The Soul of a New Machine Study Guide

The Soul of a New Machine by Tracy Kidder

BOOKRAGS

Contents

Plot Summary

The Soul of a New Machine by Tracy Kidder is about Data General Corporation and the development of their first 32-bit Eagle computer. Data General was started by four young men. Edison de Castro, who became the president of Data General, two other engineers from Digital Equipment Corporation and a fourth person named Herb Richman. The company, which began its days in a former beauty shop, has its headquarters in Westborough, Massachusetts in a building known as 14A/B or Webo. Once founded the company grew by leaps and bounds, holding its own again IBM, Sperry Univac and others.

The story of what about thirty whiz kids, known as Microkids and Hardy Boys along with a few of their managers did was almost unbelievable. They invented and designed a 16-bit compatible 32-bit computer in a little over a year with a radically new design that was more than competitive in a young computer market. This book is the story of the exciting journey that these young engineers embarked on when they went to work on the Eagle Eclipse project. Their manager Tom West relayed the specification from their company president Ed de Castro that there be no bit mode and that the new machine must be compatible with the 16-bit Eagle, meaning it must be able to use the software from the 16-bit machine. How to do it was up to the team, which is one of the reasons why the young team, many of them right out of college, like working at Data General. Other companies, like IBM, would not have given them the opportunity to play such a major role in a project like the Eagle project did.

This interesting book shows the reader how the Eagle came into being. It shows how the various technical problems were encountered and solved. Since there is so much technology involved in computers, there are many technical terms that are well-explained by Kidder. There is a lot of technological information about how computers function and malfunction. One of the most interesting parts of the book is the debugging process; as the reader watches the various team members encountering one problem after another. Kidder takes the reader through the debugging process step by step, explaining how various problems are diagnosed and fixed.

Data General's unique management process is referred to as mushroom management. Basically, there is very little direction from management. The different groups are left to negotiate their own problems, when problems arise. There is no manager that they can run to make a decision or to make assignments.

This book is exciting reading for anyone who wants to learn about computers or some of the history of the computer industry.

How to Make a Lot of Money

How to Make a Lot of Money Summary and Analysis

The book opens with a description of driving along Interstate 495 in Massachusetts. When it was first built, the big danger was hitting deer. Now there are buildings and farms. The author describes some of the relics of the past that are located along the intestate, like old stonewalls. Many of the early settlers went west when they had the chance. The old textile mills are vacant since they have left the area. They have moved to the southern part of the country or to Asia. Many of the areas off the interstate are populated with subdivisions and apartment complexes and shopping centers. Cars cause jams during rush hour as workers make their way to and from work at companies like Digital Equipment and Data General.

There is a building near the junction of Route 495 and the Massachusetts Turnpike known as Building 14A and 14B since they are joined into one building. The employers call the place Webo or Westborough. It really is the Data General Corporation's worldwide headquarters. The building was designed to be efficient and cheap by the company's own engineers. The building was in keeping with Data General's thrifty image.

Security is tight at the building. There is only one door in for outsiders that lead to a lobby with a receptionist. The visitor must sign-in by providing various information about himself and then must wait for the company employee to come to the reception area. The visitor cannot walk in by himself. The lobby is comfortably decorated and contains a showcase that contains the first NOVA. This is the first computer that Data General ever produced and it is still functional. The computer displays the company's financial reports.

"Someone unaccustomed to reading financial reports might have missed the full import of the numbers on the screen, the glee and madness in them. However, anyone could see that they started small and got big fast. Mechanically, monotonously, the computer in the case was telling an old familiar story - the international, materialistic fairy tale come true" (Chapter 1, pg. 11).

The first computer came into being in the 1940s as a result of a joint effort by the military, academia and corporations. IBM quickly established itself as a world leader in the market even though there were some smaller companies. The crowning glory was the 360 line of computers that was introduced in the 1960s. The early computers performed mainly bookkeeping and mathematical functions repeatedly. The machines were big and bulky in the early days. Most were kept in a dedicated and locked computer room where the machines could be viewed from behind plate glass windows. Scientists and engineers wanted a smaller machine that they could use themselves and this is what led to the development of the minicomputer. The use of computers grew in America. By the late 1970s, almost all businesses were using computers in various

degrees and home computers were coming into being as businessmen recognized their potential.

The computer industry came into being because of the development of the transistor. These are devices that control the flow of electricity to circuits, and three Bell Laboratories scientists won the Nobel Prize for their work on transistors. Transistors were very small and inexpensive to produce. The second important stage in the development of computers concerned the ability to link transistors together into circuits and chips. This is what allowed for the development of pocket calculators, watches, computers and other devices.

The development of the microprocessor allowed for the development of the minicomputer. This led to the expansion of the industry and the development of plug-in peripherals which made the market more competitive and the equipment more affordable to people. This led to the development of many software companies who wrote the software for these machines. The growth of the computer and peripheral industries exploded. Even though many companies made money, there were also huge losses sustained by companies like RCA and Xerox.

There were many lawsuits during this period. The Department of Justice tried to break up IBM claiming it was a monopoly. The case went on for more than ten years before the Justice Department dropped the case in 1980 because of the changes that took place in the market. IBM was no longer a monopolist by this time. At this time, Data General was a minicomputer company that was doing approximately $3.5 billion of business by 1978 when it was number three in the minicomputer industry. The company was experiencing a 30% yearly growth rate.

The first minicomputer, the PDP-8 was produced by Digital Equipment Corporation, known as DEC who began to market the machine in 1965. Edison de Castro, who led the team that developed the PDP-8, left DEC with two other engineers in 1968 and joined Herb Richman in establishing Data General Corporation, which produced minicomputers. They originally set up shop in a former beauty parlor in Hudson, Massachusetts and challenged IBM based on venture capital of $800,000. They didn't need much more because they could reach their target market through trade journals. Data General was just one of a myriad of new computer related new companies that were forming on a daily basis in the country. Data General was one of the successful ones as its NOVA was an instant success. One of the reasons for Data General's early success was that its founders used the company stock as a basis for growth. They finally sold some of their stock when their lawyer insisted they do so. In this way, they wouldn't feel threatened by financial loss when they entered into negotiations for the company.

Data General operated in a different way than IBM did. IBM would send a repair Team to the customer's site when there were problems. First like Data General wouldn't. Their customers handled their own problems for the most part and the successful marketing and advertising campaigns of Allen Kluchman, resulted in many customers for the company. When DEC began warning their customers about Data General, the

customers, naturally, sought information about the company and by the end of 1978, Data General was number 500 on the Fortune 500 list. This was the beginning of the company's climb on the list.

One early scandal involving Data General had to do with a small competitor called Keronix. When the Keronix warehouse burned, they accused Data General of committing the crime, and there were some on Wall Street that agreed with the charge. Trading became erratic and the New York Stock Exchange had to suspend trading in Data General stock. Nothing was ever proven against Data General. The company also made it clear that they wouldn't tolerate debt and non-payment from their customers. They did not shy away from litigation.

Analysts confirmed that Data General had a yearly growth rate between thirty and forty percent and they waited for something to go wrong. They did not think that the company could sustain this rate of growth. They though that something would go wrong in production results in non-delivery and lawsuits. Change was so rapid in the computer industry that one year was a long time. A lot could happen in one year. Companies had to keep up or be left behind. Data General welcomed initiative on the part of its employees.

The Wars

The Wars Summary and Analysis

Tom West was an engineer at Data General and he headed a team of engineers. The big thing in the market now was the 32-bit supermini and DEC had just introduced a news machine called the VAX 11/780. Data General did not introduce their own 32-bit supermini, but many of their competitors did and West knew that they had to have one available soon if they were to survive. Customers usually stay with companies who stay current with the latest technology. West organized his own team and tried to put together a 3bit supermini in a hurry. He hoped to have Data General's answer to VAX within a year.

West even traveled to an unnamed city to try out the VAX. When he arrived, the DEC technician was still installing the machine. West did not volunteer information about who he was but said he would not have lied to the technician if he had been asked. As soon as the technician departed, West began to take about the VAX, examining its parts. He looked at all of the boards and chips and other pieces and decided that it probably cost a littler over $22,000 to manufacture the machine which sold for over $100,000. West figured he could build a better machine less complicated than the DEC machine. Data General did admit publicly that they had been trying to build their own 32-bit supermini for over five years but kept running into problems.

Computers, Kidder explained, work with two symbols and these are symbols that exist in electrical form. The two symbols are low voltage and high voltage. Everything the computer does is based on these two symbols. A bit is a single high or low voltage. A bit represents one piece of information with one of two integers being used to represent each bit. The number of things that bits can represent increases when the bits are arranged in rows. Packets represent standard combinations of bits. The newer generation DEC computer handled packages of 32 bits where the Data General NOVA and Eclipse only handled packets of 16 bits. The 32-bit machines run faster and are, for the most part, easier to program than the 16-bit machines.

