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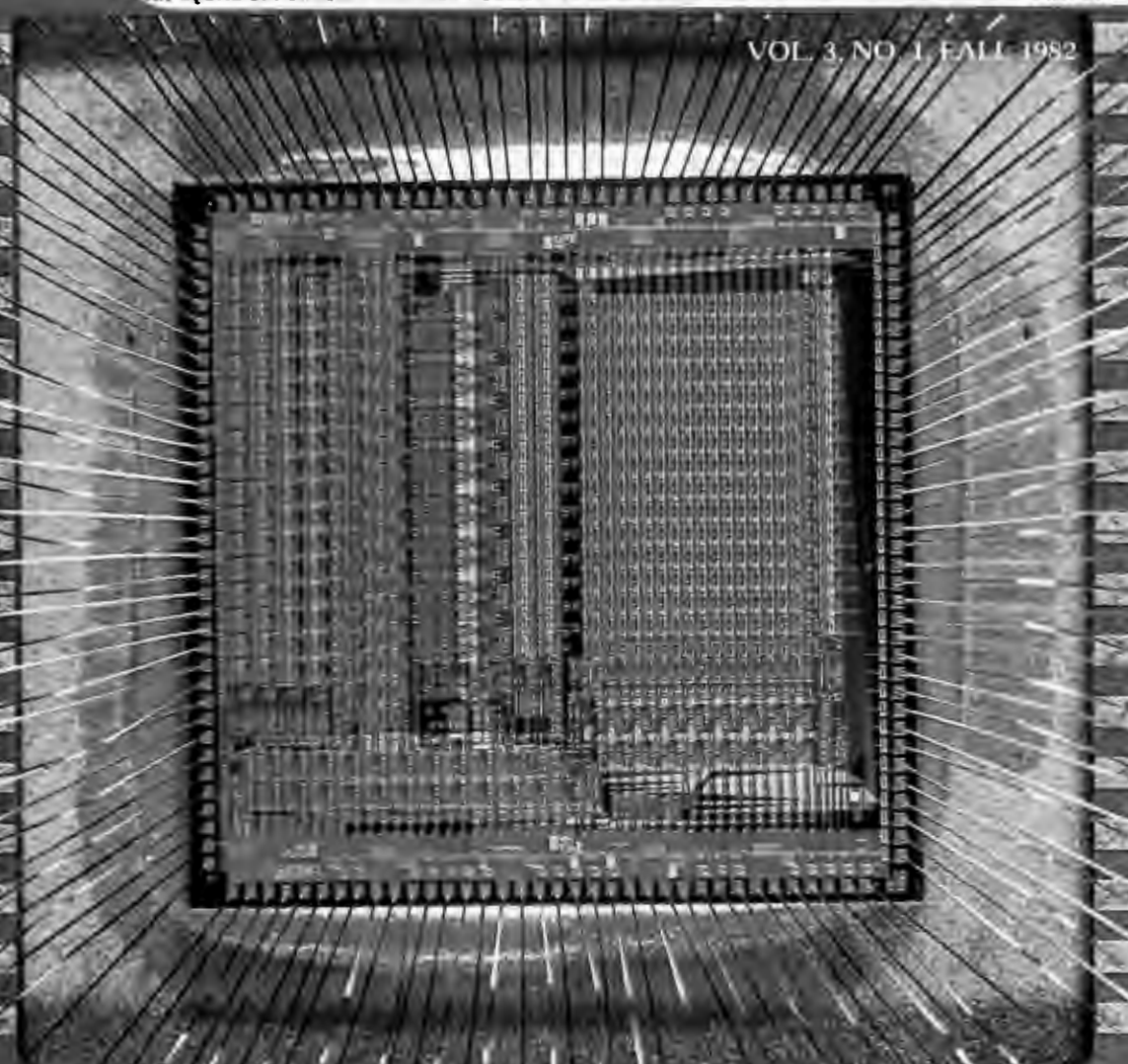


THE

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VOL. 3, NO. 1 FALL 1982

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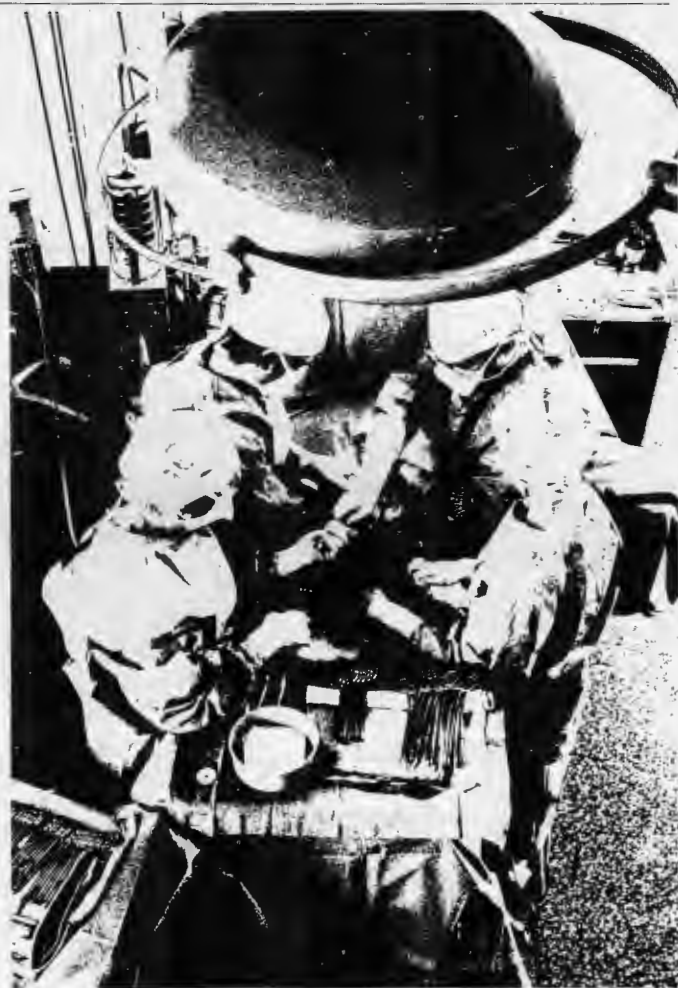
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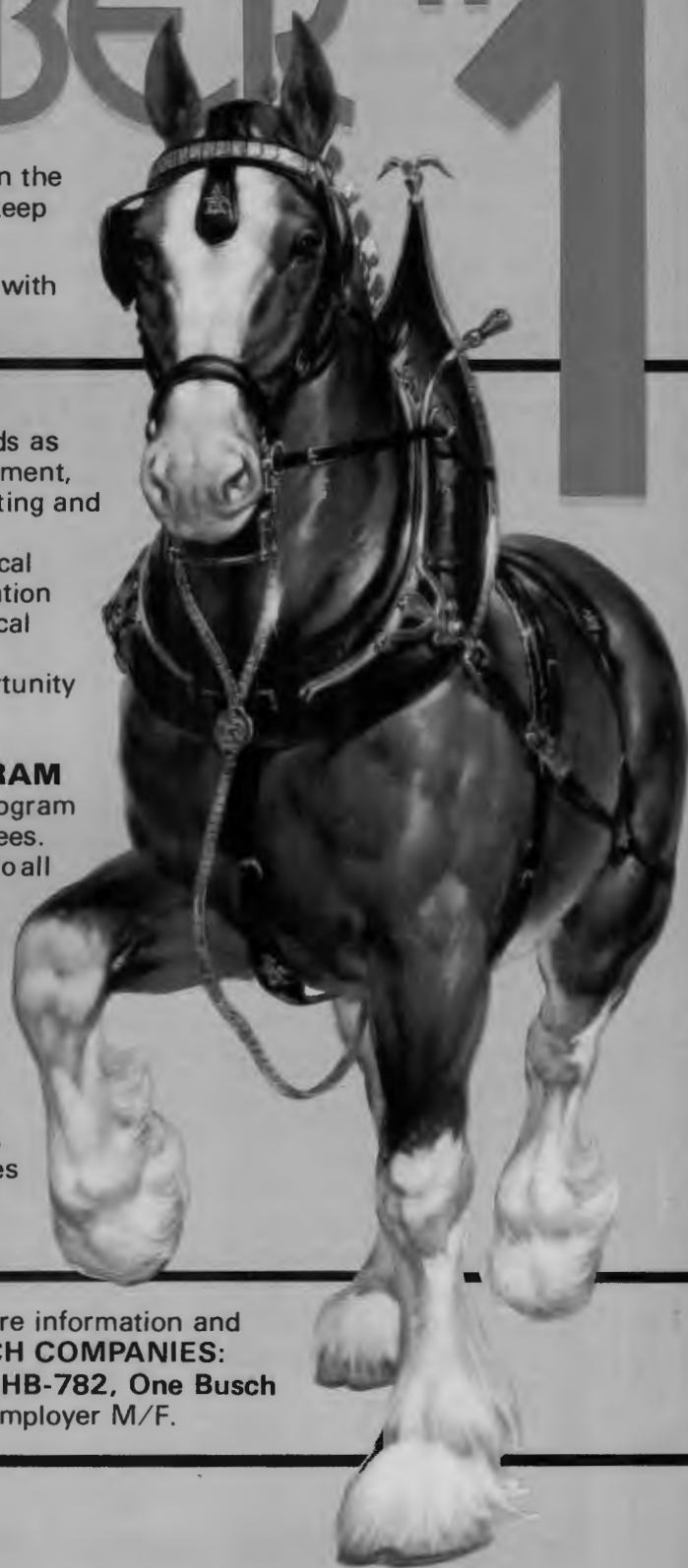
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EDITORIAL

A writer we know, who works at home, recently invested in a personal computer, complete with elaborate peripherals, text-processing software, a telephone inter-connect, and a subscription to a very large data bank/communications network. Several weeks later, she posted an open-response query on her net: "If I live in an electronic cottage, how come I still have to do dishes?"

It's an excellent question. Unfortunately, she hasn't received any excellent answers. We found the same problem on another level. With some notable exceptions, most of the writing about computers seems to overlook the human scale, the humdrum nitty-grit of reality that we all share. Some of the writing is technical, and while it's excellent information — in fact, we are planning articles along these lines — people are invisible. Other articles, usually by systems analysts, treat humans as a particularly inconvenient and glitch-prone type of software. Finally, there are reams of projections about the future impact of computers, studded with sweeping scenarios that promise utter bliss or absolute doom. Sadly, most of us live in the middle ground of mixed results.

It was because we wanted to try to restore a sense of the human scale that we focused on the interaction between humans and computers, an idea we have tried to express in the section title, COMPUTER/PEOPLE. In that section, we feature an article on artificial intelligence, which focuses on the efforts of people — scientists, engineers, and systems specialists — to create computers with that most human attribute, the power of independent thought. There's an article on Grace Hopper, a software pioneer whose innovations have become basic to modern information processing. And, along with several other stories, there's a look at some of the different ways people might work in the electronic office. It's based on the historic truth that tools can create or destroy, depending on how people choose to use them.

That last point is very important to us. There are a whole range of choices involved in deploying a technological development. As engineers and scientists, you will play a part in making those choices. And some of them may have a profound influence on the quality of other people's lives.

While our current issues focuses on computers, this principal applies to every type of engineering and applied science. Sometimes the choices involved in technological applications are made by omission, or by faulty or limited analyses. All too often, the result is an inhumane technological achievement. It's true that human factors are not precisely quantifiable, but that does not mean they don't have an impact: an inhumane system wastes human resources.

The distinguishing mark of a true profession is that it gives its members the power of specialized knowledge. In return, professionals accept the responsibility of using their power ethically. Doctors have an oath, and lawyers have codes of ethics, to try to guide them in fulfilling this duty. Engineers have it rougher: they have no such guidelines, unless they decide to become professionally certified. Yet they still bear the responsibility of using their skills, and their power, to serve both people and society.

When *Woman Engineer* began, we stated that one of our objectives was to help our readers become good engineers. For us, the word "good," in that context, means ethical, as well as technically competent. That puts a heavy load on you, but if you are determined to become an engineer, the chances are that you're not one to duck challenges. We hope you all become good engineers, in all the senses of the phrase, and we hope we can help you.

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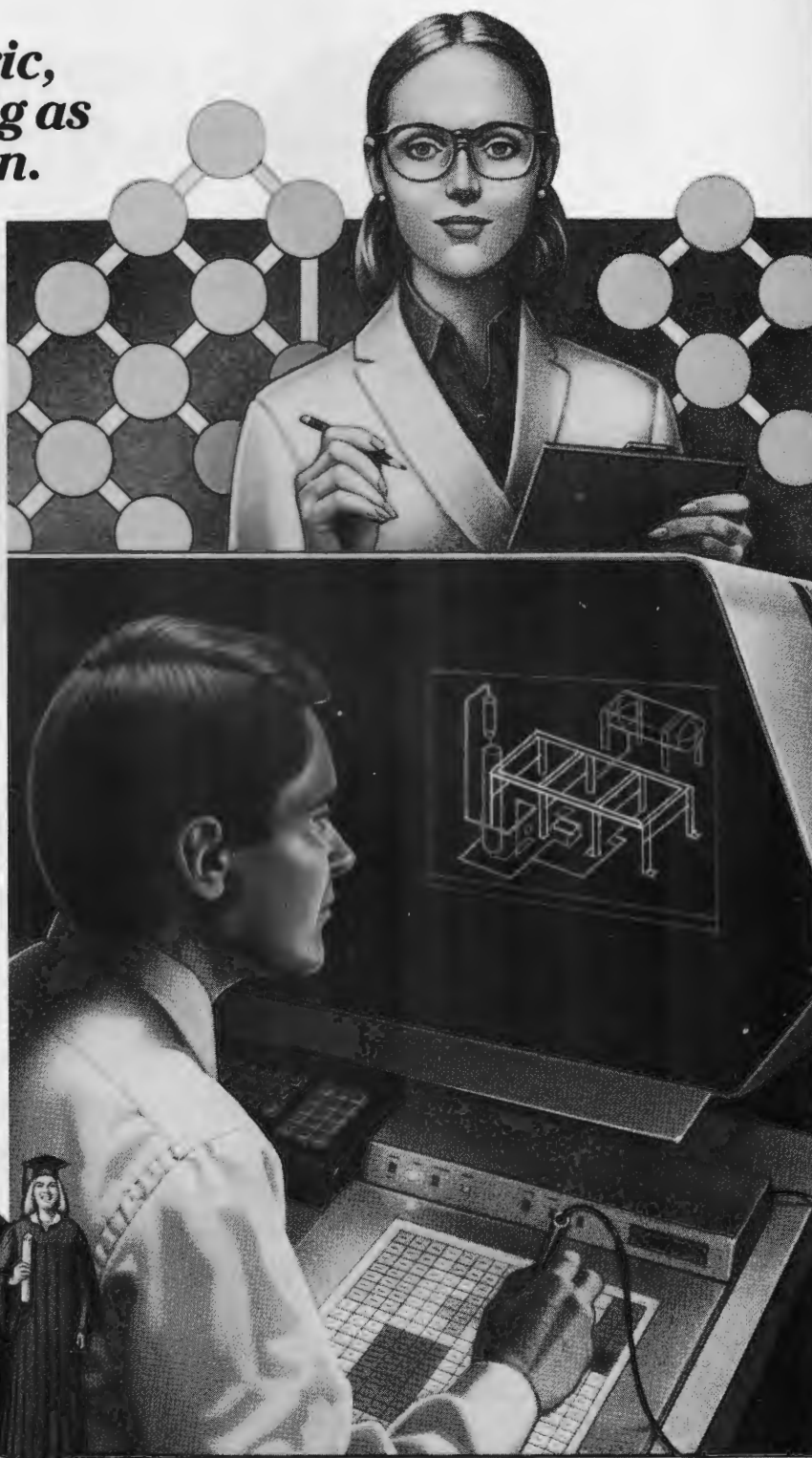
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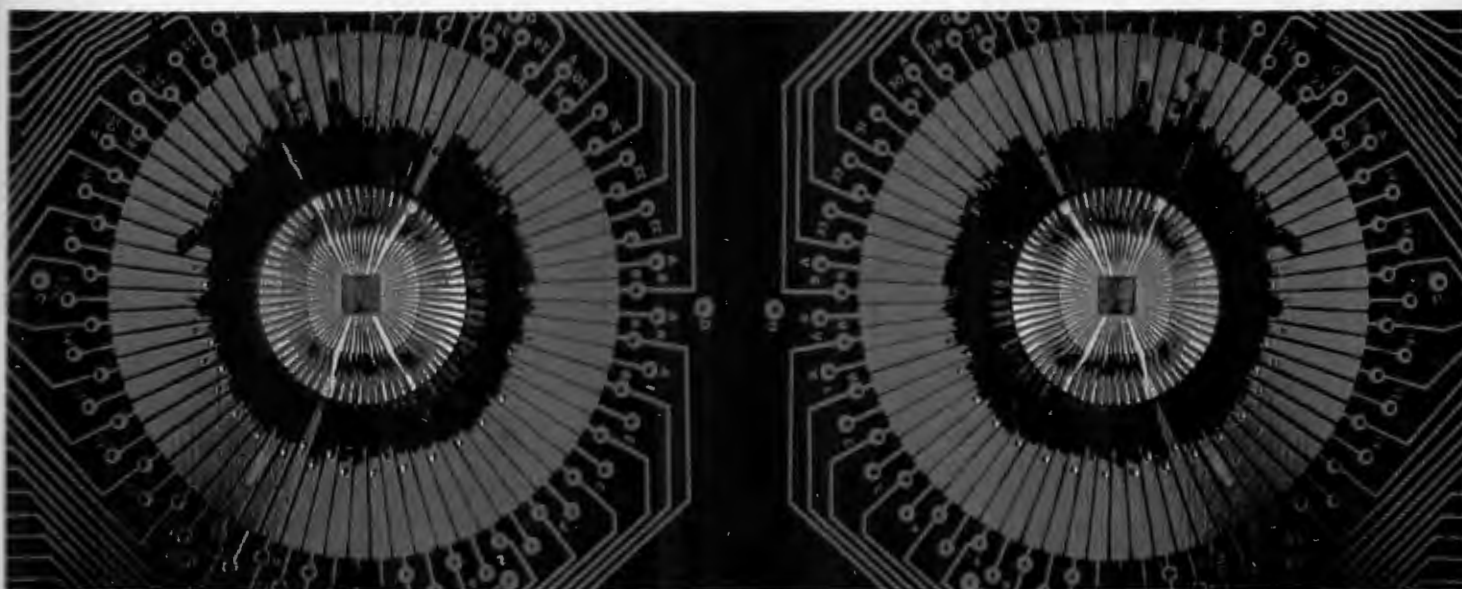


Photo: Phillip Hamilton/G.E.

A.I. another kind of mind.

By William Stockton

A.I. stands for “artificial intelligence” — making computers think. It’s perhaps the most exciting, challenging, and troubling area in computer science today.

Although the computer in its short life span of three decades has made staggering advances, becoming capable of prodigious calculations that have led people to endow it with anthropomorphic characteristics, it is, in fact, a dumb machine. A computer does exactly what it is told — nothing more, nothing less.

A French philosopher began his proof of human existence with the premise “I think, therefore I am.” What will happen to our definition of humanity if a machine can make the same statement?

But what if computers were intelligent, like HAL, in the Stanley Kubrick film “2001: A Space Odyssey”? Imagine a machine that would compel us to use the pronoun “who” when talking about it, a machine who could think, reason, make logical deductions, remember past experiences, solve present problems by recognizing analogous situations. Would not such a computer hold the capability that has always distinguished “I am,” Rene Descartes, the 17th century French philosopher and mathematician, said? Now, some of the world’s philosophers, mathematicians, linguists, psychologists, electrical engineers and computer scientists are working to create machines which will

be able to work the same claim: machines with artificial intelligence (A.I.). These experts believe — though there are some dissenting voices among them — that they are beginning to succeed to an extent inconceivable only 20 years ago.

A.I.—THE ULTIMATE TOOL

In the future, artificial intelligence could produce powerful assistants who manage information for us, reading books, newspapers, magazines, reports; preparing summaries, avoiding those things the computer knows won’t interest us, keeping abreast of everything that happens in the world, seeing that nothing we really should know about escapes us. These intelligent computers could analyze the decisions that face us, searching libraries of knowledge for facts that will help with a decision, and then presenting us with possible courses of action and their probable consequences. They could understand specialized knowledge and know how to put it to work in some of the highly skilled areas in which we humans function — law and medicine, for example. A.I. programs could guide robots that do our dirty work: collecting garbage, mining coal, cleaning up the radiation of a damaged nuclear reactor.

But the real promise of artificial intelligence is even greater — that it will become an incredible tool for

A.I. . . .another kind of mind. . .

extending the human intellect further than was ever dreamed, for lifting human creativity itself to new heights of achievement. In fact, there is now talk in the scientific community that the forging of a man-machine symbiosis could represent the next great development for man, equivalent in its portent, perhaps, to walking erect or building the first tool.

"The amount of intelligence we humans have is arbitrary. It's just the amount we have at this point in evolution," says Marvin Minsky of the Massachusetts Institute of Technology. "There are people who think that evolution has stopped and that there can never be anything smarter than us." Minsky, who is one of the founding fathers of the artificial-intelligence research field, says that is like saying that a person can't build a house any higher than he can reach.



A.I. as threat: in 2001, two astronauts plan to disable HAL, an intelligent computer which has become psychotic. In response, HAL (visible through porthole in center of picture) kills most of the crew in an attempt to take sole command of the space craft.

THREATS INSIDE THE PROMISE

There is a dark side of the forecast, however. If this new technology could be subverted, enormous evil could result. Computers that understand speech could be programmed to listen in on virtually every human conversation, for example, and the computers themselves could be programmed to know whether what was said would be of interest or be alarming to the authorities — and, if so, to sound the alert. Then there is the ultimate fear that the computers will conspire to take over.

This has been the stuff of science fiction for years. In the Stanley Kubrick movie "2001," the intelligent computer, HAL, kills nearly the entire crew of a Jupiter-bound space probe. It develops that HAL has gone insane: because of internal contradictions in its programming, it is attempting to assume command, and is killing potential opposition.

The 1968 film was entertaining but, of course, it was totally fictional. What artificial-intelligence scientists conceive of as being a far more realistic threat is the possibility that the human race will become too dependent upon its machines; that we will lack the ability to understand why they reach the decisions they do and take the actions they do. Finally, there is the fear that machines could come to possess all the capabilities that have set humans apart. By permitting the creation of intelligent machines, would we assure the immortality of machines and unwittingly sow the seeds of our own extinction?

In the minds of many of the experts, the question is no longer *whether* computers can ultimately be programmed to exhibit human attributes, but rather *how* to do the programming.

THE DIFFICULT WE DO AT ONCE; THE SIMPLE IS MUCH HARDER

One irony of the current research work is that the most difficult problems arise in the attempt to create machines that mimic the simplest elements of human behavior, while the successes have been in modeling some of the highly specialized skills that people

The real promise of A.I. is that it will become the ultimate tool for extending the human intellect, lifting creativity itself to new heights of achievement.

develop. Artificial-intelligence computer programs that simulate eye-to-hand coordination by hooking television cameras to computers and mechanical arms do not perform as well as an infant in diapers playing with blocks on a living-room carpet. On the other hand, the computers can now perform extremely complex exercises that humans become good at only after years of effort — playing chess well, for example, or diagnosing disease.

Developing these types of expert systems is a major part of the artificial-intelligence research work at such places as S.R.I. International in Menlo Park, California. One of its creations is PROSPECTOR, an electronic assistant geologist.

To build PROSPECTOR, the S.R.I. International researchers have worked with experts in geology to codify the knowledge that a geologist uses in studying a particular region. So PROSPECTOR can be given a list of types of rocks and configurations clearly present in the outcropping of a region that his boss has under study. PROSPECTOR then lists the types of ore deposits that might be present and asks the geologist to rule out those he feels don't apply in this situation. The computer's questions become progressively more specific. Finally, PROSPECTOR reaches a conclusion: "There is a probability that a copper ore deposit exists in the region."

A program called INTERNIST has been developed at the University of Pittsburgh by Drs. Jack D. Myers and Harry E. Pople. They focused on internal medicine, studying how an expert medical diagnostician approaches a patient. INTERNIST asks the doctor who is using it for specific information about the patient: disease symptoms, items from the patient's medical history, laboratory and other test results and so on. Then INTERNIST, just like a real doctor, discards some diagnostic possibilities and explores others further. Ultimately, a diagnosis is suggested. The Pittsburgh scientists say they have already codified the majority of human illnesses, and have about 175 more such programs to write. "We hope to begin field trials for INTERNIST here at our own institution by next spring, and to send it out to other institutions within two years," says Dr. Myers.

ELECTRIC WARRIORS AND EDITORS

Much of the funding for artificial-intelligence research projects has come from the military, which is

directly interested in its applications. S.R.I. International is now working on computer programs that might assist electronic-warfare officers. An aircraft equipped with a computer would have the capability to digest information given the "E.W. officer" during a preflight briefing, then help during the flight to make rapid decisions. "Ultimately, such a program could give the pilot advice about what to do next," says Nils Nilsson, head of S.R.I. International's artificial-intelligence program.

Computer programs to process and understand information — the written and spoken word — are

There is talk in the scientific community that A.I. could lead to a human/machine symbiosis as important to human evolution as walking erect or building the first tool.

being created at Yale University's artificial-intelligence laboratory. Yale has focused on how to represent knowledge in a computer so that the link between words and ideas can be made and lead in turn, to logical conclusions.

Its FRUMP program reads short news stories and writes perfectly grammatical, one-sentence summaries in English, Spanish and Chinese. Not that it doesn't make some mistakes. FRUMP was asked to summarize a wire-service story about the shooting of the San Francisco mayor in 1978. The story had reported that the "shooting shook San Francisco," and thus the computer concluded that there had been an earthquake in California. On another occasion, a Yale computer mistakenly summarized a news story twice. The story was about Filipino terrorists kidnapping a missionary, and the computer, falsely perceiving a pattern because of its own error, concluded that "terrorists tend to kidnap missionaries."

But, although obviously not yet ready for night rewrite, FRUMP is normally right on the job. Presented with a 600-word story about the death of the anthropologist Margaret Mead, who died in 1978, the computer writes the following summary: "Anthropologist Margaret Mead, 76, has died from cancer." Given a 400-word story about a fire in a boardinghouse, FRUMP summarizes: "A fire in a boardinghouse in Farmington has killed 25 people and injured 7 people and destroyed a building."

To write this summary, the computer was programmed with a vocabulary that both defined words and represented their relationship to other words. The words were represented symbolically within the computer so that the FRUMP program "knew" that fires can damage property and injure people. It had to know the difference between injury and death. The UPI story said that the fire had killed 25 people and "injured 7 others." FRUMP had to understand the concept of the pronoun "others," knowing that in this case it referred to residents of the home but that in a different situation "others" could mean something else.

TERMINAL-SIDE MANNER

A Soviet scientist, touring the United States, sat down in front of a Stanford University computer that had been programmed to simulate a psychoanalyst.

The Russian was instructed to read questions that were flashed before him by the computer program, named DOCTOR, and to type in his answers.

"What brought you to see me today?"

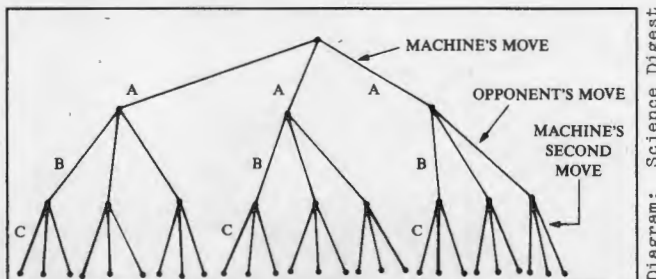
DOCTOR asked.

"I'm feeling a bit tired," replied the scientist.

"Why do you think you are feeling a bit tired?"

"Well, I've been traveling a lot. . ."

The Russian was introduced to the computer by Pamela McCorduck, then an assistant at the Stanford computer center, who says he was, indeed, tired, that he had been traveling for weeks, struggling with a language he didn't speak fluently, and that this probably contributed to what happened next. The scientist, though he was a computer expert himself and well aware that he was conversing with an inanimate machine, surprised those present by his reaction when DOCTOR said to him, "Tell me about your family." The Russian began to provide intimate answers; he spoke of his worries about his wife and his children and his emotional distance from them.



In a checkers game, a computer evaluates three possible moves (the As) by calculating its opponent's probable responses to them (Bs) and the options that would follow (Cs).

"There were four or five of us in the room," Pamela McCorduck recalls. "Some of us turned away in painful embarrassment. I was mesmerized. I hung over his shoulder. I couldn't tear myself away." In her book, *Machines Who Think*, she wrote: "Something about that impartial machine had evoked a response from the visitor that the norms of polite human conduct forbade."

DOCTOR was developed in the 1960s, when AI was scarcely a decade old. Kenneth Colby, then a Stanford Medical Center psychiatrist, adapted it from another program called ELIZA, created by Joseph Weizenbaum of the Massachusetts Institute of Technology. But in the years that followed, Weizenbaum has become appalled at the number of people who have reacted to programs like DOCTOR and ELIZA just the way the Soviet scientist did, who have seemed almost eager to embrace the computer as a metaphor for themselves, or their fellow man.

HOW MUCH CAN A MACHINE UNDERSTAND?

"There are aspects to human life that a computer cannot understand — cannot," Weizenbaum said in an interview three years ago. "Love and loneliness have to do with the deepest consequences of our biological constitution. That kind of understanding is in principle impossible for the computer."

But is it? The questions Weizenbaum has raised go to the heart of artificial intelligence's future and its ramifications. It is now becoming apparent to more and more scientists in the field that computers can exhibit intelligent behavior.

Continued on page 105

A New Kind Of Apprentice



Back in the time when skilled craftsmen were the backbone of American industry, learning a trade was a long and humbling process. You didn't just start out tooling the leather or forging iron in those days. You needed a patient but firm instructor who would take you on as an apprentice to do the dirty work, the dull, menial tasks that prepared the work for the master craftsman's touch.

Today, the apprentice has all but vanished from the scene of the American workplace. Industry can no longer afford to relegate its vital labor base to the drudgery yesteryear's apprentices endured. Employees would quickly become discontented with their jobs and management would lose the skill potential most people possess. Product quality and volume would also suffer because human workers are prone to error and limited in their ability to constantly perform arduous tasks hour after hour.

It was for these reasons that machines were invented — to lighten the load, to do what human workers could not. And just as the assembly line ameliorated the factory worker's task, computers can now eliminate menial mentation for the white collar worker. Because computers revel in the repetitive and behave predictably over long periods of time, humans are freed for more creative tasks and decision making.

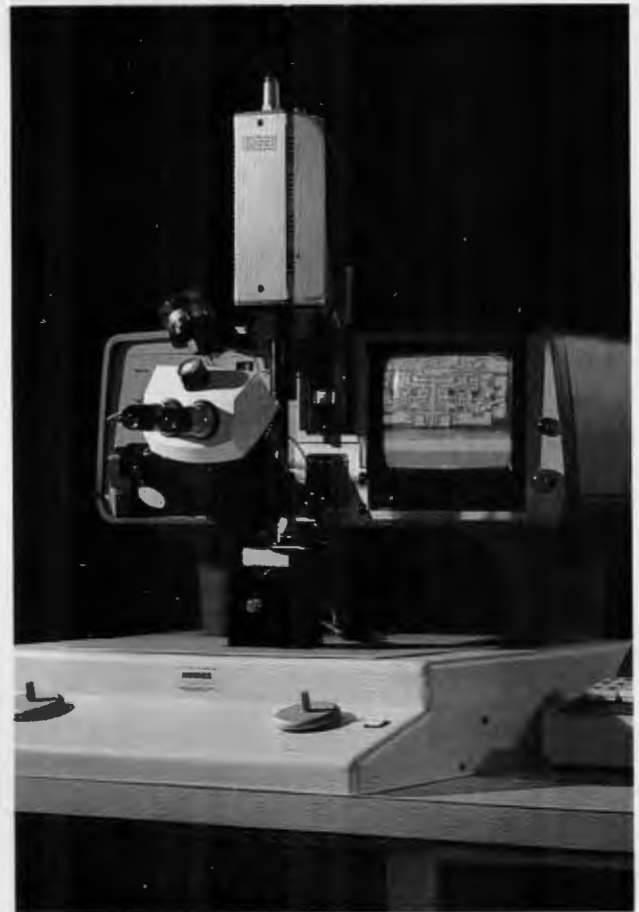
It was only logical that these two developments in industry — machinery and computers — would be combined into one entity, giving birth to a new kind of "apprentice" in the workplace. This apprentice takes orders and performs incessant rote functions as long as required. But unlike the craftsman-to-be of earlier times, it's content to stay rooted in one place, clicking out the job day after day, year after year.

