant that current Data General customers could move up to a new level of performance and capability without sacrificing their enormous investment in software.

The very fact that the Eagle was limited in its objectives gave it a huge advantage over the revolutionary Fountainhead Project. Since it was, at heart, simply an upgraded ECLIPSE, it did not need a whole new suite of software. While there was a parallel software development effort going for the Eagle, including the AOS/VS operating system, as a hedge against delays in its development, West convinced de Castro to announce the Eagle with no new software, allowing them to make the announcement earlier. Eagle would be announced as being able to run all existing ECLIPSE software. Although that alone would not take full advantage of the Eagle's new performance capability, it would allow customers to start using it immediately, before its own suite of software was available. And, it would allow Data General sales people, for the first time since 1977, to start fighting back against DEC.

Racing Down to the Wire on Software for "Eagle"

In trying to fill the 32-bit gap about to be created by DEC, the Data General software people were faced with a huge mountain of projects to accomplish in minimum time. One of them was a complete rewrite of AOS/VS for the Eagle. The other was to port all the 16-bit programs and protocols to Eagle. As usual, there were the false starts. Bill Foster, head of software development at the time, assigned Ed BeLove and Steve Wallach to head task forces that quickly became overly ambitious and were cancelled by either Foster or de Castro as taking too much time and too much resources. The message went out, "get it done fast, but cheap."

Bob Downs, a former systems engineer from the West Coast, was given the AOS/VS assignment in 1978. VAX was announced that year, putting the fire to everyone's feet. Downs at the time had only a few programmers assigned to him. His principal programmer was a young designer named Steve Kludt who began the AOS/VS effort. But Downs knew he had to convince Foster and de Castro the he was doing a "skinny, bare-bones" rewrite. He proposed to do the job with nine man years in less than 18 months. "I was afraid that if I proposed what I really figured it would take, it would never fly. So we underestimated the task by factors of three or four, then hustled like crazy," recalls Downs.

West had obtained de Castro's approval to get Eagle out without the full rewrite of AOS/VS in order to get it out early. But Downs gambled that West would be late, as hardware designers often were, giving the AOS/VS team time to complete their rewrite and port the 16-bit software. Downs recruited Terry Dowling into the VS group and began to build it up. Dowling, who later became head of the VS team, came from a small OEM on the west coast.

Once Eagle's announcement date was fully committed, Downs had no trouble selling management on the extra people and resources he needed. And as the team built itself up, the people became committed to the unauthorized goal to get VS out by Eagle's arrival. "It would have been a terrible

embarrassment if we had failed. That put tremendous pressure on us to deliver," Downs said.

The gamble was that West would slip Eagle. By mid-1979, it was clear he would. Announcement would slip out until spring 1980. Downs got his first prototype Eagle that would "quiver" in October. It crashed constantly. The software people had access to it between 4:00 AM and 5:00 AM for software debug time. Downs' team was building up to 100 people. Bob Steingart was brought in to head a group to port 16-bit programs. Each software group in the company contributed a person to help in the porting chore, building up the effort at one time to over 80 people.

But the gamble paid off. The hardware was late enough for Downs' to both deliver VS for the Eagle and port most of the 16-bit software by spring 1980. Eagle, now with its official name, the ECLIPSE MV/8000, was introduced at New York's Roosevelt Hotel in April 1980. The system was demonstrated driving 128 terminals, a feat only possible with the rewritten AOS/VS. It got a warm reception and marked a major step ahead for the firm. The effort was a real achievement of groups of computer hardware and software people coming together to bring the event off. While the VS software was not "commercial strength" yet, it went out to Boeing, the first MV/8000 customer, a few months later.

Overall, however, 1980 was a disappointing year. The company had experienced its first ever decline in profits in the fourth quarter of 1979, and 1980 continued the slippage. Not that Data General did not continue to grow. Sales were up 29 percent for the year, net income up 10 percent. Those would be good figures for most companies, but for Data General they were discouraging. Of course, no one could tell at that point whether the ECLIPSE MV/8000 could turn the trend around, but there was great hope that it would.

In hindsight, it was clear that Fountainhead had been too ambitious and that segregating people and projects into an "elite" effort had been a mistake. In addition, company

How "Soul" Came to be Written

Tracy Kidder had been writing science articles for **The Atlantic Monthly** for several years – pieces on biology, medicine and solar power. But Kidder confessed to the managing editor at the time, Richard Todd, that he was going stale, running out of subjects that interested him or the magazine.

Todd suggested computers. At Amherst College, Todd had roomed with a physics major who had later become a computer designer. Kidder said he didn't know anything about computers, and he had found them dull reading, but he was willing to try. Following Todd's suggestion, Kidder contacted Todd's former college roommate, Tom West, a computer engineer at Data General, who, as luck would have it, was just getting the "Eagle" project off the ground. West saw a chance to juice up the morale of his "kids" by having a writer tag around, and said, "Why not?" Kidder himself got caught up in the "Eagle" excitement and devoted a full two years to the project. The result was **Soul of a New Machine** , published almost a year after the MV/8000 system was announced.

A natural conflict of interests between Kidder and the company existed throughout the relationship that was always managed to stay balanced by the mutual benefits of the relationship. Kidder's initial ignorance of computers turned out to benefit both him and Data General. The book focuses on people rather than machines. It ignores technical data available to Kidder about the "Eagle" project that was proprietary to the company at the time. As a result, much of the subject matter that made the book successful also finessed the business concerns about giving away secrets on unannounced computers to competitors.

Both author and company tooks risks as the book and computer project developed. Neither fully understood what the other's project was about or how it would turn out. One risk to Data General was that the book or excerpts of it might be published or leaked before "Eagle" landed and the MV/8000 announced. It was a critical time for Data General. Although the company was three years late into the 32-bit market, "Eagle" became during its development the "ace in the hole" to get the company back into the game. The risk appeared to be a minor one, however, since as the book shaped up around the project's engineers, it would have no end until the project was completed or abandoned.

On the other hand, Kidder was concerned that the book be kept clear of any taint of Data General sponsorship or commercialism. He and the publisher could not afford to have **Soul** appear to be a timely promotion for the MV/8000. It had to be an "underground" work unauthorized by "management" and the front office. By keeping his distance from "management" in the text and reporting on the working lives of the engineers and their supervisors, Kidder solved the commercialism problem. This approach also fit Data General's own interests, since West and Carl Carmen, Vice President of Engineering at the time, wanted to keep Kidder away from the business and management issues on "Eagle" that would get him into deeper proprietary areas.

After **Soul** was published, meetings were arranged by the publisher to promote the book. The most successful was a public meeting held on a Saturday morning at the DEC Marlboro (Ma.) plant's main lunch hall where both Kidder and West spoke. The hall was mobbed for the event with standing-room only. Although little advance notice of the meeting was made, every computer designer or electrical engineering student in New England was there or tried to get there. Since neither Kidder or West were practiced public speakers and both of them felt uncomfortable in directly promoting a "commercial" publication, a format was decided on that got them both off the hook: they would have a conversation that everyone would listen to; later, questions would be taken from the floor.

A sample exchange at the meeting illustrated the friendly tension between parties – Kidder: "Had I known that "Eagle" would turn out to be such a successful computer, I might have done some things differently in the book." West: "Had we known your book would be so successful, we might have done a few things differently, too."

Someone asked West at the meeting if he had read the text of the book before publication. West said: "Yes, I did, but my hands trembled a lot."

At that moment, every computer designer in the world would have gone to work for Tom West at Data General.

leadership had been slow to move decisively to throw enough resources into the MV development program. Yet the program had been an example, once again, of how much a few people fired by ambition could achieve. The whole extraordinary story of the Eagle project was told in a book, *The Soul of a New Machine,* that won a Pulitzer Prize for author Tracy Kidder. The book showed, in a way that few people inside or outside the computer industry had ever before seen, the human drama involved in the development of a complex technical product. It also allowed the world to glimpse Data General in a way that few companies had ever before been seen. People both inside and outside the company agreed that they found Data General to be demanding, tough, competitive, certainly not perfect, but a deeply exciting, challenging environment in which talented people got to do challenging jobs. And, where if they succeeded, they got to do it again.

CEO And A New Marketing Direction

In November 1981, Data General entered an entirely new market, office automation, with a product called CEO, comprehensive electronic office automation software. The company believed that CEO was a superior concept in office automation, but at the time it seemed to many observers that the product was unlikely to succeed. A brief reference to CEO in the company's 1982 Annual Report said little more than that it "was developed to increase office productivity at all levels – managerial, professional and clerical."

The target market for CEO was Fortune 1,000 firms – one already filled with strong competitors including Wang, IBM, and a host of other smaller office automation specialists. Data General was a newcomer and, at the same time, a late-comer. The most obvious question to ask was who would even consider buying office automation from Data General?

In just over a year, Data General stunned the computer industry with an answer by selling the two largest integrated office automation systems ever built.

On February 22, 1983, E.F. Hutton & Co. announced that after an intensive research and bidding process, they had selected Data General to construct an office automation system that would tie together more than 5,000 brokers in as many as 400 offices.

Then, on July 8, 1983, the Forest Service of the United States Department of Agriculture announced that it had selected Data General to build an office automation system that would reach out to some 800 installations all over the country, the biggest such job ever attempted. The system was called FLIPS – Forest Level Information Processing System.

FLIPS side

In acquiring its office automation system, the Forest Service conducted a very well-organized vendor evaluation. In March 1982, Data General identified the Forest Service's call for proposals as a major strategic opportunity. They were convinced it was worth as much as $70 million in business. Such a contract would literally put CEO on the map by linking Forest Service locations from Washington, D.C., to Zigzag, Wyoming.

The Forest Service had created an exceptionally tough set of specifications for the job, including a rigorous set of benchmarks three years in the making. Data General put together a "major opportunity team" to win the business. When the team received copies of the benchmarks, they spent several weeks preparing to run them.

By January 1983, the Forest Service sent a team from Washington to conduct the benchmark tests in Westboro. But, as the first day of a scheduled three-day test ended, the head of the Forest Service evaluation group told Data General executives Bob Miller and Dave Lyons that the company was not doing well on the tests and since it had two shots at it, maybe they would be better off aiming for the second one.