The computer stores information in bits, both data and programming instructions. A 32-bit machine can handle more than 4.3 billion storage areas, instead of the 65,000 that a 16-bit machine can handle. Many of the industry experts foresaw the need for a 32-bit machine. A secret group at Data General, called the FHP group, for the Fountainhead Project, was working out of a suite in an apartment complex. Data General opened a research facility at Research Triangle Park in North Carolina that provided a much more favorable tax environment for businesses than Massachusetts did. A newspaper report revealed that the FHP groups and others were being relocated to North Carolina, which didn't do much for morale at the Westborough headquarters.

West and his group were in Westborough working on a new machine called the EGO. This machine could handle both 16 - and 32- bits. West and his group presented their

design to de Castro, knowing that the management couldn't support their EGO and the North Carolina project. They didn't have the money for both and de Castro told West to work out the differences with North Carolina. This was the beginning of a big fight that ended with de Castro making the decision to stop building the EGO. This had an effect on the Westborough group as some of them soon quite the company.

West told the balance of the group that they were out of the research and development area and would concentrate on building better Eclipses using the 16-bit technology. West was told to build faster Eclipses without using mode bits. By this time, the VAX was on the market and was being very successful. Software was also very important. There are user programs that the users do themselves telling the computer what they want it to do. There is also system software that functions as translators of user programs. As hardware costs were decreasing, software costs were rising. It was into this environment that IBM introduced the 360 line of computers all of which were software compatible with one another. This meant that IBM had only one set of software development costs and that customers who wanted to trade up would not have to buy new software.

The other manufactures followed IBM's lead regarding software. So did Data General. All NOVAs could use the same software and all Eclipses could use the same Eclipse software. Eclipses could also use NOVA software, for the user who wanted to trade up. Compatible software was a tremendous marketing tactic, as West learned from his marketing department. This led West to the promotion of a news machine called the Eagle that would be compatible with the Eclipse.

Building a Team

Building a Team Summary and Analysis

West's group was located in the lower level of Building 14A/B in a Restricted Area. The area consisted of cubicle workspaces for the staff. Cubicles allowed for more workers and changes in the workspace area that could be easily made. Kidder describes the area as she is led to the research are by West one evening. There is usually someone working, even in the middle of the night. West had one of the few small offices in the area, designating his rank. He has framed pictures of computers on the wall since it is a tradition of the marketing department to give everyone involved in the design and development of a new computer a framed picture of the computer.

West is considered a very competent engineer by his peers. Many remember him from his pre-management days as a very good problem solver and debugger. When the Eclipse' original team manager left for North Carolina, West asked to be in charge and was told he didn't do the work on an IOP that he told to do. West worked continually for the next seven weeks and completed the project. After that, he gradually took over the Eclipse Group. In the early days, he held pig roasts for the staff, but those days ended long ago. Now the newer staff barely knew him and there were a lot of rumors about him that circulated among the newer staff.

Along with Alsing, Rosemarie Seale had been with West for many years. She watched him change after the EGO project was killed but knew that he was thriving on something. She had worked for the Eclipse Group from the time she was first hired at Data General and was very happy working there.

Some of the engineers didn't want to be involved with the EAGLE, after the EGO project was killed. It took West until the spring of 1978 to form a team of a dozen engineers for the project. "For a time West thought that their numbers would suffice, but really they were just a cadre. It became obvious, when they started designing the 'logic of the new machine, that such a tiny group would never be able to produce a computer like this in a year. 'We need more bodies,' said West to Alsing, and Alsing agreed" (Chapter 3, pg. 58). North Carolina had drained much of the research staff from Westborough so Alsing and West talked about hiring young talented kids to meet their staffing needs. They got the idea from a taped movie about Seymour Cray who hired young engineering graduates right out of school and was a legend in the computer world. They also considered the fact that they might be hiring their own replacements.

West and Alsing decided on hiring new graduates and doubled the size of their team by fall. The new hirees were known as the 'kids' and the group that worked on hardware circuitry became known as the 'Hardy Boys". Alsing ran the software part of the group and they became known as the 'Micro kids.' Most of the Microkids were happy at Data General because they wouldn't have received the same opportunity from a company like IBM. Data General demanded a lot of hard work from its Microkids. When they

signed up for a project, they were expected to sacrifice just about all of their time until the project was finished. Data General was able to compete with IBM by offering opportunities that IBM did not. The work at Data General was more challenging because of this.

Wallach's Golden Moment

Wallach's Golden Moment Summary and Analysis

Many of the Microkids had dreams of building the perfect computer. West was looking for an architect at the time. This person will describe what the machine will do for the software people. West was trying to build a 32-bit Eclipse compatible machine that didn't use a bit mode and he didn't know if it was possible. He wanted Steve Wallach, a Data General employee, for the job. Wallach had come to work at Data General on the FHP project, but when it was moved to North Carolina, he didn't go with. He studied the VAX when it came out and felt that the EGO was a better machine, but de Castro had cancelled the project. He was knowledgeable and ready to help make the machine.

Wallach resided in Framingham when the author first met him. He relates some stories to the author and discusses how he felt when the FHP team moved to North Carolina. Wallach and others who remained at Westborough felt that the move to North Carolina was a personal insult to them. They would never again design important machines at Westborough, is what the feeling was at the time. This is why Wallach sneered when he first heard about the 32-bit Eclipse. He didn't have much faith in the project being successful given what had happened with the EGO machine.

Wallach was not happy with the EAGLE or with the 32-bit Eclipse. At one point West told him that his job depended on the project. His job was to develop architects and the EAGLE was the only project that needed an architect. Wallach goes to talk to de Castro about the project. De Castro tells him that he wants a 32-bit Eclipse without a bit mode. Wallach returned to his office to work on the machine. He began with the memory management problem. From there he went on to figure out how to protect information that was stored.

Most computers, like the Eclipse, were based on time-sharing. Users could work at their desk using terminals and have the full capability of the machine. However, they weren't using the machine alone; they were sharing it with others. The users don't have to be in the same room; they can be on different continents. Computers were used to store sensitive and important information, some of the most sensitive and important information that companies have. Oil companies store their seismic information this way. Unauthorized access can result in huge monetary costs and a lot of damage to a company. Users could access the computers information and memory. Because of this danger, there have been many projects looking at the security aspects. Once such project was MULTICS, a project funded by the Department of Defense.

Wallach had studied these security programs and read whatever information he could find over the years, especially since he had worked on the FHP project. He chose a system of rings that came out of the MULTICS program and happened to be used by the VAX. In this system, users can move around their own ring but can't move to higher rings without authorization. The computer compares ring numbers to ascertain whether

the user has access to another ring. This means that numbers have to be assigned to the different memory compartments, and this is the problem that Wallach now addressed as he examined different approaches.

Wallach didn't like the method employed in the VAX, so he designed another method. Wallach's plan was simple and cheap to implement. The instruction set for the compute is the next topic Wallach addressed. The Eagle had to be compatible with the Eclipse so the new instruction set had to contain the Eclipse instruction set. Even though Wallach was still bemoaning the problems with the defunct EGO and the constraints of management, he was beginning to like the looks of the new system. Wallach would run the new instruction by West before he included it. If the instruction was a non-Eclipse instruction, they would write a memo to the Eclipse Group asking for permission to include it in the Eagle.

The details of the hardware architecture implementation had to be worked out with Ken Holberger, another member of the team. In addition, all of the instructions had to be defined. All of the instructions had to be written and contained in a book. Wallach began each chapter with a famous quotation.

Midnight Programmer

Midnight Programmer Summary and Analysis

Carl Alsing was working late at night and promised to show the author what midnight programming was. They were playing the game of Adventure, which traveled among the nation's computer programmers. It is a game where the players try to move through the levels by typing in their instructions on the screen. The game is extremely popular among computer programmers who have to find the best solution for each situation. They left the game to go for coffee.

"How can the machine perform its tricks? The general answer lies in the fact that computers can follow conditional instructions. They can take two values and compare them - that comes down to simple arithmetic - and, if so commanded, can perform one action if the values are equal and another if hey are not. In this ability to follow conditional instructions - an ability built into the machine - lies much of the computer's power. You can set before it, in sequence, bifurcating webs of conditional instructions, until the machine appears to make sophisticated decisions on its own" (Chapter 5, pg. 90). The computer follows instructions and appears to make its own decisions.