One modern-day craft that has had its share of drudgery is the production of hybrid microelectronic circuits. Hybrid assemblers have had to manually bond each of several pairs of connections on a chip. When it is realized that a hybrid can consist of many chips, the task can be analogous in difficulty to inscribing biblical text on the head of a pin. Even with a microscope helping to single out these tiny connection points, the potential for error was as great as the prospect of high-speed production was dim.

A new apprentice in the form of a microcomputer-controlled wire bonder built by Hughes Aircraft Company has now reported for duty, to change forever hybrid circuit production.

The HMC-2460 features an all-star cast of components from several technologies. The roster includes an ultrasonic generator; a microscope; a camera with closed-circuit television; a rack-and-pinion drive bonder slide; a servo motor-controlled bonding table; fiber-optic cabling; and a pyrometer. Yet for all the brawn this synthesis provides, the 2460's real strength lies in its brains — a microcomputer that makes use of distributed processing techniques resident in large mainframe computers.

The 2460's computer, which comes equipped with a stylized keyboard and floppy disk drive, literally takes the wire bonder out of the operator's hands. It controls all functions of the wire bonding process: positioning the bonder in three-dimensional space, determining the right amount of bonding force and power, looping the thread-thin gold wire from one connection point to the other. As a result, a wire-bonding process that formerly took 40 minutes to complete manually can now be done in less than three minutes.



Gifted though it may be, the 2460 cannot just start bonding wires by itself. Like any apprentice, it needs to be taught. The operator who formerly did all the positioning manually now sits at the machine and runs through the steps he would normally perform, showing the 2460 where on the hybrid to make bonds. This sequence of operations defines a program that the computer will use when it later does the bonding automatically. Provided with just two reference points that describe opposite corners of each of the circuits on the hybrid, the computer is able to orient the parts and place bonds in the right places.

A New Kind Of Apprentice. . .

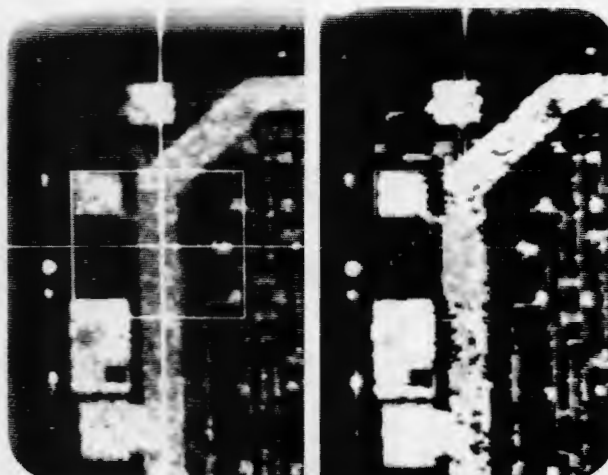
A new development that contributes to the 2460's advanced capability is a technique called digitized video pattern recognition — a technology borrowed from Hughes TV-guided missiles. Just as the smart missile's TV seeks a target that matches a previously stored image, the wire bonder's TV looks for a hybrid orientation that matches the one stored in memory during the "teaching" phase.



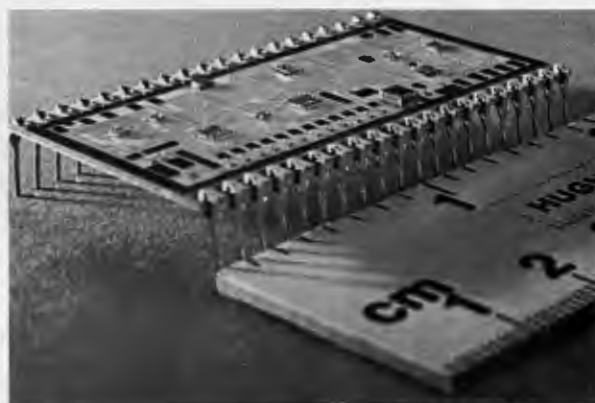
The HMC-2460 automatic wire bonder does much of the dirty work associated with hybrid circuit production—the tedious, rote tasks previously performed by human operators.

It does this by scanning across the entire field of view of the TV camera, digitizing the video signal for each search area and comparing the digitized data bits to those of the memorized reference pattern. It then "recognizes" the image that matches most closely. This entire process takes place in about fifteen hundredths of a second and enables the 2460 to begin bonding the right connections.

The immense hardware and software power of the Hughes automatic wire bonder has brought a new and permanent apprentice to the microelectronic craft. And along with it comes a greater degree of speed, efficiency and accuracy in hybrid circuit production. But best of all, the human operator who was the apprentice now becomes the craftsman responsible for giving the orders and teaching the trade.



These two TV images illustrate the 2460's optical pattern recognition capability. The display (left) is normal video, received via the TV camera. Each video image that the 2460 receives is digitized and compared with a target image stored in the computer's memory (right). When the two images correspond, as they do here, the 2460 has recognized the proper chip orientation and is ready to begin bonding.



A hybrid microelectronic circuit, the finished product of the 2460's bonding operations.

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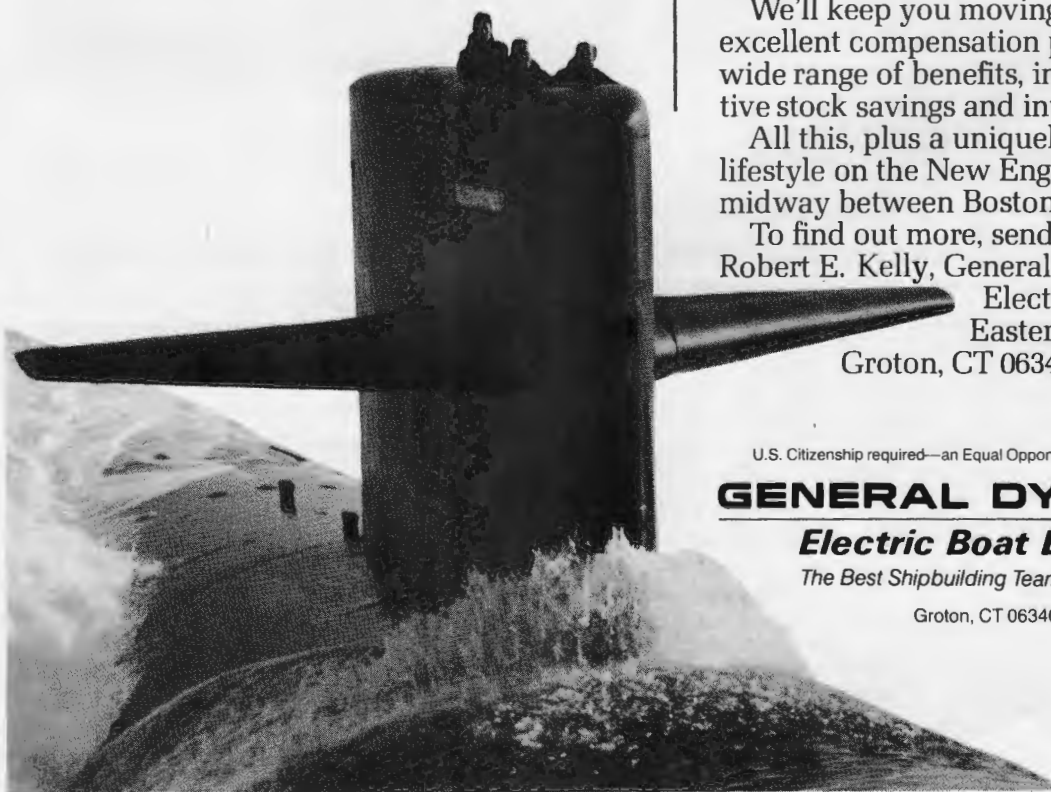
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Living In The Electronic Office

By Joe Celko

Technology can enslave as well as it can liberate. So will tomorrow's automated office be the unstructured, creative places some predict, or will they be electronic sweatshops?

*Stitch! Stitch! Stitch!
In poverty, hunger and dirt;
And still with a voice of dolorous pitch—
Would that its tone could reach the rich!—
She sang this "Song of the Shirt!"
19th Century song*

There has been an assumption that the office of the future will be a wonderful place to work, with all the dull work done by robots, computers and word-processors. Just look at the ads in any of the trade

magazines: well dressed, happy people are playing with the latest whizbang from the advertiser, while the copy tells how much effort and time are being saved.

Machinery can most certainly change working conditions. That became clear at the start of the Industrial Revolution. However, I would like to question the premise that computers, or any machinery, have the power to improve working conditions in and of themselves. Americans, and most especially those of us in data processing, have been prone to believe this premise.

There is a cherished myth about the way things were in the earlier days of the industrial revolution. Every high school textbook has pictures of child labor and sweatshop girls, accompanied by texts of horror stories about exploitation. The reality, however, was much more complex; for many, it was a positive picture.

The bad old days?

In the late 1700's in England, a child was paid one penny per day for a 12 hour workday. It sounds bad, doesn't it? But what the high school textbook does not tell you is that one penny could buy a week's food and lodging at an inn; you slept in the pub, and got supper.

Suddenly, the wage does not look so bad. And if you compare it to staying on the farms of England at that time, it looks great. The population of England tripled with the industrial revolution. This increase was not due to immigrants or greater family size. The records of birth and death kept by the local churches show that people started to live longer in tenement slums than they did on farms. The myth of the beautiful farm life contains a large component of the unavoidable agricultural by-product, manure.

Many of the New England mills began a tradition of education at a time when most people (—and certainly not females—) were not educated. In some factories, in places that were quiet enough, some workers would read to the rest of the staff; employers supported such efforts. By the 19th century in America, the women who worked in the factories of Lowell, Massachusetts, could get what would today be grade school thru two years of college. This is not a bad fringe benefit, even today.

Let us start off with an agreement on what things are like now and give two versions of where they could go in the near future.

The Second Industrial Revolution, Cybernetic Revolution, or Third Wave (as Alvin Toffler calls it) is rolling, driven by the computer and the use of information. Computer Science is already being taught in high schools. An inability to use computers will become an ever-greater handicap. This is not just because computers will be a dominant part of everyday life. Bank machines, automobiles, vending machines, game machines, watches and pocket calculators are all present examples of computers in everyday life. Who knows how far things will be carried in the near future?

Two scenarios

The first scenario is that the office of the future will be no office at all. People will be connected through communications networks to employers and fellow workers. They will perform their work at home or in the field, pretty much whenever they feel like it. Even manufacturing will be done by remote because the factories are staffed with robots.

The executive in this environment must be able to work with a computer directly, or he is going to have to hire a secretary to follow him around constantly. And I do mean constantly. The whole concept of regular business hours and location is shot to hades by the communications network. The executive must learn to type well enough to use a terminal, or else always have a voice input unit with him, simply to get a report or look at a bit of data. Even clerks or lower level workers could be floating in an electronic labor pool as independent sub-contractors.

Now, let us try scenario number two.

*Punch! Punch! Punch!
In poverty, hungry so hard;
And as she skipp'd
And as she dupe'd
She sang this "Song of the Card!"
Devil's DP Dictionary*

Imagine a room filled with small workstations each having video display units. The employees, almost all female, arrive and sit keying-in data. Unlike the original keypunch shops, the workflow is kept uniform, breaks

are controlled, and each employee is isolated from everyone else.

Unlike the original keypunch room, there is no upward career path. In the early days of the computer age, skilled keypunchers could become machine operators, then programmers and perhaps eventually have a shot at management.

A slavedriver boss can be built into the computer system itself. The machine can display messages such as, "YOU TOOK 1.27 MINUTES TOO LONG ON COFFEE BREAK ONE. YOUR PAY WILL BE DOCKED FOR THIS TIME UNLESS IT IS MADE UP DURING COFFEE BREAK TWO." The Boss can claim not to be responsible for this policy by blaming the computer. In fact, the boss actually can be actively opposed to this system, and still have no chance to change it.

The Atlanta Public Library installed a computer system which, among other things, would compute the fines on overdue books. Anyone with fines was stopped from using the library until they paid. This sounds fine and like something the branch head librarian would enjoy. The problem with the system was that many of the branch head librarians had been "harboring criminals." Many of the poor children who were heavy readers would keep the books overdue, and the branch head librarians would simply not collect fines on them. Now they had no choice about it. The machines would either pull the kid's cards or the books would not balance. Many of the librarians paid the fines out of their own pockets, until the system was modified.

Herein lies the great danger. In the sweatshop of the first Industrial Revolution, only the tools were locked into rigid mechanistic molds. The worker was left with some individual interaction with fellow humans, some decisions making power over the work environment.

In the sweatshop of the second Industrial Revolution, not only the tools, but also the individual interaction and the decision making power can be locked into the Skinner boxes.

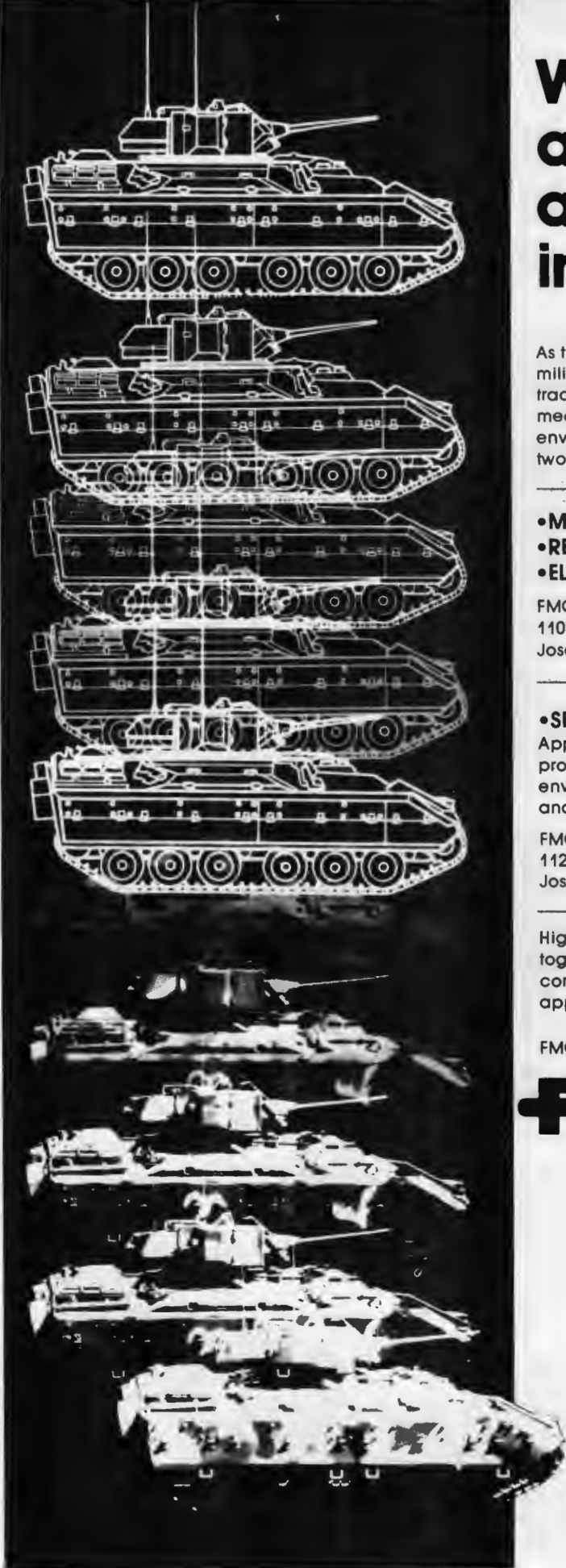
Which scenario is the true one? Both and neither. Right now, you can find examples that approximate both of these models.

Toffler talks about the possible changes in the world as a result of scenario one. The whole outlook on how the work environment and social interaction is viewed will change. That is very scary, and people do not like to be scared at that level of their lives.

The second scenario is an easier adjustment. It makes the office into a factory for data. We have social institutions that deal with factories. White collar labor unions are one possible answer. Neo-Luddites—anti-machine groups actively engaged in computer crime and sabotage—are another. Total automation, at a level not yet possible is one new-fashioned solution.

I cannot suggest any great answers to the possible problems of the electronic sweatshop that have not already been applied to other situations that feature dull, repeated labor. Good management is good management — and bad management is bad management — without regard to the technology of the organization. The machinery will not save you. Even in the electronic office, people will have to make their lives for themselves. □

Joe Celko is a software specialist presently involved in advanced systems research projects at Georgia Tech.



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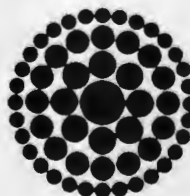
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COMPUTER ADDICTS

By Dina Ingber



A “computer hacker” is someone who is so deeply involved in systems that his life revolves around computers. Is that too much of a good thing?

It is 3 a.m. Everything on the university campus seems ghost-like in the quiet, misty darkness — everything except the computer center. Here, 20 students, rumpled and bleary-eyed, sit transfixed at their consoles, tapping away on the terminal keys. With eyes glued to the video screen, they tap on for hours. To the rest of the world, it might be the middle of the night, but here time does not exist. As in the gambling casinos of Las Vegas, there are no windows or clocks. This is a world unto itself. Like gamblers, these young computer “hackers” are pursuing a kind of compulsion, a drive so consuming it overshadows nearly every other part of their lives and forms the focal point of their existence. They are compulsive computer programmers. Some of these students have been at the console for

30 hours or more without a break for meals or sleep. Some have fallen asleep on sofas and lounge chairs in the computer center, trying to catch a few winks but loath to get too far away from their beloved machines.

Most of these students don't have to be at the computer center in the middle of the night. They aren't working on assignments. They are there because they want to be — they are irresistibly drawn there.

HACKER MADNESS

And they are not alone. There are hackers at computer centers all across the country. In their extreme form, they focus on nothing else. They flunk out of school and lose contact with friends; they might have difficulty finding jobs, choosing instead to wander from one computer center to another, latching on to

other hacker groups. They may even forgo personal hygiene.

“I remember one hacker. We literally had to carry him off his chair to feed him and put him to sleep. We really feared for his health,” says a computer-science professor at MIT.

Of course, such extreme cases are very rare. But modified versions are common. There are thousands of them — at universities, high schools, even on the elementary school level — wherever young people have access to computers. One computer-science teacher spoke of his three-year-old daughter who already likes to play endlessly with his home computer.

What do they do at the computer at all hours day or night? They design and play complex games; they delve into the computer's memory bank for

COMPUTER ADDICTS...

obscure tidbits of information; like ham radio operators, they communicate with hackers in other areas who are plugged into the same system. They even do their everyday chores by computer, typing term papers and getting neat printouts. One hacker takes his terminal home with him every school vacation so he can keep in touch with other hackers. And at Stanford University, even the candy machine is hooked up to a computer, programmed by the students to dispense candy on credit to those who know the password.

At the high-school level, students have been known to break into the computer room after school and spend hours decoding other systems. By breaking the code, they can cut into other programs, discovering the computerized grading system of their school or making mischievous (and often costly) changes to other people's programs.

Computer-science teachers are now more aware of the implications of this hacker phenomenon and are on the lookout for potential hackers and cases of computer addiction that are already severe. They know that the case of the hackers is not just the story of one person's relationship with a machine. It is the story of *society's* relationship to the so-called thinking machines, which are becoming almost ubiquitous.

Many feel we are now on the verge of a computer revolution that will change our lives as drastically as the invention of the printing press and the Industrial Revolution changed society in the past. By the most conservative estimates, one out of three American homes will have computers or terminals within the next 5 to 10 years. Electronic toys and games, which came on the market in 1976, already comprise a more than half-billion-dollar business. And though 300,000 Americans now work full time programming computers, at least another 1.2 million will be needed by 1990. Many of them are likely to come from today's young hackers.

The computer hackers who hang out at university and high-school computer centers are, for the most part, very bright students. They are good at problem solving and usually good in mathematics and technical subjects. And they are almost always male.

There is a strong camaraderie and sense of belonging among hackers.

They have their own subculture, with the usual in jokes and even a whole vocabulary based on computer terminology (there is even a hacker's dictionary). But to outsiders, they are a strange breed. In high schools, the hackers are called nerds or the brain trust. They spend most of their free time in the computer room and don't socialize much. And many have trouble with interpersonal relationships.

Two hackers sitting next to each other communicate by means of their computer consoles, rather than speaking directly.

Bob Shaw, a 15-year-old high-school student, is a case in point. Bob was temporarily pulled off the computers at school when he began failing his other courses. But instead of hitting the books, he continues to sulk outside the computer center, peering longingly through the glass door at the consoles within.

Pale and drawn, his brown hair unkempt, Bob speaks only in monosyllables, avoiding eye contact. In answer to questions about friends, hobbies, school, he merely shrugs or mumbles a few words aimed at his sneakered feet. But when the conversation turns to the subject of computers, he brightens — and blurts out a few full sentences about the computer he's building and the projects he plans.

"Apparently there is a class of people who would rather use the computer than watch TV, go bowling, or even go out on a date," says Ralph Gorin, Director of Computer Facilities at Stanford University. "They find that the computer has a large number of desirable properties. It's not terribly demanding, and it does what it's told, which is much nicer than human beings. I mean, when was the last time someone did what you told him to do?"

"People are afraid inside," explains Lizzy, a 16-year-old high-school computer-science student. "Sometimes it's easier to be a friend to a computer that won't make fun of you. It's easier than the pressures of a peer group."

"The computer will never insult you," says another youngster.

"Everyone has problems socially to some degree, and the computer can act as just another escape mechanism," Gorin explains. "The youngster feels like 'I just can't stand it anymore,' so he runs down to the computer room. The computer doesn't care what time it is or what you look like or what you may have been doing lately. The computer doesn't scold you or talk back."

SOCIAL MISFITS

Are the hackers just a group of social outcasts who hook up with machines because they can't make it with people? That would probably be a gross exaggeration — and yet, "Most hackers do have problems adjusting socially," admits J.Q. Johnson, a graduate student at Stanford. "Perhaps because they don't have much social life, they spend more time at the computer center."

Joel Bion, a sophomore at Stanford, explains how he got hooked: "I've been working with computers since I was eight. I grew up in Minnesota and I didn't have many friends. I wasn't into sports and couldn't participate in gym class because I had asthma. Then I found a computer terminal at school. I bought some books and taught myself. Pretty soon I was spending a few hours on it every day. Then I was there during vacations. Sure, I lost some friends, but when I first started I was so fascinated. Here was a field I could really feel superior in. I had a giant program, and I kept adding and adding to it. And I could use the computer to talk to people all over the state. I thought that was great social interaction. But, of course, it wasn't, because I never came into face-to-face contact."

Joel managed to break his addiction after a few years and is now a peer counselor at Stanford. But his lack of interpersonal relationships during the hacker period is common, and this problem has led Stanford psychologist Dr. Philip Zimbardo to take a closer look at the hacker phenomenon.

Hackers at Stanford have what is known as an electronic bulletin board that allows them to send each other messages on the computer. What struck Zimbardo was that the programmers could be sitting right there next to each other at adjacent consoles, but rather than talking directly, they communicated via computer.

Zimbardo also noticed that the messages left on the bulletin board

COMPUTER ADDICTS...

lacked emotion, and the thoughts were expressed in formulalike terms similar to programming language. "It could be," says Zimbardo, "that people who become hackers already have social deficiencies and becoming a hacker is a way of coping out of having intimate relationships."

"I've known some hackers whose addiction to playing with the computer and thinking exclusively in terms of information transmission makes it impossible for them to relate to anyone who's not a hacker," Zimbardo continues. "The danger is that they can come to think about people in much the same way that they think about computers. Computers are always consistent, so they begin to expect that consistency from people, which by virtue of human nature is not possible or even desirable."

Zimbardo describes the case of a computer student who was working with him on a special assignment. The student interacted with excessive formality. He couldn't deal with small talk, and all his conversations were task-oriented: "You will do this. This must be done." He gave commands rather than making requests or suggestions. And he couldn't deal with the "fickleness" of human nature. All this, according to Zimbardo, was a reflection of the way the student interacted with the computer. Ultimately the student was dismissed because of his inability to get along with others.

STRANGE INTERACTIONS

"In some extreme cases, hackers exhibit elements of paranoia, because people can't be trusted the way computers can," says Zimbardo. "When people don't do just what he orders them to do, the hacker begins to perceive hostile motives and personal antagonism."

It would be absurd to label all hackers paranoid or even deviant. But it would also be naive to shrug off the hacker phenomenon as meaningless.

Perhaps this attachment to a machine could be viewed as just another side of man, the technological animal, who has always been obsessed with tools, machines, gadgets and gimmicks.

"There used to be a time when the term *hacker* referred to someone who was just enthusiastic about computers. It wasn't pejorative. Some people feel that way about cars or music to some degree," says Ralph Gorin.

Certainly the outstanding

members of any creative field — Picassos and the Beethovens — spent extraordinary amounts of time at their craft and were considered somewhat odd. And as Gorin points out, the computer, by its nature, has an even stronger pull.

"Computers are attractive because, to a higher degree than any other object, they are interesting and malleable."

Interesting and malleable: two key

"In some extreme cases, hackers exhibit elements of paranoia, because people can't be trusted the way computers can."

words if you want to understand the hacker's addiction and the increasing allure of the computer for all segments of our society.

The computer can be almost as interesting as a human being. Like people, it is interactive. When you ask it a question, it gives you an answer. And because it stores great quantities of information, it can often answer more questions, more accurately, than human friends.

This interaction has led some to attribute human characteristics to the machine. Such anthropomorphizing of inanimate objects is not unusual. Ships, trains and planes, for example, are often given human names.

But humanizing the computer seems much more natural because the machine does appear to "think" and "talk" like a person. As a result, some students form strong emotional attachments to their computers. "Some kids probably think the computer 'likes' them," says George Truscott, a math and computer teacher in Palo Alto, California.

Hackers are not the only ones interacting with the computer on a personal level. The amazing powers of the machine have enticed even the most sophisticated scientists into wondering just how human it can become. The newly developing science of artificial intelligence aims at programming the computer to think, reason and react in much the same way that people do. Computers can diagnose a patient's ailments and recommend treatments. They can mimic the dialogue a psy-

chotherapist or the reasoning of a lawyer.

If computers can replace our most admired humans, the professionals, then why shouldn't the hackers feel close to them and invest emotional energy in them? After all, the computer seems to have unlimited potential. Already, with today's technology, tens of thousands of words can be stored on a tiny silicon chip measuring less than a centimeter square and a millimeter thick. And any item of information on the chip can be called up and displayed on a TV screen in a fraction of a second. So the computer user has access to worlds of information within reach, literally, of his fingertips. And the computer can rearrange that information and interrelate facts or draw conclusions at the programmer's command. It is, as Gorin points out, extremely malleable.

By programming a computer, a youngster can create a world of his own. That is, he feeds a set of rules in, and it acts according to those rules only. It is bent to the will of the programmer.

A favorite hacker pastime is playing computer games; these are not the games you see in pinball parlors but much more complex versions that hackers invent.

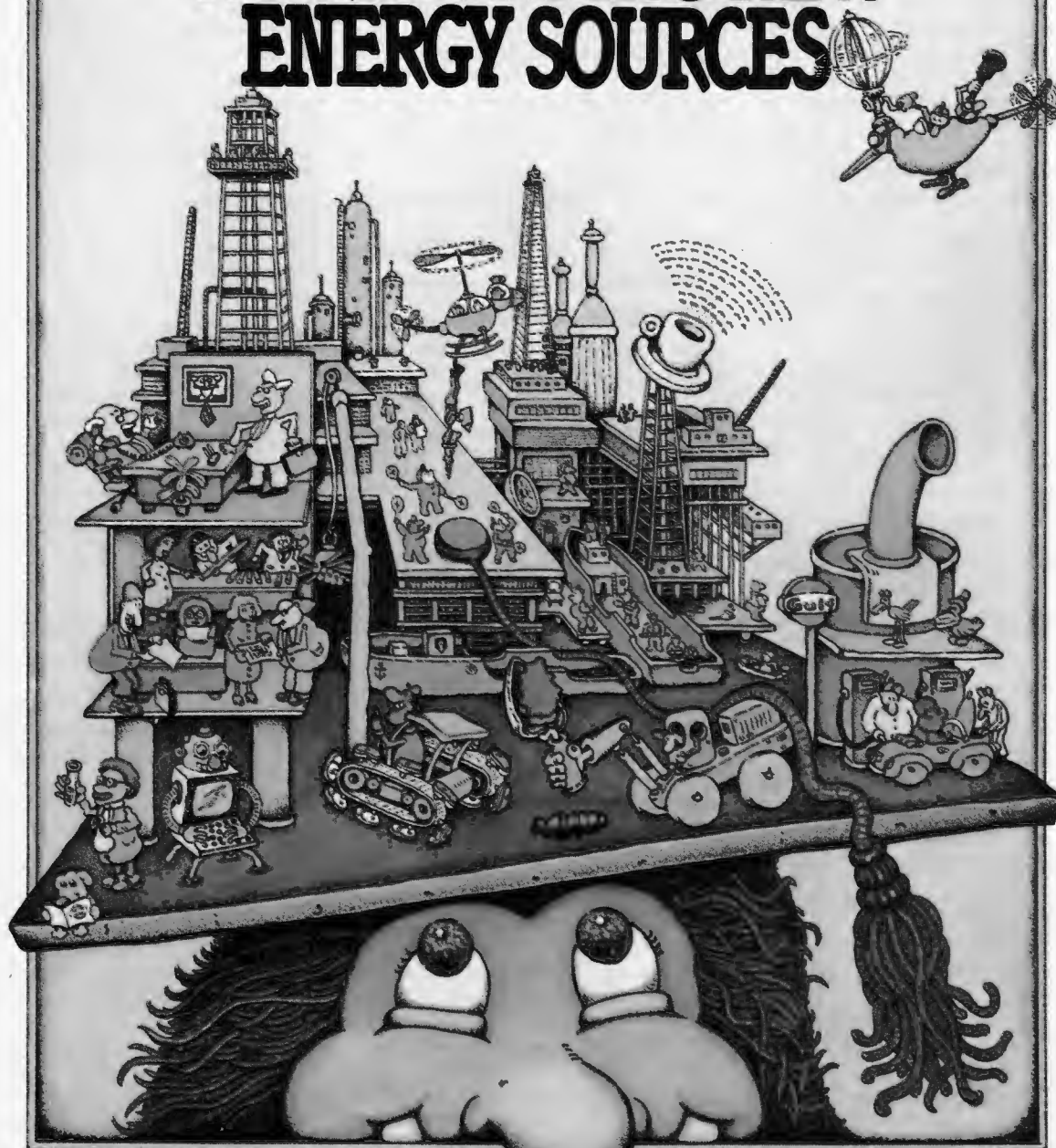
At Stanford, for example, hackers stay up into the wee hours playing *Adventure*. The object is to find various pieces of treasure hidden in different parts of a cave. To do this, you must instruct the computer (that is, type instructions into the console) as to what direction to take (north, south, east, west, up, down, jump, run, etc.). After each command, the computer describes the area you have reached and what lies around you. You encounter obstacles along the way — snakes, dragons, darkness, slimy pits — but you also encounter magical objects that can help you overcome the obstacles.

"With a computer, the possibilities are limited only by your imagination," Gorin explains. "You can be a spaceship pilot, a great explorer or a treasure hunter. It can lead you into the world of fantasy, all of your own making."