Data General took the advice, but was discouraged. Members of the major opportunity team thought they had done a

good job of preparing. The basic problem with their approach was a shortage of resources. The benchmarks called for testing a series of programs on a variety of hardware configurations. In order to provide the required hardware, the same basic equipment was utilized for each benchmark then simply reconfigured by adding terminals, peripherals, memory, etc., when appropriate. All the hardware shuffling ate up valuable time and energy.

Six weeks later, in March, when the Forest Service team showed up for the second time, it saw a different Data General. Everything was in place, right down to the "Welcome, U.S. Forest Service" signs. Under Miller's direction, the team set up different hardware configurations for each benchmark. Although this tied up an enormous amount of equipment it eliminated a lot of non-productive hardware juggling and enabled employees to concentrate on passing the benchmarks. Data General became one of only three companies to successfully complete the benchmark portion of the bidding process, out of nearly 30 companies that tried.

Next came the financial portion of the bidding process. Data General formed two bid teams: its own, and a competitive team, headed by Arun Taneja, whose members were to pretend they were a team from DEC and prepare a bid based on their extensive knowledge of the DEC product line. Bids were compared then both teams went back to upgrade its quotes. It was an intense intramural scrimmage. The "DEC" team was highly adept at finding more cost effective ways to get the job done, forcing the Data General team to respond.

At the same time, there were ongoing question and answer sessions held with the Forest Service representatives. Data General sent vice presidents to those meetings, impressing the Forest Service people with its commitment. Miller was sure they were doing well, and he believed the contract would be as important as the earlier E.F. Hutton contract in establishing the credibility of CEO.

One thing Miller thought Data General was doing right was *listening* to and *learning* from the Forest Service people, rather than telling them how to do their job. Miller was convinced that the Forest Service group was extremely sophisticated and knowledgeable about computer technology, and that perhaps the competition was making an error by underestimating this prospective customer.

On June 13, 1983, Bob Mague, Data General's Federal Marketing branch manager in Washington, D.C., walked into the Forest Service headquarters to hand over the thick stack of documents that made up the Data General quote. Meanwhile in Westboro, Miller was confident. He felt the Forest Service people were complete professionals who would give the Data General bid a very fair, non-political review.

The Forest Service spent several weeks digesting the quotes. On July 8, 1983, it named Data General as the winner.

The Data General team was exultant. In just over a year, CEO had vaulted from nowhere to become a major force in office automation. This was a significant accomplishment in the company's effort to broaden its markets.

There was another positive fall-out from the sale. Miller believed the FLIPS contract was a catalyst in accelerating sales of ECLIPSE MV/Family machines. In fiscal 1983, the ECLIPSE MV systems made a major contribution to the total sales picture with something less than 1,000 units sold. In fiscal 1984, ECLIPSE MV sales quadrupled. The Forest Service deal was a "strategic" sale in that helped build momentum for the ECLIPSE MV/Series. The two major office automation deals lent Data General tremendous credibility just at the time when it could kick rising sales into a much faster track.

Data General also learned a great deal from winning the Forest Service deal – much more than the losers could learn. It learned, not only competitive lessons, but also how to solve *successfully* the substantive problems of building large-scale office automation systems.

The Forest Service has become the world's largest user of CEO with more than 30,000 employees on its network.

CEO became the leading integrated office automation product on the market. Through the first five years following the introduction of CEO, Data General issued more licenses for its office automation product than competitors, including IBM, DEC, Wang and Honeywell, had issued for their integrated office systems. In 1988, the company introduced a streamlined version of CEO, CEO Light, to better serve smaller customers, and the CEO success story continued. Through fiscal 1988, Data General had issued 7,800 CEO and CEO Light licenses serving more than 260,000 users around the world.

Real Change In Sales Force

The major wins with sales to E.F. Hutton and the U.S. Forest Service signified a change in direction for Data General's sales approach. Data General still had, in 1980, a sales force that was extremely good at OEM sales and not very good at end-user sales. There had been lots of talk and occasional action in this direction in the past, but never much in the way of results. It was not simply that the sales people were pigheaded. They had never been successful at end-user sales because the rest of the company, from engineering to field service, training, documentation, and accounting, was not organized to support end-user sales. That finally began to change in 1978, when the field service organization got the funding to allow it to provide the level of support that end users expect.

The 1981 reorganization into marketing divisions made the sales force more responsive to end users' expectations and encourged the company to address the real needs of end users. One of the new divisions, the Technical Products Division, was still primarily an OEM operation. But, the other two divisions, Information Systems Division and the Small Business Systems Division, were end-user oriented. The new divisions began to drive the definition of new groups of customers, and they also began to drive the profile of the Data

General sales force. And, that profile soon became more end-user oriented.

As the customer profile changed, products changed to meet the profile, with the new division again providing the driving force in defining the new products. The success of CEO had a profound effect. Now Data General could represent itself as a company with a serious end-user product line. Therefore, they could recruit end-user-oriented sales people for the first time. They still wanted people who were strong technically, but it was no longer considered essential. In fact, sales management began to identify people who were technical, not in terms of computer operation or functionality, but in terms of the application they were trying to support.

For the first time, Data General began to address customer needs with a long-term perspective, selling in terms of life-cycle costs and long term growth paths, rather than supplying "bang-for-the-buck."

Instead of every sales person selling every product in a territory, in each sales office there began to emerge specialists in specific market areas. The new sales people were much better at understanding the users' problem, consulting with the user, taking the time to do some "hand-holding" and to develop a solution to the problem, then follow through to make sure the problem was solved. Sales training became more formal and extensive. Sales people were encouraged to sell training to customers, as well.

Some of the veteran OEM sales people stuck to OEM sales. Others changed their spots and learned how to be successful with end-user customers. Others could not or did not want to make the change, and they left. But, for the first time, after a series of fits and starts, the character of the Data General sales force had at last changed, largely because the company behind it had finally changed.

The 32-bit Systems Line Evolves

Throughout the 1980s, Data General continued to add power and performance to the ECLIPSE MV/Family of computers. The ECLIPSE MV/8000 was the foundation for a growing family. First came the smaller MV/6000 in 1981, followed by the MV/4000 in 1982, then two additional models of the MV/8000 - the MV/8000C (commercial) and MV/8000 II (rack-mount) - along with the MV/10000, debuted in 1983.

The MV/4000 was aimed at small industrial and commercial applications, while the mid-range MV/8000 models introduced a second generation of technology to the 32-bit product line. The larger ECLIPSE MV/10000 was the most powerful system ever offered by Data General. The new MVs, combined with CEO software, led the company to a string of six quarters of explosive growth, beginning in mid-1983 and continuing through December 1984 (the first quarter of fiscal 1985).

But, the company did not stop there. Larger, more powerful systems were on the drawing board, along with smaller systems that would fill the performance gaps.

Development of the DATA GENERAL/One

One of the markets Data General had missed during the development of CEO was the PC market. The company aborted an early effort with a 16-bit system called the Enterprise, its first attempt at a personal computer. By this time, the IBM PC was emerging as the de facto standard in business applications. In addition, Osborne Computer had just topped $100 million in sales with what seemed like a nice but simple product.

De Castro became convinced that Data General's next shot at a personal computer should be an IBM PC-compatible portable, priced around $2,000. That was the vision. The reality was that Data General simply could not do all those things immediately, in one product. So two products were launched.

The first was the DESKTOP GENERATION, which met many of de Castro's criteria. It was a single- or multi-user machine that fit on a desktop, ran standard operating systems (both MS/DOS and CP-M) and application software, and was compatible with both the IBM PC and CEO.

At the same time, Data General launched an effort to develop a truly portable computer. De Castro believed that Osborne Computer, in spite of its success, did not have the answer. Their machine was too heavy at 27 pounds, and its screen, which could display only 12 lines of text at a time, was too small.

For Data General, the answer, he believed, lay in Japan. The people in Westboro had grown confident in the skill of their Nippon•Data General colleagues after their successful efforts on the DESKTOP GENERATION tape system as well as with the ECLIPSE MV/8000. The Americans believed that if they provided a good functional specification, the Japanese could return an effective implementation.

Japan offered other advantages, too. Data General simply had no volume production resources available in the U.S.; everything was tied up with the DESKTOP GENERATION. And the technology to create a large flat-panel display, specifically the computer-aided design capabilities needed to develop its circuitry, existed *only* in Japan. At the same time, Nippon•Data General needed an entire product to work on, not just a piece of a product.

Late in 1982, Systems Development Division Vice President Tom West built a mock-up of his concept of a new portable computer, something he called "the book," because it was small and its cover flipped open to reveal a flat screen. De Castro bought the concept and told West to go tell Nippon•Data General to build it. West knew that he could not simply "tell" the Japanese; he would have to "sell" them the idea, and gain their enthusiastic support. West, who had made a long and diligent effort to understand what motivated the Japanese he worked with, succeeded in getting Nip-

pon•Data General "signed-up" for the project. In the fall of 1982, Nippon•Data General made its initial project proposal.

Bob Miller, who headed the company's three business divisions, also became very involved in the portable computer project. He believed that IBM had a huge jump in the field, and that the only way to close the gap was not to chase them faster, but to figure out a way to take a shortcut and get to the next logical interception point before they did. He thought a true portable computer represented just such a point.

Miller believed that great things could be accomplished when Japanese and Americans worked together, American technology combined with Japanese implementation skill. By 1983, Miller had become the spiritual leader of the portable project; his vision drove the project.

The first product presented by Nippon•Data General was not completely IBM PC-compatible. Miller insisted it must be. Miller pushed the idea that it have dual 3 1/2-inch floppy disks. De Castro pressed for a screen big enough to display a full page of text, not just a few lines. Others chipped in, too. As the machine became more firmly defined, everyone involved with the project became more strongly committed to an incredibly aggressive target. They were going to pull off a whole series of firsts: the first full-size LCD screen; the first commercial application of dual 3 1/2-inch floppies; one of the most highly automated mass manufacturing facilities in the computer industry; all-CMOS logic; and a battery as the primary power source, not just as back-up power. All these innovations were to go into a single product. Miller thought of it as betting a five-horse parlay with a 6,000-mile backstretch.

Work on the portable was split between Japan and the U.S. Nippon•Data General did all the electronic design, while the mechanical design and packaging was handled in the U.S. The project was in high gear by mid-1983, with a completion date set at October 1984. Miller constantly checked the progress. He was amazed at the pace being set. Because the project was spread halfway across the globe, and because en-

Touring Europe

Fiscal 1984 was the best year of the decade for Data General. Revenues exploded by 40 percent.