Kidder asks Alsing what he thinks about artificial intelligence. He more or less sidesteps the question. Computers function on the basis of electrical charges. Kidder explains the basis of the use of binary integers where 0 represents low voltage and 1 represents high voltage. An open gate represents a 0 and a closed gate represents a 1. The gate helps control the voltage. Larger numbers are attained by building numerous gates and control wires. The computer functions by producing the right pattern of opened and closed gates in response to various signals. Boolean algebra provides the rules that are required because it is a way of defining relationships between statements. It is the mechanism used to build gates.

Alsing found that at his school he could walk into the computer room at night and program the computer. He called himself a midnight programmer since he was taking a FORTRAN course and writing program that he tried on the computer. He had a group of ten students that joined him in this programming and many times, they would stay up all night. Many, including Alsing, flunked out of school because of their nighttime programming. Alsing also liked to program Trixie, the name of one of the Data General computers, late at night. Kidder became involved through playing the game Adventure.

Computers can be programmed in assembly language that feeds the instructions into the actual circuits. This is referred to as hard-wired. Microcoding came into being in the 1970s and is a way of translating assembly language into another language called microcode. There is a microcode program for each instruction in assembly-language. The microcode for the Eagle would be on a floppy disk and would be easy to change if they had to by just changing the floppy disk with the instructions.

Alsing's job was to write microcode. It is what he was hired to do and he kept telling his higher ups that the project was coming along just fine when he hadn't done any of it. He finally went to work on it. He wrote most of the codes in two weeks he spent working at the Boston Public Library. This was Alsing's way - to procrastinate until the very end and then to quickly do the code writing. Because of his tactics, he wasn't reward with stock as other workers on the Eclipse were.

Data General was a young company with a young staff. Most aspire to be managers and feel that they have failed if they haven't achieved this goal by a certain age. Alsing knew that he couldn't write all of the code for the Eagle in the time allowed. He had created the Microteam and chosen its members. He trained them by using a game on Trixie where they had to write programs to locate and find a certain file. Once they found the file, they found that access was denied to them. Once the Microkids finished this game, there were others that Alsing put together for them.

Flying Upside Down

Flying Upside Down Summary and Analysis

West describes working at Data General as a game to get the product out the door with their names on it. They call the game the competition for resources that is a way of describing the rivalry between the people on the Eagle project and those in North Carolina. Both groups had different vice presidents. This is what contributed to the competitive environment, and de Castro liked this. This meant that the teams not only had to design new computers, but they had to compete for the resources, like support from the Software group.

West figured that the company couldn't support two computer development sites. Most of the resources were in North Carolina and that site was billed as the research site. West felt that the Eagle was a form of insurance for the company if the FHP didn't work out. This meant that the first group to produce a machine had the advantage. "Promising to achieve a nearly impossible schedule was a way of signing up - the subject of the third rule, as I saw it. Signing up required, of course, that you fervently desire the right to build your machine and that you do whatever was necessary for success, including putting in lots of overtime, for no extra pay" (Chapter 6, pg. 113). The team that succeeded in completing the machine would be rewarded. No matter who thought what, they knew that it was de Castro who made the decisions.

The Microkids are told in a meeting that the 32-bit Eclipse is behind schedule. They know that the VAX will probably have an updated version introduced in a few months and they must have the Eagle ready several months before that. This kind of meeting and situation stimulate the Microkids to work and to work late. They put themselves under pressure to perform. People like Dave Epstein make a statement saying they can have their part in the project in four weeks in the heat of battle find themselves having to produce their part in the four weeks. Like Dave Epstein, not only is it done in four weeks, but also it is flawless. Not all of them can take the pressure. Some of them quit. Others stay, but are unhappy. No one seems to be in charge of anything until someone goofs off and then management comes from all angles.

West and his wife live near a small airport where they have a friend named Bernie who flies a small plane. Bernie likes to fly upside down and West seems to like to use the terms flying upside down. To West, this seems to mean taking big risks and to West this was exciting and desirable. When West used this term in conjunction with the Eagle project, the staff knew what he meant. They all knew that there was a chance that the Eagle could be scrapped like the EGO project was. West decided to use the PAL chip in the Eagle since he believed that PAL was the coming thing. It was new on the market. The use of the PAL gave them greater flexibility since each PAL had to be programmed.

He also defined some of the standard by requiring that is have fewer boards than the VAX and that each major element should be on one board as well as other things. West

wanted the Eagle to be fast, cheap, and attractive to the user. It is the user that they want the machine to be attractive to, not to technology specialists. There wasn't much in the way of guidance to the Microkids. He would just say that something was or wasn't right or that time was a factor.

West had to okay the circuit designs so he was the one that they had to please. Aside from that, the Microkids were pretty much on their own. There was no real formal assignment of authority for different aspects of the Eagle project. The Microkids had to work out the details with different people assuming the responsibility for the different tasks. The company management encouraged this tactic and as a result, the machine was finished within six months.

Kidder learned more about the work on the Eagle from Data General Microkid Jon Blau. He explained how an assembly-language instruction was processed. Blau explained to Kidder how the Input/Output Control board functions to process information between the engine and the terminals. He explains how a program runs on a computer and which parts looks for what kind of instructions and where. The address translation unit (ATU) looks for the address of the next instruction. He explains what happens depending on whether or not the ATU finds the next instruction and how the low voltage-high voltage signals fit it. The process of designing a computer is defined as a mind game.

La Machine

La Machine Summary and Analysis

West was becoming very irritable due to the pressure of the Eagle. There were prototypes of the Eagle and the machine was in the debugging stage. They had some extra help from their New Hampshire plant and the Hardy Boys were working two shifts in addition to the group working regularly on Saturdays. The problem for West was that the Eagle was a different kind of machine and he didn't know how to debug it and he had his doubts about the staff. West had to learn how to trust his staff and that was hard for him.

The Westborough group won a victory over the North Carolina facility when word got around that the FHP groups was going to miss their deadline. This enhanced the Eagle's importance to the company and made it more imperative that the April deadline be met. Wallach, Rasala, Alsing and West discussed this information at their Friday afternoon weekly meeting.

The two prototypes were running by the end of January. One was named Coke and the other was named Gollum. Rasala was working on them with a logic analyzer, a machine that helps determine what is happening inside the computer. He was discussing some of the problems with Holberger and other staff members. Different engineers were working on different problems in each of the machines.

Rasala never billed himself as a computer inventor. He viewed himself as an implementer, a designer and a debugger. Rasala worked out the problems that occurred. He surrounded himself with people who were interested in the entire computer, not just their part. Rasala realized that they had to debug a machine that none of them really understood. None of them knows how all of the machine's pieces worked together. They know bits and pieces.

There were two big fears involved in debugging a new machine. First was the fear of making a big mistake that would be overlooked until the end of the process and require a major redesign of the machine. The result could be a delay that would be fatal to the project. There was also the fear that the machine would never be reliable or that it wouldn't work. They all learned to live with anxiety.

The Wonderful Micromachines

The Wonderful Micromachines Summary and Analysis

The Microteam consisted of four staffers that shared the same office called the Micropit. Because of the need to escape the basement where the Group was located, the Microkids created an outdoor lounge area. The Microteam could write the code at their leisure. They were not yet under the same pressure as the Handy Boys were.

Chuck Holland was organizing the microcode for the Eagle. He had to make sure that the microcode and the hardware worked together so that one microprogram didn't interfere with another. He organized it all in a book that contained the microverbs and the rules. They had to decide what to do in microcode and what to do in hardware. Changes in the book had to be made continually. Due to Data General's management style, there was no one in control so the different teams had to continually negotiate with one another to achieve the goal. They all managed to deliver their part of the project on time and with fewer mistakes than Alsing had expected.

"One main reason why they did not fall into an enthusiastic chaos was Holland himself. He helped Alsing choose the team. He organized their work. He reviewed all of it carefully. He helped mediate the battles over UINST. He wrote some large chunks of code himself. No one had more skill than Holland at the art of intricate construction, and no one worked harder than he did. Nobody had ordered him to do all this. Alsing had made the opportunity available, and Holland had signed up. On the whole, he was happy in this work" (Chapter 8, pg. 160).

One of the reasons why their work progressed quickly and smoothly was the existence of a simulator program. This program allowed them to test the instructions for the new computer on existing computers. Alsing wanted a simulator. He had always debugged machines by using the prototype. The Eagle was in a situation where both the hardware and the microcode were being debugged at the same time, which meant when something happened, they didn't know if the problem was in the hardware or the software. Alsing finally received the okay from West to develop a simulator. Alsing figures that it would take a programmer one and one half years to write the program and he didn't have that much time.

