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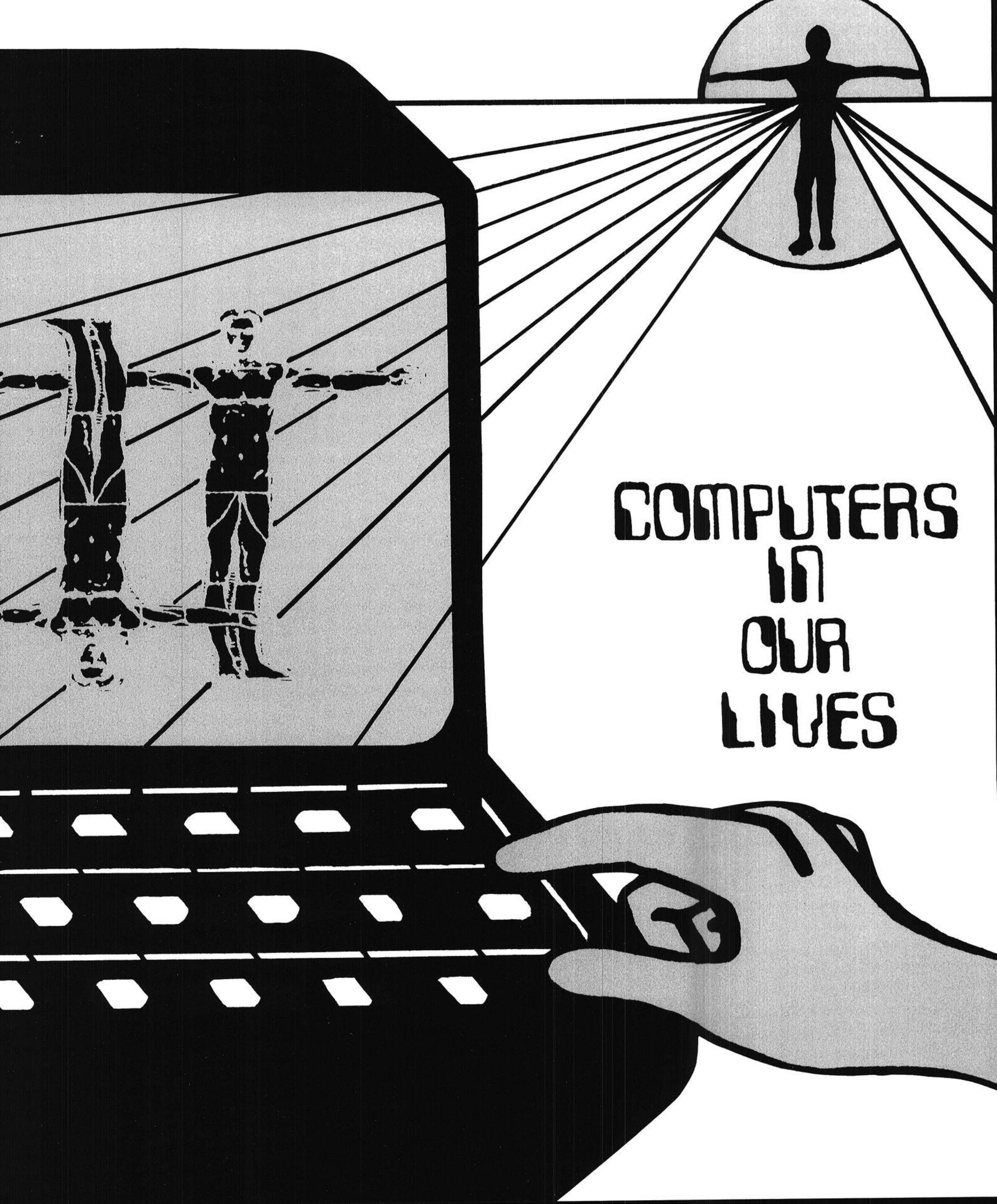
February, 1982

wisconsin engineer



Luis Castellanos mines copper with software.

Most copper is found deep underground. But the Bell System's 995 million miles of copper cable have tons of it above and below ground. That copper provides vital circuit paths to transmit customer voice, data and video signals for today's Information Age needs.

And Luis Castellanos, seven years out of undergraduate school, supervises one of the groups that helps Bell System companies "mine" all that copper. He works with one of the largest computer hardware and software systems in the world—the Trunks Integrated Record Keeping System (TIRKS). Every day it "mines" the vast Bell network for available circuits and equipment. As a result of efficient use of network facilities, the Bell System saves millions by eliminating the need for certain capital expenditures.

Plus, there's more to TIRKS than "mining copper." It also configures circuits and assigns components needed for each circuit path. That allows Bell companies to respond faster to customer requests for complex services like video and data transmission. Employees are more productive too, because TIRKS helps them set up circuits and forecast facility needs.