It seemed to be an appropriate time to list the stock on the London Stock Exchange. Trading on Europe's largest stock exchange would help deal with the "Data Who?" problem in European markets. It would provide easier access to European financial markets. And it would help European employees buy and sell their Data General stock more quickly and efficiently.

Credit Suisse First Boston, Data General's investment banker and one of the most influential firms in Europe, got a chance to show off its stature to a growing young high-tech firm. Data General was just the kind of client CSFB wanted more of. The grand tour of the European financial markets was arranged, followed by the big ceremony at the medieval Painters Hall in Little Trinity Lane in the City of London's financial district. The entourage included de Castro, Ken Jaeggi (Chief Financial Officer at the time), Ray Fortune (head of European sales), George McClelland (Treasurer) and Brad Stroup (Public Affairs). CSFB scored some kind of coup by arranging a private dinner for the group with Jacob Rothschild, head of Charterhouse Ltd., David Benson, head of Kleinwort, Benson Ltd., and Christopher Reeve, head of Morgan Grenfell Ltd., three of the most prominent investment houses in London.

The group toured Edinburgh, Zurich, Geneva and Paris. In the middle of the night in Zurich, de Castro received a phone call from Dick Brown (head of public relations in Westboro) telling him that a higher court had reversed a judge's decision in favor of Data

General in an anti-trust suit brought seven years earlier by Fairchild Instruments and several smaller firms. De Castro was faced with public speeches to investors the next day and the formal London Exchange listing ceremony that week. Should he mention the jury decision? After more trans-Atlantic phone calls to lawyers, the group concluded that the event was not material, that it was not likely to influence an investor one way or another, and it should be ignored. It turned out to be the right decision. Even though a short article ran in the Wall Street Journal the next day, nothing unusual happened to Data General stock.

At Painters Hall, de Castro stated the Data General problem of 1984 succinctly: "In the past 12 months, we have exchanged a demand problem for a supply problem." Jaeggi reported to the London investors that revenues for the March quarter were up 33 percent over the year earlier quarter. The stock had begun to fly. Entering 1984, its low was $34. By June its high was $50. They had a tiger by the tail.

gineers in Japan and in Massachusetts put in ten to 12-hour days, development work was happening around the clock.

Coordination was tight, but effective. Data General was learning how to manufacture a low-cost, high quality product in volume, a skill it would need to compete with other Japanese firms and with experienced volume producers such as AT&T. The DATA GENERAL/One project taught them how to execute at all levels of the market, and it dramatically increased Data General's customer constituency, putting the company on the map with a whole new class of end-user customers.

The NDG connection helped Data General gain critical experience in CMOS gate array technology. Gate array technology made it possible to develop the DATA GENERAL/One and bring it into full production in less than two years. A gate array is a type of integrated circuit that contains a large number of undifferentiated gates – thousands of tiny on-off switches that have not been set one way or the other. In order to build a gate array to do a specific job, a final layer is overlayed on the undifferentiated, uncommitted gates – a final layer which commits the underlying gates to do a specific task.

The initial cost of developing, manufacturing, and testing these devices is low, because the base product never changes and costs are amortized over a long production life. The only downside of gate array technology is a penalty in size. Because the circuit is a general-purpose one, it may take more gates to accomplish a given function than it would if the designer could custom design special circuits for that job. But at the scale of micro-circuitry, even a 50 percent or 100 percent penalty in real estate may amount to only a few square inches for an entire product. The benefits earned were enormous. A new product can be brought to market in a fraction of the time required if it were implemented entirely in custom logic. And in today's computer industry, with product life cycles getting shorter, time to market can be the difference between success and failure.

Less than two years after Tom West built his first mock-up of "the book," the DATA GENERAL/One was introduced on September 20, 1984. It was fully IBM PC-compatible, weighed less than ten pounds, had a full size LCD display, battery power, and dual 3 1/2-inch floppy disks.

Bob Miller's five-horse parlay had come in.

Internationalizing Continues in the '80s

Despite the worldwide economic slowdown in the early 1980s and the rising strength of the U.S. dollar in the first half of the decade, Data General continued to grow its international business. Compound annual growth averaged about 12 percent, and from 1981 through 1985, international revenues ranged between 32 and 35 percent of total revenues.

Two officer appointments made in 1984 reflected the increasingly international character of Data General's business. Hisashi Tomino, president of Nippon-Data General, was named a vice president of the corporation, and Colin Crook, formerly managing director of British Telecom Enterprises, joined Data General as vice president, International Development.

International business no longer simply meant Europe. In China, an original equipment manufacturer (OEM) sales agreement, valued in the millions, was concluded in 1983.

One of the most important events in international business took place in 1984. In a hotel function room in Toronto, Herb Richman handed a Canadian flag to the new manager (an Australian, by the way) of an integrated Canadian operation. The audience of Data General employees from across Canada broke into applause.

The gesture was a symbol of a change in strategy toward Canada. From 1978, when the Canadian subsidiary, Datagen of Canada, Ltd., was dissolved, through 1983, Canada was treated as a branch office in the North American sales or-

ganization. All that changed in 1984. All the top managers in Canada reported to a single Canadian manager. Now there was a Canadian strategy, supported by Canadian prices, Canadian policies, salaries, etc. Most important, Canadian success was measured by Canadian profits and losses.

The change in structure yielded almost overnight acceleration in Canadian business. Fifteen years after Data General took its first steps outside the U.S., Canada was finally on its way to becoming one of the company's largest markets.

New Direction for Manufacturing

The introduction of the ECLIPSE MV/Family of systems in 1980 gave Data General a major presence in the 32-bit, high-performance computer market. It helped the company make the transition from a niche supplier in a few markets, to becoming a broad line computer systems supplier in many markets. With the changing strategy, de Castro directed a major restructuring of the company, decentralizing operations and delegating more responsibility to lower levels of management.

Three major functional areas – hardware engineering, software development and product marketing – were reorganized into three integrated business divisions – the Technical Products Division, the Information Systems Division and the Small Business Systems Division.

In 1981 Frank Silkman came to Data General as senior vice president overseeing the three newly-formed business divisions. Silkman had 24 years' experience at IBM. He came to Data General because he saw opportunities to do things quickly that would have taken years to accomplish at IBM. But to do what he wanted, he needed help. One of the chief areas in which he felt he needed support was in manufacturing. He needed someone in authority in manufacturing with whom he could work closely, who could give him the support he would need to meet his goals in the marketplace. He felt he needed someone with IBM experience, and the person he

wanted was Dave Chapman. Chapman had worked for IBM for 22 years.

But in 1981, Dave Chapman was ambivalent about IBM. Unlike many of the IBM people who came to Data General, Chapman was not frustrated by "the system" at IBM: he knew how it worked and he used it to get things done. But he did have doubts about his future. He did not see very many people from manufacturing in the top jobs at IBM. And, there were things he wanted to accomplish that he felt were not possible at IBM. Specifically, he wanted to compete head-to-head with Japanese in manufacturing quality and economy.

Early in 1981, Silkman contacted Chapman to present a fascinating situation. "Here is a place where you can really *do* things," he told Chapman. And Silkman needed someone in manufacturing who could support him as he led Data General into new areas. This was an opportunity to have an impact: Data General was full of bright people, yet they were often pulling in different directions, and the company's manufacturing facilities were antiquated. In short, it was a place that could create heros.

Silkman's pitch succeeded. In the summer of 1981 Chapman came to Data General as vice president, U.S. Manufacturing operations. In less than a year he was vice president for all manufacturing operations.

Chapman became the driving force behind a massive investment in upgrading manufacturing capability in the early 1980's - an investment that was made in the face of slowing revenues and profits. The first area he concentrated on was quality. His goals were twofold: to make the quality control (QC) operation more efficient by actually eliminating many test procedures, and, at the same time, to increase quality by concentrating, not on testing for quality or even manufacturing for quality, but on *designing* for quality. Chapman tightened relationships with Data General product engineers to make sure that quality problems were designed-out of the product. He also tightened relationships with vendors and

The Maiden Voyage To Disney World

Just before dawn on Saturday, June 13, 1981, 100 people boarded a 727 airplane at Logan International Airport. Three hours later, they landed in Orlando in the sultry heat of Florida. In just ten short hours the group took it all in – Mickey, Minnie, Goofey and Space Mountain. By Sunday morning they were back in Boston. Aside from having a great, but hectic, time what did all these people have in common? They were the first group of Data General employees honored in Florida for 10 years of company service.

From that year on, the 10-Year Service Award trip has become an annual affair. Employees who have been with Data General for a decade are treated to a weekend of celebration at the Magic Kingdom, now usually in May and almost always with Ed de Castro leading the way.

That first trip to Disney World was more a family of friends on vacation than co-workers on a company trip. It took a couple of weeks to plan and Mike Murphy (Employee Communications) acted as manager and escort. These employees had been together since the early days of the company when they all raced around to get NOVAs out on schedule, working weekends or around the clock on the next revision of RDOS, for instance. Together, they had sold, built and serviced hundreds of the original NOVAs and SUPERNOVAs. A few of them had worked in the beauty-parlor in Hudson before moving to Southboro. They all knew that Data General NOVAs were driving many of the Disney World animated figures in the automated shows. They joked about volunteering to fix any of the Data General systems if they happened to crash. None did.

After a sizzling day touring the Magic Kingdom, the group was treated to a steak barbecue at Lake Buena Vista in the park. There were no formal speeches, but de Castro managed to chat with each employee during the evening. Soon it was time to catch a late Saturday night charter flight back to Boston.

That year, 1981, marked the beginning of a Data General tradition which has since seen thousands of employees and guests travel to Disney World to celebrate a decade of company service with the company. In 1988, more than 900 employees, 2,000 guests in all, were part of the annual extravaganza. The crowd was so large that the trip was split across two separate weekends in 1988. Months of advance planning and hundreds of staff hours are now devoted to making this trip a success. Hotel reservations are made two years in advance.

Now, instead of flying back to Boston after the Saturday evening dinner and festivities, guests can get a good night's sleep and fill another whole day or more in the Magic Kingdom. Few, however, will forget that maiden voyage.

steadily shifted the burden of quality to them. The new test strategy eliminated most incoming tests and moved testing higher up in the process. At the same time, new procedures allowed production workers to verify quality at each step of the process.