There were two Data General employees, Dave Peck, an old-timer, and Microkid Neal Firth who were assigned to develop the simulator. The Microkid felt he could write the software in six to eight weeks. Firth was assigned to work with Peck. It took Peck six weeks and Firth two and one half months to do their respective simulators. After another two months of refinement, the Microteam had a fully functional Eagle simulator. Instead of having to test their microcode on the prototypes, they could test it y using the similar program that they could access from their desk terminal to Trixie.

Firth was the microcoder who had to write the programs for each of the microverbs. The simulator allowed him to test them one at a time to be sure they didn't void one another.

A Workshop

A Workshop Summary and Analysis

West usually worked a twelve-hour day. He would become mentally transformed while driving to and from the office. He didn't smoke at the office, but did when he was away from the office. He was an amateur musician who would sometimes spend the night playing music with friends and then go directly to the office, without any sleep. He also liked to do building renovations and moved to a farmhouse when he finished renovating his original house. The farmhouse needed a lot of work which he enjoyed doing. West had several different kinds of workshops and almost every kind of tool at his farm.

He decided to become a computer engineer as a way of avoiding Viet Nam. He worked for a company providing vital parts for the war. He had learned logic design while working at the Smithsonian. He read what he could on computers from the local library and talked his way into a job at RCA. By the time he could bill himself as a computer engineer, RCA was going out of the computer business. He found a job at Data General. He went to work on the first Eclipse. West did not like to use computers in his off time. He didn't even keep one in his office for long. He was interested in building computers, not using them.

The Case of the Missing NAND Gate

The Case of the Missing NAND Gate Summary and Analysis

April came and the Eagle was still in the debugging stage. Debugging continues after a computer is on the market, sometimes for years. Some minor defects might never become known before the machine's life is over. Defects can create problems so it is important that they identify and fix as many as they can, especially the more important ones. Alsing and Rasala talked West into obtaining a micro-diagnostic program or the task might have taken much longer. "According to the Eclipse Group's theory of debugging a computer, you did not try to prove by exhaustive analysis that the machine was in all its details logically correct. You exercised the computer instead, and fixed it when it didn't work. The higher-level diagnostics had to provide the exhaustive analysis, in other words. They were crucial. They had to exercise Eagle strenuously. They had to be nasty, unfair and subtle, and not full of error themselves" (Chapter 10, pg. 184). The Eagle had to perform the 16-bit functions of the original machine but it also had to perform the 32-bit function. The Group did not have diagnostic for this and Rasala said that he needed them right away. The Diagnostics group was slow in producing them.

One of the features of the Eagle was its use of accelerators that were designed to prevent problems between the IP and the System Cache so the computer wouldn't have a delay in looking for the next instruction. The computer would make assumption about the next several instructions while executing one instruction and other instructions in various stages of preparation for execution. The System Cache stores instructions so they can be retrieved faster. The accelerator is a good time saving device but they can cause problems during debugging.

The accelerators are constantly bringing in and throwing out blocks of information. Any kind of electronic event can result in problems with the various accelerators. Eventually the machine will execute the wrong instruction. The debuggers can't find the problem easily because the failure was set with an event that happened at a previous time. This is the kind of problem that the debuggers encountered with the Eagle. This situation is what is called a time bomb.

Rasala and Ken Holberger were working on debugging the Eagle. Holberger designed most of the IP for the Eagle. There is a diagnostic program called Eclipse 21 that both Coke and Gollum keep failing. In these tests, the machine must perform various instructions repeatedly with different data. The machine responds with an error message on the console if it fails in the tests. The Eclipse is reporting a failure rate of 30 in 921 runs. It is not a large number but it is one of the hardest situations to solve. Both machines report the same failure rate, which rules out noise or loose wires according to Jim Veres who is one of the Hardy Boys. They now have to find the problem and fix it.

Veres and Holberger work well together, even though most of the Hardy Boys tend to be loners. Veres designed most of the IP. Veres and Holberger start to test Gollum to try to find the failure problem. They analyze the problem step by step to find out exactly what the machine is doing when it fails and discover that there is a wrong instruction. Computer engineer Jim Guyer walks in at this time and is brought up to date on the problem. Veres and Guyer are known to be a good debugging team. Veres and Holberger eventually leave after a long day, leaving Guyer with the problem.

Guyer eventually figures out that the problem involves switching the contents of the mailboxes. The move is know known to the IP but is known to the System Cache. Somewhere the I-cache didn't get the updated instruction because the address it has contains an error message. Guyer runs more diagnostics and finds that the computer keeps returning to the same general area of memory and sometimes it fails, but not all of the time. Veres reads Guyer's notes the next morning and starts to track the problem backward to the source. He finds the place where the problem occurs and that there are two tag numbers involved. They must find out which is the correct number. The shift changes again.

Veres decides to take a different approach to the problem the next morning. He decides to search forward instead of backward. He'll go to the fourth pass where the problem occurs and then run the program step by step. He finds the problem, where tag 21 is replaced with tag 45. Now that the problem is found, the solution is simple. The error is with the IP. The solution is a NAND gate, or a delay to keep it from getting the signals mixed. Holberger names it 'not yet'. They install the NAND gate and fix the problem.

Shorter Than a Season

Shorter Than a Season Summary and Analysis

Josh Rosen is in the computer lab working with Ed Rasala trying to get the ALU to perform some functions. The ALU performs some very important manipulation functions for the computer and the Coke machine is having some problems. While Rosen is testing the machine, an electronic event takes place. After Rosen designed the ALU, he decided it required some design changes that required more chips but was told by Rasala not to do it. He received a less than satisfactory performance review and felt that he was being treated unfairly. He felt affronted by the fact that West never talked to him and he felt that Rasala was rude to him. Rosen didn't feel a part of what was happening at the Eclipse Group.

He was a hard worker, working eighty-hour weeks and skipping vacations. He occasionally missed deadlines, and his manager would remind him of that fact. He was one of the few that was so obviously unhappy at Data General. He thought that he was burning out from his all work-no play lifestyle. He spent several months debugging his ALU board in the Eagle.

Pinball

Pinball Summary and Analysis

Progress on the Eagle continued. Sometime they had to slow down to wait for a new part to arrive. As summer approach the temperature in the basement level rose since the air conditioning was broken. It didn't get repaired until after the Hardy Boys walked out. The Hardy Boys didn't have four Eclipse models as the Microteam had. In fact, they didn't even have one for their own dedicated use. Holberger would send out emergency warning messages on the computer called Woodstock when he needed to use it. If he didn't, he had to wait until someone else logged off.

A Data General in-house newsletter bragged that the company spent a greater percentage of its profits on research and development than most others companies did. In spite of this, the Eclipse Group could not get the equipment that they wanted or receive overtime pay. Peck had been sent to the company's facility in California to work on a project that he didn't finish. They refused to let him return to finish the project.

Most of the workers in the Group felt that they were building the Eagle by themselves. They had little direction from management. They felt that Carl Carman knew them better than Tom West did, and West was their immediate superior. The group felt that the Eclipse was their machine and that the company had little to do with it and West wanted them to think that for the present. "The managers had sealed off the team right from the start, telling every recruit not to do so much as mention the name Eagle to anyone outside the group. Although occasionally the pencil supply did grow short, the worst administrative problems never touched the Microkids and Hardy Boys. 'We were buried, to the point where we were almost underground,' said one of the Microkids long afterward, adding, with the air of one from whose eyes scales have just fallen, that Rosemarie served them so well they never realized the full extent of what she did for them" (Chapter 12, pg. 226). Eventually Rasala told them that they had to work fewer hours because Software needed to use the prototypes.

Rosemarie hears them complaining about West. West has always remained aloof from them. She feels sorry for West because she knows that the young engineers don't know him very well. They thought he didn't care about anything, because that is the appearance that he gave them. West didn't give his workers pats on the back but he didn't complain either. West was concerned with many details of the project without telling them. Would the Eagle fit into an elevator in other parts of the world? When Rasala had taken a model of the M/600 to London, they found it wouldn't fit in the elevator and he had to disassemble the machine in the parking lot and reassemble it inside. There were questions about cables and connectors and whether or not the machine should start from a button or a key. West was preparing for the day when the Eagle would be formally presented to de Castro.

West had made the decision to use PALS in the Eagle. There was only one manufacturer and there were rumors of the firm going into bankruptcy. This was one of the big worries for West.

Going to the Fair

Going to the Fair Summary and Analysis

The Eclipse Group is preparing for the yearly convention put on by the computer industry called the National Computer Conference, or the NCC. The conference is in New York and they are all going on a bus. Alsing and Carman made the arrangements. Rasala and Holberger left Do Not Disturb signs on Coke and Gollum. West would not attend the conference even though Rasala and others tried to talk him into it. The bus left Westborough carrying the Hardy boys, Microkids and others. When they arrived at the conference, they went off to find different things. Rasala, Alsing, Holberger and Wallach went to find the DEC exhibit with the VAX 11/780. They opened the cabinet to look at the inner parts and were sent away.