Joseph Weizenbaum, professor of computer science at MIT, thinks that this sense of power over the machine ultimately corrupts the hacker and makes him into a not-very-desirable sort of programmer. The hackers are so involved with designing their program, making it more and more

Continued on page 79

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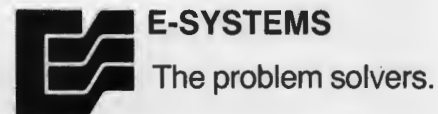
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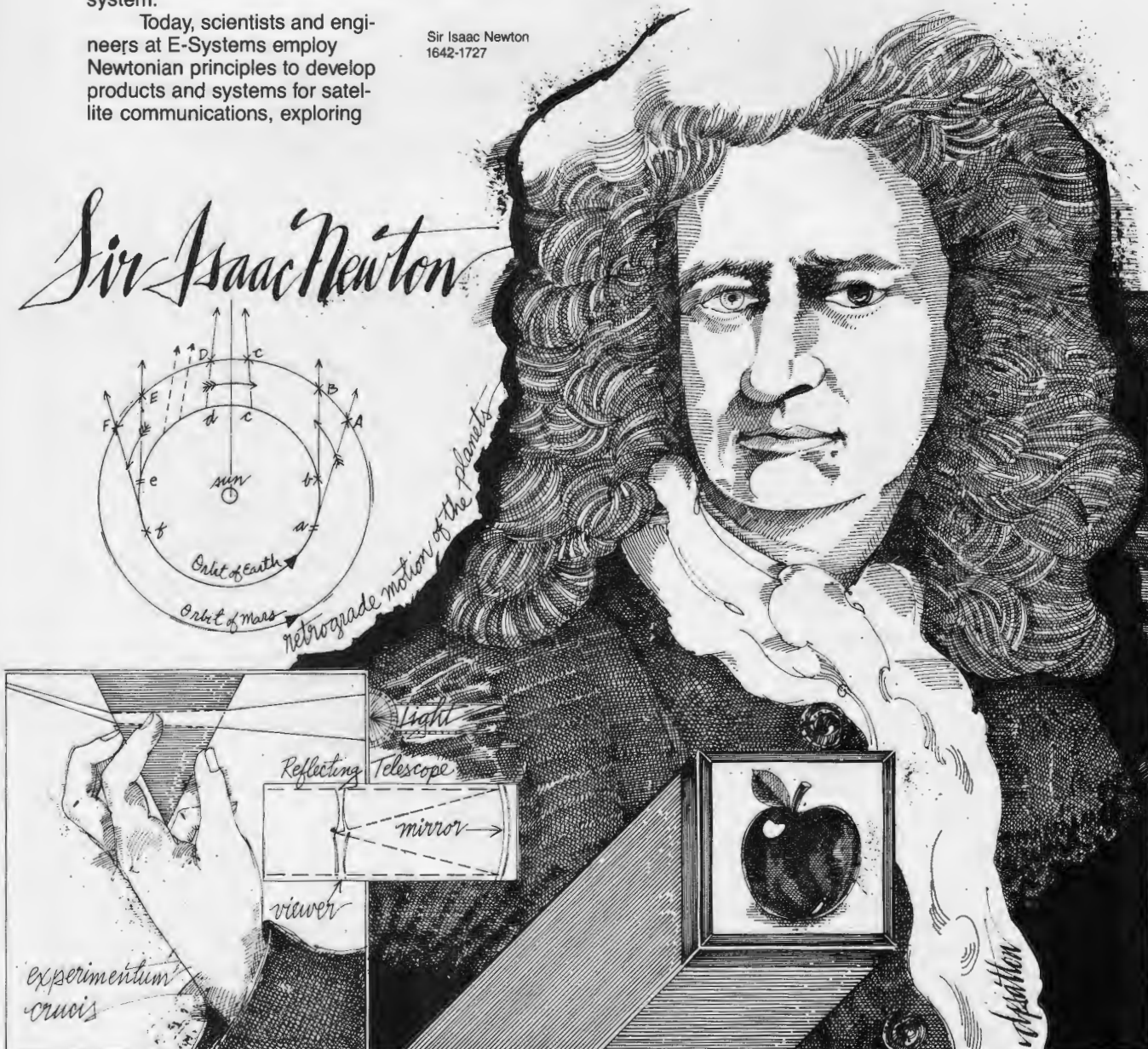




Photo: U.S. Navy

Grace Hopper, Computer Tamer

By Laurel Sherman

Without software, computers would be useless masses of circuits. And Grace Hopper's innovations—such as compilers and some of the first higher-level languages — helped shape modern software.

"Grace Hopper doesn't admit to being halfway through her computing career," said one writer. The comment sums up the vitality and dedication of an extraordinary woman, now 75, who is responsible for many of the early software innovations that shaped the development of the electronic computer. The first compiler and some of the first high-order computer languages are credited to her and the team she headed. She was at the first meeting of the committee which coordinated the development of COBOL, a language which used many of the elements of a programming language she devised.

Her interest in things mechanical and mathematical dates from her early childhood: "I remember when I was about seven, we had seven bedrooms in our summer home... Each room had an alarm clock, one of those round ones with two feet and a bell up on top that rings like crazy when the alarm goes off. When we were going on a trip, Mother would always go around at night and set all the alarm clocks. One night she went around to set them and they had all been taken apart. What happened was that I'd taken the first one apart and I couldn't get it together so I opened the next one. I ended up with all seven of them apart. After that I was restricted to one clock." Her curiosity, and the indulgence of parents who allowed her that one clock, combined to make her a woman who has never been satisfied with the ordinary.

As an undergraduate at Vassar she studied math and physics, "I was very fortunate in that my father believed that his daughters should be given the same opportunities as his son, so my sister and I both went to Vassar." Graduating in 1928, she went on to Yale, where she received a M.A. in 1930 and a Ph.D. in 1934. Her first position, in 1931, was Assistant in Mathematics at Vassar, eventually rising to Associate Professor.

World War II, and her subsequent association with the Navy were turning points in Hopper's life. She joined the U.S. Naval Reserve in December 1943, following a family tradition of which she is very proud. When she was commissioned Lieutenant (jg), she was ordered to the Bureau of Ordnance Computation Project at Harvard. It was there that she met Howard Aiken, the father of early computers, and became the third programmer to work on the new Mark I, an electro-mechanical computer. "I walked into a room and Prof. Howard Aiken said, 'Lieutenant, that is a calculating machine!'" The calculator was 51 feet long. She continued at the Harvard Computation Lab, working on the Mark II and Mark III, until in 1949 she became Senior Mathematician with the Eckert-Mauchly Computer Corporation, which was developing the UNIVAC. The company was eventually bought by Remington Rand, and then by Sperry; she remained in charge of what was then known as automatic programming through all these changes.

The sense of comradeship and fun that permeated these early endeavors shines through her description of those days. "Those were precarious days. We used to say that if UNIVAC I didn't work, we were going to throw it out one side of the factory, which was a junk yard, and we were going to jump out the other side, which was a cemetery."

To understand what was so unusual about her early work, one must know how those early computers operated. At first, those who wanted to use the computer had to address it in its own digital "language." They used an octal (base 8) code, writing all their instructions again and again in this machine language. (Those who wrote the instructions were called "coders" — the name "programmer" was a later import from Britain.) Every instruction had to include the

Grace Hopper, Computer Tamer...

"information address": where to hold an element of data, or where to find an element which was already in storage. There were many problems with this. People found themselves writing the same program, with only minor address and operation changes, again and again. They made mistakes often when copying earlier programs. If they had a library of programs to use, they would make mistakes in addressing the instructions. There was little communication between "coders," so frequently they duplicated each other's work. Jean Sammet, an early programmer herself, and an authority on the history of programming languages, said, "...they wanted the ability to use other people's code, and this couldn't always be done, because of differences in notations and lack of an effective way to link the pieces together. One of the main motives for using other people's code was that certain programs were being written over and over again... square root and trig routines were being written by the dozens. There developed the need for a library facility that could be invoked by the programmer."

such function, that I knew checked out and was correct, so that I could use them again in another program. I kept them in a notebook. But to put them in a new program, I still had to copy them, and add all the addresses. Copying and adding the instructions to addresses was a very dull occupation, and I found I made mistakes. And there sat the big computer. It would do it. So I decided to make a library of all these pieces of code; I'd give them each a name, and then I'd tell the computer to put them together, copy them, and add them to the addresses. So I built the first compiler." This was the beginning of what came to be called "automatic programming," something which the latest generation of computer users takes for granted.

The next step was to make it possible for anyone to address the computer in English-like statements. Her group's invention of the languages MATH-MATIC and FLOW-MATIC were early steps in that direction. She has always had a firm commitment to making computers more accessible and this was a major step toward that goal. "Very few people are really symbol manipula-

Photo: Graft Laboratory, Harvard Univ.

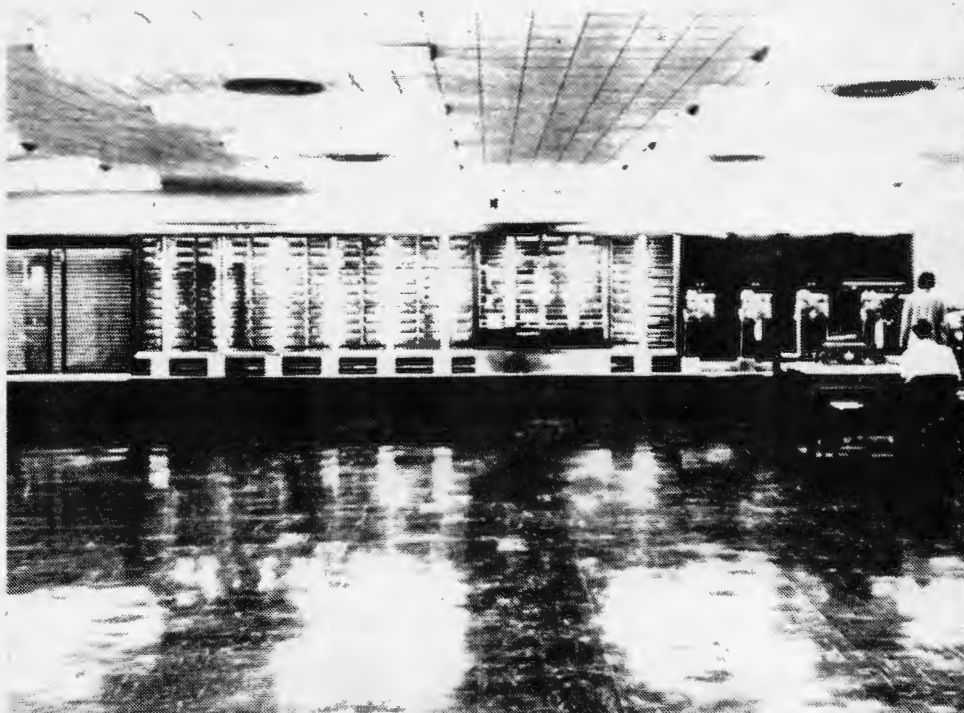


Photo: New York Public Library

In the beginning, there was the Automatic Sequence Controlled Calculator, better known to its friends as Mark 1. It was the first automatic, general-purpose, digital calculator; it is not considered a true computer because it contained mechanical as well as electrical components. Grace Hopper joined the Mark 1 team at Harvard in 1943; here she is shown inspecting paper tape, which was one of the main means of input, along with punch cards and physical switches. At this point, the job of programmer was so new that no one had invented the word "programmer" yet; Hopper and her co-workers were called "coders".

Grace Hopper was one of the first to address this need. She claims that one important influence on her work was the inability to balance her own checkbook. After hours of trying, she finally handed it over to her brother, who pointed out that from time to time she had lapsed into subtracting in octal. "That may have been one of the things that sent me to get rid of octal as far as possible."

"When we started programming computers, we had to write all the programs in base 8, instead of base 10. When you start doing that, you can sure make mistakes. So what I had done over time was to collect pieces of code, to compute a sine or a logarithm or some

tors. If they are, they become professional mathematicians, not data processors. It is much easier for most people to write an English statement than it is to use symbols. So I decided data processors ought to be able to write their programs in English, and the computers would translate them into machine code." Eventually, this led to the development of today's "high-level" languages.

The initial reaction to the innovations of Hopper's team was disbelief and an unwillingness to use them. "Nobody believed it could be done," she recalls. Programmers were accustomed to building up their own programs, using personal shortcuts, and each believed

Grace Hopper, Computer Tamer. . .

his way was best. They didn't want to give up the freedom they had to personalize each program, and to tailor and streamline it to fit one specific computer. She remembers "... there were testimonial letters that were written saying, 'Yeah, we used the compiler and we find it useful, and it saved us some time.' They're almost naive to look at today, and yet they tell you a little bit about the atmosphere, which was totally unwilling, or seemingly so, to accept a new development." To those programmers, "it was obvious that you always wrote your best programs in octal."

The first meeting to discuss the creation of what became COBOL (Common Business Oriented Language) was held in 1959; and Grace Hopper was one of six people present. The result was a much larger meeting, attended by forty people at the Pentagon on May 28-29, 1959. Grace became an advisor to the executive committee called CODASYL, "Committee on Data Systems Languages," a group which supervised and coordinated the work of the smaller committees which actually devised COBOL.

Her main contribution to the language, however, is the legacy of her initial work on FLOW-MATIC. FLOW-MATIC used full data names instead of the symbolic names common to FORTRAN. It also used whole words for commands, such as ADD and COMPARE. And it took data descriptions and instructions separately, so addresses could be assigned by the computer, rather than linked to each instruction. These features all became part of the new COBOL.

Even in 1967 Hopper still had to argue for standardization. Many companies allowed their programmers to build up their own set of conventions for data names and operations routines. However, as she pointed out in the Annual Computer Supplement to the *Financial Times* of 1967, standardization offered a large range of benefits. It made it possible for compatible programs to be run on several computers, and programs could be converted for use on new systems. It saved machine time as well as programmer and clerical time. It allowed one system to be substituted for another, and it permitted the use of general-purpose compilers and powerful and elaborate operating systems and testing routines, designed and issued by computer manufacturers.

We take this kind of standardization so much for granted now that we have difficulty imagining that the use of COBOL might have to be enforced. This is an ironic tribute to people like Grace Hopper, who worked to give computers their present high standards of efficiency and accessibility. One authority wrote, "Commercial computing languages in general, and COBOL in particular, owe their inception to a very few pioneers, of whom Dr. Hopper was the most articulate and determined."

Dr. Hopper retired from the Naval Reserve in 1966, but in 1967 was called back to duty one year later, when the Naval Data Automation Command in Washington needed assistance in validation programs. As COBOL compilers proliferated, each compiler had to be tested to show that it would give the same answers on different computers. Her group at the Navy has also been responsible for devising a translator program which can accept older versions of COBOL, converting them to standard COBOL.

Grace Hopper made history in 1973, when a special act of Congress made her the first person in the Naval

Reserve ever to be promoted to the rank of Captain. Although she retired officially from Sperry Rand in 1974, she continues her work for the Navy to this day. Since Admiral Rickover's retirement, she is the oldest person on active duty in the Navy.

She believes that women have a special role to play in the computer industry. "During World War II, and right after the war, when the men came back, they were all busy going to college and getting their degrees. So women got in on the very beginning of the computer field, and they've stayed there. It's probably one of the best fields there is for women to move up in. Women turn out to be very good programmers for one very good reason: they tend to finish up things, and men very often don't finish. After men think they've solved a problem, they want to go off and get a new one, whereas a woman will always wrap it up in a neat package and document it. I think that's because you don't half-cook a dinner, you finish it and put it on the table, ... We're sort of used to finishing things."

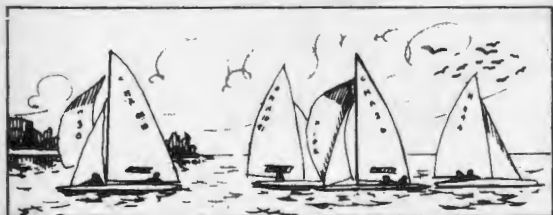
She doesn't hold back when asked about the women's lib movement. "Tommyrot and nonsense. If you want to do something, you can do it. Being a woman won't hold you back, if you have the desire, the courage, and the skills," she says, reflecting the unique position of strength that women held early in the computer era.

Captain Hopper has a vision of the computer's role in the future: for example, she is convinced that it is not too soon to be looking for livable planets to house future generations. "The computer will be a great help in resettling people when this happens!" she states with confidence. She's more cautious about predicting the nature of tomorrow's computers. "It's the darndest thing with the computer industry: you never know what it's going to do next. In just 30 years, we've gone from a \$3 million computer to a \$360 computer with one thousand times as much capacity."

She has often said she would like to live until January 1, 2000. "I have two reasons. The first is that the party on December 31, 1999, will be a New Year's Eve party to end all New Year's Eve parties. The second is that I want to point back to the early days of the computer and say to all the doubters, 'See? We told you the computer could do all that!'" □



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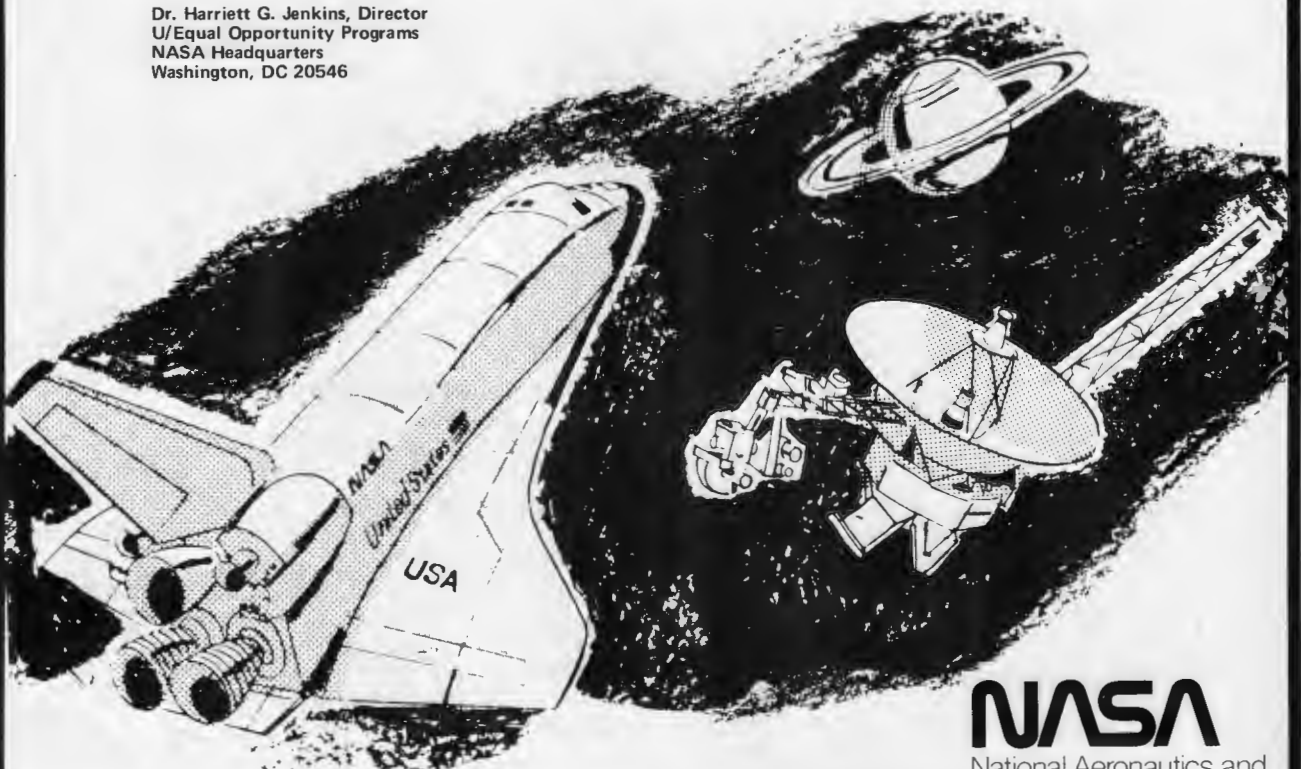
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A Comparison. . . of Men and Women Undergraduate And Professional Engineers

Carolyn M. Jagacinski and
William K. LeBold
Purdue University

Between 1972 and 1980 there has been a tenfold increase in the number of undergraduate women enrolled in engineering schools throughout the country (see table 1).¹ Although this increase seems quite dramatic, women still represent a relatively small proportion of U.S. engineering students: in 1980, 14.5 percent of the freshman engineering students in the nation were women. The large gain is partially a response to the women's movement.

Table 1. National Trends in Engineering Enrollment.

<i>Full-Time Undergraduates</i>			
<i>Year</i>	<i>Total No.</i>	<i>Women No.</i>	<i>%</i>
1972	194,727	4,487	2.3
1973	186,705	6,064	3.2
1974	201,099	9,828	4.9
1975	231,379	15,852	6.8
1976	257,835	21,936	8.5
1977	289,248	28,773	9.9
1978	311,237	34,518	11.1
1979	340,488	42,027	12.4
1980	365,117	48,944	13.4

<i>Freshman Students</i>			
<i>Year</i>	<i>Total No.</i>	<i>Women No.</i>	<i>%</i>
1972	52,100	1,542	2.9
1973	51,925	2,417	4.6
1974	63,444	4,266	6.7
1975	75,343	6,730	8.9
1976	82,250	8,545	10.4
1977	88,780	9,921	11.2
1978	95,805	11,789	12.3
1979	103,724	14,031	13.5
1980	110,149	16,004	14.5

Affirmative action guidelines have contributed to engineering job opportunities for women during the past 10 years. Many universities have made substantial efforts to attract talented women into engineering and to provide support services for them during their college years.

In 1980, 22.8 percent of the freshman engineers at Purdue were women; this figure is substantially above the national percentage of freshman women engineers. We will compare the experiences of men and women in engineering, both academically and professionally, using data drawn primarily from statistical studies and surveys of Purdue engineering students and graduates.

The Pre-College Years

Academic Performance

The SAT scores, high school rank and high school grades of Purdue engineering freshmen, 1979-80 are shown in table 2. The figures reflect the gradual, nationwide decline in SAT scores across the years. This decline is more pronounced for SAT verbal scores than for math scores among the Purdue students. Women engineering students consistently achieve higher mean verbal scores than the men, while their math scores are generally not significantly different. The women students also have higher high school ranks and grades in English, math and science than the male freshman engineers. Unlike the SAT scores, high school grades of entering freshmen have increased somewhat across the years. In general,

freshman women engineers are as academically competent as their male peers and may even be somewhat better prepared for college, especially in their verbal abilities and high academic performance in high school.

Aside from academic abilities, there has been some evidence at Purdue that women engineering students feel they are lacking in spatial and mechanical abilities.² In a recent survey of Purdue engineering graduates, women graduates rated their own mechanical and visualization ability lower than did men graduates.

Career Decision

What factors influenced the engineering student's decision to study engineering? During the summer of 1976 the Purdue entering freshman engineering students were asked to rate how important a number of factors were in their decisions to pursue engineering study. Table 3 contains some of the more important factors grouped into categories related to people, school, and work. Men and women students tended to agree on which factors were most influential. Work characteristics and high school math and science courses tended to play a major part in their decision to study engineering. Men were more influenced by physics and mechanical drawing courses than were women, but women were more concerned with having a challenging career that allowed them to be of service to others.

Table 2. Purdue Engineering Freshman SAT Scores, High School Rank, and High School Grades.

Yr. & Grp.	No. of Cases	SAT-Verbal			SAT-Math			H.S. Rank			English		Math		Science	
		X	%GE* 600	%LT* 400	X	%GE 700	%LT 500	X	%GE 90	%LT 70	Mean Grade †	%A	Mean Grade †	%A	Mean Grade †	%A
1970																
T	(1,412)	519	17	7	626	18	5	84	42	12	6.1	19	6.9	42	6.6	36
M	(1,391)	518	17	7	626	18	5	84	42	12	6.1	19	6.8	42	6.6	36
F	(21)	563	34	0	643	14	0	95	84	0	7.6	59	7.9	75	7.6	59
1975																
T	(1,482)	494	13	13	606	16	8	83	42	16	6.7	34	6.9	42	6.9	44
M	(1,269)	489	12	14	606	16	8	81	37	18	6.5	28	6.7	38	6.7	40
F	(213)	520	21	9	607	15	9	91	72	2	7.8	65	7.8	67	7.6	66
1980																
T	(1,428)	485	10	15	599	11	9	87	52	9	7.1	45	7.4	52	7.4	55
M	(1,108)	479	8	17	600	11	9	85	46	11	6.8	37	7.2	48	7.2	51
F	(320)	509	15	10	595	10	10	93	73	2	8.1	72	7.9	66	7.9	70

* GE = greater or equal, LT = less than

T= Total; M=Male; F=Female.

† A=9, A-=8, B+=7, B=6, B-=5, C+=4, C=3, C-=2, D+=1, D & F=0.

Table 3. Factors Influencing Male and Female Students to Study Engineering.

	Percentage of male and female engineering students who rated each of the following factors as somewhat or very important:	
	Male	Female
People		
Father	60%	58%
High school teacher	40	47
Engineer—friend	37	41
Engineer—famous	31	42*
Engineer—student	31	41*
Mother	30	34
Engineer—relative	30	32
High school counselors	27	28
School		
Math courses	77	85
Problem solving	73	78
Physics courses	66	60*
Interest and aptitude tests	60	66
Chemistry courses	56	59
Vocational education info.	32	42
Mechanical drawing courses	28	19*
Biology courses	21	32*
Career education courses	20	26*
Work		
Type of work	87	90
Challenge	85	90*
Technical work	84	89
Salary	84	81
Creativity	82	84
Security	79	81
Prestige	77	76
Rapid advancement	76	71
Leadership	67	71
Service to others	65	74*
Independence	59	52*
Work experience	47	39*
(No. of cases)	(992)	(164)

* = significant at < .05

College Years*Academic Performance*

Given the higher grades and high school rank of entering women engineers, how does their college performance compare with that of their male classmates? Semester grade point averages for men and women engineering students are presented in table 4. In addition to grade point averages, the percentage of distinguished students and students on academic probation are given. The women students tend to have slightly higher GPA's; in many cases these differences are statistically significant. An analysis of covariance, however, performed to adjust for the initial differences between the men and women students in terms of SAT scores and high school rank, showed that in most cases the adjusted GPA's of men and women were not significantly different. The college performance differences between men and women engineers therefore can generally be explained in terms of initial differences in verbal ability and high school scholastic performance.

University and engineering retention and graduation rates for students entering engineering can be found in table 5. Although the graduation and retention rates for engineering are lower than those for the university (since university retention includes both engineering and transfer students), in general the engineering retention and graduation rates have increased in recent years, while the university rates have remained fairly stable. The engineering retention and graduation rates for men and women appear to be comparable after

Table 4. Semester Grade Point Averages of Purdue Engineering Students.

Year & Group	Semester 1				Semester 3			Semester 5			Semester 8		
	No.	Mean	DST	PRB	Mean	DST	PRB	Mean	DST	PRB	Mean	DST	PRB
1970													
Total	1,413	4.54	12	10	4.54	17	15	4.76	21	9	5.00	29	4
Male	1,392	4.54	12	10	4.54	17	15	4.76	21	9	5.00	29	4
Female	21	4.82	19	9	4.77	26	13	4.97	23	7	5.06	18	0
1975													
Total	1,488	4.89	24	5	4.61	19	14	4.66	19	13	4.84	23	8
Male	1,274	4.87	24	5	4.56	17	15	4.63	18	13	4.81	21	9
Female	214	5.00	26	2	4.89	30	8	4.88	26	8	5.01	34	6
1979													
Total	1,618	4.78	20	6									
Male	1,294	4.76	19	7									
Female	324	4.88	25	4									

DST = percentage of distinguished students (A- to A grades); PRB = percentage of students on academic probation (variable but less than a C average)

1969, whereas in the mid and late 1960s retention and graduation rates for women were about half of those for men.

Post-College Years

Data concerning post-college performance will be derived primarily from a recently conducted survey of Purdue engineering graduates who participated in cooperative (work-study) programs and those who did not.³ A questionnaire similar to those used in other studies conducted at Purdue^{4,5} was mailed to a sample of both groups who graduated between 1958-1974, matched by year of graduation, CPE engineering field and sex. Approximately 67 percent of the sample returned the questionnaires. A sub-sampling consisting of all the women respondents (393) and a group of male respondents (420) also matched by field and year of graduation, constitute the group that is discussed here. Most of the engineers in our sample were recent graduates: 59 percent received their bachelor's degree in 1975 or later, and 69 percent have had only one employer. To compare male and female graduates, chi-square analyses of frequencies were used; only statistical significance levels of .05 or less are noted.

Continued on page 43

Table 5. Trends in University and Engineering Retention and Graduation Rates.

Year & Group	No. of Cases	University		Engineering	
		Retention 5 Sem.	Grad. 11 Sem.	Retention 5 Sem.	Grad. 11 Sem.
1967					
Total	(1,639)	77%	67%	47%	36%
Male	(1,625)	77	67	47	37
Female	(14)	71	50	28	21
1968					
Total	(1,479)	72	67	46	43
Male	(1,465)	72	67	46	43
Female	(14)	64	57	21	21
1969					
Total	(1,347)	76	67	57	48
Male	(1,319)	76	67	57	49
Female	(28)	78	57	60	42
1970					
Total	(1,412)	75	64	52	45
Male	(1,391)	76	65	52	45
Female	(21)	66	47	52	38
1971					
Total	(1,051)	76	68	58	52
Male	(1,026)	76	68	58	52
Female	(21)	75	59	47	47
1972					
Total	(918)	80	72	63	57
Male	(893)	80	73	63	57
Female	(25)	75	59	63	47
1973					
Total	(1,064)	80	70	64	55
Male	(1,002)	80	70	64	55
Female	(62)	79	79	61	56
1974					
Total	(1,194)	80	67	64	53
Male	(1,089)	80	67	64	53
Female	(105)	81	67	68	56
1975					
Total	(1,482)	80		66	
Male	(1,269)	79		66	
Female	(213)	82		64	
1976					
Total	(1,659)	81		65	
Male	(1,429)	81		67	
Female	(224)	83		59	
1977					
Total	(1,478)	82		64	
Male	(1,217)	82		65	
Female	(257)	81		62	

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INTERVIEWS, SITE VISITS, OFFERS

Job Search

Figure 1 compares the number of site visits, job interviews and job offers received by this sample of recent graduates. There were no significant differences between men and women engineering graduates in terms of interviews, site visits and job offers. Over a third of the graduates received five or more job offers, while only a small percentage did not receive any offers. Most of those not receiving offers were planning to continue their studies in graduate school.

Job Characteristics

Various characteristics of the jobs of engineering graduates are presented in figures 2 through 6. There were no differences between the men and women in terms of the size of the organization, type of employer, or technical responsibility. The majority of men and women engineers in the Purdue sample work for large manufacturing firms in jobs which involved a moderate level of technical responsibility.

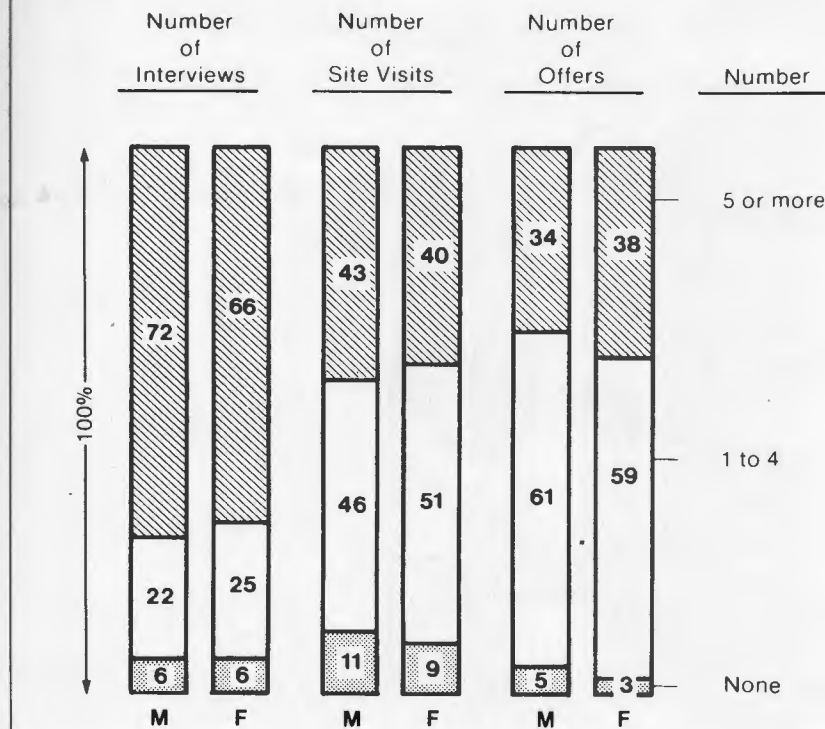


Figure 1. Percentages of male and female engineering graduates receiving different numbers of job interviews, site visits, and job offers.

EMPLOYER SIZE IMPORTANT?

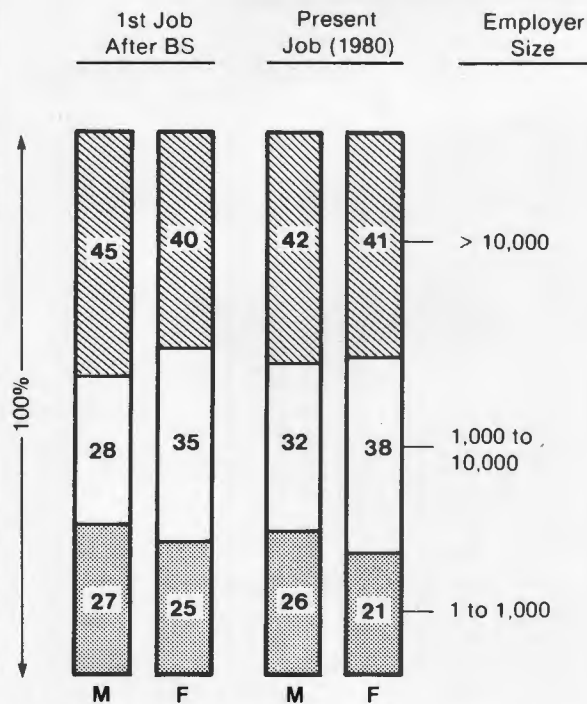


Figure 2. Percentages of male and female engineers working for organizations of different sizes on their first job after B.S. graduation and present job.