Before TIRKS was available, keeping track of communications circuits and facilities required enormous amounts of paperwork and manual calculation. Every day, the average Bell System company handles orders involving 1500 circuits and up to 7500 individual components associated with them. Each detail has to be specified and accounted for.

Now, thanks to people like Luis, TIRKS keeps track of all that information instantaneously using computers. Information is up-to-date. It's instantly available. And it's more accurate.

According to computer scientists like Luis, the benefits from TIRKS are just beginning. He believes that, as more computer hardware and software systems like TIRKS interact, new benefits for customers may be possible, as well as additional productivity increases for employees.

Luis joined Bell Labs with a B.S. in computer science from Pratt Institute. Under a company-sponsored graduate study program, he attended Stevens Institute of Technology for his M.S. in computer science. At the same time, he worked part-time assuming responsibility for a large piece of TIRKS software. Working with design teams, he gained valuable insight from experienced members. Now, his technical performance has earned him a promotion to supervisor.

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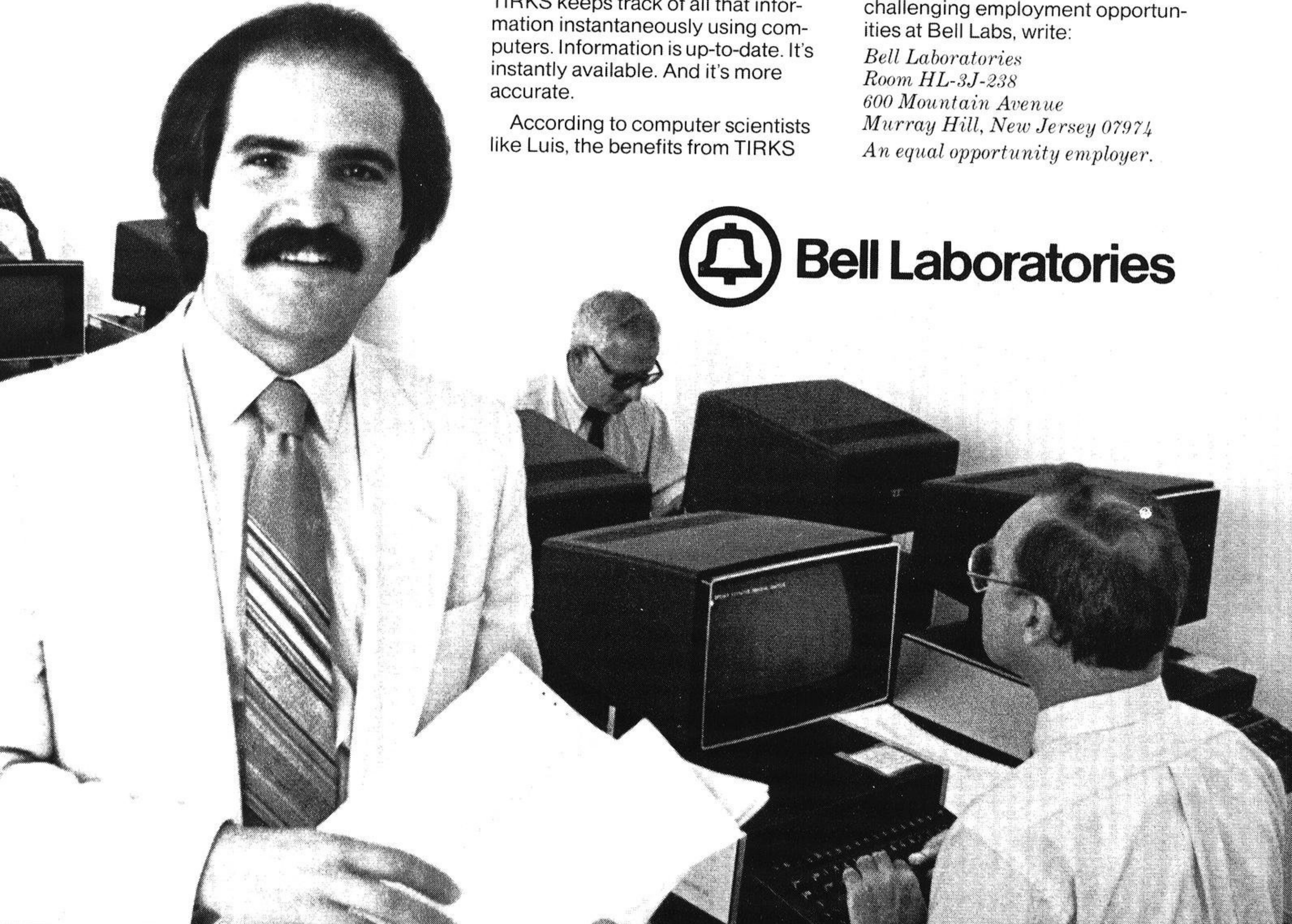