Eleven years early Data General announced its existence at one of these conferences and Data General had an exhibit at this one. They hung their sign high. They always had something unusual at their exhibit and this year they had a sport doctor showing how to use the computer to enhance athletic performance. The company had donated a computer for his use and it made national television. The Data General group met various computer people from other companies as they came through their exhibit.

The IBM people were here with their new 4300 line. They had been on the market for several months now. The machines were so popular that they were having a problem producing enough to meet the demand. It was estimated that they had three years worth of backorders. Many smaller computer companies met their fate when they found themselves confronted with this situation. Manufacturers of peripherals, especially the plug-compatible peripherals, strive to be IBM compatible.

Wallach and the others visited some of the other exhibitors like Sperry Univac and Burroughs. Wallach was interested in seeing all of the 32-bit machines since they would be the Eagle's competitors. Graphics were becoming important so they checked out those exhibits. Pie charts were very popular then. Wallach noticed a lot of Japanese and there was talk of imposing tariffs of the cheaper foreign imports. Data General wasn't hurt because they owned half of a Japanese firm. After a while, many of the exhibits began to look the same to them. There were four floors of firms with exhibits at the conference.

The advent of the computer resulted in many discussions about the effects on privacy and on the levels of employment. Would the computer result in job losses or in job creation? By the late seventies, they had seemed to do neither. Computers are becoming a part of everyday life.

After a day at the NCC fair, the Data General group boards the bus for the return trip to Westborough. Some of them had spent some of the time sight seeing in New York City. Most of the group was more interested in making computers than they were in selling

them. After completion of the Eagle, an OEM would build machines for sale to the Defense Department. Not all of the group liked this idea.

The Last Crunch

The Last Crunch Summary and Analysis

By August, vice president Carl Carman was asking when the debugging would be finished. Rasala replied that he didn't know when. The Eagles had to be programmed by the Software Department and the date for this kept being postponed. The staff had awards that they made up and awarded to their own. The machines still had problems but the problems were harder to find. By this time, Josh Rosen had quit and Jon Blau had become a Hardy Boy. Blau was working on debugging the ALU. Rasala took it very hard when Rosen left.

Even though they had four Eagle prototypes, they still have problems with everyone getting the proper amount of time on the machines that they required for the debugging and other work. "Scheduling 'machine time' was tricky, and an engineer keeping quirky hours could disrupt everything. Moreover, the bugs now tended to be synergistic; someone working on a problem in the IP might need to have the ALU's expert around" (Chapter 14, pg. 252-253).

One day Holberger went to Rasala to complain about Guyer who was spending a lot of time working on what Holberger saw as a low priority problem. Rasala said to leave Guyer alone and let him work on whatever he wanted to work on. There was a lot of pressure because they were approaching the September deadline. The Eagle must be able to form single-precision floating point arithmetic and double-precision floating point arithmetic. This is the kind of operations required by scientists. The computer's functioning in this area could be tested by the Whetstone Benchmark test. The Eagle was lagging behind the VAX in the double-precision floating point arithmetic. They couldn't match the VAX while using only one board. West decided they could live with the double precision problem because the single precision performance would make the Eagle a faster machine but the test results showed that it wouldn't be faster.

Since Data General didn't have a team of finishers, Rasala decided to change things around and work in the lab himself along with Guyer as his partner.

Right before the September deadline, Gollum experienced a serious problem on a diagnostic test. Rasala, Guyer and Holberger spent hours working on the bug. They couldn't find the problem and tried running the program on Coke, which ran it without a problem. Then they noticed that Coke had an extra memory board. Adding an extra board to Gollum solved the problem. At the end of September, they decided to see if it would run the Adventure game and found they couldn't. They kept receiving a FATAL ERROR message. The two other prototypes were Gallifrey and Tartis, and Gallifrey rejected its microcode. After this, the Eagle kept failing its Multiprogramming Reliability Test. They finally cured this problem.

They tried the Adventure game again on October 4 and this time it worked. They ran the Whetstone Benchmark tests again and the Eagle passed in flying colors, proving to be faster than the VAX. The problem was the machine had a flakey problem occurring occasionally on low-level tests. Carman shook a board and the machine failed so they knew where the problem was. On October 8, the Gallifrey was sent to Software.

Canards

Canards Summary and Analysis

Part of the reason for the delay of the Eagle's was West's decision to use PALS. It turned out to be a good decision, but it was risky at the time. The delays gave the others more time to develop and test the machine. "Computers are sensitive things. With some makes you dare not switch the boards of one with those of another supposedly identical machine. But you could switch boards among Eagles without worry by the time they were done" (Chapter 15, pg. 269). The Eagle had one more serious problem that they managed to solve.

The Eagle, when it was released, was a big success for Data General. It was de Castro who wouldn't allow a bit mode, and this is what made the Eagle such a good machine. De Castro was very pleased with the work of the Eclipse Group. Rasala one day tells them that West created the design of the Eagle that many of them were not prepared to accept. This was the Data General management style. The different groups competed with one another and worked out their own problems. The group's work was divided among them but not in very small pieces. Most of them had a sizeable chunk of the product. West's management style created excitement among the staff who had to solve the problems that arose. He was able to make the project interesting and important to his staff. Data General now had a functioning 32-bit Eclipse with the orders coming in.

Dinosaurs

Dinosaurs Summary and Analysis

Even after the Eagle was introduced to the market, there were still debugging problems that appeared and had to be dealt with. Since many changes were made as each department did its part, no one person knew the whole machine. As Holberger worked on a problem, he began to realize all of what went into making the computers and how import a role that West played. At one time, West commented that a person has to believe in himself in order to achieve his goals. West believed in himself and was will to gamble on the Eagle. He was the one that did so much of the worrying about whether or not they could produce the machine successfully.

At one point, West describes his Eclipse Group as a Dinosaur. They made some enemies within the company on their way to success. West fought for his group and to preserve their freedom within the company. West lost a lot of weight during the Eagle project. In November, after the machine was on the market, West told his Group that he was leaving to take a job in marketing at Data General that would take him to Japan. Some of the group members were pleased, others were distraught at the thought of West's departure. Various members of the group left for different places in the company or for positions at different companies.

The company was slipping financially before the introduction of the Eagle. Their profits and stock prices fluctuated. Some blamed the problems on de Castro and his style of management. The company would have had more serious problems if it hadn't been for the Eagle. Data General brought in psychologists to help the staff with their problems after the end of the project. Many did not feel that they had been rewarded for their part in the Eagle project. Others received their rewards in the form of promotion and other perks.

"In the fall of 1980 the Eclipse Group was disbanded and its members dispersed into several new and smaller groups. Some of the old crew mourned the team's passing. One said angrily: 'It was a group that was formed and achieved this remarkable thing for the company, and the company has deemed to reward that group by blowing it up. It's really sad.' Many others, however, shrugged. They felt that the group's demise had been inevitable, on the one hand, and that it wasn't really dead on the other" (Chapter 16, pg. 287).

Characters

Edison de Castro

Edison de Castro is one of the founders of Data General. De Castro was a young engineer in his twenties when he led the team that developed the PDP-8 for Digital Equipment Corporation. De Castro and several others quit DEC in 1968 when DEC wouldn't accept a new machine that he designed. The disagreement meant that he wasn't being listened to and his ideas were not of value to the company. Rather than stay at DEC have their disagreement, De Castro and two other DEC engineers teamed with Herb Richman to establish Data General Corporation. Data General came to function as a direct competition of DEC. De Castro and Richman were responsible for the day-to-day operations of the company. It was de Castro who had the final say over the Eagle project and it was de Castro who specified that there was to be no bit mode and that the machine software must be compatible with the 16-bit Eclipse. De Castro agreed with the management style he set the pace for where the teams worked out their own problems without the involvement of managers. This style led to the development of the Eagle in record time.

Tom West

Tom West came to work at Data General in 1974. He was an amateur musician and liked to do building renovations. A graduate of Amherst College and a physics major, he had worked for the Smithsonian Institution for seven years, taught himself computer engineering, and then went to work at RCA. He traveled the world installing digital clocks on satellite tracking stations until he had a family and decided to stop traveling. He headed a team of engineers at Data General and was instrumental in seeing the need for the development of a Data General 32-bit supermini. After the opening of Data General's research facility in North Carolina, West and many of the design team that remained in Westborough felt that they would never again have the chance to design a new machine. This led to West heading a Westborough team that developed a design for a minicomputer that could utilize both 16 and 32-bits, but the plan was eventually rejected by de Castro. The rejection did not sit well with West, and he always remembered it. He finally led the team that developed the Eagle.