TYPE OF EMPLOYER MAKES DIFFERENCE?

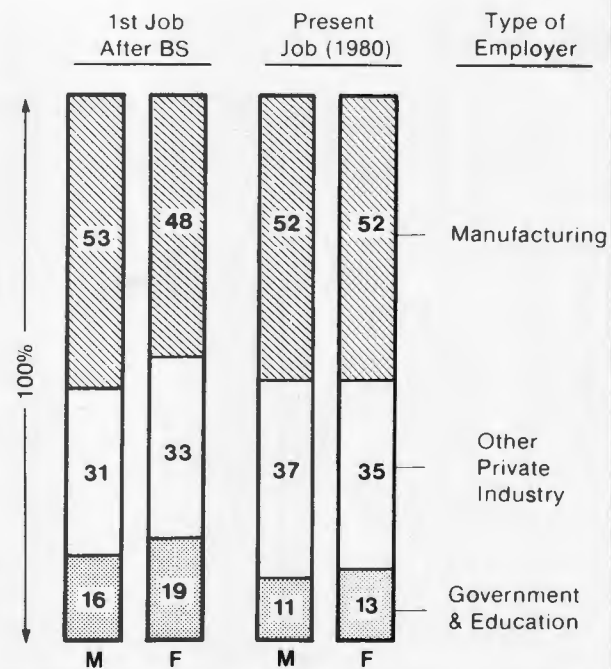


Figure 3. Percentages of male and female engineers working for different types of employers on their first job after B.S. graduation and present job.

A majority of men and women felt satisfied with their job (figure 6) and considered their education relevant to their job (table 6). This finding is consistent with the results of a national survey which showed that women in engineering are less likely to feel under-employed than women in other fields.⁶

Figure 4 does indicate a significant difference between men and women in terms of their principal function on their first job. Women in our sample were more likely to be involved in research, design and development, while men were more likely to be involved in operations, production and maintenance, testing and inspection, construction, or sales and services. This difference was only significant for the respondents' first jobs after the B.S. degree and was not found for their present jobs.

Table 7 offers information about the monthly salaries of men and women engineers grouped according to year of graduation. The median annual salaries for these groups are plotted in figure 7, along with the national average. Continued on page 74

FUNCTION WITH EMPLOYER DIFFERENT?

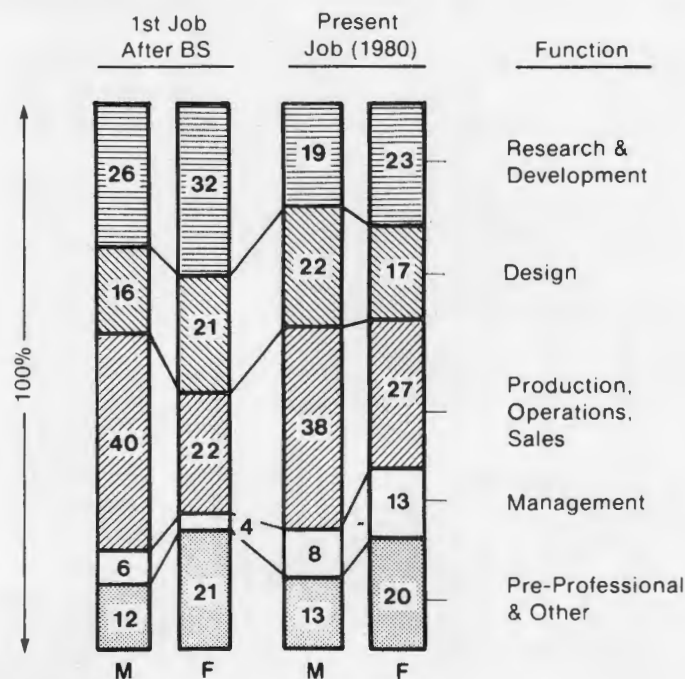


Figure 4. Percentages of male and female engineers engaging in different principal functions during their first job after B.S. graduation and present job ($p < 0.5$ for first job).

TECHNICAL RESPONSIBILITY

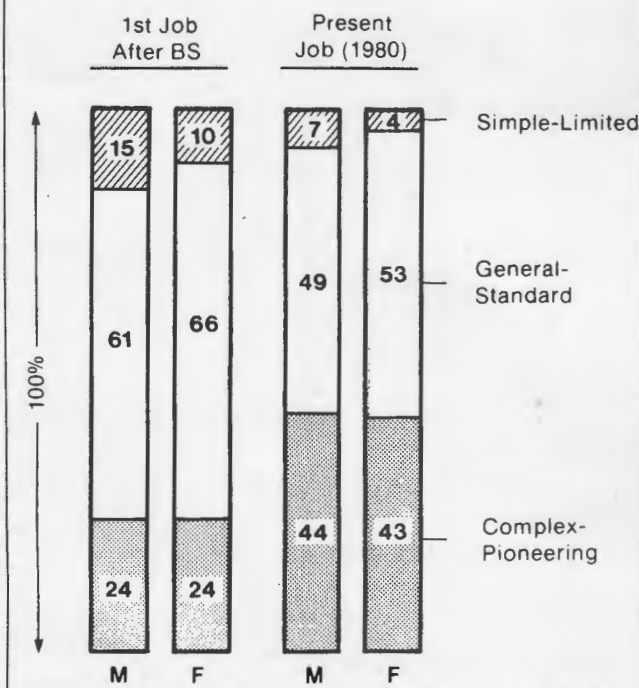


Figure 5. Percentages of male and female engineers rating their technical responsibility at different levels for their first job after B.S. graduation and present job.

JOB SATISFACTION

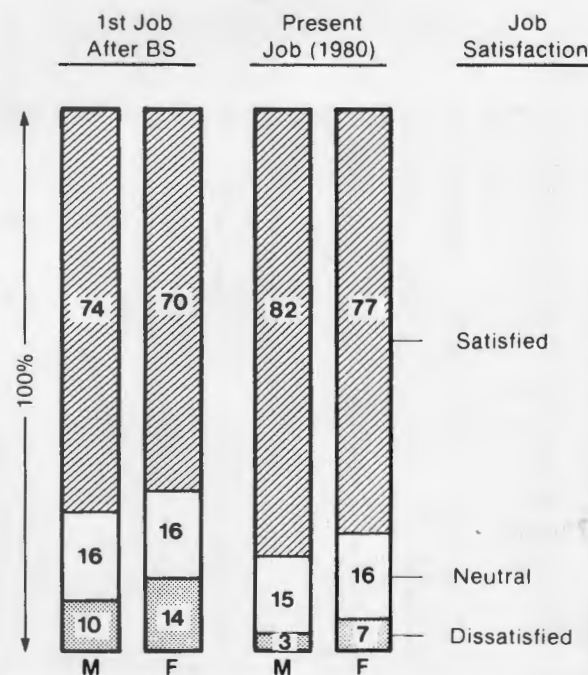
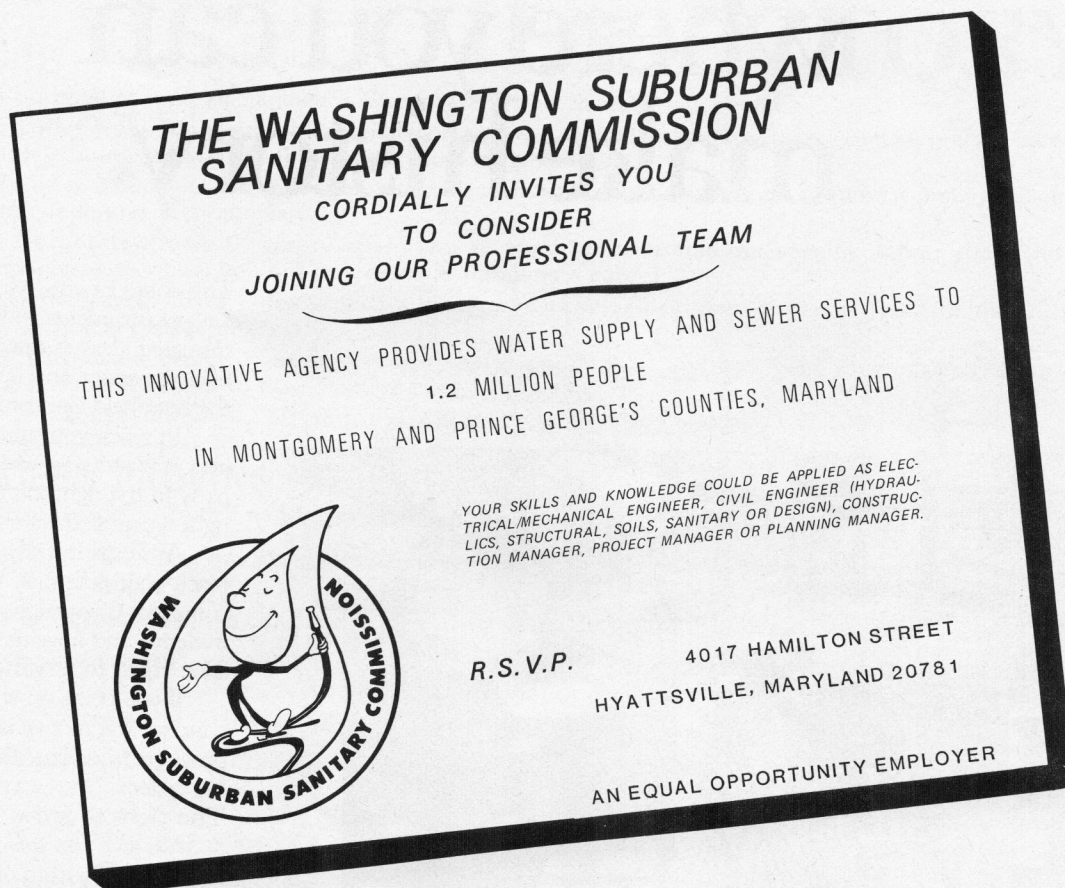


Figure 6. Percentages of male and female engineers rating their first job after B.S. graduation and present job at different levels of satisfaction.

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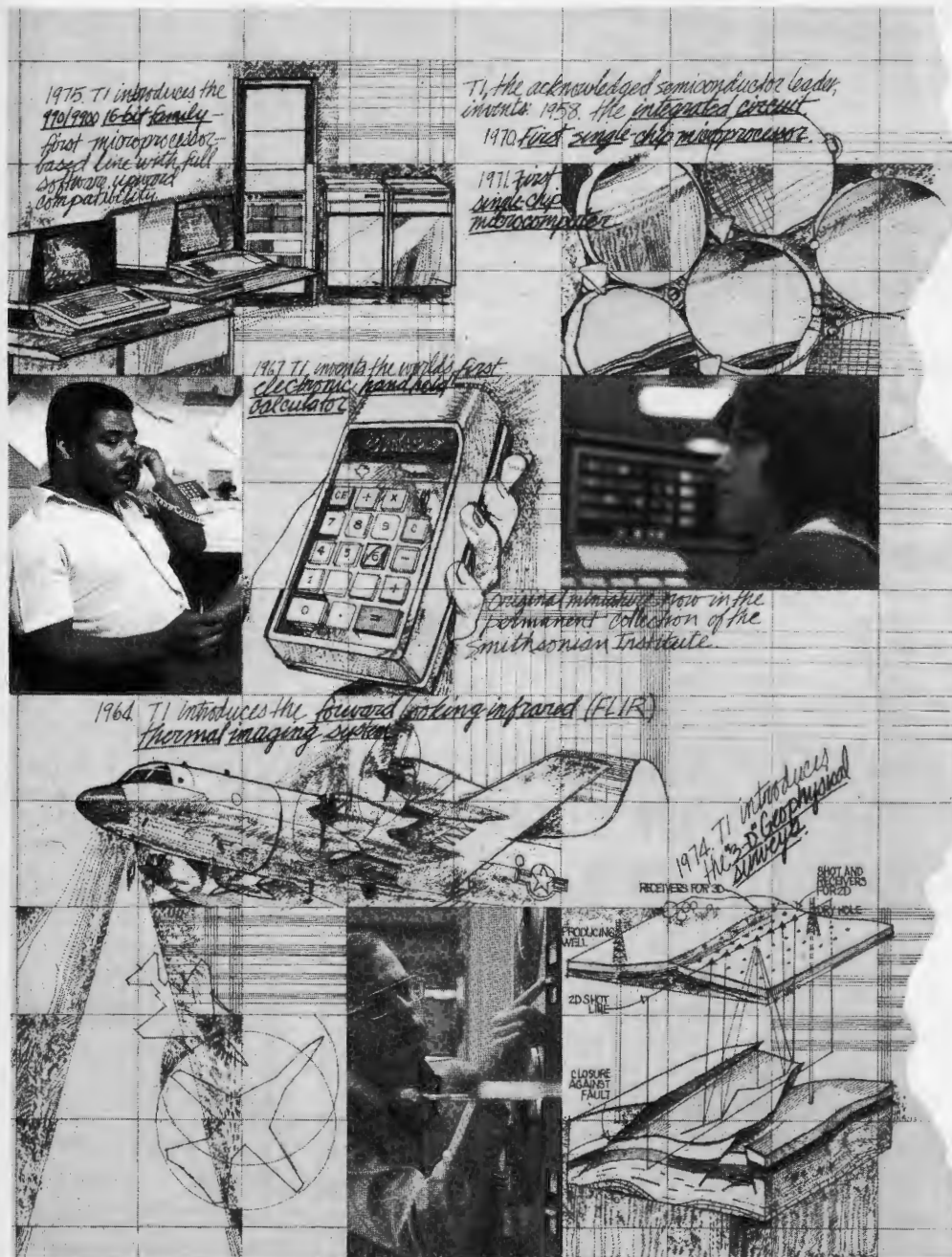
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Date Company Established: 1852

Corporate Description: Manufacture of beer, baker's yeast, corn syrup, industrial and food starches, food additive chemicals.

Career Opportunities in 1982/83: Seeks Engineers - Electrical, Industrial, Mechanical; Production Management Trainees.

Who to contact for Interview: Charles DiMercurio, Manager of Employment

Procedure for Arranging Interview: Send resume to company or arrange through college placement director.

BORG-WARNER CHEMICALS, INC.

an Equal Opportunity Employer

Home Office: International Center, Dept. C, Parkersburg, WV 26101

Number of Employees: 2,500 in the USA

Date Company Established: 1956

Corporate Description: Manufacturer of a wide range of Engineering ABS Thermoplastics, specialty chemicals and modifiers, styrene monomer and other petro-chemicals. Marketed worldwide.

Career Opportunities in 1982/83: BS Engineering: ChE, EE, ME, IE, MS Engineering: PhD, MS Mechanical, Materials Engineering: BS Chemistry (Sales): PhD Organic Chemistry and Polymer Science: BS Business Administration (Sales): MBA Accounting and Finance.

Who to contact for Interview: Robert C. Murphy, Employment Manager

Territories Open: Ottawa, Illinois, Morgantown and Parkersburg, West Virginia

Procedure for Arranging Interview: Arrange through College Placement Office or send resume to Company.

BURNS AND ROE, INC.

an Equal Opportunity Employer

Home Office: 800 Kinderkamack Road, Oradell, New Jersey 07649

Number of Employees: 2,500

Date Company Established: 1932

Corporate Description: An independent consulting engineering organization devoted to the practice of engineering, design, construction and related supporting services in the field of Power Generation.

Career Opportunities in 1982/83: ENGINEERS: Our work requires Engineers with Bachelor's or advanced degrees in the mechanical, electrical, civil, nuclear and chemical disciplines.

Who to contact for Interview: Mr. Robert A. Borsdorf at above address.

Procedure for Arranging Interview: Direct all inquires to: Mr. Robert A. Borsdorf.

COMMUNICATIONS SATELLITE CORPORATION

an Equal Opportunity Employer

Home Office: 950 L'Enfant Plaza, S.W., Washington, D.C. 20024

Number of Employees: 11,350

Date Company Established: 1963

Corporate Description: A private company, COMSAT by itself, or through its wholly owned subsidiary. COMSAT General Corporation, provides international, maritime and domestic communications satellite services and carries out such related activities as the provision of operational and technical services in the United States and other countries, and research and development to advance satellite communications technology.

Career Opportunities in 1982/83: Electronic Engineers, Computer Programmers, Spacecraft Design, Signal Processing, Scientific Software, Power Systems and RF Systems.

Who to contact for Interview: Manager, Professional Staffing, Dept. 81-6 RC.

Territories Open: Headquarters in Washington, D.C., Research Laboratories in Clarksburg, Md.

Procedure for Arranging Interview: Send resume to address shown above.

E-Systems An Equal Opportunity Employer

E-Systems, a Texas-based company, is a major worldwide developer and producer of high technology, non-consumer electronic systems and products and provides various aircraft modification, overhaul, and maintenance services for government and commercial users.

Send your resume to one or more of the divisions you are interested in to Manager of Staffing at the divisional address.



E-SYSTEMS

The problem solvers.

Garland Division

• Large data management • Digital secure voice communications • Flight service automation • Electronic warfare • Industrial solar collection

P.O. Box 226118, Dallas, Texas 75266
(214) 272-0515

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• Land- and ship-based navigation aids • Automatic flight controls

2268 South 3270 West, Salt Lake City, Utah 84119
(801) 973-4300

Melpar Division

• Airborne RPV's • Airborne and ground-based radio collection systems • Electronic countermeasures

7700 Arlington Boulevard, Falls Church, Virginia 22046, (703) 560-5000

Commercial Division

• Digital communications command and control systems for public safety • High-speed automated document processing • Complete INTELSAT and DOMSAT antennas and earth stations • Secure communications systems

P.O. Box 226031, Dallas, Texas 75266
(817) 461-3511

Greenville Division

• Airborne intelligence, reconnaissance and surveillance • Special ground electronic detection systems

P.O. Box 1056, Greenville, Texas 75401
(214) 455-3450

ECI Division

• Military communications, satellite, space and UHF • Electronic data-handling systems, telemetry, digital • Air traffic control radios.

1501 72nd Street North, St. Petersburg, Florida 33733, (813) 381-2000

Memcor Division

• Airborne, vehicular and personnel • Military radios • Electronic components

Huntington, Indiana & Tampa, Florida
P.O. Box 23500
Tampa, Florida 33623
(813) 885-7000

E-SYSTEMS, INC., GREENVILLE DIVISION



E-SYSTEMS

Greenville Division

an Equal Opportunity Employer

Home Office: P.O. box 1056, Greenville, Texas 75401

Number of Employees: 2,500

Date Company Established: 1946

Division Description: Development and integration of highly sophisticated airborne command, control and communications systems and complex aircraft maintenance and modification.

Career Opportunities in 1982/83: Electrical, mechanical, and aircraft structures engineers. Business applications and software development computer programmers.

Territories Open: Greenville, Texas

Procedure for Arranging Interview: Send resume to G. Emmet Ford, Professional Placement.

ELECTRONIC ASSOCIATES, INC. (EAI)

an Equal Opportunity Employer

Home Office: 185 Monmouth Parkway, West Long Branch, New Jersey 07764

Number of Employees: 890

Date Company Established: 1945

Corporate Description: EAI is a world leader in the design and manufacture of computation and simulation equipment.

Career Opportunities in 1982/83: Engineering: Electrical; Electronic; Nuclear; Industrial; Chemical; Manufacturing. Sciences: Computer, Physics, Mathematics, Chemistry. We prefer candidates with experience and advanced degrees, however, we welcome entry-level candidates to participate in our on-the-job training.

Territories Open: West Long Branch, N.J. and, occasionally, Customer sites.

Who to contact for Interview: Gayle Gutheil-Shupe

Procedure for Arranging Interview: Send resume to above address.

FLORIDA POWER CORPORATION

an Equal Opportunity Employer

Home Office: P.O. Drawer 670, Crystal River, Florida 32629

Number of Employees: 5,000

Date Company Established: 1944

Corporate Description: Investor owned electric utility.

Career Opportunities in 1982/83: Nuclear Engineers, Mechanical Engineers (Fossil and Nuclear Power Plants), Electrical Engineers (Fossil, Nuclear and Transmission & Distribution), Quality Engineers, Computer and Instrumentation Engineers.

Who to contact for Interview: James F. Dalonzo, Professional Staffing Specialist.

Territories Open: Northern and Central Florida, including west coast of Florida from St. Petersburg to Panama City.

Summer Employment: Summer Engineering Intern

Procedure for Arranging Interview: Send resume to company at above address.

FMC CORPORATION ORDNANCE DIVISION, ENGINEERING & OPERATIONS

an Equal Opportunity Employer

Engineering Division

1107 Coleman Avenue, Box 1201
San Jose, California 95108

Number of Employees: 5400.

Corporate Description: Research/development & production of military tracked vehicles.

Career Opportunities in 1982/83:

at Engineering Division:

Mechanical and Electrical Engineers
MIS trainees (Business Applications)

Who to contact for Interview:

Mary Ann Weingartner

Operations Division

1125 Coleman Avenue, Box 367
San Jose, California 95103

Date Company Established: 1893

at Operations Division

Engineering
CAD/CAM and MIS

Who to contact for Interview:

O. Noble

GAS RESEARCH INSTITUTE

an Equal Opportunity Employer

Home Office: 8600 West Bryn Mawr Avenue, Dept. WME-100, Chicago, Illinois 60631

Corporate Description: GRI is a national energy organization that finances, plans and manages technological research and development programs in the Natural Gas industry.

Career Opportunities in 1982/83: Technical research managers with B.S. in Engineering, or Scientific discipline and 2-5 years' experience in natural gas technologies.

Who to contact for Interview: Office of Professional Employment.

Procedure for Arranging Interview: Send resume to: Office of Professional Employment c/o above address.

GENERAL ELECTRIC COMPANY

an Equal Opportunity Employer

Home Office: Fairfield, Connecticut 06431

Number of Employees: 405,000

Date Company Established: 1878

Corporate Description: Core businesses include the research, design, development and manufacture of equipment that generates and distributes electricity, energy technologies, and natural-resource development. Wide product scope includes motors, turbine-generators, transformers, medical equipment, jet engines, appliances, plastics, transit systems.

Career Opportunities in 1982/83: Engineering (all disciplines), Computer Applications, R&D

Territories Open: Nationwide

Procedure for Arranging Interview: Send resume or write for careers brochure from: Manager, Applicant Referral Center, General Electric Company, Building 36, Schenectady, New York 12345. Arrange through college placement director.

GENERAL DYNAMICS

Electric Boat Division

an Equal Opportunity Employer

Home Office: Eastern Point Road, Groton, CT 06340

Number of Employees: 20,000

Date Company Established: Electric Boat Co.
est. 1899

Corporate Description: Designer and builder of nuclear submarines.

Career Opportunities in 1982/83: Engineers, all disciplines (electrical, civil, mechanical, nuclear, radiological control). Training programs include Rotation (design) and Career Development (shipyard management).

Who to contact for Interview: Robert E. Kelly

Territories Open: All positions located in Groton, CT.

Procedure for Arranging Interview: Send resume to Mr. Robert E. Kelly

GENERAL PUBLIC UTILITIES SYSTEM

an Equal Opportunity Employer M/F/H

Corporate Description: One of the nation's largest electric power utility systems, serving expansive, populous areas of New Jersey and Pennsylvania.

Total Number of Employees: 12,000

Date Established: 1946

GPU Member Companies:

- METROPOLITAN EDISON COMPANY
P.O. Box 542, Reading, PA 19640
- JERSEY CENTRAL POWER & LIGHT COMPANY
Madison Avenue at Punch Bowl Road
Morristown, NJ 07960
- PENNSYLVANIA ELECTRIC COMPANY
P.O. Box 539, Johnstown, PA 15907
- GPU NUCLEAR
P.O. Box 480, Middletown, PA 17059
- GPU SERVICE CORPORATION
100 Interpace Parkway
Parsippany, NJ 07054

Career Opportunities: Positions are available for those with interests or training in Engineering, Finance, Accounting or Data Processing.

Procedure for Arranging Interview: Contact your Placement Office or send resume to the Employment Department of the GPU Company of your choice.

GRUMMAN AEROSPACE CORPORATION

an Equal Opportunity Employer

Home Office: Bethpage, New York 11714

Number of Employees: 22,000

Date Company Established: 1930

Corporate Description: Research, development, design, and manufacture of aircraft, missiles, space vehicles, deep submersibles, hydrofoil craft.

Career Opportunities in 1982/83: Seeks chemists, engineers, programmers, welding engineers.

Who to contact for Interview: Kay Perry, Director, Employment Development, Dept. 311

Procedure for Arranging Interview: Send resume to company c/o Kay Perry, Director of Employment Development, Dept. 311.

GTE AUTOMATIC ELECTRIC RESEARCH AND DEVELOPMENT

an Equal Opportunity Employer M/F/H

Home Office: Phoenix-2500 W. Utopia Rd., Phoenix, AZ 85027 — Northlake-400 N. Wolf Rd., Northlake, IL 60164

Number of Employees: 10,000

Date Company Established: 1888

Corporate Description: Design & Development of Digital Switching Systems.

Career Opportunities in 1982/83: Bachelors or Masters in EE, Computer Engineering or Computer Science.

Who to contact for Interview: Phx - Mgr Manpower, Northlake-Mgr Human Resources

Territories Open: Northlake, IL and Phoenix, AZ.

Procedure for Arranging Interview: Send Resume.

GULF OIL CORPORATION

an Equal Opportunity Employer

Home Office: P.O. Box 1166, Pittsburgh, Pa. 15230

Number of Employees: 60,000

Date Company Established: 1901

Corporate Description: Fully integrated, world wide, total energy company engaged in production and distribution of petroleum, coal, atomic energy, petrochemicals, and plastics products.

Career Opportunities in 1982/83: Seeks accountants, business administrators, computer science personnel, engineers, geologists, geophysicists, and sales personnel.

Who to contact for Interview: William E. Johnston, Jr., Human Resources Department.

Territories Open: Nationwide

Procedure for Arranging Interview: For information concerning employment, send letter of interest and resume to William E. Johnston, Jr., Human Resource Department, Gulf Oil Corporation, P.O. Box 1166 Pittsburgh, Pa. 15230.

HARRIS CORPORATION-PRD ELECTRONICS DIVISION

an Equal Opportunity Employer

Home Office: 6801 Jericho Turnpike, Syosset, L.I., New York 11791

Number of Employees: 1800

Date Company Established: 1944

Corporate Description: Design development of electronic systems, including automatic test equipment for complex Avionic weapons systems; Development of Data Acquisition Systems.

Career Opportunities in 1982/83: Technical and Administrative career possibilities including; systems design, computer programming and administrative positions in accounting and finance. Manufacturing.

Who to contact for Interview: Mr. C. G. Gemuendt, Manager, Employment

Procedure for Arranging Interview: Send resume to Mr. C. G. Gemuendt, Manager, Employment, Harris Corp., PRD Electronics Division, 6801 Jericho Typke., Syosset, N.Y. 11791.

HONEYWELL INC.

an Equal Opportunity Employer

Home Office: Honeywell Plaza, Minneapolis, MN 55408

Number of Employees: 90,000

Date Company Established: 1885

Corporate Description: Research, Development, Manufacture, and sale of electronic components and control systems and computer hardware and systems.

Career Opportunities in 1982/83: Computer Science, Programming, Systems; Engineers - electrical, electronic, industrial, manufacturing, Mechanical, Physicists - Optics, solid state; Sales personnel - technical.

Who to contact for Interview: Ernie von Heimbürg

Territories Open: Nationwide

Procedure for Arranging Interview: Send resume to Ernie von Heimbürg, c/o above address.

INTEL CORPORATION

an Equal Opportunity Employer

Home Office: 3065 Bowers Avenue, MS 5-2111, Santa Clara, CA 95051

Number of Employees: 16,000

Date Company Established: July, 1968

Corporate Description: Intel is an electronics company engaged principally in the design, development, manufacture and sales of VLSI semiconductor components and systems incorporating these components.

Career Opportunities in 1982/83: Packaging, Design Facilities, Industrial, Manufacturing, Process, Product, Hardware, Software, Engrs., Technical Mktg., Tech Writers, MBAs, Financial Analysts, Planners.

Who to contact for Interview: College Relations Dept.

Territories Open: Phoenix, AZ, Santa Clara, CA Albuquerque, NM, Portland, OR, Austin, Texas.

Procedure for Arranging Interview: Send resume to company or arrange through college placement director.

INTERNATIONAL TRADE ADMINISTRATION

an Equal Opportunity Employer

Home Office: 14th & Constitution Ave., N.W. Washington, D.C. 20230

Number of Employees: 2100

Date Company Established: January 2, 1980

Corporate Description: An agency of the Department of Commerce responsible for the promotion and control of world exports of goods and services for the United States.

Career Opportunities in 1982/83: Electronic Engineers with specialization in computer system technology, or electronic equipment and component technologies including solid state devices.

Who to contact for Interview: Leonard Carter

Territories Open: Washington, D.C.

Summer Employment: Summer intern positions available.

Procedure for Arranging Interview: Send resume or Standard Form 171 to the Office of Personnel, Room 4800 at the above address, ATTN: Leonard Carter.

ITT FELEC SERVICES, INC.

ITT Federal Electric Corporation

an Equal Opportunity Employer

Home Office: 5010 Edison Avenue, P.O. Box 15012, Colorado Springs, CO 80935

Number of Employees: 1,700 approx.

Date Company Established: 1975

Corporate Description: Operations & Maintenance contractor for U.S. Air Force on Ballistic Missile Early Warning System (BMEWS) and Distant Early Warning (DEW Line).

Career Opportunities in 1982/83: ME, EE, CE, Computer Science.

Who to contact for Interview: Genevieve Rice, Supervisor of Employment.

Territories Open: Colorado Springs, CO; Greenland

Summer Employment: None

Procedure for Arranging Interview: Send resume to Genevieve Rice.

KERR-McGEE CORPORATION

an Equal Opportunity Employer

Home Office: Kerr-McGee Center, Box 25861, Oklahoma City, OK 73125

Number of Employees: 11,000 plus

Date Company Established: 1929

Corporate Description: Discovery, production and marketing of oil, natural gas, uranium and coal. Industrial and agricultural chemicals, forest products and contract drilling offshore.

Career Opportunities in 1982/83: Chemical, electrical, mechanical, metallurgical, mining and petroleum engineers.

Who to contact for Interview: E.D. Marvin Jr., Manager, professional & technical recruiting.

Procedure for Arranging Interview: Send resume to E.D. Marvin Jr. at above address.

LOCKHEED-GEORGIA COMPANY

an Equal Opportunity Employer

Home Office: Marietta, Georgia 30063

Number of Employees: 13,500

Date Company Established: 1951

Corporate Description: Aircraft - Design, Development, and Manufacture; Aircraft Logistical Support Services; Aerospace Research and Development.

Career Opportunities in 1982/83: Aeronautical, Electrical, Mechanical, Industrial Engineers; Computer Science, Finance, Industrial Relations/Personnel; Miscellaneous Manufacturing & Technical.

Who to contact for Interview: D.E. Cowart

Territories Open: Atlanta Metropolitan Area

Procedure for Arranging Interview: Send resume or correspondence to employment office at address above.

LOCKHEED MISSILES & SPACE CO.

an Equal Opportunity Employer

Home Office: P.O. Box 504, Sunnyvale, Ca. 94086

Number of Employees: 19,000

Date Company Established: 1954

Corporate Description: Research & Development and systems management in space systems, missile systems, deep submersibles & environmental systems.

Career Opportunities in 1982/83: Associate engineers in Aeronautical, Astronautical, Electrical, Electronic, Mechanical Engineering and Computer Science.

Who to contact for Interview: Employment Manager.

Territories Open: Sunnyvale, California; Huntsville, Alabama.

Procedure for Arranging Interview: Send resume to company.

MONSANTO COMPANY

an Equal Opportunity Employer

Home Office: 800 North Lindbergh Blvd., A3SB, Dept. CL-4, St. Louis, Missouri 63166

Number of Employees: 61,500

Date Company Established: 1901

Corporate Description: Agricultural Chemical, Plastics & Resins, Synthetic Textiles, Chemical and Electronic Materials.

Career Opportunities in 1982/83: Mechanical, Chemical, Electrical, Industrial and Civil Engineers, Chemist, Computer Science, Accountants.