A new quality philosophy was born. Lowest cost was no longer the sole deciding factor; quality became the guide. The company simply would not survive without quality, and, if the system were properly set up, it would cost no more to build a perfect, defect-free computer or sub-assembly than it would to build a shoddy one. Less, in fact, if unnecessary testing was eliminated.

There were new people strategies, too. Training was dramatically increased to 80 hours per year for every manager or supervisor. At the same time, new verification procedures gave each production worker constant feedback whether the job he had just done was correct. In effect, each operator became his or her own QC inspector.

Under Chapman's leadership, redistributing manufacturing capabilities geographically was also pursued. U.S. suppliers were dropped in lieu of suppliers in the Far East who delivered higher quality materials. Increased Far East manufacturing reflected Chapman's conviction that the Far East would become one of the company's largest, and fastest growing, markets and that it would pay off to be able to build products in this backyard. Similarly, distribution facilities in Europe were expanded.

A key concept within the idea to more widely distribute manufacturing capabilities was the "micro factory." Chapman pushed Data General away from large centralized manufacturing toward smaller, highly automated, and very flexible plants. By making the "footprint" of such micro factories as small as possible expanding capacity could be achieved, not by expanding a plant, but by adding another. The overhead costs of the second micro factory would be almost zero, since it would simply be a duplicate of the first.

And these micro factories would be just as easy to move, retool for new products, or shut down. They would also make it a lot easier for individuals to innovate in the interest of greater productivity and quality.

Over the years, implementing Chapman's philosophies resulted in dramatic improvements in manufacturing quality and productivity. In 1984, a boom year for sales, manufacturing output increased by enough to support the company's 48 percent increase in equipment sales, and Chapman could have shipped more if he had the capacity. Quality, as measured by every available statistical yardstick, continued to improve. But capacity, and the planning for it, had become a non-trivial problem in the face of accelerating market demand.

The Capacity Problem

The "Cornfield" factory automation project was half completed, turning Apex, North Carolina and Portsmouth, New Hampshire into high-tech facilities for final assembly and test of the latest MV-class systems. MV/10000s could be built, tested and shipped in less than a month from receipt of order, with the critical final manufacturing steps being completed in about one week. "Just-in-time" inventory procedures were beginning to reduce inventories, which were quite high at the time. "Cornfield" was increasing plant capacity in big increments with no increase in square footage. To keep up with demand, hundreds of temporary workers were hired during 1984 in addition to permanent manufacturing employees.

Despite "Cornfield," new capacity was still desperately needed, but bringing it into operation presented new problems. In the 1970s during Data General's first major facility expansion (Westbrook, Maine; Portsmouth, New Hampshire; Apex and Clayton, North Carolina; and Austin, Texas), a new industrial facility could be brought on line in a year. The Westbrook plant, for example, went into operation in less than 12 months in 1975.

Not so in the 1980s. The process of site search, selection, negotiation, local politics and approvals for industrial facilities had become a long and complicated task. It could take three years for Data General to bring the kind of facilities on line that it needed to take advantage of the market demand they were experiencing in 1984. That was about as long as it took to develop a new generation of MV computers – or for a boom market to turn sour.

The 90-Day Wonder

One of the reasons for Data General's soaring sales during 1984 was the decision to preserve short lead-times to ship product even if it sacrificed manufacturing costs. Despite huge buildups in backlogs during each quarter, shipments blew out of the plants in huge volumes, and lead-times quoted to customers remained in the 90-day range. By contrast, Digital Equipment Corporation, whose revenues increased by 29 percent in the same year, permitted lead-times to stretch out to six months.

De Castro knew the market-share lesson by heart: Big guys gain market share in weak markets, since nervous customers tend to fail-safe. Little guys gain market share in good times since they can respond quicker. And 1984 was as good times as it was likely to get.

Richman had also learned from the ups and downs of the 1970s that you lost business when lead-times stretched out. The company had been caught with too little capacity, allowed lead-times to slip out to the six-month range, and paid a price. With an aggressive manufacturing management team in place in 1984 plus a sales force reved-up on office automation, everyone wanted to avoid the earlier mistakes. So everything went "gung-ho."

Flying High and Blind

De Castro would also admit, when pressed by financial analysts, that the computer market was supporting more sup-

pliers than it could afford in the long term. The shake-out of weaker competitors was bound to continue. He believed that by the end of the century, only six or eight worldwide computer suppliers would remain. They would be large, general-purpose, and highly competitive. De Castro expected that the de facto standard for application writers found in large installed bases of computers would ultimately overwhelm the second tier suppliers. While he believed that Data General would be one of them, he admitted that the company had only a limited time to amass the customer base and business volumes to achieve that goal. Every opportunity to gain market share had to be seized. The only way to make it, de Castro believed, was to take greater risks than the big guys for the chance of bigger rewards – deja vu 1968, n'est pas?

In a meeting in June, de Castro warned investors that "since we have kept lead-times short, we have little visibility into longer-term demand patterns." It was a trade-off understood by senior people in Data General but not, as it turned out, understood by investors. Long lead-times gave you visibility into the future, but lost you business. Short lead-times gave you market share, but no feel for what future demand might be. If you wanted to fly high, you had to fly blind. Pilot de Castro decided to fly high.

In an effort to keep pace with a market expected at the time to grow in the 25-30 percent range annually, new facilities were commissioned during 1983-84 to come on line in 1985-87. The search for a new engineering and manufacturing plant in New Hampshire began in the spring of 1983. When the new facility – at 300,000 square feet, the largest manufacturing facility built during the decade – was completed in Durham, New Hampshire, some 42 months later, it had nothing to do. The world had changed.

In Singapore, negotiations were underway to build a 180,000 square foot facility for printed circuit board fabrication, central processor assembly and test. It was part of Chapman's "sister plant" philosophy from his IBM days. It was also the redundancy idea borrowed from computer designers. Sin-

gapore would be a "sister (i.e., identical mate) to Apex. The two of them would be the most automated facilities in the plant system. If one went out of operation, the other would keep going. The idea of competition was also built into being "sisters," added motivation for employees and site managers alike.

Chapman hoped to boost sales by locating a systems integration and repair facility in Mexico in exchange for access to Mexican markets. A small facility was eventually located in Chihuahua and sales offices were placed in Mexico City and Monterray.

Frank Silkman, head of Manufacturing and Field Engineering,planned to diversify product repair work in the U.S. An eastern U.S. facility was located in Field Engineering's headquarters in Milford, Massachusetts. A huge new 320,000 square foot facility in Fountain, Colorado, just outside Colorado Springs, was planned to serve the western U. S.

In addition, the Westboro headquarters complex was overflowing and could not be expanded. After much pushing and shoving among departments, the Technical Products Division under Don McDougall was moved to offices in Denver, Colorado. The rationale was that it would be closer to its customers in the heart of "CAD/CAM U.S.A." Several functions in finance were also moved to a new 100,000 square foot building in Hooksett, New Hampshire.

Thanks a Billion!

On September 29, 1984, Data General closed the books on its 16th full year of operations. At that point the company had 17,695 employees working at more than 300 locations in 60 countries. After four years of sluggish growth in sales and earnings, 1984 showed a dramatic surge. Earnings leaped from $.96 per share in 1983 to $3.21 per share, including extraordinary gains and deferred taxes. Operating margin, which the company had kept at over 20 percent for much of its first decade and had slipped to a low of 4.4 percent in

1983, rebounded dramatically to 8.8 percent for fiscal 1984 and moved past 10 percent in the last quarter of the year. The company emerged from a painful transition period of 1979 through 1983 as the leader in the fast growing 32-bit market with its ECLIPSE MV/family products, and was now a major force in office, personal and industrial automation. On top of that, the tools, people, and organizations were in place to keep growing.

There was one other notable event in 1984's final accounting. In 1984 Data General revenues totalled $1.16 billion. The billion dollar revenue mark is one which only a small percentage of American industrial companies ever reach – there were 295 such companies in 1984, according to Fortune magazine. Data General had done it faster than all but a handful.

To celebrate, Data General threw itself a party. Eleven thousand employees from throughout New England filled the Centrum performance arena in Worcester, Massachusetts. Along with the food and drink, there were proclamations, speeches, and entertainer Neil Sedaka who sang "Happy Birthday, Sweet Sixteen." Employees and families from Portsmouth, New Hampshire to Westbrook, Maine and all across New England toasted their success that night.

Ed de Castro made a short, proud speech. He said everyone had done a good job and they all ought to be proud. But, he also talked about survival. It was a theme he would stress again even as the whole world caught on to the fact that Data General was "rolling again." Some people thought it was a negative approach. But others saw it as totally consistent with de Castro's and Data General's style for the company's first 16 years.

Over the next few years the computer business became a battle among giants like IBM, AT&T, and Japan, Inc., as de Castro had predicted. In that environment, there could be heavy casualties, even among seemingly secure companies. Survival would not just be a matter of hanging on. It would

take imagination, courage as well as sound product and corporate plans to survive. It would take what Data General had been good at in the past: identifying the gut issue and attacking it head on.

The Long March (1985-to Present)

In 1985, the plane hit the mountain. Unexpectedly orders and shipments began to slow down. In February 1985, the company alerted investors and the public with an announcement of the slowdown. The stock dropped from a $76 high in February to the low $30s by June.

At first, the disappointing revenues were viewed as a temporary market adjustment. De Castro beieved the company had over-reacted to the 1984 boom, adding too many salespeople and too much manufacturing and overhead costs, in response to a 40 percent revenue explosion. These costs could be trimmed back while proceeding with longer term expansions in product development and manufacturing capacity. Chapman warned that it would take 15 percent annual shipment growth just to keep manufacturing operations fully occupied, due to the increasing levels of automation he was installing.

But as the months went by, it became clear that something fundamental was happening to demand. Business Week published a Harris survey in June 1985, on "Why Computer Buyers Aren't Buying." Forty percent of them said they had cut back capital spending due to concern over the economic cycle; 37 percent were waiting for new models to come on the market; 31 percent said they could not digest the equipment they already had; 19 percent said they were waiting for "networking," that's what they really wanted; 17 percent were worried that their suppliers would not stay in business; and 15 percent said that adequate software was not available.

Another reason for Data General's 1984 boom was CEO and the sales force. CEO had become the integrated office automation system of choice, principally because no competitors had anything like it. And the sales force, following its shift to the end-user market during 1983, had hit its stride. The combination of a unique product everyone wanted with a qualified hard-driving sales force was hard to beat.