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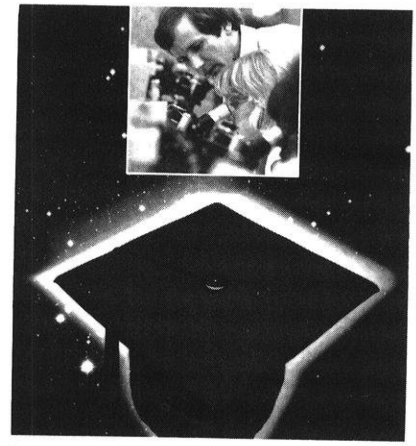
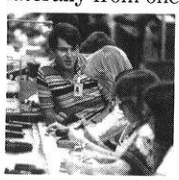


laterally from one specialty to another as well as move up. Without changing jobs.



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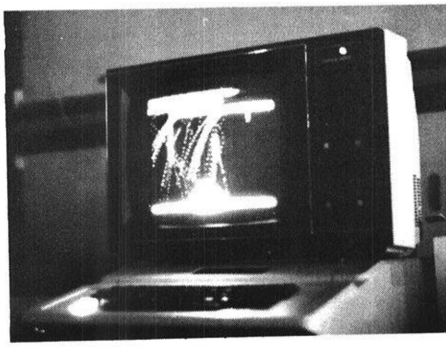
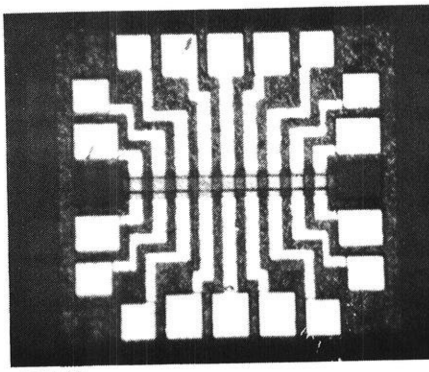
COLUMNS

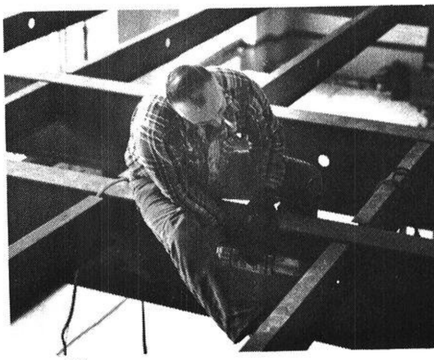
FEATURES



page 14 *RMJ Photo*



page 29 *Wis. Eng. Photo*



page 32 *Photo by Karen Biesmann*

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EDITORIAL

It is no surprise that the economic condition of the *Wisconsin Engineer* closely parallels that of the rest of the nation. Our only means of financial support comes from advertisements, subscriptions, and donations from alumni, foundations and corporations. As the country heads into a recession, the magazine suffers also. One potentially damaging result is the fate of the Engineering College Magazine Association (ECMA) convention, held in April of each year at one of the 38 member engineering campuses (see the October '81 issue). As any member of a professional or technical organization knows, conventions and conclaves are essential for maintaining standards, exchanging ideas, recognition of achievements, and presentation of the latest techniques and materials. A better morale-booster has yet to be found.

In the past, large corporations throughout the U.S. have generously contributed the money needed to hold the ECMA conventions. Because the economic outlook has been so grim, for the first time in our history any company asked to contribute has been unable to do so. As a result, the convention budget restrictions proposed by this year's host university, Purdue, may cause the *Wisconsin Engineer* to decline participation.

It is ironic that we are faced with these trials now. The W.E. staff is expanding, made up of students from a variety of disciplines. The diversity and quality of articles is said to be better than ever. Local advertising has made a dramatic comeback. We are not ready to succumb to financial setbacks as one member school of ECMA has been forced to do.

We are working hard to procure new advertising, but help from our readers would make a considerable difference. To protect the magazine from future monetary crunches we are appealing to faculty, alumni, and graduating seniors to give their support by subscribing to the *Wisconsin Engineer*. Subscriptions can be started or renewed using the form on page 15.

Money woes are not only measured in decimal places. Every student and professor feels the psychological effects of budget-cuts as classes get larger and more impersonal, impossible to get into or less fun to teach. Years ago, the teachers, students, and professional societies used the *Wisconsin Engineer* as a meeting place to present research papers and engineering campus news. The more specialized the different disciplines of engineering become, the greater the need for a common ground. The *Wisconsin Engineer* is ready and willing to become this vital place. Your help and encouragement is needed.

We have tried to include articles on both technical and social developments which would supplement the engineer's education. A knowledge of history is also important if we are to understand how modern-day achievements were realized. Historically based articles are offered not only for interest and variety, but in an effort to combat the tunnel-vision inherent in the engineering curriculum.