Herb Richman

Richman was another original founder of Data General Corporation, along with Edison de Castro and two other engineers from DEC. Richman had the poshest office at the company's headquarters as he paid for the décor out of his own pocket. Richman, along with de Castro, were responsible for the company's daily operations with Richman in charge of sales.

Allen Kluchman

Kluchman was the first director of marketing for Data General. He developed the company's first ad campaign for the introduction of its first computer, the NOVA. His first ad, slightly on the brash side, set the pace for future ads for Data General. It attracted a lot of attention and was successful for the firm. He also masterminded the company's kick-off campaign for the NOVA at the National Computer Conference.

Rosemarie Seale

Seale was the secretary for the Westborough group that West headed. Seale graduated from a Boston Secretarial school and had worked for an insurance company before being hired by Data General Corporation. Seale helped organize the disorganized mess that the Eclipse Group was she did all the work on the EGO project, only to see it shot down by de Castro. She also worked on the Eagle project and started to question how it was being treated around the company. If it was so important, why do they remodel the group's workspace in the middle of the project?

Carl Alsing

Carl Alsing is an engineer at Data General who was there from the days of the first Eclipse computer. He was born in the Northeast, and then moved to Evansville, Indiana when he was a child. He graduated from the University of Massachusetts where he became interested in digital circuits. He at first flunked out of school, but then became a straight A student when he discovered courses in electrical engineering. Alsing worked for DEC before moving to Data General. He was employed by Data General when Tom West arrived and the two quickly became friends. Alsing headed the software group on the EAGLE project and was thirty-five years old when the project began. He was their top microcoder.

Steve Wallach

Wallach was a Data General employee who West appointed as architect for the EAGLE project. He was born and raised in Brooklyn and received a scholarship to Brooklyn Polytechnic. He then went to the University of Pennsylvania for a master's degree in electrical engineering. After graduations, he went to work for Honeywell. After receiving an M.B.A., he went to work for Raytheon on a computer project that was eventually discontinued by the Navy. A few years later, he was hired by Data General to work on the FHP.

Ed Rasala

Rasala was a Data General employee who was involved with the Eagle project. He was born in Brooklyn of Polish immigrant parents. He earned his engineering degree from Rensselaer Polytechnic Institute and then went to work at Raytheon. After several years, he went to work at Data General and was assigned to the first Eclipse project. He could make the ideas of others work. Rasala's dream was to open a grocery store in Jackson Hole, Wyoming.

Carl Carman

Carman was the vice president of engineering at Data General. West reported to Carman, who set high standards for the Microkids that the company hired but said he didn't demand anything of them that he wouldn't have done itself. Carman had worked at IBM before coming to Data General.

Seymour Cray

Cray was the owner of a small Wisconsin computer company that hired young kids right out of school and produced the fastest computer in the world. A tape about him circulated through the Eclipse Group area which got West interested in hiring new engineering graduates.

Ken Holberger

Holberger works for Rasala and is in charge of the CPU for the Eagle project. Holberger did his undergraduate work at Clarkson and received a master's degree in engineering from the University of Illinois. He is married without children, and the Eagle is his second big project at Data General.

Neal Firth

Firth, born in Canada, was a Microkid computer programmer. He was one of the two man team that developed the Simulator for the Eagle.

Chuck Holland

Chuck Holland was the Microkid in charge of writing the microcode for the Eagle.

Dave Epstein

Epstein is one of the Hardy Boys at Data General. He is working on the Microsequencer for the Eagle.

Dave Keating

Keating was one of the Microkids hired by West and Alsing. He chose Data General over other companies, because he like their casual dress code and flexible hours.

Bob Beauchamp

Beauchamp was another of the Microkids. He was from Missouri and also jumped at the opportunity that a company like Data General offered.

Jon Blau

Blau was one of the Microkids who worked on the Eagle.

Tracy Kidder

Tracy Kidder is the author of the book. The book, written in the first person, is the result of her experiences at Data General and her interviews with the Data General employees.

Dave Peck

Peck was a veteran Data General employee. He was the programmer who headed the two man team to develop the Simulator.

Jim Veres

Veres is one of the Hardy Boys who worked on the Eagle's IP. He is a graduate of Georgia Tech and likes to play with computers in his spare time.

Jim Guyer

Guyer is one of the group's computer engineers. He is from the Boston area and is a bachelor. After graduating from MIT, he went to Northwestern for a year of graduate school and then went to work for Data General where he has been for three years at the time of the debugging.

Josh Rosen

Josh Rosen grew up in Chicago. He received a masters in electrical engineering from Northwestern and worked for Fermi Labs and Fairchild Space and Electronics before joining Data General. Rosen is the designer of the ALU board in the Eclipse. He came to the Eclipse Group from the Special Systems Group where he was the star. He was not very happy at the Eclipse Group, because he worked in Holberger's shadow and received a less than stellar review.

Objects/Places

Massachusetts Interstateappears in non-fiction

Massachusetts is a New England state where the books opens with a description of driving along Interstate 495.

Building 14A/Bappears in non-fiction

Building 14A/B is a building near the junction of Route 495 and the Massachusetts Turnpike in Westborough that is the world headquarters of Data General Corporation.

Hudson, Massachusettsappears in non-fiction

Hudson was the town where Data General was founded and first located in 1968.

Research Triangle Parkappears in non-fiction

The Research Triangle Park is a North Carolina business and industrial area where Data General built their new research facility.

Chippewa Falls, Wisconsinappears in non-fiction

Chippewa Falls is the location of the computer company owned by Seymour Cray, the producer of the world's fastest computer.

Framingham, Massachusettsappears in non-fiction

Framingham is the home of Steve Wallach who lives in a colonial style house in a subdivision.

Evansville, Indianaappears in non-fiction

Alsing's family moved to Evansville when he was a child. His father, an engineer for Westinghouse, allowed Carl to play around the house even though it was the telephone system that he played with.

Boston Public Libraryappears in non-fiction

The Boston Public Library is where Alsing wrote most of the microcode for the Eagle in a two-week period.

Natick, Massachusettsappears in non-fiction

Natick is the town where Microkid Jon Blau lived.

New York, New Yorkappears in non-fiction

New York is the location of the National Computer Conference that a contingent of Data General people attend.

Cain Ridge Saloonappears in non-fiction

The Cain Ridge Saloon is a place near the Westborough headquarters where the Eclipse Group goes for its gatherings and celebrations.

Themes

Value of Hard Work

The most prominent theme of the book is the value of hard work. The team that designed and built the Data General Eagle did the impossible and designed and built a radically different 32-bit machine in a little over a year. All of the team members involved in the project were hard workers. They were all willing to sacrifice for the project and work long hard hours without over-time play. All members of the team were good in their field and since all of them were young and just out of school, they found the opportunity to prove how good they were at Data General.

Much of the hard work had to do with the establishment of the company's research facility in North Carolina. This indicated to the design group located at the company's headquarters in Westborough that they would probably never again be able to design and build a new machine. People like Tom West did not want this to happen. He wanted the chance to build the machine at the Westborough headquarters and made the decision to hire the "kids" and between them and all of the hours of hard work, they made it happen.

The hard work of the Eagle team resulted in a machine that was extremely competitive in the computer market, once it was introduced.

Due to the hard work of the team, they beat out the North Carolina research facility in being responsible for Data General entering the 32-bit computer market. Without their timely entry into this market, the company might have been in financial trouble because the computer field is not one where a market participant can lag behind in technology.

Value of Hiring the

Data General and other computer firms were operating in a market where they had to find the required labor with the technological knowledge that they required. There weren't too many people with the experience and knowledge that were required by the industry. One of the smartest things that Tom West did was to make the decision to hire "kids". This term was used to refer to new college graduates, most without much experience. Even if they didn't have much experience, they had the latest knowledge and needed a chance to apply that knowledge. West made the decision to hire "kids" after viewing a tape of a successful Wisconsin computer firm that used "kids".

The "kids" hired by Data General were good performers. They were hard workers who were willing to take risks. They worked long hours without overtime pay and they designed and built whatever they needed. A company like IBM would have had them working on small pieces of some project. They wouldn't have been given a chance to show what they could do on a major project. Working at Data General gave them this opportunity since the staff allowed them to take on whatever aspects of the project that

they felt they could do. The "kids" were given the chance to prove themselves and this is what they did on the Eagle project.