Who to contact for Interview: Ray Nobel

Territories Open: Nationwide

Summer Employment: For Engineers, Chemist, Business

Procedure for Arranging Interview: Send resume to company or arrange through college placement director. See our full page ad.

MOTOROLA INC.

an Equal Opportunity Employer

Government Electronics Group

Home Office: Department 1169, 8201 E. McDowell Road, Scottsdale, Arizona 85252

Corporate Description: A diversified high technology company in electronics and systems.

Career Opportunities in 1982/83: See full page ad.

Who to contact for Interview: Call collect to Chuck Doyle (602) 949-3759 or write to Mr. Doyle.

Procedure for Arranging Interview: Call Chuck Doyle collect at (602) 949-3759 or write to Mr. Doyle.

NASA—National Aeronautics and Space Administration

an Equal Opportunity Employer

Home Office: NASA Headquarters, Washington, D.C. 20546

Corporate Description: Managing complex engineering and scientific research and development programs relating to aeronautical and space exploration.

Career Opportunities in 1982/83: Offering Mid-Level Managerial and Executive Level positions. Engineers and Scientists.

Who to contact for Interview: Dr. Harriett G. Jenkins

Procedure for Arranging Interview: Send a copy of your SF-171 or resume to Dr. Harriett G. Jenkins, Director w/Equal Opportunity Programs, NASA Headquarters c/o above address.

NORTHEAST UTILITIES

an Equal Opportunity Employer

Home Office: P.O. Box 270, Hartford, CT 06101

Corporate Description: Northeast Utilities works with the increasing energy demands and advances in state-of-the-art power technology.

Career Opportunities in 1982/83: Electrical, Mechanical, or Nuclear engineering, health physics, programming, Computer Science and Accounting.

Who to contact for Interview: Ann Johnson, Supervisor of Professional Placement.

Procedure for Arranging Interview: Send your resume to Ann Johnson, Supervisor of Professional Placement or Call (203) 666-6911 Ext. 3639.

NORTHROP CORP.

an Equal Opportunity Employer

Home Office: 1800 Century Park East, Los Angeles, California 90067

Number of Employees: 30,000

Date Company Established: 1939

Corporate Description: Northrop is a diversified high-technology aerospace company with principal interests in aircraft, communications and electronics.

Career Opportunities in 1982/83: Aeronautical, Electrical, Electronic, Mechanical, Manufacturing and Industrial Engineers. Graduates in Physics, Computer Science, Mathematics, Materials Science and Business.

Who to contact for Interview: Edward D. Martinez, Coordinator of College Relations.

Territories Open: Nationwide.

Procedure for Arranging Interview: Send resume and letter of interest to Edward D. Martinez, c/o above address.

PACIFIC MISSILE TEST CENTER

an Equal Opportunity Employer

Home Office: Code 0420, Point Mugu, California 93042

Number of Employees: 3,800

Date Company Established: 1946

Corporate Description: Navy's Major Missile Test Center

Career Opportunities in 1982/83: 120 positions Electrical/Electronics, Mechanical, Aerospace, Mathematicians, Physics, and Computer Science.

Who to contact for Interview: J. McIntosh Toll-free 800-235-5967 Out-of-State, 800-322-5973 California.

Territories Open: Point Mugu, California

Summer Employment: Approximately 100 positions in 1982.

Procedure for Arranging Interview: Send Resume or Federal Employment Application Form 1282 to above address.

PHILADELPHIA NAVAL SHIPYARD

an Equal Opportunity Employer

Home Office: 170.21, Building One, Philadelphia, PA 19112

Number of Employees: 10,000

Date Company Established: 1799

Corporate Description: A Federal civilian employer, the Shipyard provides logistic support for assigned vessels and performs construction, conversion, repair and overhaul of ships and crafts.

Career Opportunities in 1982/83: Electrical, Electronic and Mechanical Engineers and Naval Architects. Positions provide a career ladder to the full performance level, primarily through on-the-job training.

Who to contact for Interview: Richard Carr

Territories Open: All positions are at the Shipyard, U.S. Naval Base, Philadelphia, PA.

Summer Employment: Cooperative education training agreements exist with many colleges and universities.

Procedure for Arranging Interview: Contact College Placement Director regarding possible on-campus recruiting or contact the Shipyard at the address indicated above.

PUBLIC SERVICE ELECTRIC & GAS COMPANY

an Equal Opportunity Employer

Home Office: 80 Park Plaza, Room 2A, P.O. Box 570, Newark, N.J. 07101

Number of Employees: 13,000

Date Company Established: 1903

Corporate Description: Electric & Gas Utility

Career Opportunities in 1982/83: Nuclear, Mechanical, Electrical, Engineering positions — Programmers — Cobol.

Who to contact for Interview: Ted Hunziker, Personnel Coordinator

Territories Open: Newark and various New Jersey location

Summer Employment: 8 week management orientation training.

Procedure for Arranging Interview: Send resume — cover letter — indicating career objectives to: Ted Hunziker, Employment & Placement, Room 2A, P.O. Box 570, 80 Park Plaza, Newark, N.J. 07101.

PUGET SOUND NAVAL SHIPYARD

Federal Government

an Equal Opportunity Employer

Home Office: Puget Sound Naval Shipyard Code 170.2 (AW), Bremerton, Washington 98314

Number of Employees: 11,000 **Date Company Established:** 1891

Corporate Description: Ship Conversion and Repair.

Career Opportunities in 1982/83: Mechanical and Electrical Engineers.

Territories Open: Bremerton, Washington 98314

Procedure for Arranging Interview: Call Toll-Free 1-800-426-5996 (Within Washington 1-800-562-5972) or send resume to: Puget Sound Naval Shipyard, Code 170.2 (AW), Bremerton, WA 98314

REVLON, INC.

an Equal Opportunity Employer

Home Office: Room 1011, 767 Fifth Ave., New York City, New York 10022

Number of Employees: 19,500

Corporate Description: Leading Manufacturer of Cosmetics, Fragrances and Pharmaceuticals

Career Opportunities in 1982/83: Cosmetics, fragrance, scientific research, ethical or proprietary products, finance, marketing, sales, systems analysis and computer programming. Engineering: Industrial, Machine Design, Project and Maintenance.

Procedure for Arranging Interview: Send resume to company c/o above address.

ROCKWELL INTERNATIONAL

an Equal Opportunity Employer

Number of Employees: 108,000

Corporate Description: A major multi-industry Company, applying advanced technology to a wide range of products — in our aerospace, electronics and general industries businesses.

Career Opportunities in 1982/83: Electrical, Mechanical, Industrial, Aerospace, Civil and Chemical Engineering plus Computer Science, Physics and Chemistry.

Procedure for Arranging Interview: Arrange through college placement director.



Division of Sperry Corporation

an Equal Opportunity Employer

Home Office: Marcus Ave. and Lakeville Rd., Great Neck, Long Island, N.Y. 11020

Number of Employees: 5,000

Date Company Established: 1910

Corporate Description: Design and Development of radar fire control; inertial Navigation, Guidance Control, Navigation/Command Decision, flight simulation, gyro-compass and inertial, and Microwave radar systems.

Career Opportunities in 1982/83: Assistant Engineers (EE, ME and Physics Degrees preferred). Programmers (Computer Science, Math or Physics Degree-EE with CS minor acceptable. Field Engineers (application): Degree in EE, ME or Physics appropriate.

Who to contact for Interview: P.W. Smith

Procedure for Arranging Interview: Send resume to P.W. Smith at above address.

THE STANDARD OIL COMPANY (OHIO)

an Equal Opportunity Employer

Home Office: 1422 Midland Building, Cleveland, Ohio 44115

Number of Employees: 22,103

Date Company Established: 1870

Corporate Description: The Standard Oil Company (Ohio) is an integrated petroleum and chemical company. Operations include petroleum refining and marketing, manufacture and sale of consumer and industrial chemical and plastic products; Supply and Transportation; Technology; Planning; and Natural Resources.

Career Opportunities in 1982/83: Corp. Refining & R&D Engineering; Pipeline Transportation; Mktg. Const. & Maint.

Who to contact for Interview: Technical Recruitment Coordinator

Territories Open: Ohio, Pennsylvania, Texas, New Jersey

Procedure for Arranging Interview: Send resume to Company.

STONE AND WEBSTER ENGINEERING COMPANY

an Equal Opportunity Employer

Home Office: Box 2325, Boston, Mass. 01207

Number of Employees: 9,125

Date Company Established: 1889

Corporate Description: Design, engineering, construction and consulting in Nuclear, fossil-fueled and hydroelectric power generation, energy transmission, chemical, petrochemical and substitute natural gas plants, related heavy industrial projects.

Career Opportunities in 1982/83: Mechanical, Chemical, Nuclear, Electrical, Geotechnical, Environmental and Civil engineering.

Procedure for Arranging Interview: Send resume to company or arrange through college placement director.

SUNDSTRAND CORPORATION

an Equal Opportunity Employer

Home Office: 4751 Harrison Avenue, Rockford, IL 61101

Number of Employees: 15,400

Date Company Established: 1905

Corporate Description: Sundstrand designs, manufactures, and markets high technology mechanical and electrical components and systems for aerospace and industrial markets. Products include hydrostatic transmissions; high-speed pumps and compressors; heat transfer surfaces; and aerospace products such as electric power generating systems, pumps, actuation systems, and flight safety and entertainment systems.

Career Opportunities in 1982/83: Mechanical, aerospace and electrical engineering

Who to contact for Interview: Mike Trotter, College Relations Coordinator

Territories Open: Rockford, IL and other cities throughout U.S.

Procedure for Arranging Interview: Send resume to company or arrange through college placement director if we visit your campus.

SUPPORT SYSTEMS ASSOCIATES, INC.

an Equal Opportunity Employer

Home Office: 6 Bayview Avenue, Northport, N.Y. 11768

Number of Employees: 400

Date Company Established: 1969

Corporate Description: Engineering and Technical services firm specializing in Automated Electronic Test Equipment for production and product support of Electronic devices and systems.

Career Opportunities in 1982/83: Technical career possibilities including systems hardware and software design, computer programming and test programming positions. Electrical Engineers, Computer Scientists.

Who to contact for Interview: Kathy Romancyck. (516) 261-8998 or send resume.

Territories Open: San Diego, St. Louis, Dayton, Boston, Long Island, Owego, N.Y., D.C., Norfolk, Warner Robins, Ga., Jacksonville, Fla.

Procedure for Arranging Interview: Send Resume.

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

an Equal Opportunity Employer

Home Office: Bethesda, Maryland 20084

Number of Employees: 2,800

Corporate Description: Engaged in research, development, test and evaluation of naval vehicles.

Career Opportunities in 1982/83: Naval Architects; Mechanical, Civil, Structural, Chemical, and Environmental Engineers; Mathematicians; Physicists; and Computer Scientists.

Who to contact for Interview: Civilian Personnel Department

Territories Open: Washington, D.C. (Carderock, Maryland) and Annapolis, Maryland.

Procedure for Arranging Interview: Call: Civilian Personnel Department (202) 227-2867.

TEXACO INC.

an Equal Opportunity Employer

Home Office: 2000 Westchester Avenue, White Plains, NY 10650

Number of Employees: Approximately 67,000

Date Company Established: 1902

Corporate Description: Integrated oil company marketing more than 800 petroleum products and 500 petrochemicals including aviation, marine, fuel oils, asphalts, industrial and oil burner equipment.

Career Opportunities in 1982/83: Engineering, chemical, civil, electrical, geological, geophysical, mechanical, natural gas, and petroleum.

Who to contact for Interview: Virginia B. Benfield

Territories Open: Nationwide

Procedure for Arranging Interview: Contact your on-campus recruiting office or write College Recruiting Manager (WEME), Texaco Inc., P.O. Box 52332, Houston, TX 77052

TEXAS INSTRUMENTS INCORPORATED

an Equal Opportunity Employer

Home Office: P.O. Box 225474, Dept. CM1, MS 67, Dallas, Texas 75265

Number of Employees: 78,571

Date Company Established: 1930

Corporate Description: Manufacture of Semiconductor Materials and Components, Electronic Calculators, Microelectronic Watches, Minicomputers, Microcomputers, Super Computers; Electronic Data Terminals, Clad Metal Systems, Electrical and Thermostatic Controls, Optoelectronics, Radar Systems Electro-optics Equipment, Services for Global Oil and Mineral Exploration.

Career Opportunities in 1982/83: Computer Scientists. Engineers-Ceramic, Chemical, Electrical, Mechanical, Electronic, Plastics, Sales (Electronic, Computer Science); Ecological Scientists; Geophysics; Metallurgists; Physicists-Solid State.

Who to contact for Interview: Mr. George Berryman

Procedure for Arranging Interview: Send resume to company or arrange through college placement director.

TRI-STATE GENERATION & TRANSMISSION ASSN., INC.

an Equal Opportunity Employer

Home Office: 12076 Grant Street, Thornton, Colorado 80233

Number of Employees: 350

Date Company Established: 1952

Corporate Description: A wholesale power cooperative that provides electric energy for 25 member systems in the rural areas of Colorado, Wyoming and western Nebraska.

Career Opportunities in 1982/83: Electrical engineering in system planning, transmission / substation (design, project and field coordination), telecommunications and Control systems (software). Power option desirable.

Who to contact for Interview: Personnel Department

Territories Open: Denver, Colorado

Procedure for Arranging Interview: Send resume to: Tri-State Generation & Transmission Assn., Inc., Personnel Department, P.O. Box 33695, Denver, CO 80233.



TRW

ELECTRONIC SYSTEMS GROUP

an Equal Opportunity Employer

Home Office: One Space Park Drive, R6/1033, Redondo Beach, CA 90278

Number of Employees: 2400

Date Company Established: 1952

Corporate Description: High Technology Electronic Systems and components for space and military applications.

Career Opportunities in 1982/83: Seeking BS, MS and PhD Electrical Engineers.

Who to contact for Interview: Professional Employment

Territories Open: Redondo Beach, California

Procedure for Arranging Interview: Send resume to company.



UNC NAVAL PRODUCTS

Division of United Nuclear Corporation

an Equal Opportunity Employer

Home Office: 67 Sandy Desert Road, Uncasville, Conn. 06382

Number of Employees: 1100

Corporate Description: Manufacture of Nuclear fuel materials and the fabrication of reactor cores and components.

Career Opportunities in 1982/83: All engineering disciplines as well as computer science, programming, inorganic chemistry, mathematics and statistics, accounting, finance and other general management/administrative functions.

Procedure for Arranging Interview: Send resume to: Professional Employment c/o above address.

AIR FORCE COMMUNICATIONS COMMAND

an Equal Opportunity Employer

Home Office: 1842 Electronics Engineering Group, Scott AFB, IL 62225

Number of Employees: 164

Corporate Description: Communications-Electronics Systems Engineering. Specialized areas include: High-Frequency, Microwave, Satellite Systems, Switching and Control Systems, Base Transmission and Switching Systems, and Ground/Air Radio Systems.

Career Opportunities in 1982/83: Electronics Engineers.

Who to contact for Interview: Zygmund Bara

Territories Open: Illinois (20 mi. east of St. Louis, MO)

Procedure for Arranging Interview: Send resume to: Mr. Arthur R. Davis, Dept. MWE, 1842 EEG/EETTS, Scott AFB, IL 62225

US ARMY INTELLIGENCE AND SECURITY COMMAND (USAINSCOM)

an Equal Opportunity Employer Department of the Army

Home Office: USAINSCOM, 4000 Arlington Blvd., DCSPER, ATTN: TAPER-SCPO, VA 22212

Number of Employees: 1700 civilians worldwide **Date Company Established:** 1945 as the US Army Security Agency

Corporate Description: USAINSCOM is a multi-disciplined intelligence Command responsible for the conduct of Intelligence and CounterIntelligence operations for the Army.

Career Opportunities in 1982/83: See Full Page Ad

Who to contact for Interview: Ms. Dorothy Chumney/Ms. Sandra Collier

Territories Open: US locations in the Washington DC Metro Area plus various foreign locations.

Procedure for Arranging Interview:

Interested applicants should submit an SF-171, Personal Qualifications Statement, to the address indicated in Item #2. Applicants for employment with the USAINSCOM are required to meet certain minimum prerequisites. In addition to job qualifications, the applicant must:

1. Be of excellent character and discretion, and of unquestionable loyalty to the United States.
2. Be a United States Citizen. If married, spouse should also be a US citizen.
3. Possess personal habits or character traits unquestionable from a security standpoint.
4. Be subject to a full Background Investigation.

US ARMY COMMUNICATIONS ELECTRONICS COMMAND (CECOM)

an Equal Opportunity Employer Department of the Army

50 miles South of New York City—50 miles Northeast of Philadelphia
Fort Monmouth, New Jersey 07703

Home Office: CECOM, Civilian Personnel Division, Recruitment Office, Fort Monmouth, New Jersey 07703

Number of Forth Monmouth Civilian Employees: 8,000

Corporate Description: Fort Monmouth is the Army's center for conceiving, developing and procuring a vast array of vital communications and electronic equipment and systems for the U.S. Armed Forces.

Career Opportunities in 1982/83: Immediate openings exist for professional engineers (electronic, mechanical, civil, industrial, chemical, safety), with BS or MS degrees. These openings are challenging positions with a wide range of individual responsibilities and opportunities for advancement. Full tuition for job-related graduate study is provided.

Procedure for Arranging Interview: Send resume to above address, ATTN: Prudence White.

UNITED STATES ARMY TANK-AUTOMOTIVE COMMAND

an Equal Opportunity Employer

Home Office: 6305 E. 11 Mile Road, Warren, Michigan 48090

Number of Employees: 6500: 6000 civilians and 500 military.

Date Company Established: 1940

Corporate Description: Research, development, procurement, and maintenance of wheeled and tracked vehicles for all Armed Forces and 60 Allied nations.

Career Opportunities in 1982: Over 50 mechanical and electrical engineering internships available as well as advanced positions for eligible (experienced) candidates.

Who to contact for Interview: Irma Badger

Territories Open: Warren, Michigan (11 miles north of Metropolitan Detroit).

Summer Employment: Co-op programs are available to qual'd candidates.

Procedure for Arranging Interview: Send updated resume and a copy of college transcripts to Irma Badger c/o Civilian Personnel Office (DRSTA-ALR), Warren, Michigan 48090

NAVAL RESEARCH LABORATORY

an Equal Opportunity Employer

Home Office: Code 1813.2, EEO Civilian Personnel Office. 4555 Overlook Ave., S.W. Washington, D.C. 20375

Number of Employees: 3150

Date Company Established: July 2, 1923

Corporate Description: As the Navy's Corporate Laboratory, NRL conducts a broadly based multi-disciplinary program of scientific research and advanced technological development directed toward new & improved materials, equipment techniques, systems and operational procedures for the Navy.

Career Opportunities in 1982/83: Engineers with Bachelor's or advanced degrees in the Electronic, Mechanical, Materials, Aerospace, Ceramic disciplines; Physical Scientists with advanced degrees; and Computer Scientist. U.S. citizenship required.

Who to contact for Interview: Marguerite Luck

Territories Open: Washington, D.C.

Summer Employment: Cooperative education training agreements exist with many colleges and universities.

Procedure for Arranging Interview: Send resume or a Federal Employment Application Form to Agency.

NAVAL AVIONICS CENTER

an Equal Opportunity Employer

Home Office: 6000 East 21st Street, Indianapolis, Indiana 46218

Number of Employees: 2,300

Date Company Established: 1942

Corporate Description: Research, design, product development, material acquisition and testing in the field of aircraft and space electronics.

Career Opportunities in 1982/83: Wide variety of electronic, mechanical, and industrial engineering positions.

Who to contact for Interview: Director, Civilian Employment

Territories Open: Indianapolis, IN

Summer Employment: Positions available for industrial, electrical, & mechanical engineering students, computer science and physics students.

Procedure for Arranging Interview: Send resume to company or arrange through college placement director.

NAVAL UNDERSEA WARFARE ENGINEERING STATION

an Equal Opportunity Employer

Home Office: Civilian Personnel Office, Naval Undersea Warfare Engineering Station, Keyport, Washington 98345

Number of Employees: Approximately 2,600

Date Company Established: 1914

Corporate Description: This Navy light industrial complex supports undersea weapon test and evaluation, provides technical direction for assigned weapon systems, weapons and components, design cognizance for underwater acoustic ranges and integrates them into Navy operations.

Career Opportunities in 1982/83: Engineers with bachelors or advanced degrees in Electronic or Mechanical Engineering are eligible for promotion to journeyman level in Career Development Program. Undergraduates eligible for COOP Work/Study in Engineering, Mathematics, and Computer Science.

Who to contact for Interview: Mr. David Dixon or Mr. Rob Jezek, Professional Recruitment Coordinators, Code 0614, phone: (206) 396-2433/2436.

Territories Open: Keyport, Washington, San Diego, California, Lualualei, Hawaii.

Summer Employment: Summer Professional Program for Engineering, Mathematics, and Computer Science Undergraduates.

Procedure for Arranging Interview: Send resume to agency.

NAVAL WEAPONS CENTER, CHINA LAKE



an Equal Opportunity Employer

Home Office: (Code 09201) Naval Weapons Center, China Lake, CA 93555

Number of Employees: 3900

Date Company Established: 1942

Corporate Description: Navy's major R&D T&E Laboratory.

Career Opportunities in 1982/83: 150 positions available for Electrical, Mechanical, Industrial, Aerospace, and Civil Engineers, Physicists, Computer Scientists, Mathematicians, and Chemists.

Who to contact for Interview: C. Karen Altieri (714) 939-3371

Territories Open: China Lake, CA

Summer Employment: A variety of advanced degree programs offered to employees.

Procedure for Arranging Interview: Send resume to above address.

UNITED STATES STEEL

an Equal Opportunity Employer

Home Office: P.O. Box 86

Number of Employees: 166,000

Date Company Established: 1901

Corporate Description: Integrated production of iron and steel products, including Mining, Transportation, Fabrication, Construction. Also production of electrical cables; chemicals and plastics.

Career Opportunities in 1982/83: Chemical, Civil, Electrical, Mechanical and Mining Engineers. Metallurgy, Computer Science.

Who to contact for Interview: Manager, College Relations.

Procedure for Arranging Interview: Send resume to company or arrange through college placement director.

WANG LABORATORIES, INC.

an Equal Opportunity Employer

Home Office: One Industrial Ave., Lowell, MA 01851

Number of Employees: 11,000

Date Company Established: 1951

Corporate Description: Single and multi-user word processing and computer systems.

Career Opportunities in 1982/83: Electrical Engineers, Systems Programmers, Systems Analysts. BSEE or BSCS.

Who to contact for Interview: Mgr., College Relations

Territories Open: Lowell, MA.

Procedure for Arranging Interview: Send resume to Manager, College Relations, One Industrial Ave., Lowell, MA 01851.

WASHINGTON SUBURBAN SANITARY COMMISSION

Personnel Services Division

An Equal Opportunity Employer

Home Office: 4017 Hamilton Street, Hyattsville, Maryland 20781

Number of Employees: 2000

Date Company Established: 1918

Corporate Description: Public Non-Profit Water Filtration and Sewer Treatment Utility.

Career Opportunities in 1982/83: Civil Engineer (Hydraulics, Structural, Soils, Sanitary or Design), Construction Manager, Electrical/Mechanical Engineer, Project Manager, or Planning Manager.

Who to contact for interview: Rita N. Hubbard, Manager, Employment Unit

Territories Open: Montgomery and Prince George's Counties, Md.

Procedure for Arranging Interview: Send resume to Rita Hubbard, Manager - Employment Unit, Personnel Services Division at the above address.

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☐ continue receiving The Woman Engineer
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(Signature)

(Date)

(Please Print Name)

(Title—Career Position)

(Company)

(City)

(State)

(Zip)

Send to:

(Name)

(PERMANENT Mailing Address)

(City)

(State)

(Zip)

If employed, how long in current position? _____

If junior/senior engineering student:

Major _____ Graduating Year _____

Name of college/university _____

How many other engineering graduates/students or woman professionals did you share your copy with? _____

Where did you get your copy of Woman Engineer? _____

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☐ Professional Woman Engineer

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☐ continue receiving The Woman Engineer
☐ Yes ☐ No

(Signature)

(Date)

(Please Print Name)

(Title—Career Position)

(Company)

(City)

(State)

(Zip)

Send to:

(Name)

(PERMANENT Mailing Address)

(City)

(State)

(Zip)

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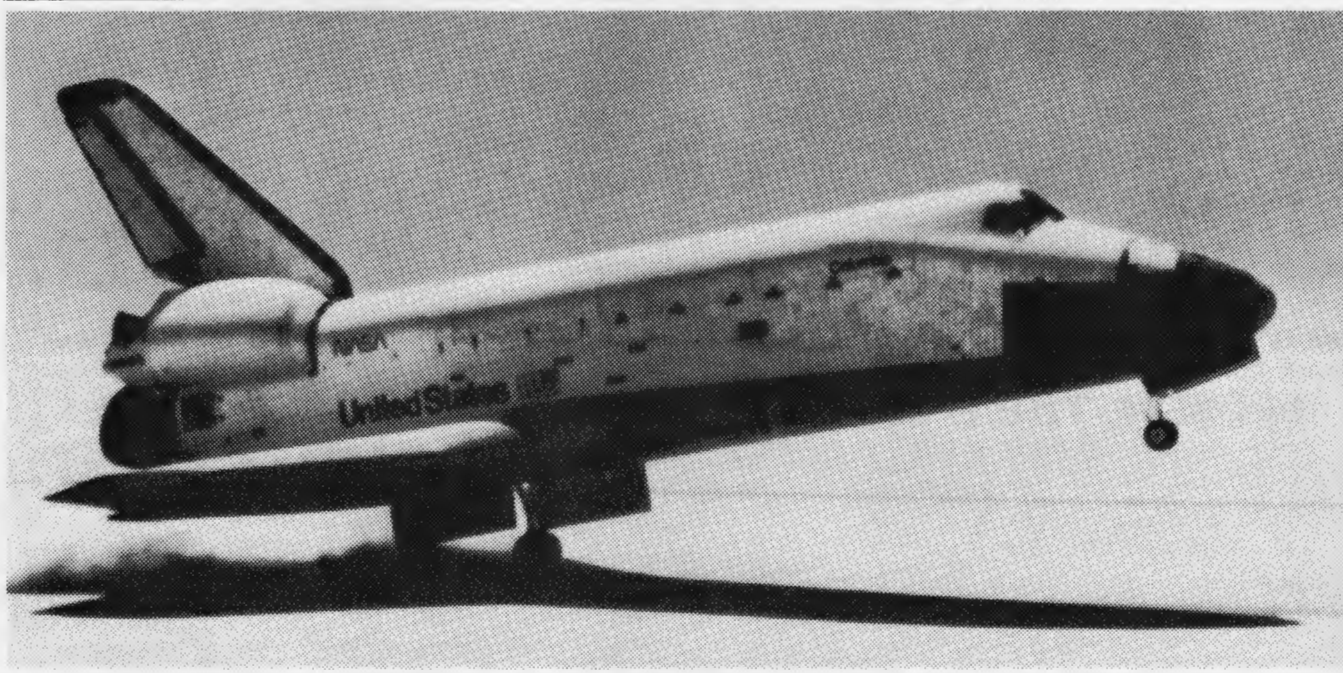
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1. Take this section and circle the companies in which you would like to pursue a career.
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FREE OF CHARGE, The Woman Engineer Staff will contact the companies chosen by you informing them of your interest and providing them with a copy of this resume form or your own resume.

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AVIONIC ENGINEERS**

- ☐ Aerojet Strategic Propulsion
- ☐ E-Systems, Greenville
- ☐ Grumman Aerospace
- ☐ Gulfstream American Corporation
- ☐ Lockheed-California
- ☐ Lockheed-Georgia
- ☐ Lockheed Missiles and Space Co.
- ☐ NASA
- ☐ Naval Air Propulsion Center
- ☐ Naval Research Laboratory
- ☐ Naval Weapons Center
- ☐ Northrop
- ☐ Pacific Missile Test Center
- ☐ Rockwell International
- ☐ Sundstrand
- ☐ U.S. Air Force
- ☐ U. S. Army Aberdeen Proving Ground

☐ **ARCHITECTS**

- ☐ Charleston Naval Shipyard
- ☐ Philadelphia Naval Shipyard
- ☐ David W. Taylor Naval Ship R&D Center

☐ **CERAMIC ENGINEERS**

- ☐ Texaco
- ☐ Texas Instruments

☐ **CHEMICAL ENGINEERS**

- ☐ Aerojet Strategic Propulsion
- ☐ Bechtel
- ☐ Bethlehem Steel
- ☐ Borg-Warner Chemicals
- ☐ Burns & Roe
- ☐ Colgate Palmolive
- ☐ Combustion Engineering
- ☐ Electronic Associates, Inc.
- ☐ Exxon
- ☐ FRU-Con Corporation
- ☐ General Electric
- ☐ Getty Oil
- ☐ Grumman Aerospace
- ☐ Gulf Oil
- ☐ Intel

- ☐ Kerr-McGee
- ☐ Monsanto
- ☐ Motorola Government Electron Group
- ☐ Naval Air Propulsion Center
- ☐ Naval Weapons Center
- ☐ Rockwell International
- ☐ Stone & Webster
- ☐ David W. Taylor Naval Ship R&D Center
- ☐ Texaco
- ☐ Texas Instruments
- ☐ UNC Naval Products
- ☐ U.S. Army Aberdeen Proving Ground
- ☐ U.S. Army CECOM
- ☐ U.S. Steel

☐ **CIVIL/STRUCTURAL
ENGINEERS**

- ☐ Bechtel
- ☐ Borg-Warner Chemicals
- ☐ Burns & Roe
- ☐ Charleston Naval Shipyard
- ☐ Combustion Engineering
- ☐ FMC-Ordnance Division
- ☐ General Dynamics-Electric Boat Division
- ☐ ITT Felec Services
- ☐ Naval Weapons Center
- ☐ Rockwell International
- ☐ Stone & Webster
- ☐ David W. Taylor Naval Ship R&D Center
- ☐ Texaco
- ☐ U.S. Air Force
- ☐ U.S. Army Aberdeen Proving Ground
- ☐ U.S. Army CECOM
- ☐ U.S. Steel
- ☐ Washington Suburban Sanitary Commission

☐ **COMPUTER SCIENTISTS
(HARDWARE/SOFTWARE)**

- ☐ Aerojet Strategic Propulsion
- ☐ Colgate Palmolive
- ☐ Communications Satellite

- ☐ E-Systems
- ☐ E-Systems, Greenville
- ☐ Electronic Associates, Inc.
- ☐ Exxon
- ☐ Florida Power Corporation
- ☐ FMC-Ordnance Division
- ☐ General Electric
- ☐ General Public Utilities
- ☐ GTE Automatic Electric Laboratories
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- ☐ Intel
- ☐ International Trade Administration
- ☐ ITT Felec
- ☐ Lockheed-California
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- ☐ Lockheed Missiles and Space Co.
- ☐ Motorola Government Electron Group
- ☐ Naval Air Propulsion Center
- ☐ Naval Research Laboratory
- ☐ Naval Undersea Warfare Engineering Station
- ☐ Naval Weapons Center
- ☐ Pacific Missile Test Center
- ☐ PRD Electronics Division-Harris Corporation
- ☐ Public Service Electric & Gas
- ☐ Rockwell International
- ☐ Support Systems Associates
- ☐ David W. Taylor Naval Ship R&D Center
- ☐ Texas Instruments
- ☐ UNC Naval Products
- ☐ USAINSCOM
- ☐ U.S. Army Aberdeen Proving Ground
- ☐ U.S. Steel
- ☐ Wang Laboratories

☐ **CONSTRUCTION ENGINEERS**

- ☐ Bechtel
- ☐ Standard Oil Company of Ohio

- ☐ Washington Suburban Sanitary Commission
- ☐ **DATA PROCESSING**
 - ☐ Bechtel
 - ☐ E-Systems
 - ☐ General Public Utilities
 - ☐ Wang Laboratories
- ☐ **DESIGN ENGINEERS**
 - ☐ Bechtel
 - ☐ Combustion Engineering
 - ☐ FMC-Ordnance Division
 - ☐ FRU-Con Corporation
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 - ☐ Motorola Government Electron Group
 - ☐ PRD Electronics Division-Harris Corporation
 - ☐ Revlon
- ☐ **ECOLOGICAL ENGINEERS**
 - ☐ Texas Instrument
- ☐ **ELECTRICAL ENGINEERS**
 - ☐ American Edwards Laboratory
 - ☐ Anheuser-Busch
 - ☐ Bechtel
 - ☐ Bethlehem Steel
 - ☐ Borg-Warner Chemicals
 - ☐ Burns & Roe
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- ☐ **ENVIRONMENTAL SCIENTISTS**
 - ☐ Burns & Roe
 - ☐ Stone & Webster
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- ☐ **FIELD SYSTEMS ENGINEERING**
 - ☐ Sperry
- ☐ **GEOLOGICAL ENGINEERS**
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 - ☐ Gulf Oil
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 - ☐ Texas Instruments
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 - ☐ Northeast Utilities
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(Title—Career Position)

(Company)

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Send to:

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(City)

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If employed, how long in current position? _____

If junior/senior engineering student:

Major _____ Graduating Year _____

Name of college/university _____

How many other engineering graduates/students or woman professionals did you share your copy with? _____

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- ☐ Naval Weapons Center
- ☐ Sperry
- ☐ David W. Taylor Naval Ship R&D Center
- ☐ UNC Naval Products
- ☐ U.S. Army Aberdeen Proving Grounds
- ☐ U.S. Nuclear Navy

☐ **MECHANICAL ENGINEERS**

- ☐ Aerojet Strategic Propulsion Company
- ☐ American Edwards Laboratory
- ☐ Anheuser Busch
- ☐ Bechtel
- ☐ Bethlehem Steel
- ☐ Borg-Warner Chemicals
- ☐ Burns & Roe
- ☐ Charleston Naval Shipyard
- ☐ Colgate Palmolive
- ☐ Combustion Engineering
- ☐ E-Systems
- ☐ E-Systems, Greenville
- ☐ Exxon
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- ☐ Puget Sound Naval Shipyard
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- ☐ Sperry
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- ☐ Texas Instruments
- ☐ UNC Naval Products
- ☐ U.S. Air Force
- ☐ U.S. Army CECOM
- ☐ U.S. Army Tank-Automatic Command
- ☐ U.S. Steel
- ☐ Washington Suburban Sanitary Commission

☐ **METALLURGICAL ENGINEERS**

- ☐ Bethlehem Steel

- ☐ Combustion Engineering
- ☐ Kerr-McGee
- ☐ Motorola Government Electron Group
- ☐ Texaco Instruments
- ☐ U.S. Steel

☐ **MINING**

- ☐ Gulf Oil
- ☐ Kerr-McGee
- ☐ U.S. Steel

☐ **NATURAL GAS**

- ☐ Texaco

☐ **NAVAL ARCHITECTS**

- ☐ Philadelphia Naval Shipyard
- ☐ David W. Taylor Naval Ship R&D Center

☐ **NUCLEAR ENGINEERS**

- ☐ Bechtel
- ☐ Burns & Roe
- ☐ Charleston Naval Shipyard
- ☐ Combustion Engineering
- ☐ Electronic Associates, Inc.
- ☐ Florida Power Corporation
- ☐ General Dynamics-Electric Boat Division
- ☐ Northeast Utilities
- ☐ Public Service Electric & Gas
- ☐ Stone & Webster
- ☐ U.S. Nuclear Navy

☐ **OPTICS**

- ☐ Honeywell Inc.