Prevalent in every aspect of today's world is the computer. In this issue we feature articles concerning computer use in medicine, automobile manufacturing, engineering design, and home applications. A valuable source of information to help sort out the merits and drawbacks of specific name brands can be found in the two articles dealing with programmable calculators and home computers. We are proud to introduce two regular features in the magazine, "Outlook" by Dean John G. Bollinger and "Bits & Threads" by associate editor John Wengler. These columns will focus on current events in the College of Engineering and worldwide.

Feedback from students, professors, and alumni is essential if we are to serve the engineering college community as best we can. The editor-in-chief of the first *Wisconsin Engineer* perhaps said it best:

> "The loyalty of our alumnus and students to "Old Wisconsin" is proverbial and it is hoped that this publication may still further strengthen the feeling of brotherhood among them and prove a source of mutual benefit, while at the same time contribute something of interest to the profession at large."
>
> E.C. Bebb
> Editor
> *Wisconsin Engineer*, Vol. 1, No. 1
> June, 1896

Joan Heitkemper
Editor

OUTLOOK

The editorial staff of the *Wisconsin Engineer* and I have agreed that this column "Outlook" could serve as a convenient communication link between the Dean's Office and the student body in the College of Engineering. I am delighted to share with you some of the College activities, opinions, and plans that are shaping the engineering educational program which is the focus of your being here on our campus. This academic year has been a period of excitement for me tempered by concern for our future. One of the most rewarding aspects of my job is to see the dedication with which the faculty and the administration have carried out their commitment to our students to provide an outstanding education in engineering. I would like to share with you some of the activities and trends which loom on the horizon.

There are many reasons for finding excitement in the directions taken by our College program. First of all, when you returned to campus this January you found a developing new program in computing. Hopefully, you discovered an increased access to interactive computing and an effective reorganization of what had become an outstanding computing facility called ECL. The hub of the new program is called the Computer-aided Engineering Center. Drawing upon the resources and staff of MACC, our College has found it possible to expand interactive computing throughout the College of Engineering. In addition to the many computer-oriented laboratories which you have experienced in the course of your academic career, this facility is being tailored to provide you with the most up-to-date orientation to engineering computing that our resources can provide. As you become familiar with this activity I think you will grow to appreciate that it is representative of the type of computing you will experience in your engineering careers throughout industry. While enhancing our undergraduate computing activity, this new effort will also provide additional access for research computing with convenience and power exceeding what we have been able to accomplish in the past with far more limited computer equipment.

From a graduate student perspective, your faculty is working on the development of a new Masters of Science program leading to a degree in Manufacturing Systems. This is an exciting new effort involving faculty from numerous departments in the College of Engineering. This program, if accepted by the University System and Regents, should open a new dimension in graduate student employment.

It is no rumor that the College is short of critical resources for replacement of equipment, new faculty, and many other aspects of our program. To help solve these financial problems we are turning to the private sector with a broad new fund-raising master plan for the College. The College faculty voted last semester to implement a program of fund-raising through the creation of gift clubs in the University of Wisconsin Foundation, and an Industrial Associates Program which we hope will enhance our direct relationships with industry. Additional resources from private and corporate foundations as well as corporations will enhance our programs. Evidence of fruit that industrial relations can bear is found in the Mechanical Engineering lobby where a new student study area is under construction. This facility is the result of an earlier gift from General Motors to the College of Engineering. You may also note the name of corporate contributors on some of the equipment you are using in your laboratory courses.

Despite the excitement generated by the efforts I have mentioned, there are reasons to be concerned for the future effectiveness of our program. High enrollment in the College is one of our major problems. The demand for an engineering education continues to rise at a rate much greater than resources are available to meet these needs. With the support of our student body, the surcharge was imposed which provided additional funds for the second semester. Unfortunately, budget cuts literally absorbed most of the benefits that would have accrued to us from the surcharge. However, when this combined situation was superimposed on enrollment funding allocations, we found we were able to invest in the offering of courses as first priority to meet the commitment that we have made to the students. The future outlook is not as bright as you and I would like, but we must recognize that the economy in our State has placed us close to a deficit situation. Our College will continue to work toward meeting the obligation we have to you, our students, recognizing that it is only possible to work within the framework of our available resources. If you have comments and impressions about your educational program do not hesitate to make them known to me, the Associate and Assistant Deans, and the Department Chairmen.