The Benefits of Mushroom Management

Data General had its own style of management that was referred to as Mushroom management. This could almost be described as no management. One of the biggest complaints of the "kids" who worked on the project is that there was no one in control. When they ran into problems, they had no manager they could go to who would make a decision. When the "kids" experienced problems, they had to meet with the other team and negotiate their own resolution. They were given the project of designing a machine and that was it. All of the details were left up to them. Whatever problems they ran into, they solved on their own.

It can be said that this style of management brought out the best in the "kids". They worked hard to prove themselves and to make the project a success. Instead of the decision-making process resting with a manager, it rested with the people who were doing the actual work on the project. They were able to make the give and take of the negotiation process work more effectively because of their hands on knowledge of the project. This is one of the reasons why "kids" wanted to work at Data General. They were given a chance to prove what they could do when they went to work at Data General. Most were rewarded for their efforts.

Style

Perspective

The author, Tracey Kidder is a Pulitzer Prize winning author and the author of many books, among them Home Town and Mountains Beyond Mountains. As such, he is a good researcher and did the research that he needed to do in order to write The Soul of a New Machine, the book that earned him the Pulitzer and the National Book Award in 1982. The Harvard graduate also attended the University of Iowa and served in Viet Nam. Born in New York, he now resides in Massachusetts and Maine.

Kidder writes in an objective tone and is very good a telling the story and in explaining the technology. The reader does not feel overwhelmed by the technological facts presented in the book and is able to learn not only how computers function but also how they are designed and built. Kidder does a good job showing how the pros deal with the problems that arise and how they approach the debugging process. The reader has to appreciate Kidder's patience in explaining the technology in simple everyday English so that readers of all levels can understand what is happening. This helps the reader in understanding what is happening and understanding the frustrations that some of the team faces when they run into problems and patiently solve them.

Tone

The tone of the book is straightforward and objective. Kidder is able to relate the events in story-like form so the reader is always waiting to see what happens next. The book reads like a novel. There is the feeling of anticipation throughout the book that keeps the reader on the edge of his seat. Even though Kidder is objective, it is still obvious that he was pulling for the team, even though he knew the outcome before writing the book.

The story is an exciting one because it not only tells how a computer was invented, designed and brought to the market, but it explains a lot of the details of technology so that the reader understands the terms and concepts and how a computer functions. It is important to the reader not to sit there and be lost in the meaning of the terms and the technological concepts.

The reader has to appreciate the tone and the style of writing. The Soul of a New Machine is a book that the reader can actually benefit from reading if he is not knowledgeable about computers. Many of the basic concepts are very well explained. This means that not only can the readers enjoy the book, but the reader can also learn from the book.

Structure

The format of the book is a little difficult for the reader. There is a Prologue, sixteen chapters with titles, and an Epilogue. There is no Table of Contents and no Index. This makes the book a little difficult for people who try to look up information. It would have been easier on the reader to have a Table of Contents or an Index but that does not detract from the excitement of the book or the story it tells.

The first few chapters are introductory and set the scene for the action of the book. They describe that area, the background of the company and what it does. The first few chapters also introduce many of the important characters and the names in the computer industry, especially DEC where de Castro and two other Digital Data founders worked. Most of the middle chapters of the book concentrate on one of the main characters involved in the Eagle project. The reader gets a chance to know the character, his job, and his part in the project. The last two chapters then concentrate again on the computers and the industry. Throughout all of this, the reader is learning about how computers function and how problems are solved.

This format makes the reader feel that he is right beside Kidder at Data General Corporation watch the Eagle come into existence. This is one of the reasons for the excitement of the book.

Quotes

"Scientists and engineers, it seems, were the first to express a desire for a relatively inexpensive computer than they could operate themselves. The result was a machine called a minicomputer. In time, the demand for such a machine turned out to be enormous. Probably IBM could not have controlled this new market, the way it did the one for large computers. As it happened, IBM ignored it, and so the field was left open for aspiring entrepreneurs - often, in this case, young computer engineers who left corporate armies with dreams of building corporate armies of their own." (Chapter 1, pg. 12)

"But around the time when Data General established itself in the beauty parlor, other entrepreneurs were starting up minicomputer companies at the rate of about one every three days. Only a few of those other new outfits survived the decade, whereas Data General, before it had exhausted its first and fairly modest does of capital, achieved and never fell from that state of grace, a positive cash flow. Why?" (Chapter 1, pg. 17)

"Partly, it was a matter of keeping up appearances: customers get married to their computer companies in many different ways and they don't usually want to get or stay married to a company that has fallen behind the state of the art. Besides, you had to grab a piece of the new market for the 32-bit supermini because that market was huge and growing fast; most observers agreed that it would be worth several billion dollars by the middle 1980s. You did not have to be the first company to produce the new kind of machine; sometimes, in fact, it was better not to be the first. But you had to produce yours before the new market really opened up and customers had made other marriages. For once they are lost, both old and prospective customers are often gone for good." (Chapter 2, pg. 29)

"Over the next several years, successive generations of engineers joining the group would know les of West than their predecessors had, until finally, but the time of Eagle, new recruits would know almost nothing about him at all. They'd know nothing of pig roasts; that custom had lapsed. Their view of West would be restricted mainly to chance encounters in hallways. West would come down a corridor dragging the knuckles of one hand along the wall, and often he would pas right by members of his own team, with, it seemed, even noticing them. For their part, most gave up trying to greet him. The distant, angry look on his face warned against it." (Chapter 3, pgs. 55-56)

"Going to work for the Eclipse Group could be a rough way to start out in your profession. You set out for your first real job with all th4 loneliness and fear that attend new beginnings, drive east from Purdue or Northwestern or Wisconsin, up from Missouri or west from MIT, and before you've learned to find your way to work without a road map, you're sitting in a tiny cubicle or, even worse, in an office like the one dubbed the Micropit, along with three other new recruits, your knees practically touching theirs; and though lacking all privacy and quiet, though it's a job you've never really done before,

you are told that you have almost no time at all in which to master a virtual encyclopedia of technical detain and to start producing crucial pieces of a crucial new machine. And you want to make a good impression. So you don't have any time to meet women, to help you wife buy furniture for your apartment, or to explore the unfamiliar countryside. You work." (Chapter 3, pg. 60)

"Many people had taken a crack at solving such problems, notably a group of engineers and computer scientists at MIT who worked with money from the Department of Defense on a project called MULTICS. In the late sixties, they produced a complex plan for making time-sharing systems secure. It was a clever plan. But many experts believed that no system of protection yet devised could withstand the efforts o smart pranksters or thieves bent on foiling it." (Chapter 4, pg. 78)

"Conventional algebra sets rules about the relationships between numbers. Boolean algebra expresses relationships between statements. It is a system of logic; it sets general conditions under which combinations of statements are either true or false. In this sense, it is a binary system." (Chapter 5, pg. 94)

"For each assembly-language instruction there exists a micro-program, and most microprograms consist of several microinstructions. Each of Trixie's microinstructions, in turn, consists of 75 bits. Seen written on a page, a microinstruction is a string of 0's and 1's. These correspond directly, or course, to strings of high and low voltages stored in a special place inside the computer - a 'microstorage' compartment. Each string of 75 bits is divided in portions, and each portion is destined for some part or parts of the machine's circuitry. The 75 bits of each microinstruction are the actual signals that will make the gates in the circuits open and close in just the right patterns. So my '/' became a linked list of, let's say, 10 assembly-language instructions, each of which became a microrogram, each of which consisted, on the average, of 3 microinstructions, each of which consisted of 75 bits. The simple '/' was now platoons of signals, which were sent out one after the other, causing Trixie's circuits to take the two numbers I had provided for division, to translate these numbers into electrical code, to determine which was to be divided by which, to run the now encoded numbers through the Arithmetic and Logic Unit in such a way as to divide them (a labyrinthine passage itself), and to put the answer somewhere for the next step in my program." (Chapter 5, pg. 99)

"That the project might be tossed on the scrap heap somewhere along the way, after months of thirty souls' passionate labor, was unthinkable. But it could certainly happen, they thought. West had felt that he had to promise to do Eagle in something like a year in order to get the chance to do it. Now he shoes to believe that to get it out the door, they really had to come close to meeting that absurd schedule. At the same time, they had to do it right - right in the commercial sense. The whole project was risky, from the start, in service of he big risk, West undertook on the team's behalf many smaller ones." (Chapter 6, pg. 117)

"I had imagined that computer engineering resembled the household electrician's work, but it seemed the bulk of it lay in making long skeins of logical connections, and it had

little to do, at least at this stage, with electricity. I wondered, too, why they had to struggle to fit Eagle's CPU onto seven boards - seven was the goal - when elsewhere engineers were routinely packing entire CPUs onto single chips. The general answer was that a multiboard CPU performs simultaneously many operations that a single-chip CPU can do only sequentially. By making a CPU on several boards, you can make it run much faster than a CPU on a chip." (Chapter 6, pg. 121)