But DEC and Wang and IBM were not far behind. DEC's "All-In-One," containing almost identical features to CEO, was beginning to attract attention. Wang Office was upgraded, although it never made it into the CEO league. IBM offered PROFS – not a very competitive counter, but it was enough to cool the interest of much of their installed base. IBM had suffered from several years of weak mid-range product offerings (System/3X). It began whispering about a major new family of mid-range systems (9370 Series) in 1985 that would turn the tables on everyone when it was announced.

Going From Bad To Worse

While revenues for Data General's December 1984 quarter showed improvement (up five percent over September), March quarter revenues were down by $13 million, the first sequential decline ever. And as the months went by, orders deteriorated further.

The industry was being hit across the board, starting first with the peripherals and component suppliers, test equipment vendors, then working its way up stream. Storage Technology laid off 1,000 in January. GenRad dropped 12 percent of its work force; Teradyne dropped 10 percent. Intel laid off 900 in February. Apple called a one week furlough in March. Mostek dropped 2,000 in May. The DEC employees "in the boat" (i.e., with nothing to do) grew into the thousands.

With characteristic directness, Data General took action in early June to cut costs and adjust operations to the business available. Approximately 1,300 jobs were cut across the board, including sales. It was the first company-wide layoff in Data General's history. Plants were closed for an additional five days following the July 4th (Independence Day) holiday. Chapman's forecast of 15 percent growth to keep the engine running was coming true.

When reported in July, the June quarter was a disaster: revenues were down $35 million (11 percent) from March,

and down $19 million (6 percent) from the year earlier. Two other records were broken: the first down revenue quarter (vs. prior year) and the first net loss ever ($8.3 million or $.32 share). Even though a restructuring charge of $14.5 million was the principal culprit, the losses in both jobs and earnings were a double blow to morale. Furthermore, de Castro warned of future possible plant closedowns if the demand weakness continued, and said, "the erratic character of demand makes it difficult to predict either revenues or profitability beyond the next few months." The June 1985 action was to be the first of annual cutbacks announced every summer for the next four years.

At the same time in what appeared to be a conflicting signal, new facilities were completed in Fountain, Colorado (field repair center), Hooksett, New Hampshire (finance) and Singapore (manufacturing). The company was caught between short-term need to cut costs due to a business slowdown that might be temporary, and need for added space to house people overflowing the Westboro headquarters plus longer term manufacturing expansion and field engineering diversification. By 1988, the three facilities built in 1985 were either closed or in the process of closing and were up for sale, along with others in Austin, Texas (peripherals development and assembly) and Manhattan Beach, California (customer support).

Technology Overtakes Sunnyvale, Austin and Hong Kong

It was not only the company's newer facilities and operations that were being affected by the changing industry. Built in 1973, the Sunnyvale semiconductor facility was Data General's first foray into vertical integration. At the time, Burkhardt and de Castro wanted to get a handle on semiconductor technology since they saw it as central to the future of computers. They believed it was important to "own the technology," regardless of whether they ever actually produced semiconductors in any volume. Sunnyvale's role in the company had been controversial since the outset.

Sunnyvale developed the microNOVA chip and later the microECLIPSE chip, both of which formed the basis for computer systems that never swept the market. It developed proprietary chips for later systems, including the MV/7800 and the MV/40000.

In 1983, $30 million was invested in expanding the facility and bringing it up to current fabrication standards for large-scale integration (LSI) of semiconductors. And it continued to absorb capital expenditure dollars as well as operating losses over the years. Some of the Westboro systems development people believed it never returned its investment, and that they could name a number of better uses for the millions of dollars put into Sunnyvale. It became known in the basement halls of Westboro building 14B as "de Castro's folly."

By the end of 1985, it became clear Sunnyvale had to go. The Sunnyvale team had made important engineering contributions, although Westboro managers fussed that Sunnyvale projects were always late and over budget. But its manufacturing capabilities were never able to achieve levels competitive with the merchant semiconductor houses. Between April 1986 and the end of 1988, manufacturing at Sunnyvale was phased out and the people associated with it laid off. The Sunnyvale facility, now 112,000 square feet in size, was put up for sale and the development team scheduled to move to other quarters.

Technology overtook Sunnyvale at about the same time it overtook Data General's mass storage efforts. The advantages of economies of scale eventually rendered non-competitive most computer systems manufacturers' design and fabrication of semiconductors, printers and disc storage. Stable and technically advanced independent vendors, non-existent a decade ago when Data General developed its inhouse resources, became the main source for these products. High-performance products from reliable sources were available at prices lower than Data General's costs. In the spring of 1986, facilities in

Austin and Hong Kong, both working on printers and other peripherals, were closed and employees laid off.

Nobody in 1985 foresaw the size and permanence of the slowdown in the U.S. Later the U. S. Commerce Department would show the extent of the damage. Office and Computing Machine (OCM) orders roared up 22 percent in 1984 on top of a 17 percent increase the year before. In 1985 they increased a scant 2 percent, then collapsed, dropping 7 percent in 1986.

What Went Wrong?

It was a tough pill to swallow, but success had blinded the company, and the gamble of 1984 had not paid off.

In the early 1980s, Data General had structured itself around three areas of automation: industrial , business and personal. The Technical Products Division under old-timer Don McDougall went after industrial automation markets, mostly OEMs and ISVs in CAD/CAM fields. The Information Systems Division under IBMer Dave Lyons went after business/commercial automation, mostly CEO in the office. And the Desktop Division under Herb Shanzer went after the personal computer market with the DATA GENERAL/One and the DESKTOP GENERATION family of products. A Federal Sales Division was also set up under Larry Holswade, an experienced government procurement sales manager. Each of these divisions had profit and loss (P&L) responsibilities and reported to Bob Miller. It was a management structure built for a $4 billion computer company, not a $1 billion company. It was similar to the manufacturing capacity, which was estimated at about $4 billion, built up during the same time.

The business divisions were designed to balance the company's resources and opportunities. If business was stronger in one area, resources could be drawn off from other areas, but a decision would have to be made to do that. But it did not work out that way.

The roaring train of the CEO office automation business overwhelmed the sales force and the balance of the business divisions. In building the Fortune 500 end-user business centered around CEO, the OEM and VAR business, on which the company's first success was founded, had been neglected. The sales force, highly commissioned by big CEO wins, dreaming of other E. F. Huttons and U.S. Forest Services, had swung away from the more technical OEM market. Important OEM customers were lost along with the sales people who knew that business.

Selling "Tops Down"

During the Bob Miller years, management and sales people had focused on making the "big score." National TV advertising was purchased for the first time, after Wang's John Cunningham used that medium successfully. Data General's dramatic TV spots featuring medieval catapults, 18th century cannons and World War I tanks became controversial hits overnight.

The idea was to command attention at the highest executive levels of Fortune 500 companies. "Tops-down" selling in the IBM fashion became the technique to win the large account. This often turned the sales people into arrangers, organizers and intelligence agents arranging for the big selling meeting between Data General's senior officers and the customer's senior people.

During 1985 and 1986 Data General went after three of the biggest minicomputer contracts of the decade: United Airlines, Ford Motor Company and Mobil Oil – each reputed to be worth hundreds of millions of dollars. After months of benchmark tests, hundreds of pieces of documentation, dozens of meetings and presentations, and millions of dollars invested, Data General won all three on technical performance grounds, but lost all three to IBM and its unannounced 9370 Series in the corporate boardrooms. Corporate "viability" and the "comfort level" associated with IBM won out over performance and merit in a nervous U.S.

The Law Suit That Wouldn't Go Away

The NOVA 1200 was introduced in 1973 and quickly turned out to be a winner. It was not only fast and reliable for its time, but elegant and simple in design. It was also easy to copy.

Since none of the NOVA architecture or basic designs were protected by patents, they were potentially attractive to "knockoff" competitors as the customer base increased. Once it reached an attractive size, several NOVA "look-alikes" appeared in the market. To customers they were attractive since they were priced on costs that did not include development expenses. The Data General customer could lift the Data General RTOS or RDOS from the NOVA 1200 and run it on the "knockoff" priced at 60 percent of the Data General price. The only problem was that this action broke the software licensing agreement the customer had signed with Data General.

Several small competitors began making NOVA knockoffs in 1975 and 1976, including Digidyne, Inc., a start-up west coast vendor, who produced several hundred boxes. In 1976 Firchild Camera and Instrument asked Data General for a license to manufacture a NOVA-compatible computer. Data General denied the request. Fairchild then introduced the 9440, designed to use the NOVA operating system. Data General sued Fairchild, Digidyne and several other vendors for "misappropriation of trade secrets" in a Delaware court in 1977. Data General lawyers chose not to specify damages sought in the complaint, knowing that advance claims of damages by plaintiffs meant very little to the court. Although the media gave little notice to the suit at the time, the stage was being set for a legal fist-fight that would last 10 years

and cost millions of dollars and workhours that nobody could afford.

A few months later Fairchild and the others turned defense into offense by countersuing Data General in a west coast court, charging antitrust violations based on tying the sale of NOVA hardware to the operating system. Much of what happened from this time on was determined by the accident of court scheduling. Partly because of the backlog of cases, the Delaware Court agreed to let the San Francisco court take up the Fairchild countersuit first. Some of what happened may have been cultural geography. The issues and arguments pitted East Coast tradition against West Coast funkiness. Parts of the case seemed to swing around the effectiveness of New York trial lawyers with San Francisco judges. As it turned out, Data General was never able to get back to its original East Coast complaint.

Fairchild lawyers decided to make headlines by specifying damages of $100 million, which would be tripled under antitrust findings. That got the attention of everybody, especially the media, who had missed the original suit. It also set the stage for the way the legal battle was to be played out in the media.

Data General (and its outside counsel Reavis and McGrath) decided from the beginning against public commentary on the legal proceedings. Fairchild's attorneys decided to do just the opposite. The risks that whatever was said in public could be used in court were risks that Fairchild was willing to run and Data General was not. But since it would be years before either suit got to court, Data General quickly lost the media battle, and appeared in public as the big predatory corporation monopolizing the market from a few little guys. What made no sense to anybody was that the market Data General was accused of restraining was its own – the NOVA market. It was as if Data General was playing by Queensbury Rules and the other guys made up their own.