John G Bollinger, Dean
College of Engineering

1/21/82

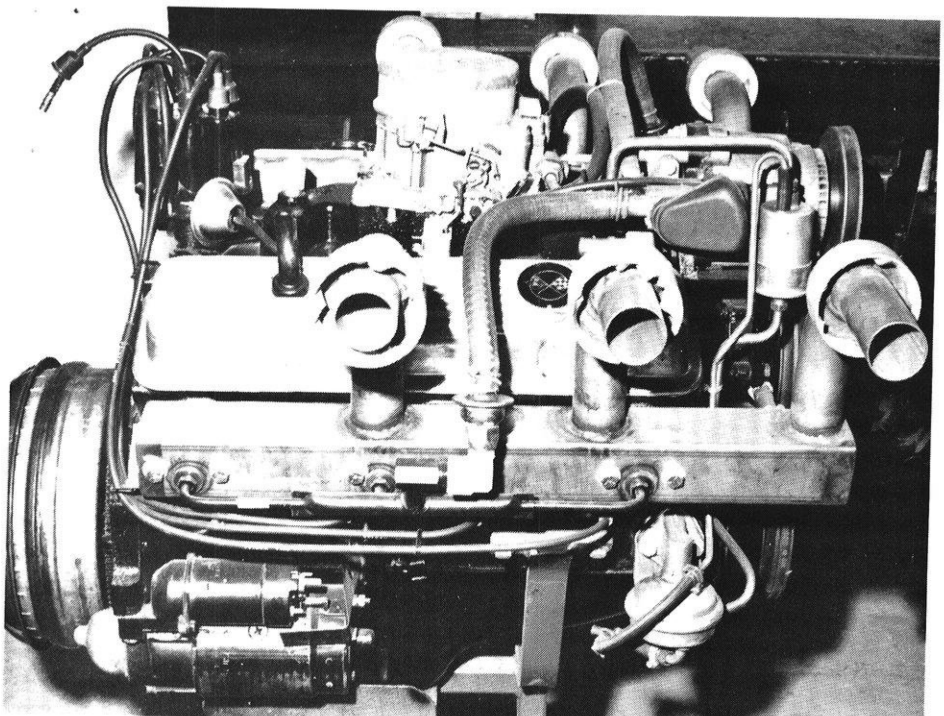
The Automobile and the Computer Revolution

by David Eiche

David Eiche is a freshman in Mechanical Engineering. This article stems from his interests in the automobile industry and computers, both of which are discussed here.

Traditionally, the automobile industry has been reluctant to incorporate new and unfamiliar technology into its products in the interests of low cost and high reliability. Today Detroit is committed to advanced computer technology from the design stage through production to the operation of the cars themselves. Engineers use computer modeling techniques to retain chassis strength while reducing weight. Computers test engines on the production line to check for defects. Powerful microcomputers play an integral role in the operation of millions of engines. The switch to computer technology was not cheap, yet even as sales fall, Detroit continues to invest in advanced production and engine control systems. What motivated these formerly conservative companies to spend huge sums of money on computerization, even when these investments sunk them deep into the red ink?

The answer lies in the conflicting demands placed upon the industry by government fuel economy and pollutant standards along with consumer complaints about poor quality control. Detroit's only recourse was to increase the technical sophistication of its products and production processes or lose sales to the imports. In most cases, increased technical sophistication meant a greater reliance on computer systems and controls for a number of functions.



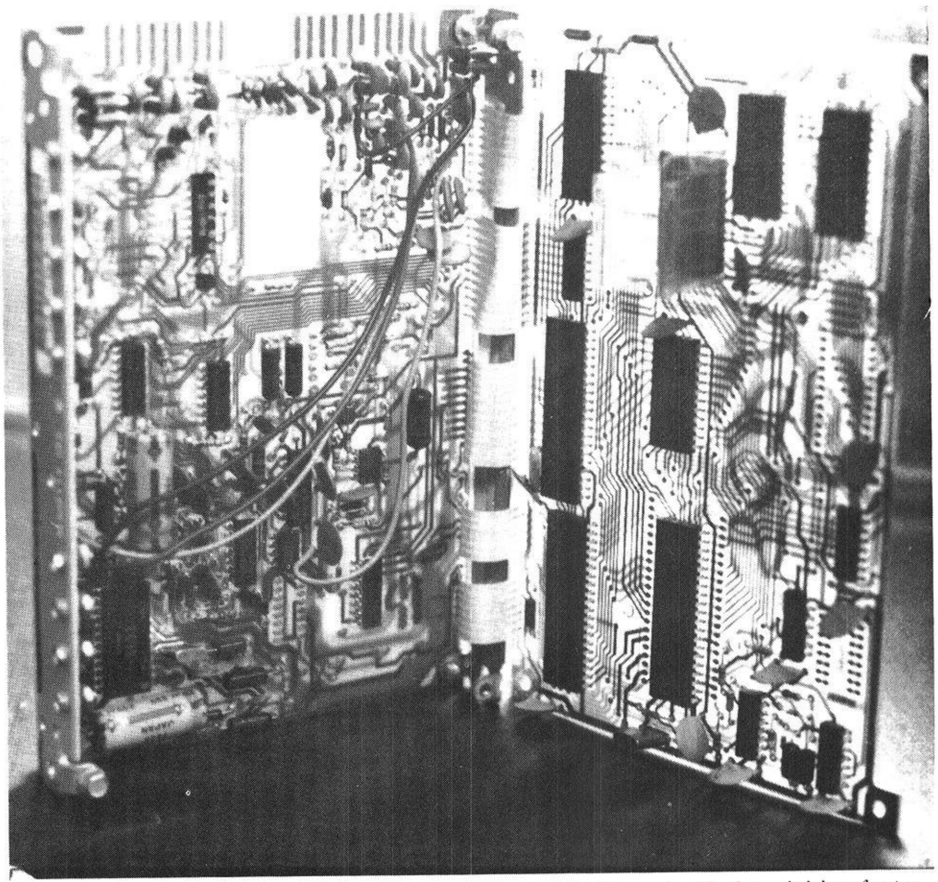
A Corvette engine from Detroit's pre-computerization days.