☐ **PETROLEUM ENGINEERS**

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- ☐ Exxon
- ☐ Getty Oil
- ☐ Gulf Oil
- ☐ Kerr-McGee
- ☐ Texaco

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- ☐ Honeywell Inc.
- ☐ Motorola Government Electron Group
- ☐ Naval Weapons Center
- ☐ Northrop
- ☐ Pacific Missile Test Center
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Table 6. Relevance of Education to Engineering Positions.

Relevance	First Job After BS		Present Job	
	Male	Female	Male	Female
Must + Very Important	54%	61%	55%	59%
Important	27	21	27	23
Some + Little Importance	16	16	16	18
Unnecessary	3	2	2	0
(Number of Cases)	(221)	(211)	(266)	(234)

No major differences between the salaries of these men and women are evident, except in the group graduating between 1957 and 1967. For this group the median of the men fell somewhat above the national median, while the

median for the women was somewhat below that figure, but the difference is not statistically significant. In general, the salaries of the men and women Purdue graduates are comparable to each other and to the national average.

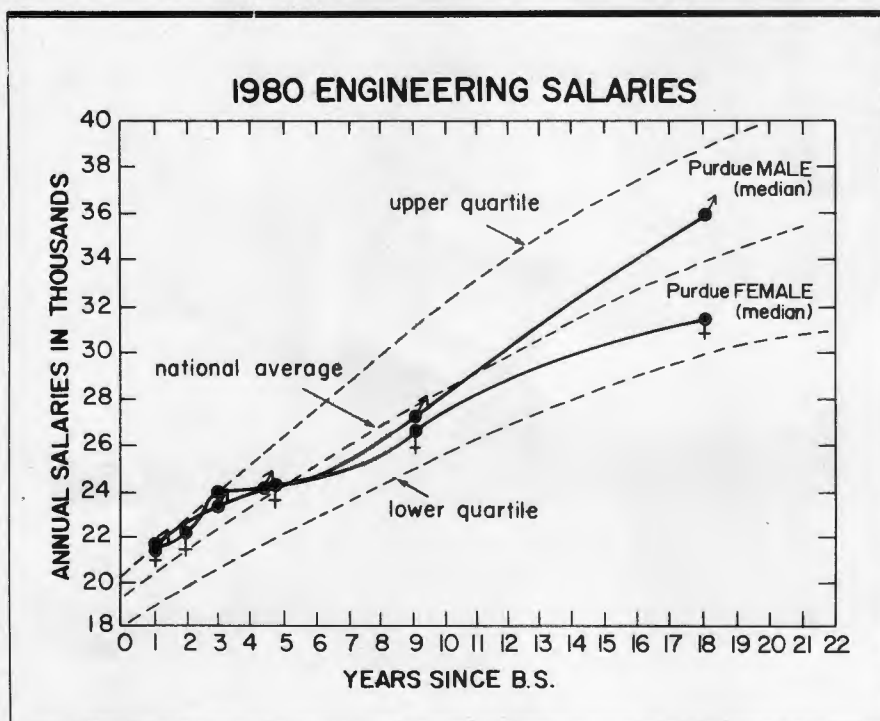


Figure 7. Median income for men and women engineers grouped according to year of graduation.

Table 7. Monthly Salaries of Purdue Men and Women Engineering Graduates.

	Year of Graduation					
	1979	1978	1977	1975-1976	1968-1974	1957-1967
Females:						
Upper Quartile	\$1,925	\$2,000	\$2,200	\$2,164	\$2,620	\$3,020
Median	1,810	1,853	2,001	2,001	2,200	2,600
Lower Quartile	1,537	1,700	1,800	1,825	1,967	1,697
Mean	1,667	1,814	1,953	1,950	2,214	2,658
(No. of Cases)	(64)	(44)	(29)	(30)	(25)	(23)
	Year of Graduation					
	1979	1978	1977	1975-1976	1968-1974	1957-1967
Males:						
Upper Quartile	\$1,900	\$1,990	\$2,130	\$2,160	\$2,600	\$3,471
Median	1,800	1,875	1,980	2,000	2,255	2,998
Lower Quartile	1,594	1,740	1,780	1,800	2,000	2,391
Mean	1,688	1,812	1,924	1,987	2,331	3,069
(No. of Cases)	(76)	(71)	(30)	(25)	(24)	(17)

This finding agrees with other national data that suggest that salaries of men and women are more comparable in engineering than in other science fields.^{6,7}

To determine what types of jobs engineers ideally prefer, graduates in our sample were asked to rate the importance of a number of characteristics of professional positions. Table 8 contains a list of the statements used in our survey, along with the percentage of men and women who rated each statement as quite or very important. The most highly rated characteristic was the opportunity to use one's skills and abilities in challenging work, which was rated more highly by the women than by the men. The least important characteristic for both men and women was the opportunity to travel. There were several other important characteristics that the men and women rated differently. Women, for example, felt it was more important to have flexible working hours and personal leave. When respondents were asked what factors actually influenced the selection of their present job, men placed greater importance on salary and opportunities for advancement than did women.

Career Influences

Since men and women graduates were comparable in their job offers, employment positions and salaries, we were interested in determining whether or not men and women differ in their career development. The most highly rated factors for both men and women were the geographical

location of job and other demands on their time. These would probably have a major impact on most professional careers. The next most important factor for the female respondents was the demands of a spouse's career; men rated this factor as having significantly less impact. Although only a small proportion of men and women rated the presence of small children in the home as an influence on their career, women were more likely to see this factor as a major influence. Women's careers are apparently more susceptible to role conflict than are men's, with women being more likely to have difficulties in balancing the demands of their roles as engineer, wife, and mother.

Education

We found no differences between the men and women in terms of their current and planned level of formal education (figure 8). It is interesting to note that more engineers are planning graduate study in non-engineering fields than in engineering. This may be a result of the increasing number of engineers who pursue M.B.A.'s or other degrees in business.

We did find some differences between men and women in terms of their participation in continuing education courses. A greater percentage of women (23%) than men (15%) reported that they had taken a short course or extension course in engineering or science during the past year ($p < .03$). Although the majority of our respondents had not been involved in continuing or graduate education programs, a greater proportion of women tended to report involvement in many of these educational activities. A greater percentage of women also reported taking a short non-degree technical course on their employer's premises (56% vs. 45%, $p < .02$). In terms of management content, a greater percentage of women than men reported attending a professional society's course or workshop (24% vs. 9%, $p < .001$) or a community course or program (20% vs. 9%, $p < .02$).

We found that 49 percent of the women respondents, compared to 30 percent of the men, are members of two or more national, professional, technical or scientific societies in their field. In addition to this technical involvement, the women graduates reported greater

involvement in the arts and literature. On the other hand, male graduates were more apt to report participation in sports.

Conclusions

In conclusion, it appears that there are no major differences between men and women engineers in terms of their college and post-college performance, although the women achieved somewhat higher grades in high school. Our data indicate that there are no major differences between our men and women graduates in terms of the types of jobs they have or the salaries they receive. Opportunities for women in the field of engineering appear to be good. In interpreting our results, however, it is important to keep

in mind that most of our respondents had been working in the field for five years or less. Whether or not women will continue to achieve comparable jobs and salaries when they have been in the field for 10 to 20 years is still an open question. Our data do indicate that women graduates are more likely to take advantage of continuing education opportunities; this may be their way of ensuring career advancement in the future.

Acknowledgements

We appreciate the invaluable assistance of Timothy Lange for the computer programming associated with sampling, storing, retrieving, and analyzing the survey results; Judith Frauenfelder, for the design

Continued on following page

Table 8. Rank Order of Percentage of Male and Female Engineers Who Rated Various Aspects of Their Professional Positions as Quite or Very Important.

Characteristics	Total	Male	Female
Opportunity to use my skills and abilities in challenging work.	96%	93%	99%**
Company is well-managed and progressive.	93	92	95
A position where people are interested in working together and not encouraging jealousy.	93	90	96*
Participation in important work-related decisions.	91	90	91
Superiors who are willing to delegate responsibilities.	90	88	93
An income which permits me (and my family) to live comfortably.	88	91	84
Opportunity to innovate and propose new ideas.	83	84	82
I know exactly what my work responsibilities are.	81	79	83
Opportunity to advance myself economically.	80	81	78
A chance to exercise leadership.	77	78	76
Adequate preparation for top level careers (e.g., by career counseling, job rotation, etc.)	72	69	75
Provides an opportunity to move into a management career.	69	72	65
Wide variety of technical work.	69	69	68
Company realizes that employees often have family responsibilities.	68	67	69
Desirable geographic location.	67	66	69
Opportunities to help others.	67	69	66
Availability of personal leave (including maternity and family related leave).	65	56	76***
Company provides in-service courses.	57	51	65**
Flexible working hours.	55	45	68***
Freedom from pressure to perform exceptionally well on every assignment.	55	57	54
The opportunity to be assigned to different areas of the company.	54	54	55
Opportunity to make significant contributions to society.	53	49	57
Opportunity to enhance my social status and prestige.	35	39	30
The opportunity to travel.	29	27	31
(No. of Cases)	(422)	(229)	(193)

* = $p < .05$

** = $p < .01$

*** = $p < .001$

A Comparison. . .

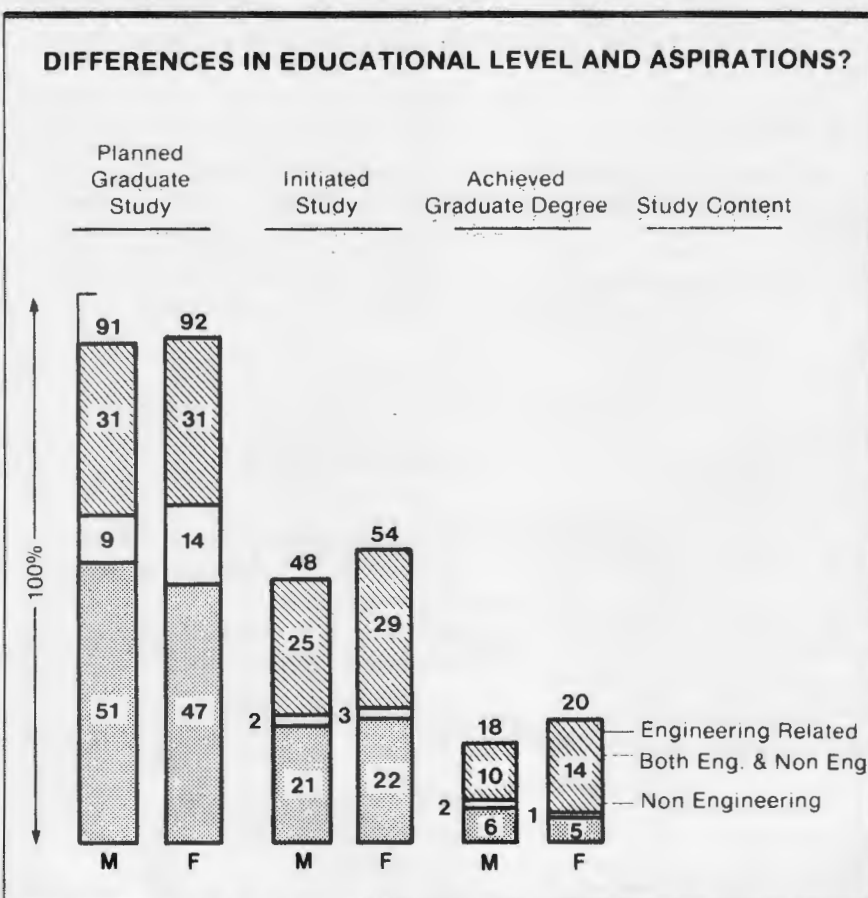


Figure 8. Percentages of men and women engineers who plan to engage in graduate study, have initiated graduate study, and have attained different graduate degrees which vary in subject matter.

and methodology used in the 1980 Purdue Graduate Survey; and of Purdue staff members Dallas Pasco, Sharon Katz, Sylvia VanDyke, Anita Bodley, and Cindy Meadows. We acknowledge the support and encouragement of the late G. Walter Bergren, Find Sangren, Jane Daniels, Will Shaliol, John McLaughlin, John Hancock, and Harold Amrine. □

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This article is based in part on a paper entitled, "Performance Data on Women in Engineering," which was presented at the 1981 ASEE Annual Conference.

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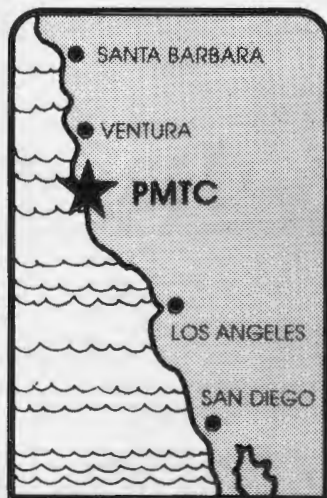


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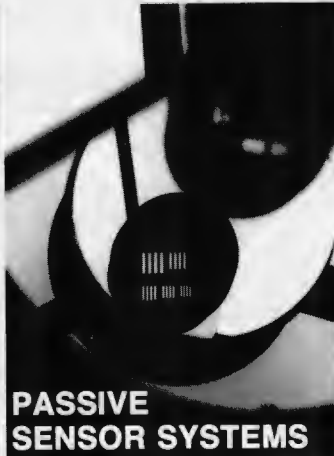
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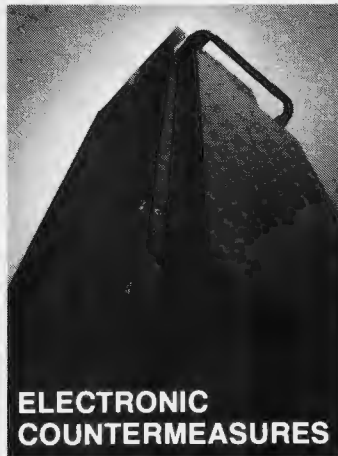
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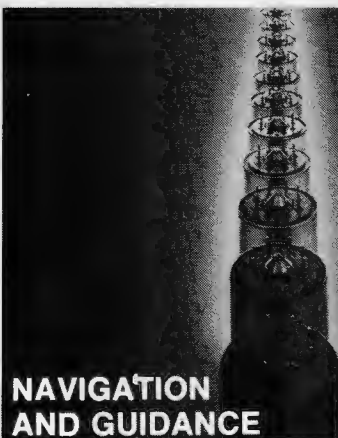
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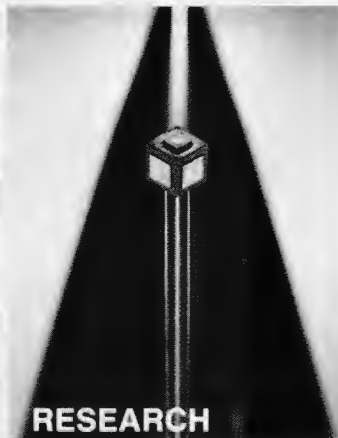
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COMPUTER ADDICTS. • • Continued from page 31

complex and bending it to their will, that they don't bother trying to make it understandable to other users. They rarely keep records of their programs for the benefit of others, and they rarely take time to understand why a problem occurred.

PROSPECTIVE HACKERS

Computer-science teachers say they can usually pick out the prospective hackers in their courses because these students make their homework assignments more complex than they need to be. Rather than using the simplest and most direct method, they take joy in adding extra steps just to prove their ingenuity.

But perhaps those hackers know something that we don't about the shape of things to come. "That hacker who had to be literally dragged off his chair at MIT is now a multimillionaire of the computer industry," says MIT professor Michael Dertouzos. "And two former hackers became the founders of the highly successful Apple home-computer company."

When seen in this light, the hacker phenomenon may not be so strange after all. If, as many psychiatrists say, play is really the basis for all human activity, then the hacker games are really the preparation for future developments.

Sherry Turkle, a professor of sociology at MIT, has for years been studying the way computers fit into people's lives. She points out that the computer, because it seems to us to be so "intelligent," so "capable," so "human," affects the way we think about ourselves and our ideas about what we are. She says that computers and computer toys already play an important role in children's efforts to develop an identity by allowing them to test ideas about what is alive and what is not.

"The youngsters can form as many subtle nuances and textured relationships with the computers as they can with people," Turkle points out.

Computers are not just becoming more and more a part of our world. To a great degree, they are our world. It is therefore not unlikely that our relationship with them will become as subjective as that of the hackers. So perhaps hackers are, after all, harbingers of the world to come.

Dina Ingber interviewed hackers at computer centers across the country for this article, which appears by special arrangement with *Science Digest*.

"I AM HUMAN, TOO!"

As computers are able to mimic human behavior more and more closely, people often begin responding to these machines as though they were actually human. This trend is distressing to some experts such as Joseph Weizenbaum, professor of computer sciences at MIT and author of *Computer Power and Human Reason*.

In his first eye-opening encounter with this phenomenon, Weizenbaum had designed ELIZA, a computer program that could "converse" in English, based on a set of rules.

For the first experiment, he programmed ELIZA, to parody the role of a psychotherapist engaged in an initial interview with a patient. To Weizenbaum's amazement, patients who conversed with ELIZA became emotionally involved, opening up their deepest secrets as they would to a fellow human being. Even his secretary, who had watched him put the program together and knew the computer to be just a collection of wires and metal, once asked Weizenbaum to leave the room because her conversation with ELIZA was getting too personal.

Scientists are now working on computers much more sophisticated than ELIZA, machines that can "see," "hear," "feel" and "sense" like humans. But are they human?

Philip Zimbardo, a professor of psychology at Stanford University, once came to class pretending to be a robot imitation of himself and challenged his class to prove that he was really human and not a machine.

"I altered my voice slightly, and I made my movements ever so much more formal and precise than I usually do. I apologized that Professor Zimbardo could not come to class today but that he took this opportunity to send me, this almost perfectly programmed robot of himself."

The students raised a whole series of questions, trying to differentiate between the real Zimbardo and the robot.

"If you're a robot, how can you express emotion?" they asked.

"Well, when Professor Zimbardo expresses emotion, he runs through several emotion programs," answered the robot. "For example, when he's sad, tears are elicited, he moves his shoulders this way, and his mouth this way. He's programmed me to do the same things."

The students became upset because they couldn't pinpoint differences.

"Computers always need a human to program them," they said.

"Yes, that's true," answered the robot. "And people have the illusion that they program themselves. But all studies show that children raised in isolation either die young or turn out to be permanently retarded. Without programming from parents and others you would not be human beings."

"But human beings can reproduce themselves and computers can't," said the students.

"Well, give us time," answered the robot, never smiling. □

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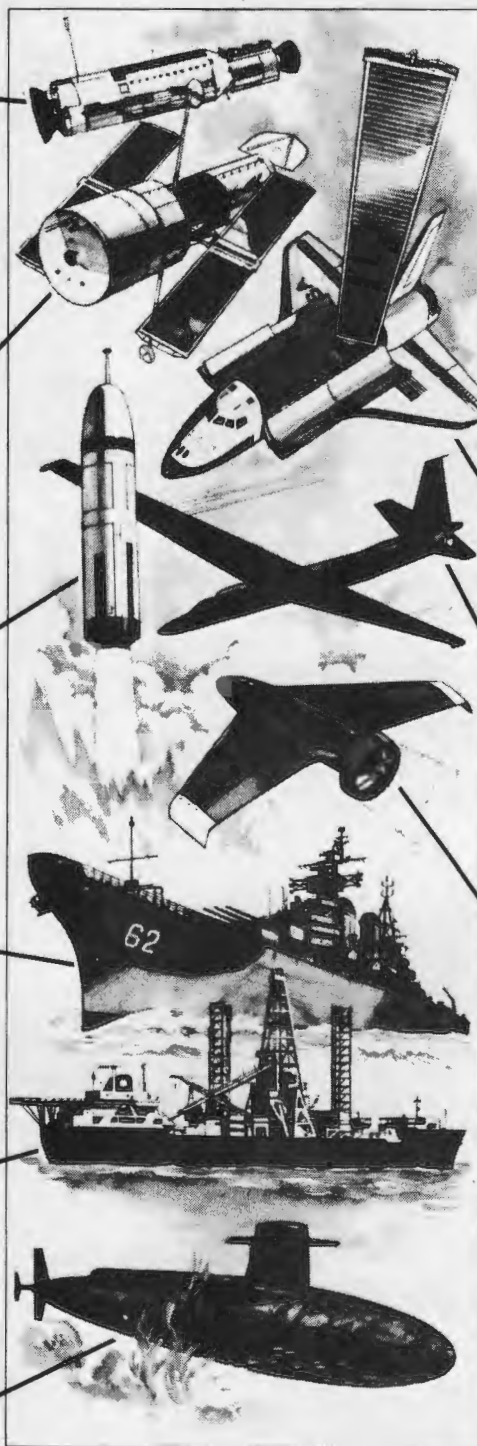
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When She Earns More Than He Does

by Abe Peck



For most people, earnings are a crucial component of one's self-image. So what happens to the delicate balance of marriage when a woman earns more than her husband?

It was lunchtime in Dallas, and Julia, a broguish-voiced 34-year-old corporate lawyer, had to watch the clock; there was a plane to catch, a seminar to attend. Before leaving, she recounted her story of life with Barry, the attorney with whom she would soon end a 10-year marriage.

Julia taught school until Barry encouraged her to go to law school — out of "embarrassment" over her job, she thinks. But as she threw herself into her new career, he became increasingly unhappy. When she landed an entry-level job paying \$4,000 more than he was making after two years before the bar, his party chitchat began to include remarks about "creating Frankenstein's monster."

Money was his barometer of their relationship, rising and falling, depending on who out-earned whom. They separated, saw each other on and off, had "a better year" when his income exceeded hers. Eventually Julia did something that many men wouldn't have, had roles been reversed: When he asked her to give up traveling, she said she would, even though it might mean losing her job.

"I wanted to get back together. I couldn't feel I was getting anywhere if my marriage was a casualty," she explains.

That didn't work, competition continued, and the couple broke up for the last time. "The immediate issue wasn't money, but money was the

big thing," Julia claimed. "Our breakups came when our incomes changed. He announced that he couldn't cope with me. I was 'too old' and 'too successful.' I'm four months older than he is!"

Carol is a video director and published author; Jerry, a much-in-demand graphic designer. Her projects have been celebrated at chic parties; he's been profiled more than once in the great gray pages of *The New York Times*. When they totaled up their incomes at the end of the last year, it turned out that she'd earned more. Neither cared. For them, money is a tool to ensure a comfortable lifestyle and clear creative vision — not something with which to notch victories.

Married for eight years, they sound like state-of-the-art honeymooners. "There is no competition between us," Carol says. "So many people in high-profile jobs feel anxiety from their partners. We have

When She Earns More Than He Does. . .

only support and help from each other. I know I'm good, and he knows he's good. If it's not happening for one of us now, it'll happen in three months."

Jerry agrees. "It's crazy to feel envious. We're in it together."

Reversing roles

And so, the agony and the ecstasy of the two-career couple. Women in relationships such as these have overthrown one of the most oft-quoted statistics of gender politics: rather than earning 59 cents to a man's dollar — that ratio existed in 1939, and still holds true today — they earn more than their men. Although overall income disparity persists, women increasingly participate in the power that earning brings.

As Caroline Bird has reported in her book "The Two Paycheck Marriage", during the late 1970s nearly 22 percent of wives who worked full-time earned as much or more than their husbands. The scenario among professional couples is qualitatively new: the men are not unemployed, disabled, retired or student; the women have careers and earn "good money"; there is no emergency involved, requiring that wives work. The arrangement may be permanent.

Husband: When I encouraged my wife to go to law school, I didn't know I was creating Frankenstein's monster.

To date, such relationships have been fraught with instability. A woman's chances of divorcing, for instance, rises 2 percent with every thousand dollars of her income, according to Shirley Johnson, an economist at Vassar. However, as more couples grapple with the problems inherent in woman-as-senior-earner relationships, new solutions are bound to emerge.

Net worth and identity

After interviewing a dozen professional couples in which the women earned more than their men, it seemed clear that such couples can falter, like Barry and Julia, or thrive, like Carol and Jerry. Which way they go depends on how each partner answers a litany of questions: How do they define themselves? How

psychologically secure are they? How much of their worth is economically determined? How do they rank their own work? Their partner's? How do others perceive them as a couple? Are they comfortable? Most important, can they reach a balance of comparative worth, in which any perceived economic inferiority is offset by other assets?

When a woman brings more to a relationship — at least economically — why does it become a stumbling block? "It wouldn't mean anything if it were only a matter of coinage; then the household would simply have more money," explains Margaret Huyck, associate professor of psychology at the Illinois Institute of Technology. "But money is one significant way we measure power."

There has been a fundamental power shift in America. Just as many women see themselves as involved in a revolution of rising expectations, men are emerging from a past where male identity was totally tied to success at work — especially financial success.

By 1980, the Bureau of the Census no longer assumed that the head of the household was male. Some men welcomed not having to provide the sole, or even the major, financial support. "For others," according to sociologist Jessie Bernard, "the feel-

Wife: Money wasn't the only problem, but it was the biggest problem. When it was clear I out-earned him, he left me.

ing of degradation matched the feelings reported 40 years earlier in the Great Depression."

Yet, the fact that a woman earns more than a man is not intrinsically problematic. If the man is secure, productive and unbound by traditional roles, his partner's earnings become simply a matter of fact, relatively low in comp values.

"I never had a feeling I was less of a man because I wasn't a senior breadwinner," says Gordon Wait, a marketing director for a Chicago-area freight-forwarding company. "There are enough other things to get convoluted about."

The unthreatened man takes pride in his own identity while recognizing his wife's ability. On the other hand, the man may be a covert sexual Tory, or he may not be doing well in

his work. The woman may demand more than he can handle. Mainstream society may judge them harshly. Then she is out-earning him. She becomes the breadwinner; for him, society says, second place is last place. He may decide that her accomplishments represent a breakdown of values, not a new freedom.

In any event, a changing financial balance demands renegotiation of the partnership. Women who earn more than men feel increasingly assertive. One woman notified her accountant that, since she was paying the bill, the least he could do was address the joint tax return to her. Another refused to contribute to her husband's child support from a previous marriage. A third told off her father-in-law when he suggested that she leave work early in pregnancy; she was healthy, and she paid most of the bills.

Most of the women senior earners I met didn't equate earning more money with overall "superiority." Only one talked about flexing her economic muscles against her husband. The goal, instead, was always "equality."

Equality and balance

Arlene and Ben exemplify this kind of balance. She is a high-ranking government official; he is a commercial photographer. They have been together for 11 years. Her gross income is typically double his — though he quickly adds that his business deductions narrow the net gap.

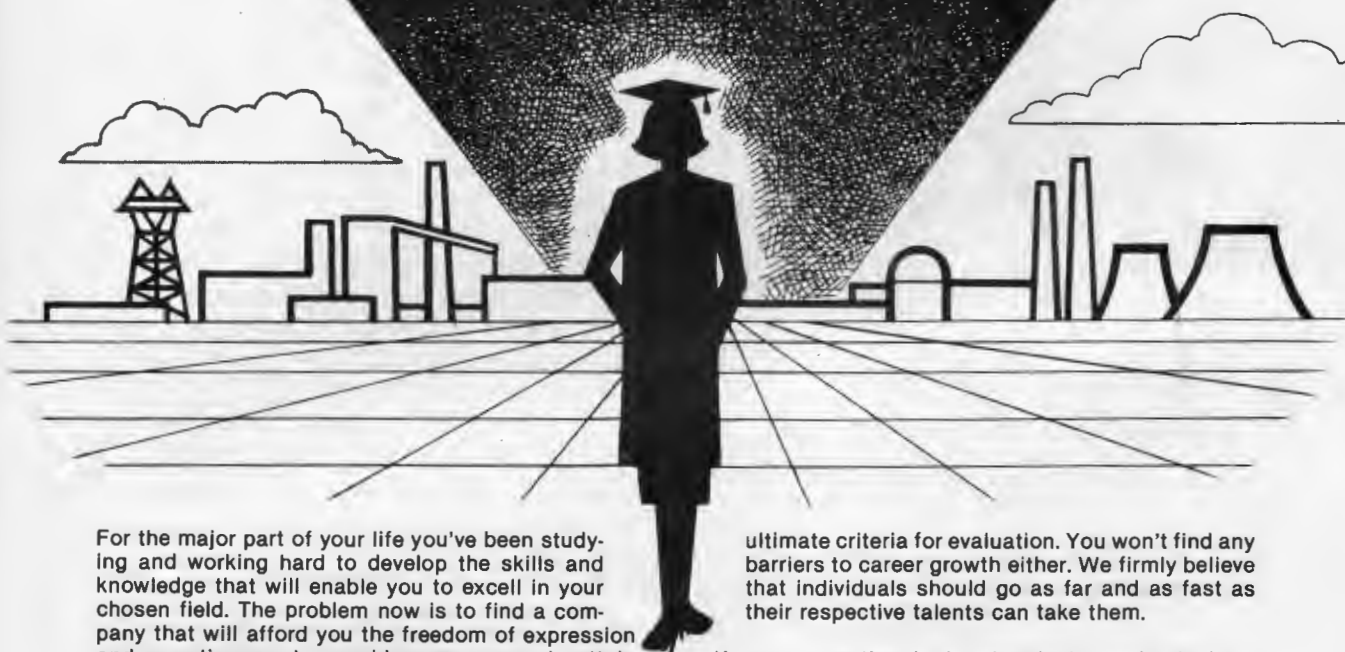
"The fact that I've made more is great," Arlene says. "The more I made, the steadier we got. Competition between us really is no problem because we have such different needs. We own our own co-op and both love it very much. Ben spends a lot more time here and is much more an aesthetic person than I am. On the other hand, we both know that there's no way we could afford it without my money. Those things aren't competitive, and I'm proud of his work."