After hundreds of depositions and interrogatories of most Data General officers (de Castro's interrogatory took 18 days) and many other employees, the Fairchild countersuit came to trial in San Francisco in 1981. It took eight weeks of highly technical testimony about "relevant markets" and software "tie-ins" with dozens of "expert" witnesses paraded before a jury drawn at random from San Francisco.

During the final preparation months, Data General's 35-member legal team occupied an entire floor of a hotel in San Francisco for almost six months. Don McDougall, who at the time was head of the company's Far East sales operations, was assigned to the Fairchild project full-time and took up residence in San Francisco with the legal team. McDougall, originally from Alberta, Canada, was an obvious choice for the job; in a career with Data General that started in 1969, he had been in marketing, planning or sales in every part of the world, from Canada to Europe, China, Japan and South America. He was especially close to customers and understood the technology involved.

The trial and the preparations for it cost the company more than $20 million in 1981 alone. The issue at stake seemed like a bad joke to many Data General employees – did Data General, with a 3 percent share of the computer market, have sufficient economic power to appreciably restrain competition?

The jury in San Francisco found Data General guilty. The judge then overturned their verdict and found in favor of Data General, saying in essence that the jury did not understand the case. Fairchild then appealed. More lawyers; more waiting. Finally in 1986, a panel of three San Francisco appellate judges overturned the lower court judge's ruling overturning the jury verdict, reinstated the jury verdict finding Data General guilty, and ordered a trial for damages to be scheduled. All of this was despite an amicus curiae brief filed on Data General's behalf by the U.S. Department of Justice. They also issued an injunction prohibiting Data General from restricting the use of its NOVA-compatible operating system to NOVAs.

By this time, of course, there was practically no market left for NOVAs. After more wrangling, Data General settled in August 1986 with Fairchild, who ironically had shipped only a handful of 9440s, for $52 million in damages. A year later, the company settled with Digidyne for $26 million. The damages, most analysts estimated, just about covered the plaintiff's legal fees. The original Data General suit was settled as part of the other settlements.

The alternative to the settlements would have been to complete the damage trial, with the risk of facing heavier damage findings, go for the Supreme Court hearing, with the risk that they would refuse to hear it, or hear it and find against the company, although most legal experts believed it unlikely. The costs of this course of action could have exceeded the costs of the settlements that were made and would have taken more years away from the real business of making and selling computers. Customers were nervous enough over Data General's viability in the face of the $300 million damage headlines as it was. Everyone associated with the case was convinced of the rightness of the Data General position, but they asked how much can one firm pay to be right.

Over the 10 years of litigation, the whole thing cost Data General more than $100 million. The price paid by the company's senior people in time, attention and energy especially during the critical 1980-81 period was probably even greater.

economic environment where corporate MIS managers wanted to "play it safe."

During the 1980s Data General missed two emerging markets that later proved almost fatal: personal computers and technical workstations. The DATA GENERAL/One, designed and manufactured by NDG in Japan, was the first portable laptop computer on the market. While it was technically ahead of its time and created wide notice in the industry, its screen was hard to read, and discouraged the pioneering customers who might have been interested. It also proved to be too little, too late in the PC market where shelf space in the retail outlets was already full. Distribution channel presence mattered more than product innovation.

Data General's neglect of the OEM and VAR market led to ignoring the need for economical technical workstations running an industry-standard operating system called UNIX. The company's first workstation, the DS/4200, came to market in the summer of 1984. But it gained little acceptance because of its relatively high price and lack of available applications software. Another engineering workstation, the DS/7500, was hurried to market in 1985, but it was late and underpowered, and did not stand a chance against the microprocessor-based hot boxes from Sun and Apollo using UNIX. Bob Miller held discussions with Sun about joint development or marketing deals but nothing came of it. What should have been a natural market for Data General was lost to Sun and CEO's success.

New Directions – Old Directions

Fundamental new directions were clearly called for starting in 1985. The "open systems" world of standards-based computers was taking off and Data General was still mired in a proprietary world of minicomputers it could not abandon. During the next few years of continuing cost cutting, layoffs and plant closings, new initiatives were needed to turn the business around. The dilemma of the computer industry has always been that customers want to do business only with suc-

cessful, "viable" vendors. As Richman said wearily, "You have to sell the customer twice: Once on the product; then again on the company."

Building Standard Communications and Operating Systems

Miller had been pushing development of an "open systems architecture" for some time. One of the great invisible resources was Data General's communications products. They allowed Data General computers to function and communicate with almost anything. The company had the most extensive array of IBM communications products in the industry. They made it possible for the MV family of computers to communicate with anything IBM built. Joe Forgione in communications products marketing, often pointed out to unbelieving customers, "Data General can communicate with IBM better than IBM can." A long list of communications capabilities went virtually unnoticed: IBM's SNA (1981), Ethernet, IEEE 802.3, TCP/IP, LU 6.2, X.25 and X.400 compliance, NFS, interfaces and document exchanges to communicate with IBM's PROFS and DISOSS. Through DG/PC*I, a set of specially developed personal computer integration hardware and software products, Data General could network IBM and IBM-compatible personal computers. At the applications level, Data General offered document exchanges with Wang word processors, IBM PCs, MCI Mail, Telex, Teletex and optical character readers.

As new international and de facto standards emerged, Data General's communications architecture recognized them: the Open Systems Interconnect (OSI) model, the Integrated Services Digital Network (ISDN), IBM's Systems Application Architecture (SAA) as well as TCP/IP for the UNIX environment.

Along with adopting communications standards, the company also began to recognize the emergence of the UNIX operating system standard. The software developers in Research Triangle Park, North Carolina, had been at work on versions of UNIX since 1983. The first DG/UX version, combining AT&T System V and Berkeley 4.2, came out two years

later. Jim Hebert, head of the development effort at RTP, called it a lucky break. "We didn't know which horse the industry would ultimately ride back in 1983, so we rode them both." When the AT&T version won out by 1987, Hebert's team was well on its way to completing the most comprehensive robust version of UNIX on the market at least two years ahead of anyone.

The whole idea was to give customers integrated computing solutions regardless of whose computer they were using. It was a major and expensive effort to bridge the proprietary computers that were choking customers and blocking them from buying Data General. The communications development work spanned over 10 years and millions of dollars in expenditures. Although it helped sell MVs to business customers accustomed to IBM environments, it was also laying the groundwork for future industry standard systems.

NTT and the Buildup in Networking

An Englishman named Colin Crook was attracted by Data General's approach to communications and the potential to link computing and communications. Crook's credentials were impeccable – a managing director of British Telecom Enterprises, design leader for the Motorola 68000. If anyone could put the two worlds together, Crook might be able to. He joined the company in 1984. Increased investments in data communications and information networking began in earnest the following year. The payoff came from the strangest place.

Nippon Telegraph and Telephone Company (NTT) had been a customer of Nippon-Data General for years. NDG sold them NOVAs and ECLIPSES for engineering and design work. Hisashi "Tommy" Tomino had been cultivating senior level people in the development functions of NTT's huge bureaucracy. In 1986 he stumbled across NTT people trying to conceptualize the next generation of intelligent networking for their business customers.

NTT was facing both deregulation of telecommunications in Japan and the privatizing of NTT by the government. Within a few years, NTT would be faced with aggressive competitors in what had been their own private monopoly market. They also would be facing public ownership of the company, which would require responsiveness to a new constituency of public stockholders. NTT's new competition would come from the large electronics and computer systems companies – the NECs and Fujitsus – who could attack NTT's base of business customers with technologies NTT was void in. New networking services for their business customers that used computer and communications technologies was one way NTT could keep the wolf from the door.

NTT is like the old AT&T before the breakup and without Western Electric. It holds 90 percent of the market but is prohibited from manufacturing anything; it must procure everything from vendors. In 1987 NTT's procurement expenditures totalled over $8 billion. In the case of the new intelligent networking service, it did not want to rely on their traditional Japanese vendors, most of whom were computer companies likely to become their primary competitors under deregulation. The business situation led them to look to offshore vendors at a time when the U.S. Government was reaching a trade agreement with Japan to require greater purchases from the U.S.

NTT came shopping in the U.S. – not just for computers, but for a long-term relationship. They were searching for a vendor who understood their needs and was willing to work with them on intelligent networks for their private network customers in Japan. They held discussions with IBM, DEC and others, but did not find anyone interesting until they came upon Data General. Their meetings with IBM and DEC were with high level sales and marketing people who wanted to sell them standard computer systems. At Data General, they met Crook and senior level development people who were not pushing current hardware. Crook and his people were developing advanced communications networks and were interested in NTT's conceptual problem. The two groups hit it

off immediately. In addition to being flexible technically, Crook's approach to networking was similar to NTT's. "It was exciting to both sides to find people who had been thinking along parallel lines," Crook recalls. "When we met, it was like someone turned on the lights."

Data General had other attractions for NTT. They appreciated the local anchor of culture and language that Nippon•Data General represented. Data General was also not likely to threaten NTT in their home markets by offering similar products to NTT competitors. The problem of small size and "viability" that concerned other Data General customers during this period was lost on NTT. All in all, it looked like an ideal fit.

The joint development project was code-named "Asparagus" since the roots were planted deep and the first sprouts would be harvested in three years. At a press conference at the National Press Club in Washington, with U.S. and Japanese government officials looking on, de Castro held up a bunch of asparagus to the cameras and passed it to Dr. Takahiko Kamae, head of the development effort at NTT.

Dazzle Them Again with Performance

When the MV/10000 was introduced in New York in March 1983, the performance numbers blew the market away – 2800 single-precision/floating point K Whetstones; 2400 double-precision/floating point K Whetstones. Nobody else was near it. By using the MV/10000 as host for CEO, over 80 terminals could be driven with no deterioration. The demand for MV/10000s took off over the next 18 months, up as much as 60 percent at one point.

"OK, let's do it again," the argument went in 1985. The successors to the MV/10000 – code named the "Viking" – were based on far more advanced technology, the performance simulations looked great, and they would be ready by mid-year. Although the date slipped until November 1985, the public announcement was held again in New York to heighten the sense of a returning triumph. If anything, the

price/performance advance of the MV/20000 family of systems over most competitors, especially the VAX, was even greater than two years before. As Tom West described it at the event:

"A 5.5 MIPS single-board CPU, separate instruction and data caches, a four-stage pipeline, 85 nanosecond cycle times – 30 percent faster than the 10-board CPU in a VAX 8600, as fast as an IBM 4381-2 uniprocessor or a 4381-3 dual-processor, the high end of IBM's scientific product line.