Automotive structural design was one of the first computer applications. Today, finite element modeling (FEM) is used to analyze the structure of an automobile by creating a three dimensional computer model on a CRT (cathode ray tube or television screen). With FEM, engineers can test and modify a design with information inputs from a computer keyboard or a "light pen" touched to the CRT. For example, FEM has been used to test the strength and rigidity of frame designs on General Motors' B and C body (full-size) cars, resulting in a great savings of time and money. FEM techniques are being developed further to offer even greater design flexibility.

Scientists and engineers find that computers are powerful tools in engine and drivetrain development. In one application, an engineer can study combustion in a diesel engine by installing sensors inside the combustion chamber and interfacing these sensors with a computer. In this way, the computer provides a sophisticated analysis of the combustion process. Computers can select the correct transmission gear ratios for particular design objectives, and they are revolutionizing drafting with their great precision and accuracy.

Auto production has felt the effects of computerization through better quality control and manufacturing efficiency. Computers are ideally suited to accurately perform repetitive tasks which human workers usually find boring and tedious. In Chrysler Corporation's Trenton, Michigan, engine plant, computer technology is used extensively. The corporation uses a central computer to monitor a number of machines. For instance, boring machines are monitored by the computer, which will adjust a machine if it consistently produces underbores. If a machine should malfunction, the computer will shut it down and sound an alarm. Chrysler also uses computerized test stands to evaluate new engines with a 54-step test. The tests are almost entirely computerized, and in the event of an engine failure, the computer notifies the repair department and suggests repairs for each problem.

Given sufficient capital investment, computers could assume a high percentage of production processes. One Japanese automaker has a plant which is 90 percent automated. If such high levels of automation become prevalent in this country, there would be profound effects not only on productivity but also the labor force. Critics of the developing computerized robot technology claim that unskilled workers would find their jobs being taken by robots who have no use for wages, fringe benefits or unions. The robot manufacturers respond that the work robots would do is the tedious, dangerous work that humans should not do anyway. In any case, a robot takeover of factories would increase the demand for the skilled workers and engineers needed to maintain and design the machines and control systems. Robot industry officials expect the demand for their product to grow, a demand which could be stimulated by the new corporate tax laws. However, the domestic auto industry is in serious financial trouble, and overly ambitious plans may have to be curtailed or cancelled.



An on-board computer used for all 1980 GM models; the only distinguishing factor between the one installed in a Cadillac and the one in a Chevette is a different prom-chip plugged in the module (upper right center of photo). (Courtesy of Dean Leidel.)

RMJ Photo

One ambitious plan that did become reality was the proliferation of automotive microcomputers. The small yet powerful computers offer a number of attractive features. Microcomputers are compact and durable enough to withstand the temperature variations and vibrations likely to be encountered in automotive applications. The units are relatively inexpensive and may become even cheaper to produce as manufacturing technology is developed. Reliability is another strongpoint; if a computer system should fail, replacement of the failing components is easy. In fact, the systems can diagnose themselves by producing a series of codes. The most important feature, of course, is the microcomputer's ability to store and process information, thereby functioning as an electronic brain to make engines "smart" as well as powerful.

Chrysler introduced one of the first engine control microcomputers in the 1976 model year. Since late 1974, nearly all domestic cars had used catalytic converters in the exhaust system to meet federal standards for carbon monoxide (CO) and hydrocarbon (HC) emissions. Chrysler intended to design an engine control system which would reduce CO and HC emissions without a catalytic converter.

At lean air/fuel mixtures (18:1, air/-fuel, by weight), HC and CO emissions are low, but precise control of engine ignition timing is necessary to ensure good drivability and performance. In 1975, the systems used to control ignition timing were mechanical and most only responded to engine load or speed. Since there were more variables which needed to be accounted for, these systems were too crude for use with lean mixtures.