"West had assumed that debugging Eagle would resemble the debugging of Eclipses. He had been deceived. You had to make many parts of Eagle star working, it now appeared, before you could really begin to fix it - this because of certain new features, which everyone agreed were 'sexy'. West couldn't ignore the evidence; he didn't know how to debug this machine, and he could not make himself believe that Rasala and his Hardy Boys would figure it our for themselves." (Chapter 7, pg. 130)

"The days of the debugging wore on. In March West said, referring strictly to the debugging, 'Most of the fear is gone now.' He was speaking only for himself, however, the team had passed through the first sharp fear. But they had designed the machine much too fast for prudence. It had features that none of the group had dealt with before. At this stage none of them dared claim to understand in detail how all the parts worked and fit together. Sufficient cause for worry about the debugging remained." (Chapter 7, pg. 151)

"In theory, a computer can mimic the behavior of anything. It can do so accurately only if the thing being imitated is thoroughly defined. So computers achieve only partial success, at best, when instructed to simulate the behavior of a city or to foresee the future of a national economy. Computers do well, however, when instructed imitating other machines, including other computers - unbuilt ones that exist only on the paper of an architectural specification. You make the old computer imitate the new by writing a program. This program - the simulator - makes the existing computer respond to instruction just as the contemplated, unbuilt computer should. Essentially, your program translates instructions designed for the unbuilt compute into instructions that the existing one obeys." (Chapter 8, pg. 161)

"As it was in fact, the Microteam could test their code right at their desks, via their own terminals. Firth's simulator was a program stored inside their computer, the Eclipse M/600 - Trixie. They merely had to feed into Trixie the microcode they wanted to test, order up the simulator, and command it to run their code. They could order the simulator to stop working ant any point in a microprogram. The simulator could not tell the microcoders all by itself what was wrong with their code, but it arranged for the storage of all the necessary information about what had taken place while the code was running, and would play all of it back upon demand. Thus, without having to invent ingenious approaches with logic analyzers, the team could examine each little step in their microprograms. They could find out what was going wrong in an instant, in many cases. In the Microteam's small corner of the world, Firth's was an heroic act." (Chapter 8, pg. 165-166)

"Ever since he had gone to work for Data General, West had been talking about quitting. Someday he'd wander off. In a sense, he already did so every day." (Chapter 9, pg. 172)

"For some time during the debugging of the first Eclipse, West was ill every morning before work - a psychological form of morning sickness, perhaps. But when the job was done and he went to the factory floor and saw a long file of brand-new Eclipses come gliding down a conveyor belt, some great delight, which he would describe as 'almost a chemical change,' came over him, and what he wanted most of all to do then was to do it all over again someday, only better." (Chapter 9, pg. 178)

"The veterans in the Eclipse Group maintained that most computers never get completely debugged. Typically, they said, a machine get built and sent to market and in its first year out in public a number of small, and sometimes large, defects in its design crop up and get repaired. As the years go by, the number of bugs declines, but although no flaws in a computer's design might appear for years, defects would probably remain in it - ones so small and recurring only under such peculiar circumstances that they might never show up before the machine became obsolete or simply stopped functioning because of dust in its chips. Big bugs in the logic of a machine, however and even what might seem to be fairly small ones, have to be found and cast out in the lab. The hardware of modern computers is remarkably reliable, and needs to be. A computer like Eagle does a cycle of work in 220 billionths of a second. If it tended to fail only once every million cycles, it would be a very unreliable contraption indeed." (Chapter 10, pg. 184)

"Some problems are easy to find and hard to fix; some are hard to find and easy to fix; some go both ways. They have seen and will continue to encounter permutations of all three. This one was hard to find. It happens to be easy, almost trivial, to repair." (Chapter 10, pg. 208)

"Rosen, who designed the board called the ALY, is trying to get it to perform addition. It is not a large exaggeration to say that everything else in a computer exists in order to bring information swiftly to the ALU for manipulation; and for the ALU, adding is the mechanical equivalent of breathing. But this evening, whenever the diagnostic program has asked the ALU to add two packets of bits, the ALU has sent out a wrong answer and then performed a series of incomprehensible action." (Chapter 11, pg. 211-212)

"That summer, in Mini News, one of the two in-house company papers, an article appeared bragging that Data General was spending a larger percentage of its profits on research and development than almost any other company in the industry - more, indeed, than the vast majority of American companies of every sort. Holberger say the article. He took it into West's office, 'Hey, Tom, where's it all going?' Was the lion's share

going to North Carolina? Some suspected it was - but only in moments like these, the competition had receded so much." (Chapter 12, pg. 222-223)

"A certain broad division between companies was apparent. The established and successful, with many wares to show, had sectioned off pieces of the central floors, setting up theaters and playhouses. The smaller, newer, less diversified had small booths along the walls. They were the little jewelry and camera stores wet of Broadway. Wallach gave them a window-shopper's tour. Many of these little outfits were selling 'pin-compatible memories,' ones that could be added to DEC's and Data General's machines more cheaply than the extra boards offered by the big manufacturers." (Chapter 13, pg. 238)

"To some the crucial issue was privacy. In theory, computes should be able to manage, more efficiently than people, huge amounts of a society's information. In the sixties there was proposed a 'National Data Bank,' which would, theoretically, improve the government's efficiency by allowing agencies to share information. The fact that such a system could be abused did not mean it would be, proponents said; it could be constructed in such a way as to guarantee benign use. Nonsense, said opponents, who managed to block the proposal; no mater what the intent or the safeguards, the existence of such a system would inevitably lead toward the creation of a police state." (Chapter 13, pg. 241-242)

"A computer of Eagle's class must perform at high speed two special kids of arithmetic called single-precision floating point and double-precision floating point. Scientific users, especially, care about this matter. Maybe more important, this is one of the few areas in which the quality of a computer can be measured and given a number, through a standard test called the Whetstone Benchmark. It is not the or necessarily the most important standard by which to judge a computer - if you want to do trigonometry on your computer it's very important - but it is a popular test, partly thanks to Data General." (Chapter 14, pg. 254-55).

"West's risky decision to use the new chips called PALS had some troublesome consequences. Months passed before Data General could be sure of getting enough of those parts to manufacture Eagles. So the machine's public debut was put off, again and again, until the spring of 1980. As time went one, however, it became clear that West had made the right choice; PALS really were a chip of the future...
In the months that followed Eagle's debut, it would become evident that the computer was probably going to be a big win, just as West had promised. Rumor had it that by early 1981 the dollar value of orders for Eagles represented more than ten percent of the value of all new orders for Data General equipment. So it did seem that Eagle had arrived just in time to rejuvenate the upper end of the company's product line. Data General was already late entering the supermini market, and might have missed the market altogether if it hadn't been for Eagle, because by the Spring of 1981 North Carolina still had not produced a machine." (Chapter 15, pg. 269)

"Adopting a remote, managerial point of view, you could say that the Eagle project was

a case where a local system of management worked as it should: competition for resources creating within a team inside a company an entrepreneurial spirit, which was channeled in the right direction by constraints sent down from the top. But it seems more accurate to say that a group of engineers got excited about building a computer. Whether it arose by corporate bungling or by design, the opportunity had to be grasped. In this sense the initiative belonged entirely to West and the members of his team. What's more, they did the work, both with uncommon spirit and for reasons that, in a most frankly commercial setting, seemed remarkably pure." (Chapter 15, pg. 272)

"West and the other leaders of the Eclipse Group had acquired some enemies who would not mind seeing them taken down, and Wet got into a long-running battle, which heated up as the debugging approached completion. As he explained it to Rasala, West felt he was fighting to preserve the group's substantial freedom and to prevent a situation in which the team would simply be delegated to do certain jobs." (Chapter 16, pf. 282)

"I did not think that Data General had the look of a doomed enterprise, but rather of one that was suffering harsh growing pains. During this period, what seemed to be an unusually large number of people in crucial positions left the company; they included important sales personnel and several vice presidents - among them, Carl Carman. Downstairs, remembering that the Eclipse Group had once been called 'a strong foundation, who are we holding up?'" (Chapter 16, pg. 285)

Topics for Discussion

How did Data General Corporation come into being?

Why was Data General so slow in developing a 32-bit super mini computer?

How did Data General develop the policy of hiring new college engineering graduates without experience?

What is one of the big problems and dangers with time-sharing?

What was the management style and philosophy that existed at Data General? How did this affect programs like the Eagle?

What were some of the problems experienced in debugging the Eagle? How did they handle them?

What is a time bomb?