"You can add a CP-board and build a 10-MIPS dyadic processor with space for two additional channels, 25 I/O controllers, two 500-megabyte disc spindles and up to six power regulators for a maximum of 2000 watts.

"The linchpin in the design is a 2800-gate ECL/TTL array, over twice the density of its VAX 8600 counterpart: a second generation, hybrid technology... This is the industry's first complete 32-bit system on one board.

"It's accurate to say that Data General doesn't out-invent its competition – we out-implement them. This practice is often misunderstood in the American industrial sector; but for us, it was learned in Japan in the 1970s, where most of Data General management watched it work."

They were brave words. The open architecture was there; the data communications protocols and languages were there; marketing and software focus in technical, commercial and federal sectors were there. Now there was the family of advanced systems to drive everything right into customers' sites and pocketbooks. During the months ahead, Data General had on the table the biggest advantage in computer power of any company in the world in its market sector.

But nothing happened. Six months later, MV orders were barely up at all. Fiscal 1986 equipment sales went down five percent. Only vigorous growth in service revenues drove total

revenue to a skimpy $6 million increase over 1985. Equipment sales were down another $18 million in 1987.

Who Wants Price/Performance?

The MV/20000s were to be the lever that opened every oyster – especially at the big three, United Airlines, Ford and Mobil. They were what the marketing structure had been rebuilt for under Dave Lyons from IBM and the sales force had been converted and trained to sell under Ray Fortune, long-time DG sales manager from the U.K. The debate over price/performance as a strategy had been brewing internally for some time. It came to a head: "Price/performance doesn't sell computers in the large end-user markets. They are looking for long-term cost of ownership advantages... They want solutions to their problems, not hot boxes... Too much is allocated to product development; not enough to industry marketing... We need to invest more in software, especially independent software vendors (ISVs) to write for AOS/VS... We have too many end-user sales people; not enough OEM/VAR sales people... We are understaffed generally in sales and systems engineering people; we are overstaffed in engineering and marketing... We must cut costs and improve profits to prove our viability to customers." There was enough truth in most of the assertions to go round for everybody.

DeCastro shook up the sales and marketing people by saying in a press interview at the time that "Data General will not concentrate on Fortune 500 customers in the future but on smaller organizations closer to our own size." He identified the losses of the big deals with the customer's lack of "comfort" in working with a small vendors like Data General. "We will focus on the customer in the $500 million to $2 billion range," de Castro commented. This included a lot of customers, but it also excluded a lot, many of whom were good Data General customers already. "Anyhow, why should we publicly write off any customer?" said one sales manager. Richman had always said that Data General was an equal-opportunity vendor.

But it became clear that Fortune 500 customers increasingly were not giving Data General a share of their business. They were reducing the number of firms on "the short list" of suppliers qualified to sell computers to them IBM was always on it; then usually Univac or Burroughs or Honeywell; more often Hewlett-Packard or DEC; then sometimes Wang; but for mid-range applications, it was increasingly DEC. And this was occurring despite a superior Data General product and a sales force now largely trained and experienced at large account end-user selling.

Part of the reason was their concern about the long-term viability of their computer vendor. Data General's slow growth and poor profitability did not help. The uncertain economy in the U.S. in 1986, culminating in the national tax debate of that year and slower rates of capital spending, turned corporate MIS managers into conservative "fail safe" decision-makers. During such a period, most large corporate customers would normally have decided on IBM when they had to buy computers. But IBM's offerings in the mid-range product area were unusually weak (System/3Xs, 4381s) and incompatible with the rest of their line. DEC on the other hand had strong product offerings in the areas where IBM was weak – the VAX 8600 (the long overdue Venus project) and the MicroVAX line. And they had sufficient size and sales coverage in 1985-1988 period to pass most viability tests. This explained why DEC with less competitive products was growing at 20-30 percent a year and Data General was not.

A management era at Data General was passing. With a future filled with contractions in manufacturing, Dave Chapman accepted a position as president of Cullinet Software. And Bob Miller, faced with a difficult technical and marketing transition unlike anything in his IBM background, left for California to head start-up MIPS Computers, Inc.

A couple of new approaches to customers emerged in 1987: selling bottoms up; and selling OEMs and VARs.

Selling "Bottoms Up"

If Data General with the best product line in the industry could not sell "tops down" into the corporate world, it would sell "bottoms up." It had been the company's strength anyway, the sales force argued.

In selling tops down, Data General was forced to play to its weakness. It had to reach the highest levels in a large company populated by senior executives with backgrounds in law, finance, and sales, but rarely in engineering. To base the selling argument on having the best product for the job, you presented a technical argument that they understood least. They delegated all that to somebody else. The customers' senior people were mostly interested in the business side of the computer purchasing decision – vendor viability, support, personal trust and rapport with the customer's people and organization. There was a cultural fit and feel that Data General was missing.

In selling bottoms up, Data General played to its natural strengths. Its salespeople met with the operators and managers of one of the customer's sites. The discussion centered around the product's capabilities and the customer's needs. Benchmark tests were run; checks of other customers were made; support and service capabilities were documented. The decision was a small one to the large customer; a large one to Data General. Once established at one site, Data General could move to other sites and applications, carrying a record of success with it inside the customer's organization. The word would spread. Over time, the corporate decision to go with Data General would have been made without the involvement of the senior corporate level of the organization.

Ironically, this approach appeared to be working in the three Big Deals that had been lost. The operating computer levels within United Airlines, Ford and Mobil, had been forced to accept an IBM decision in 1986 against their recommendation for Data General. The IBM systems were later thrown out of all three sites, where the technical people

Endurance of the Long-Distance Runner

Several times between 1985 and 1988, Ed deCastro held meetings with large groups of employees to discuss business conditions and shore-up morale. Some called them "cattle calls." Several hundred R&D people crowded into the Westboro cafeteria one afternoon in July 1985, to gain a better understanding of the business slowdown. When conditions did not improve the following year, in September 1986, deCastro expanded the discussion to include all Westboro employees. This time, the message was different. Comments on "what's wrong with the business," were wrapped in part of a larger vision deCastro had of the future. It took two sessions, each attracting some 1,500 people, but everyone in Westboro, Southboro, and Milford, along with managers from Portsmouth and Westbrook, had the opportunity to hear the message and ask questions. The meetings were held in an open floor of a building being leased and furnished for occupancy. But deCastro was not sure the message was sinking in.

In January 1987, deCastro again tried to convey to employees the vision of long-term endurance he saw that was required in Data General's future as well as in the whole industry's future. He wanted to prepare them for a different future than they were expecting. At 48, he had lived long enough to begin to see the broader sweep of history in global enterprises, and had tried to give this sense to employees at another large general meeting, held in the same location as the discussion four months earlier.

This time, employees in Westboro were reeling from fresh layoffs and plant closings, and a second year of anemic growth and weak profits. The quarter's results (December

1986) had just been announced, and they were disheartening. A cloud of malaise hung over Westboro. Everybody was in a funk. It was the day before the Annual Meeting of Stockholders in late January, giving the meeting an immediate air of suspense. Almost 2,000 packed the carpeted but as yet unfurnished floor of the building, breathless with anticipation and rumor-swapping over impending catastrophes about to be announced.

"Tommy" Tomino gave a talk in broken English about how Japanese organizations handled tough periods. Many were unsure of what he was saying, but everybody applauded loudly because they appreciated his trying. So far, everybody was still alive. DeCastro then walked to the podium and showed a bunch of slides, a preview to his Annual Meeting talk, reviewing the business outlook, which was not bright. He then concluded with a comparison of the consumer electronics industry with the computer industry. He pointed out that in 1960, U.S. companies held 70 percent of the world consumer electronics industry:

"But when they were faced with competition from the Germans and the Japanese, the U.S. industry lost its balance. It propped up its sagging profits by cutting R&D, factory automation, new products and features. They sacrificed their future for their current performance. Today, you would be hard pressed to find a radio, TV or stereo made in the U.S.

"Today the U.S. computer industry has a position similar to the U.S. consumer electronics industry of 1960. But I believe that we have learned from the earlier experience. Most suppliers have resisted the temptation to trim our future investments to soften the present tough times. I believe we have all done a good job in balancing the present with the future. It has meant some pain today, but it will prevent more pain later, and promises to produce success in later years. We are all the stronger for it.

"Through hard work, Data General has preserved the essential resources while laying the groundwork for our future. I want to tell you how proud I am of each of you who have done the hard work and made the hard decisions and sacrifices that it took to achieve this readiness. I may not know of every instance, but I am certainly aware that we have reached the upper limits of some pain thresholds in reducing jobs and costs while learning to accomplish more with less...I cannot promise that a boom in business is just around the corner, and all we have to do is wait. But we have never been better prepared..."

Then there were a few questions from the floor about products and more layoffs, and the meeting broke up. Everyone walked out in the cold January afternoon breathing a sigh of relief, but shaking their heads.

Prophetic as the talk was, the message remained a mystery to many of the employees, the young engineers, programmers and product marketers five to 10 years out of college. They were not accustomed to thinking in such global terms. The collapse of the consumer electronics industry happened before most of them were out of high school. They saw no parallel with the computer industry, and could not relate the parable to their own jobs and lives. The talk about pain made them uncomfortable. Leaving the building, one said to the other: "I think we got warned about something, but what do I do different now?" The gap between age and experience had become a wall of confusion.

More than a year later, in April 1988, deCastro elaborated on the theme of long-term investments. He pointed to the savings from three years of major cost cutting as a source of funding for both communications networks and future computer systems. "We are making major long-term investments that will only begin to payoff in the next three to five years," he told a group of investors. He warned them that Data General was expecting marginal profitability, even a few red quarters, until the transition was complete. The investors, all from big institutions accustomed to thinking three months in advace, rolled their eyes and sold DG stock short.

remembered the benchmark performance of the Data General MV systems earlier. In 1988 all three were looking again at Data General. In Mobil's case, Mobil Japan ordered MVs to do the work that the IBM systems could not. "It may take awhile, but we may yet prove our case to these customers," de Castro said to a sales conference.

Rediscovering OEMs, VARs and ISVs

"If the large end-user wouldn't buy from Data General direct, then let's sell him indirect, like we used to," said Herb Richman. The only problem was that much of the experience in managing an OEM marketing effort had been lost during the 1980s, and much of the sales force was end-user and business-focused.