Chrysler developed a system which measures engine speed, intake manifold vacuum, throttle position and rate of throttle movement, along with coolant and air intake temperatures through various sensors and changes the ignition timing accordingly. Due to the computer's great computation speed, the timing can be adjusted many times per second. Thus, the microcomputer afforded the precise control of ignition timing necessary for low emissions and good drivability.

Buick looked to the microprocessor to solve a different engine problem. The GM division intended to introduce a turbocharged version of its 3.8 liter V-6 engine, but the turbo's high compression pressures produced detonation, commonly known as pinging. High-octane fuel would have solved the problem, but unleaded fuel of sufficiently high octane was unavailable. Another remedy was retarded ignition timing (firing the spark plug later in the compression phase), but this causes a drop in engine power and fuel economy. The solution was a detonation sensor which is sensitive to the frequencies produced by detonation. When the engine detonates, the sensor sends a signal to a computer, which retards the ignition timing for approximately 20 seconds. Thus, timing is retarded only when necessary.

The turbo engine and sensor are still in use. The sensor has been moved and connected to a microcomputer system with far more functions than that of the original turbo engine. The new GM system, known as Computer Command Control, is used on the corporation's

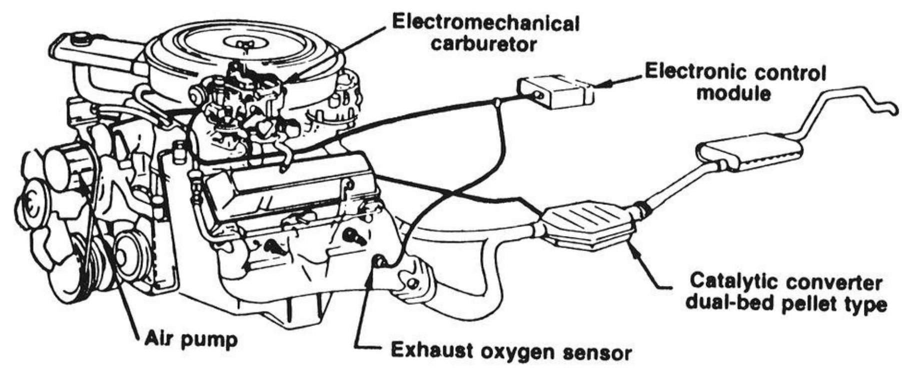


Figure 1. A typical closed-loop engine control system. *(Courtesy of Chemtech magazine, October 1980.)*

gasoline-powered models primarily for emissions control, but also to promote good fuel economy and drivability. The other domestic automakers also use engine computer systems whose operation is similar to that of the GM unit.

Computer Command Control was introduced nationwide on certain 1980 model cars and used with a three-way catalytic converter to meet stringent federal standards for CO, HC, and oxides of nitrogen (NO_X) (see Fig. 1) This was not the first use of the three-way catalyst: Volvo and Saab introduced their "Lambda-sonde" system in the 1977 model year. Research showed that conventional techniques for oxidizing CO and HC would increase NO_X and vice versa. Scientists found a three-

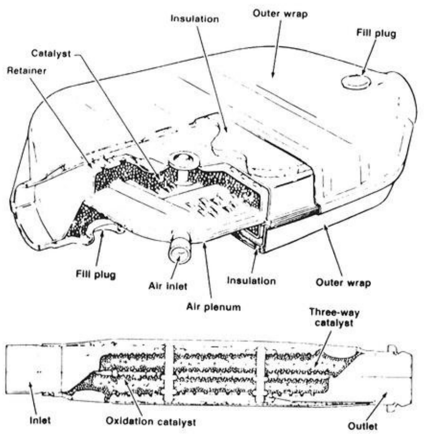


Figure 2. Three-way catalytic converter. *(Courtesy of Chemtech magazine, October 1980.*

way catalytic converter which would simultaneously decrease HC, CO, and NO_X (see Fig. 2). However, the new catalyst was effective for all three polluntants only when the air/fuel mixture was very near the stoichiometric (chemically correct) air/fuel ratio. At the time of the catalyst's discovery, no fuel delivery system was able to control the mixture precisely enough for successful use of the converter.

As in the earlier cases, the right combination of sensors and electronic controls provided the solution. The aircraft industry had developed a zirconium dioxide sensor which acted as an oxygen switch (see Fig. 3). When placed in a car's exhaust system with one side vented to the atmosphere, the sensor produces a voltage of nearly 900 m V when the air/fuel mixture is richer (more fuel vs. air) than stoichiometric. When the mixture is leaner than optimum, voltage falls sharply. The sensor's signal is evaluated by a microprocessor, which in turn controls the vacuum produced by a vacuum modulator. The vacuum modulator applies vacuum to feedback controls in the carburetor which control the air-fuel ratio by adjusting the idle air bleed and a rod in the main fuel jet (Fig. 4).