Ben's remarks cut closer to the bone. "I'm not threatened because what I do has nothing to do with what she does. If she were a photographer and made three times what I did — if she made one dollar more than I did — it would be a threat. But she does something completely different. And I'm not without power in my work. Mine is 'soft power' — the

Continued on page 85

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Money means power. When wives earn more than husbands, the balance of the relationship shifts, and the level of stress for both partners climbs.

power to influence people's perception."

Arlene and Ben's "emotional fit" — balancing the assertiveness she needs to succeed in politics, the "soft power" he requires in his work — is common to the couples with whom I spoke.

Even though income disparity today is the same as in 1939 — on average, women earn 59 cents to every dollar earned by men — nearly 22% of married women who work full-time earn more than their husbands.

Many of the professional women I encountered were involved with free-lance writers, social-service employees or other men who were neutral or negative about the business world and spoke of "not caring about" or "not being good with" money. Corporate men oriented toward traditional power (financial and otherwise) may be threatened by ambitious women. An executive woman may desire a man who will not replicate the fang-and-claw Darwinism she encounters at work. The man who marches to a different drummer may welcome the spark of a high-drive woman.

Earning self-images

The woman-as-senior-earner arrangement is not the mirror image of relationships economically dominated by men. "A man may sweep along a wife as he goes up the occupational ladder, but there is no comparable image of a wife sweeping along her husband," Cynthia Epstein wrote in "Women in Law."

"Most people feel sorry for such a husband and consider him eclipsed, although if he were the more successful one, they would congratulate the wife on his achievement and assume she was enhanced by it. A woman, by cultural definition, improves in image with her husband's success; a man may well be diminished by his wife's success."

Censure is minimal if the man is perceived to be doing fairly well in his own right. But life can be devastating if he is obviously floundering while his partner prospers. Women who earn more than their men want them to have some form of recognizable success.

"If he were teaching on the college level — a goal he can achieve — there would be no problems," says Rhonda, a Chicago banker earning more than her husband Stu, a physics teacher. "But if he stayed the same, it would be a problem."

The ultimate male fear is of being a wimp, a useless appendage to a woman. Yet some men couldn't care less about the economics of living with a talented woman. And in a relationship where the earnings gap isn't too large, men who do care can achieve a sense of balance with non-monetary talent or social assets. But when the gap is very wide, a man can have a hard time establishing comparable worth.

Cynthia was advancing in the real-estate business, while Roger's contracting company was being bulldozed during the building slump. After spending six years together, they were contemplating marriage even as some of Cynthia's "friends" were telling her that they'd never make it. They'd been to a counselor, and Roger is active in a men's group. He spoke of being aware of his greater physical force.

Not only did Cynthia and Roger have an earnings gap, but they were moving in opposite directions and against expectations. "Just when I thought I'd have some extra money, he hit this slump," Cynthia said. That bothered her; so did what she saw as Roger's power-tripping in the past.

The ultimate male fear is of being a wimp, a useless appendage to a woman.

"Before, when he took me out to dinner, he never let me forget where the money was coming from. Now, if there comes a time to beat him over the head with it, I do. It's real tense."

Roger sounded as though he'd lost a civil war. "I am frustrated to the quick. If I am working, even if I'm losing money, I have a decent sense of self-esteem. If I'm not working, I'm a bum. The hardest thing is borrowing money from her. It really makes me squirm."

Roger's sense of self-definition was shaky. He and Cynthia both felt insecure. They defined their worth economically. They thought she was doing well; they saw him as failing. They competed for superiority. Peers openly questioned their ability to stay together.

A woman's chance of divorce rises 2% with every thousand dollars of her income.

Almost all the women I spoke with felt that a minimum requirement for a satisfying relationship was acceptance of their abilities by their men. Some relationships may fall into widening cracks; the men will feel overwhelmed; the women exploited, or bored. But in other better relationships, stronger partnerships will emerge, based on mutual benefit, positive self-image and independence from financial stereotypes.

The new balance of worth offers the option for either partner to prosper without freaking out the other. At their best, these partnerships are rich — for a lot of reasons other than having money. □

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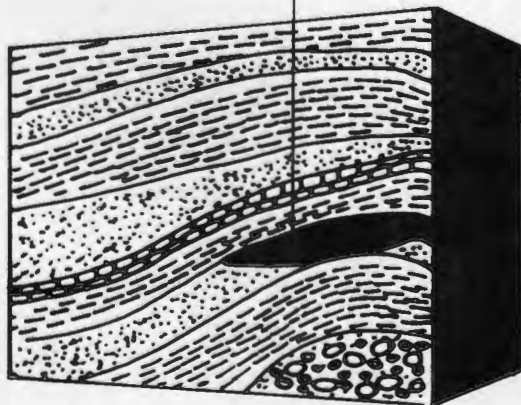
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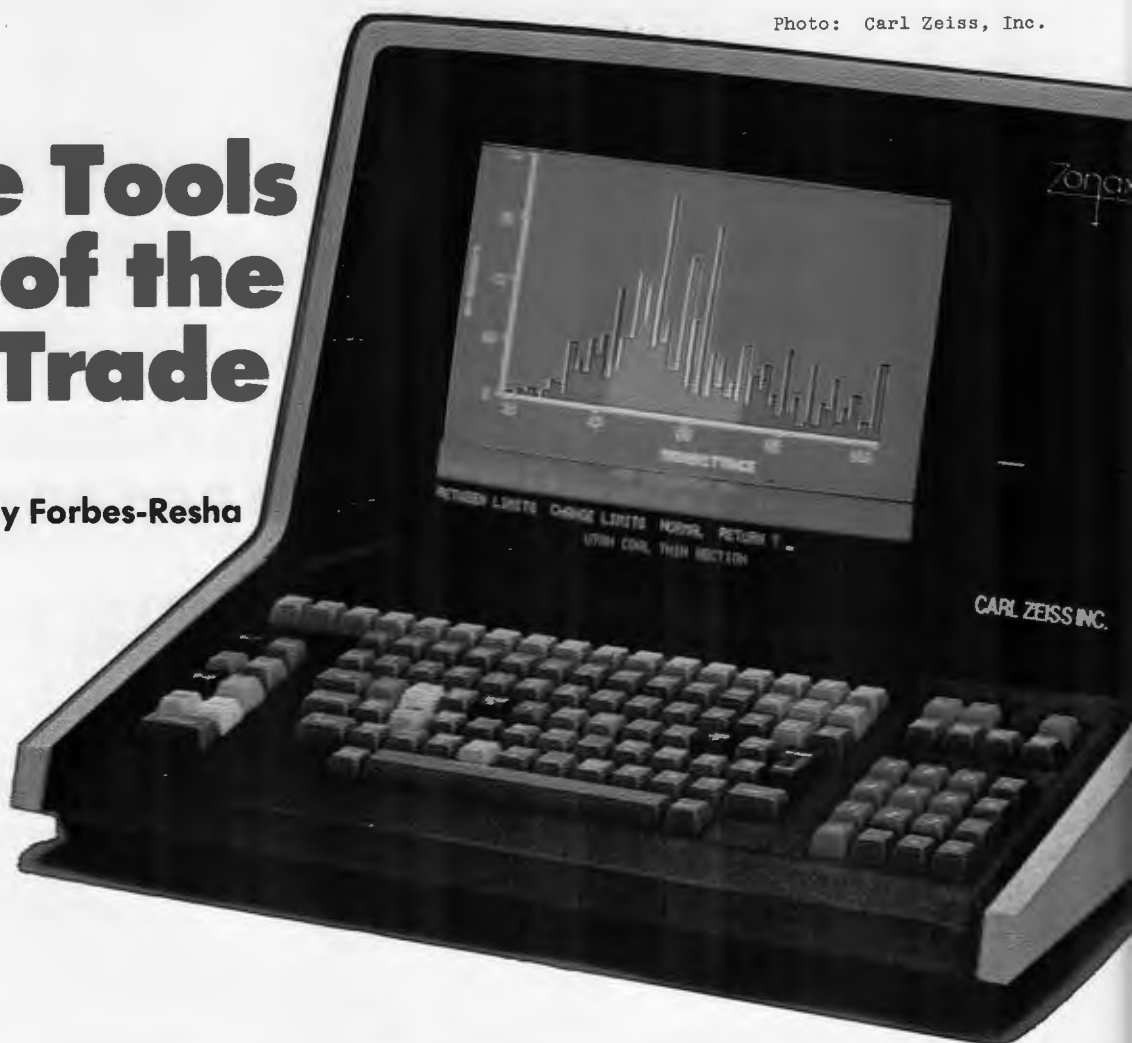
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The Tools of the Trade

By Judy Forbes-Resha



The same tools which have extended our professional capabilities may be threatening our personal abilities. For example, how many of today's engineers can figure cube roots without their calculators?

What have these to do with your future in engineering?

- Calculators
- Robotics
- CAD/CAM
- Space Environments
- Computer Languages
- Lasers
- Word Processors
- High & Low Power Plasmas
- Computer Graphics

The obvious answer is that they are developing technologies that you might work on in the future. Equally true is that these advances may work for you — or perhaps against you.

These are the new tools of engineering, additions to the set of measuring instruments, fabrication devices, data handling mechanisms, computational schemes, and communication media that define the

way we do our jobs. Each one can open new doors, solve problems and extend the engineer's capabilities. But they often don't come with instruction manuals, or warnings, or warranties. They may replace yesterday's tools or supplement them; they may be used alone or in combinations; but they all require the user's understanding of not only their use, but of their limitations.

Consider the proliferation of the personal calculator. Certainly it has increased our capability to handle detailed calculations, but it may have also reduced our ability to perform the basic mathematical operations. How many of you can find the square root of a six digit number without a calculator? Were you ever taught how? Perhaps more important, if you get the answer on a calculator, can you quickly verify to

yourself that it is probably right? Do you? As engineers, we must be careful not to lose the quality of being at ease with the most basic tools of our trade: our mathematical skills.

Warning lights flash in my head as I say this, and I am reminded of the elder of an aboriginal tribe who continued to teach the skills of snaring the saber-tooth tiger long after that beast was extinct.

No, I don't mean to tell you not to use your calculators, but I am concerned that, in relying on computers to do our "thinking", we may lose our ability to "guesstimate", to "ball-park", to think on our feet. In these expressions of quick, credible estimation is the intuitiveness of engineering — an honored skill born in training, experience and awareness.

The Tools of the Trade...

The problem with calculators is that you can punch the buttons and copy the answer without being aware of the process in between — much as a secretary can type a letter without reading it.

Not convinced? Let's take a step up from calculator to computer.

Consider the use of the maxi-programs like NASTRAN and CINDA. To implement these, an engineer specifies a data set which combines various sub-programs. There should be a manual with descriptions of the variables, subroutines, input and output.

These are the new handbooks of engineering — complex, specialized methods for dealing with specific problems — not unlike CRC's tables and formulae or the Machinery Handbook. Handbook engineering has its place, but, even with the most sophisticated handbook, that place is limited. The engineer has the responsibility to know when handbooks apply and to seek innovative solutions when they do not.

As engineers, we must be careful not to lose the quality of being at ease with the most basic tools of our trade: our mathematical skills.

That point can be expanded to include all computational and data analysis tools. There are compromises and implications to forcing a problem into an analytical form so it can be solved with the tools which are available and with which we are comfortable. We are responsible for the models. Tools like Kalman filtering, approximation and statistical treatments do their best to fit data to the model. The engineer's intuition and understanding determine the suitability of both the tool and the model.

The best illustration I've heard of the seriousness of this situation was given by Russell Hopps, Vice President and General Manager of Lockheed, in a speech for AIAA last spring. In looking at the exponentially rising cost of developing new aircraft, Hopps speculated that a large portion of that increase was improper use of computers. To support his speculation, he discussed a personal survey.



Photo: Perkin-Elmer

Can you trust your machine's numbers? Before you say yes, you should know that there's been a rapid rise in verified reports of errors caused by the basic programming of arithmetic operations in many calculators and computers. Besides, if you know how to do the calculations, not only can you check your machine, you'll be able to work if the batteries go dead.

A problem was defined and solved in about 20 minutes with a "back of the envelope" calculation very common in design and development activities. The problem was then given to various engineers to see how they would handle it. As expected, several methods were used. Solution times varied from hours to weeks. Different assumptions skewed the answers in different ways. Some solutions were fairly straightforward, others involved statistical, iterative or Monte Carlo techniques which are only practicable using computers. But were they practical for this problem? Hopps questioned how much computer core time and how much engineering time was spent applying inappropriate methods.

This is the problem for all tool users. If you were told to cut a piece of wood, before you decided whether to use a hand saw, a band saw, a chain saw or a laser beam, you would want to know what kind of end product was expected. Engineers are responsible for the end product. Ours is the selection criteria and the accountability.

in production related technologies. Robotics, computer aided design and manufacture. Laser measurement and machining, special environments like controlled temperature and pressure are tools that are available to engineers in the areas of manufacturing.

The injunctions are the same. More specific design, more complex machines are better engineering aids *only* when applied with awareness of their limitations. Less flexible, more costly installations, for instance, are sometimes, not always appropriate.

Maybe the tools you assemble will be in communications: high density data storage, graphics, languages, etc. These are new tools to enhance old skills. If you are conscious of their details, you may be able to not merely adapt from the old methods, but expand both the tool's capability and your own.

The tools that you acquire set the direction of your career. Your mastery of their use is a factor in the level of your career. Tools must always be used with a purpose, and when you become proficient with

The essence of engineering is responsible evaluation and appropriate selection of tools, and accountability for that selection. If you don't accept that, then you might as well not be an engineer.

This magazine is devoted to careers, so why am I concerned with tools? Because an engineering career is determined by the tools you learn to use.

Rather than the computational tools, you may extend your abilities

some, it may imply giving up your facility with others. The speed with which you perform long division is one example of this — but so is the decreasing technical dexterity that accompanies increasing application of management skills.

The Tools of the Trade. . .

Photo: Apple Computer



Tools like CAD/CAM, simulation languages, and computer graphics are wonderful extensions of an engineer's capability, but you must understand both their limitations and the times when their use is inappropriate.

The things that must be maintained are the ability to think and hence to innovate, and the sense of responsibility for the selection, mastery, use and result of the tools of our trade. ☐

Judy Forbes-Resha is an aerospace engineer in Southern California, and a Selection Representative to the governing body of the Society of Woman Engineers. She recently was the first woman ever selected to deliver a paper before a professional

session of the California division of the American Institute of Aeronautical and Aerospace Engineers. This article is adapted from a speech given at the Univ. of Illinois.

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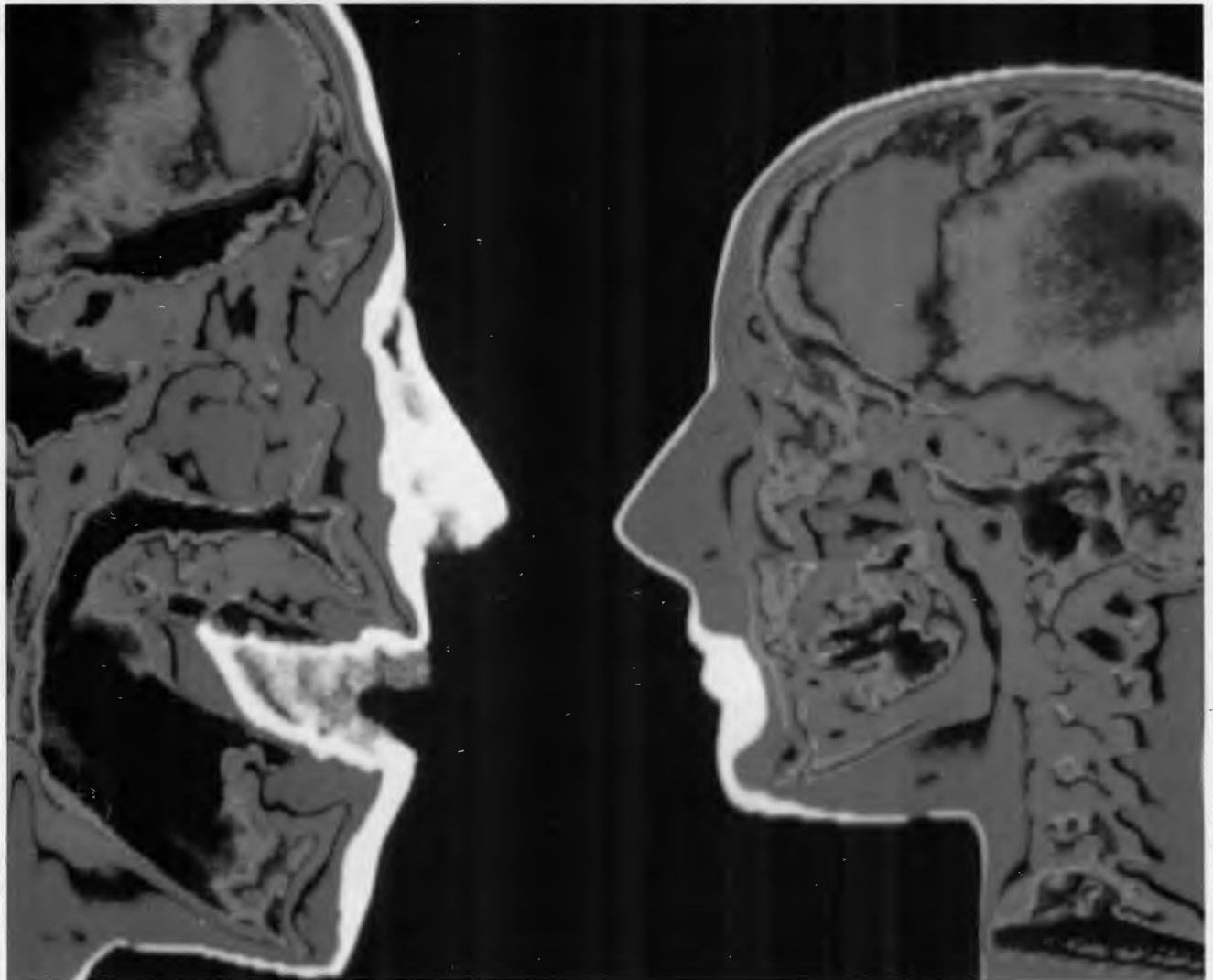
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Mensa: It's a State of Mind

Photography: Howard Sochurek



—But a Mind Finely Tuned

by Marvin Grosswirth

If you fall in the 98th percentile on an IQ test, you're eligible for this diverse 'elitist' group

To the casual observer, it looks like any typical social gathering: small groups standing around and chatting, couples trying to get to know each other, the social butterfly, the wallflower, the bore and the boor, the charismatic and the enigmatic—in short, all the characters from Central Casting that are required for a cocktail party of the 1980's.

But there *is* a difference. At first, it seems vague, more atmospheric than tangible, as though some sort of current or energy permeates the room. A special kind of liveliness pervades even the most mundane conversations. People talking about the commonplace—politics, inflation, automobiles, sex, their jobs, their hobbies—but those who are not

talking are actually listening. And they are challenging and questioning. Someone quietly announces an undeveloped thought, a far-out idea, and then proceeds to articulate it, allowing others to polish or demolish it as they choose.

Mensa: . . .

And there's something else, too: These people come from diverse backgrounds. A single group may consist of a housewife, a teacher, a nuclear physicist, a computer programmer, a janitor, a writer, a fireman, an actor, a carpenter. But one common bond unites them and brings them, time and again, to such gatherings: All are members of Mensa, which means that each has a score on an IQ test that is in the top 2 percent of the population in intelligence. Some 50,000 of them live around the world—about 40,000 in the United States—and they meet in large and small groups. Most of the time, they just talk.

Immediately following World War II, two British barristers, Roland Berrill and Dr. L. L. Ware, decided that a possible means of eliminating war would be a select panel of highly intelligent people who would combine their intellectual resources to help preserve world peace. They promptly set about to organize such a panel. In a sense—as a quick glance at today's headlines readily reveals—their idea failed. But the organization they dubbed *Mensa* flourishes as a place where intelligent people can gather and allow their intelligence to run free. Some even let it run wild.

To become a member of Mensa (or, as members refer to themselves, an "M"), one must score somewhere in the 98th percentile on a standard IQ test. Thus, Mensa often is called an elitist society. On the other hand, because that is the only requirement for membership, its rolls comprise one of the most diverse collections of individuals anywhere. "Yes," says Charles M. Fallon, a Chicago business consultant and former chairman of American Mensa, "we are an elitist society. But we're the most democratic elitist society in the world."

An Anti-Social Device?

Still, some critics denounce Mensa not so much as an organization but because it is based on what they see as an antisocial device: the IQ test.

The concept of an *intelligence quotient* (IQ) was evolved from the work of Alfred Binet (1857-1911), an experimental psychologist at the Sorbonne in Paris. In the early 1900's, he developed tests to identify "mentally defective" children in the French school system. Binet presented problems that were graded in difficulty to a large sample of children. From the resulting answers, he was able to assign to each age group a set of

problems which the average child in that group was just able to solve, giving rise to the concept of *mental age* (M.A.). Thus, a child who could solve the problems that the average 10-year-old could solve was said to have a mental age of 10, regardless of his chronological age (C.A.). If a child whose C.A. was eight was found to have a mental age of 10, he was said to have an IQ of 125, based on the following equation:

$$\text{I.Q.} = \frac{\text{M.A.} \times 100}{\text{C.A.}} = \frac{10 \times 100}{8} = 125$$

Binet then discovered that IQ tends to remain constant all through a child's development. (Later research has unearthed some exceptions to this rule, and some evidence indicates that the aging process also affects IQ but, by and large, the rule tends to hold.) Since Binet's work, dozens of other standardized IQ tests have been developed, and on many of them a score in the 98th percentile qualifies for Mensa.

But critics claim that IQ tests are, at best, inaccurate, primarily because "intelligence" is difficult to define—it comes in a wide variety of shapes,

Try These Typical IQ-Test Questions

1. What word means the same as (p-a-y) in one sense and the same as (b-o-t-t-o-m) in another sense?
2. Which of the following sentences best describes the meaning of the old bromide "The used key is always bright?"
 - a. Keep on the scene in order to stay with it.
 - b. If you use a test key, you will appear bright.
 - c. New devices often don't work well.
 - d. Old ideas are the best.
3. Which one of the following games does not belong in the group?
 - a. Chess
 - b. Bridge
 - c. Go
 - d. Mah-jongg
 - e. Backgammon
4. The word *procure* is the opposite of which of the following words?
 - a. Retain
 - b. Abscond
 - c. Forfeit
 - d. Appropriate
 - e. Purchase
5. Complete the following analogy: Green is to yellow as orange is to _____.
 - a. Blue
 - b. Purple
 - c. Brown
 - d. Yellow
 - e. White
6. The word *aggravate* means the same as which of the following words?
 - a. Burden
 - b. Enrage
 - c. Infect
 - d. Intensify
 - e. Complain
7. Which of the following words are most opposite in meaning?
 - a. Intense
 - b. Extensive
 - c. Majority
 - d. Extreme
 - e. Diffuse
8. Which of the following words does not belong in the group?
 - a. Stone
 - b. Brick
 - c. Canoe
 - d. Pontoon
 - e. Oar
9. Which two of the following words have the most similar meanings?
 - a. Divulge
 - b. Divert
 - c. Reveal
 - d. Revert
10. Complete the following analogy: Mountain is to land as whirlpool is to _____.
 - a. Fluid
 - b. Wet
 - c. Sea
 - d. Sky
 - e. Shower
11. The old saying "Don't trade horses when crossing a stream" most nearly means which of the following?
 - a. You might fall off and get wet.
 - b. Don't attempt something until you are fully prepared.
 - c. Decide what you are going to do before you do it.
 - d. Don't change plans when something is half completed.

shades and uses. Furthermore, so far, nobody has been able to devise an IQ test that is "culture fair." All such test scores are probably a reflection, at least in part, of the test-taker's environment, which, if intelligence is considered innate, should not enter into the picture.

"We're fully aware of the shortcomings of IQ tests," says Gabriel Werba, a Detroit public relations consultant who is American Mensa's current national chairman "but at the moment, it's the best measurement tool we have. I think it's foolish—maybe even destructive—not to know

what your intellectual potential is so that you can use it fully."

"Intelligence isn't everything. In fact, by itself, it probably isn't worth much at all. You need education, experience, talent, ambition, and personality to accomplish anything in this world. Intelligence is not a substitute for any of those attributes. But it does go a very long way toward enhancing them."

Why Join?

Still, why should intelligent people join such an organization as Mensa? Aren't there plenty of opportunities

for mind-stretching in the day-to-day world?

Well, no, at least not according to Mensans, many of whom find themselves locked into rigid mediocrity in their lives outside of the organization. Even professionals who are likely to associate with other highly intelligent people find that activities and conversation tend to center on the narrow fields of their own careers. Thus, it is the uniquely odd combination of *elite equalization* that attracts most active members.

"You don't have to prove anything in Mensa," Charles Fallon points out. "You've already proven it by qualifying for membership. So you don't have to hold back for fear of showing up or antagonizing a superior on the job, or a friend or relative. On the other hand," he adds with a wry smile, "you don't have to be afraid to show your ignorance or make a mistake, either. Everyone here knows you're not stupid."

Even the organization's name announces its egalitarian commitment: *mensa* is Latin for "table," connoting a round-table society in which everyone is equal.

Women in particular often find Mensa an enriching equalizer. Although women now compose only about one-third of the total membership, their numbers are increasing as more and more discover that, in Mensa, their minds are at least as important as their other attributes. Sometimes the results are disastrous. Married women who have been living for years in their husband's shadows discover their own intellectual potentials and begin looking for richer fields in which to cultivate them. The divorce rate is high among Mensans—but so is the rate of marriages among people who meet in Mensa.

Meeting—and talking—is what Mensans do most. "We now have about 150 chapters, or local groups, as we call them," explains Margot Seitelman, American Mensa's executive director. (She heads the organization's small paid staff, so that, while she qualifies for membership, she is not permitted to join; this is intended to help maintain her impartiality and egalitarianism.)

"Some local groups are quite large," she says, "with several hundred members; others consist of only a handful of people. Most of the groups have some sort of monthly meeting, usually featuring a provocative speaker, followed by discussion and general socializing."

Continued on page 101

12. If a house is 36 feet long and 27 feet wide, how wide would a house of the same proportions be if it were 72 feet long?
13. Which number, when multiplied by 4, is equal to $\frac{3}{4}$ of 112?
14. What word means the same as (h-i-r-e) in one sense and the same as (b-e-t-t-e-r) in another sense?
15. Which word does not belong in the following group?
 - a. Car
 - b. Moon
 - c. Fish
 - d. Happy
 - e. Belief
16. If seven belly dancers can lose 20 pounds altogether in eight hours of dancing, how many additional belly dancers would be needed to lose that same 20 pounds in only four hours of dancing, providing the new dancers shed weight only half as fast as the original seven dancers?
 - a. 7
 - b. 21
 - c. 27
 - d. 14
 - e. 12
17. Which two of the following words are the most similar in meaning?
 - a. Autonomy
 - b. Autocracy
 - c. Oligarchy
 - d. Dictatorship
18. What number comes next in the following series? 2, 3, 5, 9, 17 _____
19. Some Mensa members are geniuses. All geniuses have some human virtue as redeeming qualities. Using these two facts, which of the following conclusions is most correct?
 - a. Mensa members all have some virtues.
 - b. All geniuses are quality Mensa members.
 - c. Some Mensa members have redeeming qualities.
20. The old saying "The good is the enemy of the best" most nearly means which of the following?
 - a. If you are good, you will best your enemy.
 - b. Be good to your best enemy.
 - c. Don't accept less than your best.
 - d. The good struggle against the best.

Mensa Quiz Answers

1. (Foot). 2. (a). 3. (b). 4. (c). 5. (d). 6. (d). 7. (a & e). 8. (a). 9. (a & c). 10. (c). 11. (d). 12. (54 feet). 13. (21). 14. (engage). 15. (d). 16. (d). 17. (b & d). 18. (33). 19. (c). 20. (c).

Scoring Scale

Give yourself one point for each correct answer. You receive an additional four points if you completed the test in less than 10 minutes; three points if you completed it in less than 15 minutes; two points if you completed it in less than 20 minutes; and one point if you completed it in less than 25 minutes.

If you scored:

20-24 points You are quite intelligent—a perfect candidate for Mensa.

15-19 points This should put you in the high upper percent of the population—certainly a Mensa candidate.

10-14 points An honorable score. You might want to try the Mensa test.

Fewer than 10 Forget about joining Mensa, but you're in good company. Many world-famous figures (writers, businessmen, artists, etc.) don't have exceptional IQ's either.

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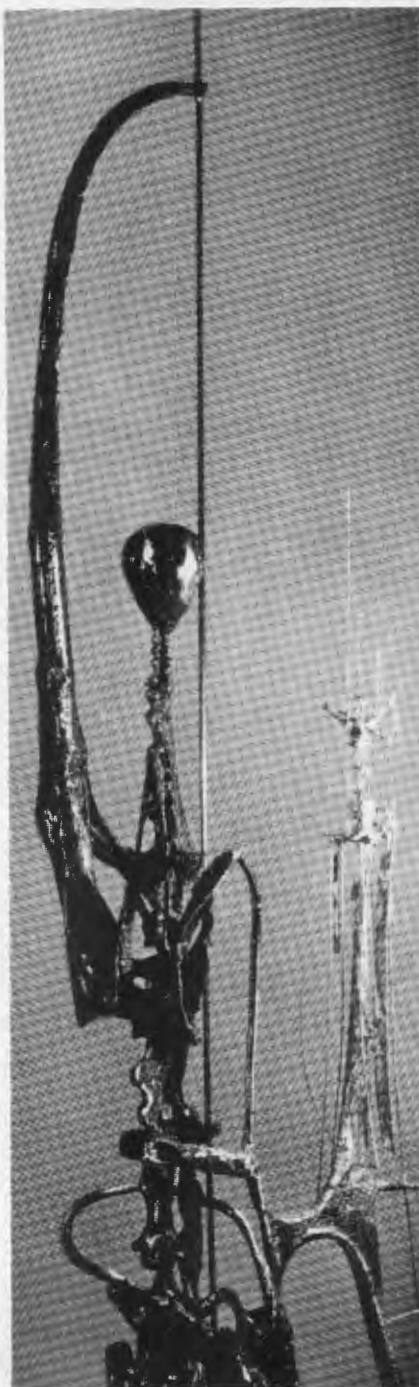
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The Second Mile

William E. Wickenden

William Elgin Wickenden (1882-1947) was director of ASEE from 1922 to 1929. He was in charge of the major evaluation of engineering in the 1920s known as the Wickenden Report. In the course of a long and distinguished career, he taught electrical engineering at MIT, was president of the Case Institute of Technology and vice president of AT&T. He is probably best known for "The Second Mile," which was first presented at the annual meeting of the Engineering Institute of Canada in 1941. We think this work, although written forty years ago (and reflecting some conditions that no longer prevail—such as the reference throughout to professionals and students as men), remains highly pertinent to the practice, teaching and study of engineering. The basic issues have changed little over the years.



Sculpture: Theodore Roszak--*Surveyor* (1959)

A classic in the literature of engineering points the way toward success in today's world.

This article appears by special arrangement with *Engineering Education*, a publication of the American Society of Engineering Education.

Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession.

Of professions there are many kinds; open professions like music, to which any man may aspire within the bounds of his talents, and closed professions like medicine which may be entered only through a legally prescribed process; individual professions like painting and group professions like law, whose members constitute 'the bar', a special class in society; private professions like authorship and public professions like journalism, artistic professions like sculpture and technical professions like surgery; ameliorative professions like the ministry and social work, and professions which safeguard social institutions through a technique of destruction, like the army and navy. Despite all these differences of pattern, certain characteristic threads run like a common warp beneath the varying woof of every type of professional life and endeavor.

If one searches the authorities for definitions of a profession he will probably find four kinds. One is likely to hold that the determining quality is *an attitude of mind*, that an altruistic motive can lift any honorable calling to the professional level. A second may say that it is a certain *kind of work*, one requiring special skill on a high intellectual plane. A third may state that it is a special *order in society*, as the bar, the bench or the clergy. Still others insist that no work can be professional without a *confidential relationship* between a client and his agent, as that of patient to physician, litigant to lawyer, etc. None of these definitions is self-sufficient. Taken together, like

the legs of a table, they give a profession a stable base of support.

What is the distinctive mark of professional man? First, we may say that it is a *type of activity* which carries high individual responsibility and which applies special skill to problems on a distinctly intellectual plane. Second, we may say that it is a *motive of service*, associated with limited rewards as distinct from profit. Third, is the *motive of self-expression*, which implies joy and pride in one's work and a self-imposed standard of excellence. And fourth, is a conscious *recognition of social duty* to be fulfilled among other means by guarding the ideals and standards of one's profession, by advancing it in public understanding and esteem, by sharing advances in technical knowledge, and by rendering gratuitous public service, in addition to that for ordinary compensation, as a return to society for special advantages of education and status.