The answer was found in Ward MacKenzie, an 18-year veteran of DEC who had built their OEM business, and who had moved on to become president of a floundering artificial intelligence start-up in Cambridge, Massachusetts. MacKenzie had none of the traditional DEC paranoia about Data General, welcomed the challenge, and had a healthy visibility and credibility among third-party customers. He began rebuilding the marketing efforts aimed at OEMs, VARs and ISVs in 1987. He established new volume discount policies for them; he developed selling practices that minimized "cross-channel" conflicts between Data General sales people and their VARs. He developed conversion aids, so needed by many VARs in getting off unsatisfactory hardware and onto Data General. A market Data General was instinctively close to and had neglected for years began to come back. It was a sort of homecoming.

The timing of MacKenzie's program was also right. DEC, in its zeal for the IBM commercial base, was neglecting its OEM and VAR business. It was also competing more directly against its own OEMs and VARs to get at IBM customers. Such tactics were disturbing many OEMs. Data General became a happy home for many. Within a year, MacKenzie and his team had sold over 100 new OEMs and VARs in the U.S. alone; more overseas. It offset the losses of other Data

General OEMs to standards-based vendors such as Sun Microsystems, and the shut-out situations among large end-users. MacKenzie took over as head of corporate marketing in late 1987.

The Fourth Wave

After two years of flat revenues, however, it was clear that marketing programs for OEMs and VARS would not return Data General to the market-share-gaining years of old. And selling office automation to end-users was an installed-base upgrade business only. The fundamental demand character of the market would have to be addressed in fundamental ways.

De Castro began convening a series of development meetings in 1987. They were often held weekly and eventually involved almost everybody in the development and marketing groups of the company. They started out with the basics. Tom West said it was like starting out with a clean sheet of paper. Eventually everything got out on the table. Then, the meetings became a process to assign, develop and review plans for products and markets, including budgets and manpower. De Castro turned it into a big consensus-building process for all the key players in the company. The process took almost a year, but at the end of it, there was a product plan for where the company was going over the next five years. And most people bought into it since practically everybody had been part of developing it.

In essense, the plan identified the UNIX operating system hosted on commodity RISC (reduced instruction set computing) microprocessors as the wave of the future. The key word in the development plan was "commodity." West's people had built several RISC machines in the last few years and manufacturing had enough cost data to know that Data General could never produce them in volumes that would get the costs down to levels competitive with the merchant semiconductor houses. Data General would buy its future CPUs from the house that made the most of them in order to com-

pete. The die was cast, and it said that Data General would eventually get out of the design and manufacture of computer central processors.

Enter Motorola with the 88000

Everyone knew that the UNIX development team in Research Triangle Park was well on its way to a major breakthrough, based on the development meeting reviews. Then Motorola approached West with the 88000 RISC microprocessor. The technical doors were beginning to open. Marketing plans began to be formulated. Things were beginning to come together.

West liked to work with semiconductor vendors early in their development cycle so that he could design systems using emerging component technologies before they were available in the merchant market. By the time a technology was generally available, he typically had the systems product into manufacturing. He had worked this tactic well with Motorola in developing ECL gate arrays for the MV/20000. Furthermore, West's people and the Motorola design people had developed mutual respect for each other's engineering talents, something normally difficult to accomplish between systems and component designers.

This time, West was interested in a joint deal to develop the ECL version of the 88000 RISC machine. This would result in a version of the 88000 about six times faster. This project would be in addition to Data General's adoption of the CMOS 88000 chip set as its CPU for standards-based systems. After considerable study of alternative RISC micros, including SPARC from Sun, the MIPS Computer offerings, Advanced Micro Devices and Data General's own, a deal with Motorola was signed in early 1988. There would later be some controversy over the Motorola decision since DEC later chose MIPS Computer's chip which had an earlier delivery date. West's response was, "Think about what it would be if it had happened the other way around. Then, where would we be?"

Motorola needed to quickly establish the 88000 as the standard second generation RISC microprocessor for the industry if it was to be successful. To do so it had to sign up adoptors like Data General early and announce it quickly and very publicly. Motorola needed to stage a bandwagon that everyone would jump on – application writers and hardware vendors alike. This was also to Data General's advantage, since the more vendors and software writers adopted the 88000, the larger the market for the future Data General 88000-based UNIX systems would be.

Catch-22

It also presented Richman and the marketing people a "Catch-22." By climbing on the 88000 bandwagon long before a systems product was available, it could spook the traditional Data General customer who had no interest in UNIX and RISC. The sales force was not prepared to handle a UNIX/RISC world and were commissioned to meet near-term goals, all based on proprietary MV products. The commitment to a standard RISC architecture could threaten future commitments to the company's proprietary MV-AOS/VS base. In a future world of industry standard products, Data General could have even more difficulty in distinguishing itself from competitors. R&D funding, already a larger share of revenues than at most computer vendors, could be siphoned away from proprietary products. The first 88000-based products, TOP-GUN and MAVERICK, were a year away, if the schedule were to hold. The ECL implementation was more than three years off, if then. On the other hand, a number of OEM and VAR customers might be keenly interested in the new direction. Data General was losing them steadily because it did not have a UNIX path for them.

Finally, it presented de Castro with a strategic dilemma. Ron Skates, brought in from Price-Waterhouse to head up first Finance and Administration, later to become Chief Operating Officer, was taking major operating costs out of the business at considerable pain to the company in an effort to shore up profitability. The new UNIX/88000 strategy, on top of major investments in communications and networking, could spend

most of the savings Skates had paid so much to gain, further discouraging investors, dropping the stock price and increasing the risks of a take-over. Revenue growth during the period before the standards-based systems were projected to make major contributions was likely to be marginal at best. If the new public commitment to the 88000 discouraged even a few current customers or even delayed some orders during the interim period, revenues would decline, throwing the break-even profitability balancing act into the red. And, finally, there were some who even questioned whether the world would ever go for UNIX in a big way. What if UNIX were just another flash in the pan? What then?

De Castro's answer was crisp and simple: "The real risk is to do nothing." He saw no reason to delay or waffle on the decision. "We are committed to our existing customers with proprietary systems indefinitely. We are also committed to the needs of the standards-based market of the future." Data General had always had a product in the oven while another was on the table.

Committing to Standards

In April 1988, Motorola held a big conference in New York, followed by others in other cities, to unveil the 88000, together with 28 early adopters, many of whom were there in person, including Data General. The next day, Data General held a briefing for press, financial analysts and consultants, where Ward MacKenzie and Tom West reviewed the Data General standards-based strategy. The stately mahogany library of New York's Metropolitan Club was packed with the faithful, the curious, and the cynics among the industry watchers.

For the first time in the history of the company, de Castro was not present at such an event. The meeting date had been determined by the Motorola announcement the day before. Unfortunately de Castro was away in the Far East on a long-standing commitment that could not be changed. It was also the first time the company had ever announced a business strategy and talked about products it had not yet announced.

MacKenzie talked about "strategic" things; West talked technology; neither talked substance. Predictably, the audience was thoroughly confused.

There was considerable debate internally about the wisdom of making the strategy statement public. But Data General had to climb onto the Motorola bandwagon. Data General was clearly so early in the fourth wave that nobody understood what they were doing except key customers and software writers. And that was enough for now.

Once More Into the Breach

By 1988 the high-end of the MV line was running out of gas. The MV/20000, never a market barn-burner, was being outclassed by the later VAX 8800. The Hewlett-Packard Spectrum RISC-based UNIX line stacked up well in engineering and business applications. If West was to keep to his "halving and doubling every two-to-three years" rule of thumb (half the cost for the same performance; double the performance for the same cost), then the Systems Development troops were due. The pipeline was full: SPHINX, OBELISK and MERCURY were to come out at the same time – the MV/40000 HA (high availability) quad processor at 50 MIPS, the MV/40000 uniprocessor at 14 MIPS, and the Message-based Reliable Channel (MRC), a new input/output system for the MV/40000s.

Once more to New York for the show to bring the systems out. On October 3, 1988, at the Plaza Hotel, the power and performance of new MVs came alive again:

"High-density gate arrays at 20 MHZ; integrated RAM for implementing entire logic subsystems, complete with local store, on individual arrays; first full ECL-implemented machine, five-stage pipelining, 50 nanosecond cycle time; separate write-back caches for instructions and data; integrated floating-point processing; a memory controller generating a high-bandwidth bus to keep 27-MIPS dual processor operating at full blast; I/O, communications and mass storage with

bandwidth and performance to match the processor; layered software to manage data bases; fault-tolerant 30 megabyte per second bus, I/O data rate averages of 15 megabytes per second; aggregate I/O bandwidth of 120 megabytes per second." It was the fastest and most comprehensive set of systems in the industry. Everything anybody could think of was there. Nobody would be able to touch them for at least a year.

There was a difference, however, between this time and the high-hopes days of the MV/20000 introduction in 1985. Three years of hard road intervened. At the Plaza, de Castro said: "We are here today to deliver on a commitment – to continue to provide our customers with a strong and growing line of proprietary systems...Customers are not going to throw away decades of programming code for UNIX, RISC or anything else. That's not the way the world works. We are committed to meeting the long-term needs of our customers."

De Castro reflected the dilemma being faced within Data General when he quoted at the event a *Datamation* article:

"Established vendors are having to find new ways to add value in a world of open systems, and users are wrestling with ways to preserve proprietary systems' advantages while achieving connectivity among dissimilar platforms."

For some time to come, that about said it all.

Epilogue: Vision of the 1990s

The changes in the computer markets and technologies occurring in the 1990s promise to be the most fundamental since Data General's formation over 20 years ago. The challenges it presents to the company were best stated in the 1989 Annual Report, and have been referred to as DG's "three-legged stool."

[1] Preserve the advantages of proprietary computing systems (the ECLIPSE MV family of systems) while achieving connectivity among systems from many vendors.

[2] Distribute customer applications on networks of products based on industry-standard microprocessors and operating systems (the AViiON family of RISC computers using UNIX).

[3] Integrate computing and telecommunications.

Each leg of the stool must carry its own weight and reinforce the others, making it something that everybody can sit on comfortably – customers, investors and employees. If it works, the payoff is enormous, according to most experts, including everybody at Data General. It is like starting all over with the same risks and rewards of 1968.