Next, what attributes distinguish the corporate life of a group of persons as professional in character? We may place first a *body of knowledge* (science) and of *art* (skill) held as a common possession and to be extended by united effort. Next is an *educational process* based on this body of knowledge and art, in ordering which the professional group has a recognized responsibility. Third is a *standard of personal qualifications* for admission to the professional group, based on character, training and proved competence. Next follows a *standard of conduct* based on courtesy, honor, and ethics, which guides the practitioner in his relations with clients, colleagues and the public. Fifth, we may place a more or less formal *recognition of status*, either by one's colleagues or by the state, as a basis for good standing. And finally, there is usually an *organization* of the professional group, devoted to its common advancement and its social duty, rather than to the maintenance of an economic monopoly.

The traditional professions of

law, medicine and divinity had a common fountainhead in the priestcraft of antiquity. What is professional in modern technical callings such as engineering can be traced back only as far as the medieval craft and merchant guilds, which arose out of the breakdown of feudalism.

There being no other effective authority, the guilds took over the regulation of the hours of labor, the observance of holidays, the length and content of apprenticeship, the wage system, the standards of workmanship and the quality of goods. The guilds also tested the progress of novices, apprentices and journeymen, and finally admitted them to the ranks of the masters with imposing ceremonies, of which college commencements and inaugurations are the most picturesque survivors in our modern day.

"...a profession must guarantee to the public the trustworthiness of its practitioners."

Many features of this distinctive type of citizenship are perpetuated in our modern professional bodies. The public grants to a profession more or less tangible monopolies and self-governing privileges, in consideration of which the profession engages to admit to its circle only men of proved competence, to guarantee their trustworthiness, to insist on the observance of ethical relations and practices, and to protect the public against bungling and extortion.

When a layman comes face to face with the complex and often terrifying specialization of professional skill and knowledge, he is likely to be baffled or easily misled. If you have a problem of mental illness in your family, how can you be sure you are dealing with a qualified psychiatrist and not with a plausible but unscrupulous quack? To protect you in these emergencies the public wisely puts the burden of guaranteeing at least minimum standards of competence and ethics on the profession itself.

The state may implement the obligation of a profession to

guarantee competence by designating a group of its members to conduct professional examinations and to issue public licenses to those who pass them successfully, or it may leave professional bodies free to issue their own credentials. Both of these practices may exist side by side, as in the realm of medicine, where the state licenses general practitioners through a board of examiners, while the various groups of specialists have voluntary organizations which examine and certify physicians seeking recognition in their respective fields. In the end, it comes down to the same principle—a profession must guarantee to the public the trustworthiness of its practitioners. In return, the public protects the profession from the incompetent judgment of the layman by a privileged position before the law.

Professional status is therefore an implied contract to serve society, over and beyond all specific duty to client or employer, in consideration of the privileges and protection society extends to the profession. To possess and to practice a special skill, even of a high order, does not in itself make an individual a professional man. Mere technical training, at any level, is vocational rather than professional in nature. The difference between technical training and professional education is no simple matter of length—any difference of two years, or four, or six; nor is it a mere matter of intellectual difficulty. It is rather a matter of spirit and scope. More specifically, it can be described as an overplus beyond the knowledge, however intricate, a man needs to master his daily tasks.

The overplus in professional education, in short, is that which enables a professional man to view his work not only as a skilled service to a client but also in terms of its consequences for society. No professional body can be

The Second Mile. . .

strong and effective unless it contains a substantial nucleus whose intellectual attainments far exceed in depth and breadth the technical demands of its practice.

The ethical obligations of a profession are often embodied in codes and enforced by police powers. Even when not written canons exist, as in the artistic professions, unwritten usages and standards exercise a powerful guiding and restraining influence. The physician and the lawyer are bound by explicit obligations. As engineers, our codes are less tangible and the

means of enforcement less explicit, in proportion as our duties are less definable, but our ethical obligations are no less binding morally.

No professional man can evade the obligation to contribute to the advancement of his group. His skill he rightly holds as a personal possession and when he imparts it to another he justly expects a due reward in money or in service. His knowledge, however, it to be regarded as part of a common fund built up over the generations, an inheritance which he freely shares and to which he is obligated to add; hence the duty to publish freely the fruits of research and to share

the advances in professional technique. If the individual lacks the ability to make such contributions personally, the least he can do to pay his debt is to join with others in creating common agencies to increase, disseminate and preserve professional knowledge and to contribute regularly to their support. That is the purpose to which a large share of the membership dues of our professional societies is devoted.

Too many engineers exhibit an unenlightened and petty attitude on these matters; mature men who complain that the direct returns to them of the researches and publications of a professional

Pencil sketch for an allegorical colored monograph which depicts Sir Isaac Newton seated at the bottom of the sea; water being the symbol of his materialistic philosophy.

William Blake: study for *Newton* (c. 1795)



society are not worth the annual fee, and young men who grumble because membership does not lead to direct preferment in rank and salary. Shame on us!

Many men who call themselves engineers and who have proved themselves competent in accepted technical practices, have not attained a real professional stature. Some are victims of a deficient education, not in the sense that school and college failed to teach them all they would ever need to know, but rather failed to inculcate a taste and a capacity for continued learning under self-direction. They are usually the men who have let their scientific training slip away after they have mastered a specific job, who have been unable to surmount the routine of early experience and have gradually grown content with mediocrity. Some of the difficulty may be inherent in the operating routine so often associated with an engineer's work. If these deficiencies exist, they are not solely a reflection on the individuals involved, but also on the professional body. One of its obligations to its younger members is to give effective stimulus and guidance to their growth.

There is a school of thought which has two quick and ready remedies for all the ills and shortcomings of the engineering profession. One is to keep students longer in college and to compel them to cover courses in both liberal arts and engineering. The second is to limit strictly the use of the title 'engineer' to men who have obtained a public license. One need not quarrel with either the aims or the means; so far as they go both are good, but they cover only the first mile.

Registration will probably always be a qualifying standard rather than a par standard for the engineering profession. By its nature, it cannot be a standard of distinction. It will go far toward keeping the wrong men out of the profession, but it will serve only indirectly to get the right men in. Beyond it lies a second mile of growth and advancement for which effective guidance, incen-

tives and rewards can be provided only within the profession itself.

The proposal to compel all engineering students to remain six years or more in college in order to complete combined courses in liberal arts and in engineering is attractive in theory but unworkable in practice. Some young men should do so, but the majority will not. Those who do are likely to find that the advantage gained comes quite as much, or even more, from sharing the life and spirit of two divisions of education with differing ideals and traditions, as from a more extended range of studies.

The engineer needs his profession for his personal advancement. That is the purpose which brought it into being.* He needs it most at the beginning of his career. Young men need for their

integrity and competence. He needs protection against those who assume that he is 'just another employee' and against sub-professional groups seeking to act for engineers in the process of collective bargaining. He needs protection against the levelling influences of unionism and of civil service. He needs his profession because of his stake in the advancement of knowledge and technical skill.

Few engineers can do much about it alone. Collectively their capacity to advance knowledge is beyond calculation.

Millions of individual, unrelated efforts will not add up to the future that invites our profession. This is no time for engineers to wrap themselves in the mantle of isolation; let us get together and be about our common business.

"Professional status is therefore an implied contract to serve society, over and beyond all specific duty to client or employer..."

advancement wider sources of information, more varied personal associations, broader stimulation to achievement and less formal contacts with their seniors than they usually find in their daily jobs. As men mature they come to value professional rewards—friendships, recognition, responsibility, pride in belonging, evidences of distinction, etc.—no less and often more than money rewards. These are the durable satisfactions of life.

The engineer, in a society based largely on group relations, needs his profession to safeguard his occupational and economic welfare. He needs protection against unethical competition, against indiscriminate use of the title 'engineer,' and against all influences which might undermine public confidence in his

*The first professional society, The Institution of Civil Engineers, was organized in London. The official account of its founding begins, 'It was toward the end of the year 1817 that a few gentlemen, then beginning life, impressed by what they themselves felt were the difficulties young men had to contend with in gaining knowledge requisite for the diversified practice of engineering, resolved to form themselves into a society.'

There are undoubtedly some who feel that the cultural and spiritual interests of society are menaced by a greater dominance of technological education. I am unable to share these fears. We of the engineering schools have no quarrel with liberal education.

We are not indifferent to culture, save that of the dilettante type. Culture is to us not a form of professional interest, nor the fruit of any form of pose or academic exposure, but the fruit of spontaneous activity which all may share on an amateur basis in that second mile which lies beyond the compulsions of one's economic occupation. Expressional activities—sport, music, writing, speaking, dramatics, and the arts of design—also the reading of books, are flourishing on many an engineering campus today quite as vigorously as in many a so-called liberal college. If destiny is to make our technological institutions responsible in the future for a major stem of higher education, and not merely for some of its specialized phases, I have faith that we shall give a good account of our stewardship. Ω

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"We also have special-interest groups, known as SIG's," she adds. "Of the approximately 150 of those, the areas range from astrology to astronomy, from gourmet cooking to game-playing, and an enormous variety of interests in between."

One reason for so many SIG's is that Mensa, as an organization, is committed to taking no stand on any

issue whatsoever, to preserve the concept that intelligence—and only intelligence—is the society's *raison d'être*. But opinions, ideas, causes, and crusades among members are vigorously encouraged—through the SIG's.

Mensa contends that on the basis of that 98th-percentile IQ requirement, one out of every 50 people qualifies for membership. Several thousand of them are reading this article. You may be one of them. To find out, write to Mensa for a list of acceptable IQ scores. If you don't know, or can't document, your IQ score, Mensa will provide (for \$8) a valid take-at-home IQ test. If you do well on that test, you'll be asked to take a proctored test for a \$12 fee. And if you jump that hurdle, you'll be invited to join Mensa. Annual dues are \$30, for which members receive a 10-times-a-year magazine, plus the contact with other high IQ types in the area. And then there's the knowledge that you have brains—perhaps more than you ever realized, or used.

For more information, write to Mensa, Dept. EO, Brooklyn, New York 11223 □

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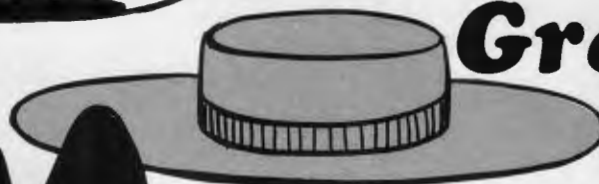
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White Hats, Grey Hats, Black Hats

by Joan F. Knox

Business, like all other human activities, contains potential ethical problems. Your response depends on your personal ethics. However, there are alternatives to going along.

One of the main objectives of job applications and letters-of-reference is to assure the honesty of the employees. But what happens when employees are confronted with dishonesty on the part of co-workers or superiors? This is one of the most stressful, complex and discouraging situations facing those who are at the bottom of the work ladder. Consider:

- Helen's new Notary seal was paid for by the law firm she just joined as a legal secretary. She is told to notarize a document which has already been signed. She asks the secretary across the hall whether she should, not having witnessed the signing nor even recognizing the signature. She is told that they do it all the time, and she'd better just go ahead and notarize the document.
- Jane gets her first job as a bookkeeper for a construction company. She notices that several of the workers are slipping sacks of concrete, bricks, and nails into their cars at the end of the day. She wonders whether to speak to her supervisor, when she sees him loading his pick-up with lumber.
- Sylvia is secretary to the company Treasurer. She is told to issue airplane tickets for the President, his parents, wife, and three children, to Miami for a week. Knowing that office-issued tickets are to be used only by company personnel, she questions her boss. She tells Sylvia that the company rules and policies can be broken by the President.

- Sally works as an administrative assistant for a governmental official. A month before Christmas he tells her to deliver two rolls of stamps to his wife. Feeling as though she would be participating in a theft from the taxpayers, she tries to avoid becoming involved. Her boss becomes angry and tells her to do as she's told or she can look for another job.

* * *

These stories are true and illustrate some of the types of problems confronting employees. Such situations are not the rule; unfortunately, they are not rare, either. Let's examine how these specific cases were resolved.

Helen had notarized the document in question and several others like it, when someone tells her that what she has done is a misdemeanor of the third degree. To protect herself in the future, she suggests Helen say something like, "In case I'm asked to testify under oath in court, I want to be able to say that, even though I can't remember the specific document, it has always been my practice to notarize only those signatures I witness personally."

Jane, the bookkeeper, decides to say nothing about the material being taken from the company, since she is not directly involved.

Sylvia, the Treasurer's secretary, is told to make out the airline tickets or someone else will be given her validating stamp. Sylvia is afraid to put her job on the line, even though she knows that the cost of the tickets for the President's family will end up as a business deduction. She makes out the tickets.

Sally's boss tells her that he will be responsible for her taking the stamps to his wife. Her job is interesting and pays well, she reasons, and she needs it to support herself and send a little money home each month. She finally does as she is told. The wife adds to her discomfort by being visibly embarrassed. Sally feels worse and worse, and concludes that only she can be

responsible for her actions. She ends up with peace of mind when she buys two rolls of stamps and puts them in the office stamp box.

* * *

When there is a confrontation over ethics, the employee will understandably feel resentment. The employer will often feel defensive and angry. Neither will forget. Sometimes superiors have even been known to make more questionable requests, as if to force control or break the employee's ethical will. An employer can even make an employee quit. What are the limits?

Confrontations over ethics leave employees confused and resentful, while superiors often feel defensive and angry.

Sally's boss takes seven more rolls of postage stamps during the year. Each time he takes the stamps with his own hand and she buys no more replacements. On several occasions she notices, and asks him about, duplicate expenses for items such as gasoline, meals and motel rooms on his office Master Charge, which are covered by his per diem and travel allowance. He becomes angry and tells her to do as she is told.

Feeling increasingly uncomfortable, she writes to an out-of-state lawyer friend. He replies,

"I don't want to discourage you, but it's a fact of life that there is some dishonesty in many businesses. There are many reasons for this, having to do with the state of the economy and the world, dealings between strangers instead of friends, and the erosion of traditional standards and values. You can stay on the job, or you can go.

"It's hard to avoid getting pulled into direct involvement. If you can bring yourself to do it, go ahead and ask about discrepancies, and try to avoid doing improper things yourself. Never mind the other fellow's conduct. If you know someone in personnel, or have a supervisor you trust, you might discuss the problem and see what happens.

"Keep an Office Diary! Keep it at home! Note the date, what he said, what you said, what you did, what he did. This will provide you with details which you would otherwise forget, and which you can use, if necessary, to protect yourself."

"Everybody does it" is an easily understandable rationale for going along with unethical practices. It's not, however, a valid defense.

Over the months Sally gradually learns more and more, and becomes more involved in unethical business practices. She thinks and worries about the situation a great deal. One day she refuses to do what she is ordered to do and quits. Some of her friends tell her she should have waited until her boss fired her, and then she could have collected Unemployment Compensation.

One day Sally goes to the State Employment Office and then next door to the Unemployment Compensation Bureau. She learns some interesting things from a counselor. An employee cannot be forced to do something that is against the law, and, if there is sufficient cause, an employee can quit a job and still collect unemployment insurance.

Sally decides that, although she is afraid of being labeled a trouble-maker, she needs the money and wants to follow through because of the principles involved. She applies and is turned down, for lack of sufficient cause. She appeals, although she is afraid of confronting her boss in person at the hearing. She receives notice of the date, time, and place of the hearing.

When the day comes, a tape recorder is on the table between her and the District Appeals Referee. There is no one else in the room. Her boss does not appear. She is sworn in. She asks if she will incriminate herself by what she says. Although she is told the hearing is confidential, she is not reassured and tries to say as little as possible.

The Referee, after half an hour of questioning, focuses on the specific reason for her leaving. He asks her, "Did your employer ask you to do something which was illegal?"

She answers, "Yes." He ends the interview.

She receives a notice in the mail within a few weeks that she has won the appeal and will be eligible to receive a weekly check while she looks for another job. However, enclosed is a page summarizing the hearing, including her accusations. While it makes her shudder to imagine her boss reading his copy, she has the satisfaction of knowing that his new administrative assistant will also read it.

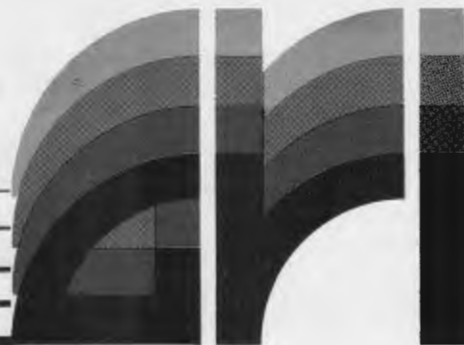
"Never mind the other fellow's conduct." The question must be, "What do I do in this situation."

She writes to her lawyer friend to inform him of what has happened. He replies,

"Many government officials and company executives who end up in the courts for dishonest practices have their aides, assistants, and secretaries beside them as co-defendants. So watch out!

"The Office Diary is about the only way I know for an employee to establish a long-term pattern of ethical intent without actual witnesses. Try to see that office policies and procedures call for authorizations, such as initialing or signing of vouchers and reimbursement applications. You can even try for a letter of authorization or instructions which will cover your actions.

"The best to you, my friend. There are plenty of good-guys out there, and I hope you find one to work for soon." □



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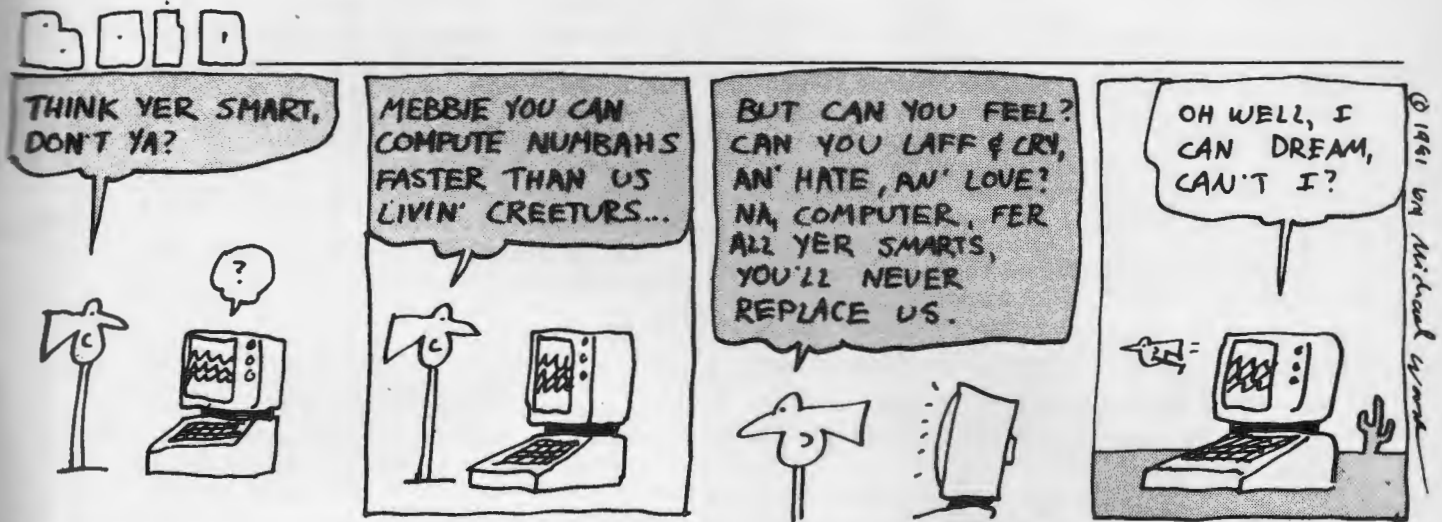
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One fundamental change that thinking machines will make will be to process information in a manner radically different from the way it is done now. Hints of what the future will be like in this regard can be seen at Yale University, whose artificial-intelligence research stresses computer programs that deal with words and ideas.

FRUMP, at Yale, enables the computer to truly "understand" a word and ideas associated with it, and to use its understanding to reach logical conclusions.

Another Yale program has read news stories of former Secretary of State Cyrus Vance and can answer questions about Vance's activities, based on its knowledge of the relationship between various activities and their meaning. Asked, for example, if Vance's wife ever met the wife of the Soviet leader, Leonid Brezhnev, CYRUS decides that the answer to such a question probably resides in an analysis of diplomatic social functions where both Vance and Brezhnev have been present, since their wives probably also would be there. It discovers that the two men did, indeed, attend the same reception with their wives and concludes that Mrs. Vance and Mrs. Brezhnev probably have met.

COMPUTER ASSISTANTS

Such capabilities, however rudimentary, lead Raj Reddy of Carnegie-Mellon University in Pittsburgh to speak of intelligent computer assistants aiding people who deal in information, from journalists to stockbrokers to scientists to bureaucrats. "If a computer can read a book, for example, a sophomore-level physics book, and answer the questions at the end of a chapter, then it is beginning to do the kinds of things you would expect from an intelligent assistant who has gone to college," he says.

"A machine that is going to act as an intelligent assistant must be able not only to learn from books, but also from examples and by observations, by discovery of things. When that happens we will begin to see a significant enhancement of our capabilities," Reddy says. "Our assistant will have the capability to examine quickly a vastly larger body of knowledge than you or I could and then report back with the alternatives available to us. It might say, 'Here are the five best alternatives for dealing with this problem and here are the implications of each.'"

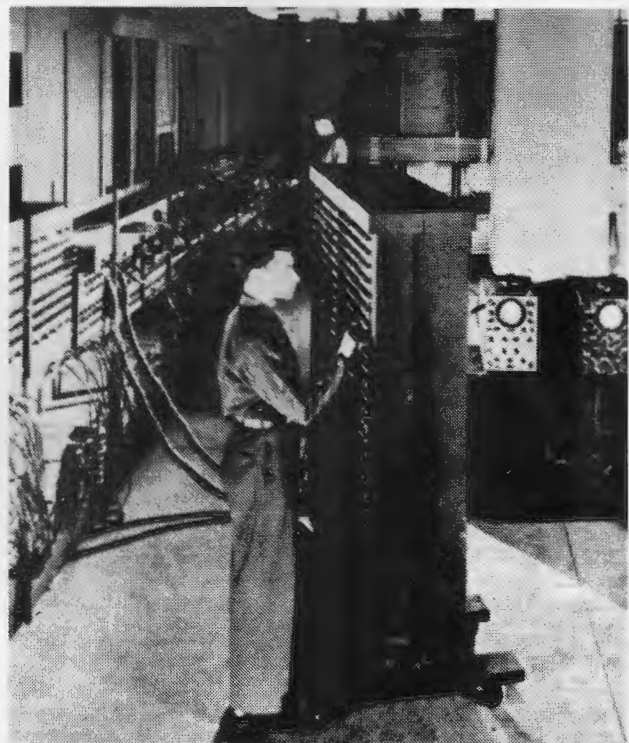


Photo: Smithsonian Inst.

The first of the first generation: ENIAC, at Univ. of Pennsylvania's Moore School of Electrical Engineering, was the first general-purpose electronic calculator. It went on-line in 1946. Its primary task was computation of ballistic tables, but it was also used for a wide variety of other scientific problems.

The CYRUS program at Yale suggests how intelligent computers will be able to see relationships between events. Asked, for example, why President Carter did poorly in his native South in presidential voting this year, a descendant of CYRUS will analyze campaign speeches, journalists' interviews with voters, public-opinion polls, post-election analyses and other information to offer an explanation in as much or as little detail as desired.

Market analysts already rely on computers' awesome computational skills to chart trends in stock prices or price-earnings ratios. But the stockbroker's intelligent

A.I. . . .another kind of mind. . .

computer assistant will also be able to read news reports about industry trends, to digest annual reports, to interpret analysts' statements and even to scan the speech that a large corporation's president is giving to the graduating class at his alma mater. Then the computer can give the broker its "buy" or "sell" order. At that point — if it weren't for that little matter of human intuition — an investor might well wonder whether he needed his broker at all.

Very sophisticated programs can read and digest news stories, perform complex medical diagnoses, and play championship backgammon, but no one has yet been able to develop a machine that can handle eye-hand coordination as well as a human baby does.

ROBOTS

The common perception of intelligent machinery is the robot that trundles about the home or office doing a variety of mechanical tasks in the manner of a general-purpose servant. But the most important robots of the future will be highly specialized machines.

"If you want to imagine robots in the home," says Nils Nilsson of S.R.I. International in Menlo Park, Calif., "it's more likely there will be a self-making bed that employs artificial-intelligence technology or a specialized device to sweep the floors."

Much of the effort in robotics at the moment, such as that at Carnegie-Mellon's Robotics Institute, is focused upon refining intelligent machines that can now do assembly-line work. Research there and at other institutions, such as S.R.I. International, Stanford University and MIT, is leading to more and more skillful mechanical arms and other machinery that will perform highly specialized, sometimes extremely undesirable or unsafe jobs with grace and speed. But in the not-distant future robot-run factories will exist.

"I think our problem of industrial productivity is sort of hopeless unless this country begins to develop robotics to help in this area," says Marvin Minsky, of MIT, who was an early worker in the robotics field.

Reddy, Minsky and others say robots will be constructed, for example, to be used in ocean-bed mining, trundling along far beneath the ocean at depths where no human can go. Firemen will have rescue robots that go into a burning building, their mechanical eyes searching out human forms lying in hallways and rooms and rendering aid. Surgeons will have assistants with microscopes for eyes and precision mechanical hands designed to perform microsuturing with more skill and certainty than the human hand, which can shake or slip. Robots will play a major role in future space exploration.

"There are aspects to human life that a computer cannot understand — cannot. Love and loneliness have to do with the deepest consequences of our biological constitution; understanding them is, in principal, impossible for a computer."

COMPUTER DEPENDENCE?

But artificial intelligence also will produce knowledgeable specialists of the future — computerized lawyers, doctors, traffic engineers, chemists, air-traffic controllers, military tacticians, economic forecasters, marketing experts, weather forecasters, laboratory technicians — yes, perhaps even electronic psychoanalysts more sophisticated than DOCTOR, who interviewed the Soviet scientist.

Such developments have led to the fear that the machines will take over all at once. "That's not the danger," says Daniel Bobrow of Xerox. "The real danger is that we will get to be more and more dependent upon the machines, too dependent."

For example, if an intelligent machine that assists a doctor makes a mistake, who should be sued for malpractice? The doctor who used it, or the humans who created it? And is it possible that a computerized assistant will lull the doctor into relying on it too much, permitting himself the dangerous luxury of not staying on top of the latest research? Will the day come when medical students will not be trained in the fine points of diagnosis because the intelligent machine makes such training seem superfluous?

In the last analysis, it is emotions, feelings, attitudes that seem to argue most profoundly against the notion that machines can become as intelligent as humans, that machines will ever truly duplicate mankind. More than anything else, emotions seem to make us unique.

A.I. experts are not truly concerned about a take-over by intelligent systems. What does worry them is that humans might find A.I. systems so convenient that more and more human functions of responsibility and decision-making will be delegated to them.

Many artificial-intelligence scientists believe that it will certainly be possible to program an intelligent computer, at least to act as if it had emotions — to undertake the actions that are expressions of loving someone, of being sad or happy. The Yale scientists have a computer program now in which two antagonists argue about Middle Eastern politics. At one point in the argument, one of the computers may react "angrily" to what it knows to be an untrue assertion. "You know damn well that is not true," the machine will print out. But this interchange, while amusing, is nothing more than an artifact, merely a computer programmer's sleight of hand. The computer is not feeling an emotion. It is, however, exhibiting certain signs of emotion, manifestations that are similar to those of humans.

Can man make a machine with a soul? It is a question that no one can now answer for certain.

There are those, of course, who do believe that the answer is no, and that perhaps we are taking the whole subject too seriously. Consider the conversation between two computers executing different artificial-intelligence programs. One was ELIZA, the program that acted like a psychoanalyst. The other was PARRY, developed by Kenneth Colby, now of the University of

A.I. . . .another kind of mind. . .

The real threat, A.I. experts believe, is not a take-over by intelligent systems, but of ever-increasing human dependence on such systems.

California in Los Angeles; PARRY simulates the behavior of a paranoid patient.

PARRY: In my opinion, you have a one-track mind.

ELIZA: What makes you think I have a one-track mind?

PARRY: I used to go to the track every week.

ELIZA: What does that suggest to you?

PARRY: I avoid racetracks now because the races are fixed.

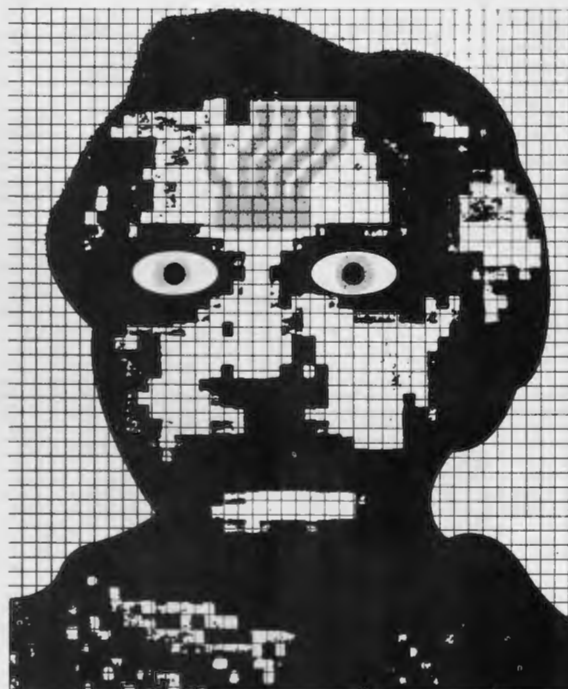
ELIZA: Is that the real reason?

PARRY: I'd rather not discuss it.

ELIZA: What else would you like to discuss?

PARRY: That's something I don't want to go into. □

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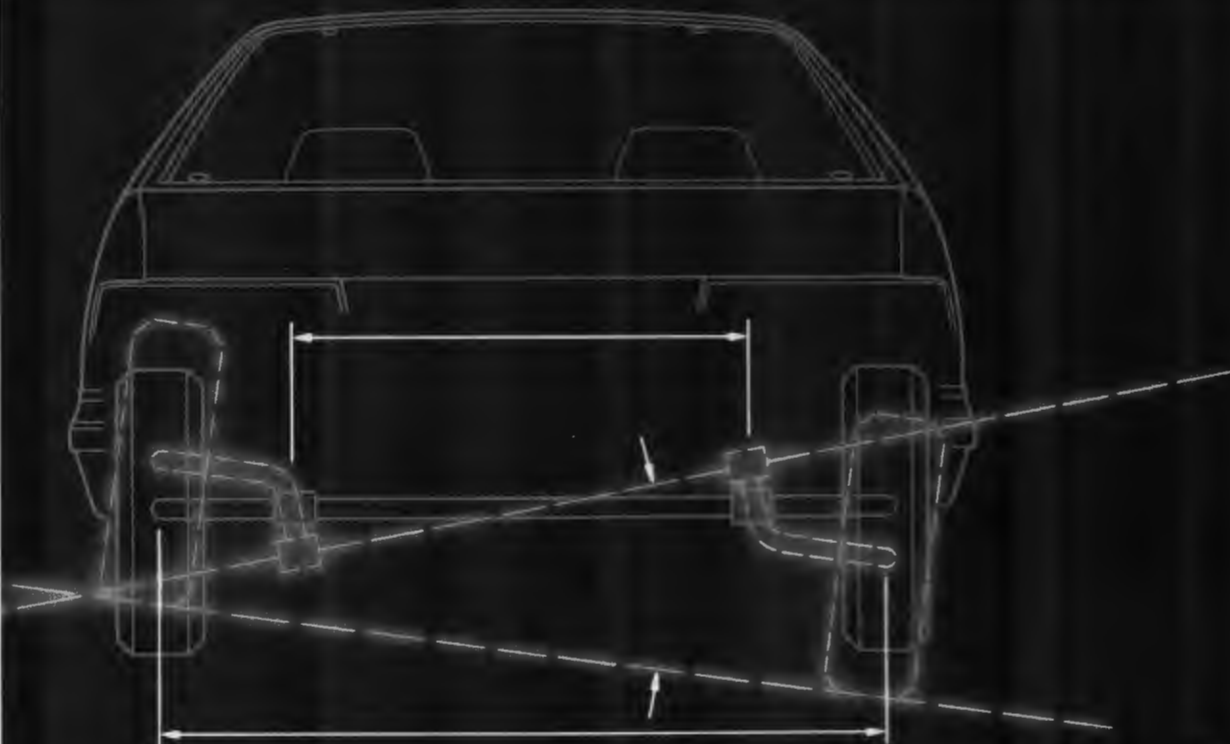
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