The above explanation gives only the basic elements of the system. A number of problems arose in the development stage. For example, there is time delay between the exhaust sensor output and the air/fuel mixture produced by the carburetor at low engine speeds. Thus, the sensor cannot immediately detect changes in the air/fuel mixture as it moves through the engine to the exhaust. The solution is a change in the sensor signal (proportional control)

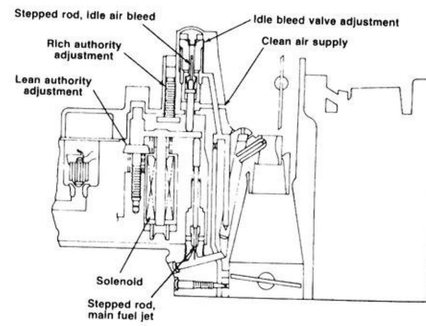


Figure 4. Carburetor with electromechanical controls used with computer-controlled engines. *(Courtesy of Chemtech magazine, October 1980.)*

which accounts for the time lag.

In addition, closed-loop fuel mixture control based on signals from the exhaust sensor is suspended at certain times. The system is then said to be under open-loop control. This occurs when the engine is cold and the exhaust sensor does not provide a signal. Open-loop control is also used when the throttle is open fully in order to provide top performance.

The microprocessor monitors more than simply the air/fuel mixture. A variety of sensors send signals representing engine speed, coolant temperature, and throttle position, among others. With this information, the computer can keep idle speed constant even under the sudden load of a power steering pump, and thus, low idle

continued on page 27

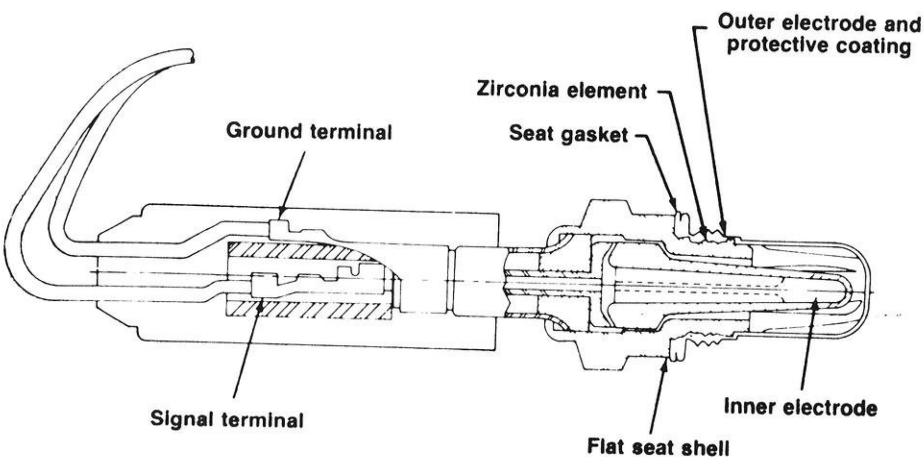


Figure 3. Exhaust gas sensor. *(Courtesy of Chemtech magazine, October 1980)*

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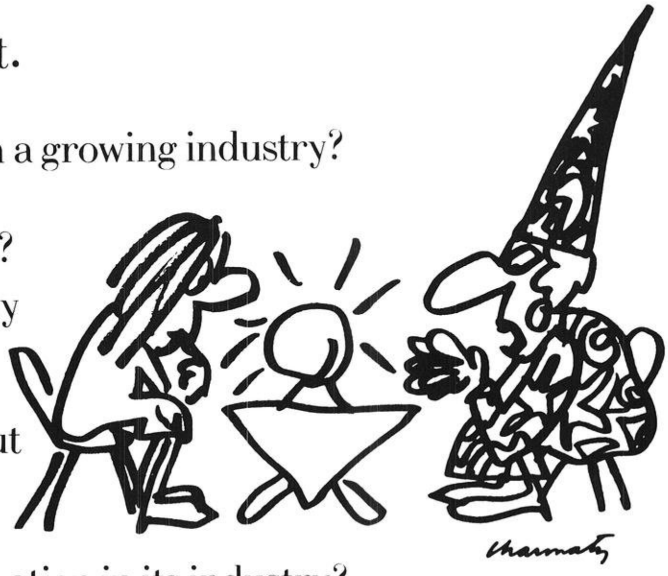

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Computers: Rx for the Mental Health Field

by Bonnie Buhrow

Bonnie Buhrow is a senior in Industrial Engineering and has a B.A. degree in English. She hopes to combine her interests in writing and engineering by becoming a technical writer.

Storage and retrieval of vast amounts of information, rising costs, inadequate staffing - can computerization help solve these and the many other problems which plague modern psychiatric medicine? Here at the University of Wisconsin, researchers are attempting to answer that question by exploring computer diagnosis, treatment, and prevention of mental health problems.

Computer Interviews & Diagnosis

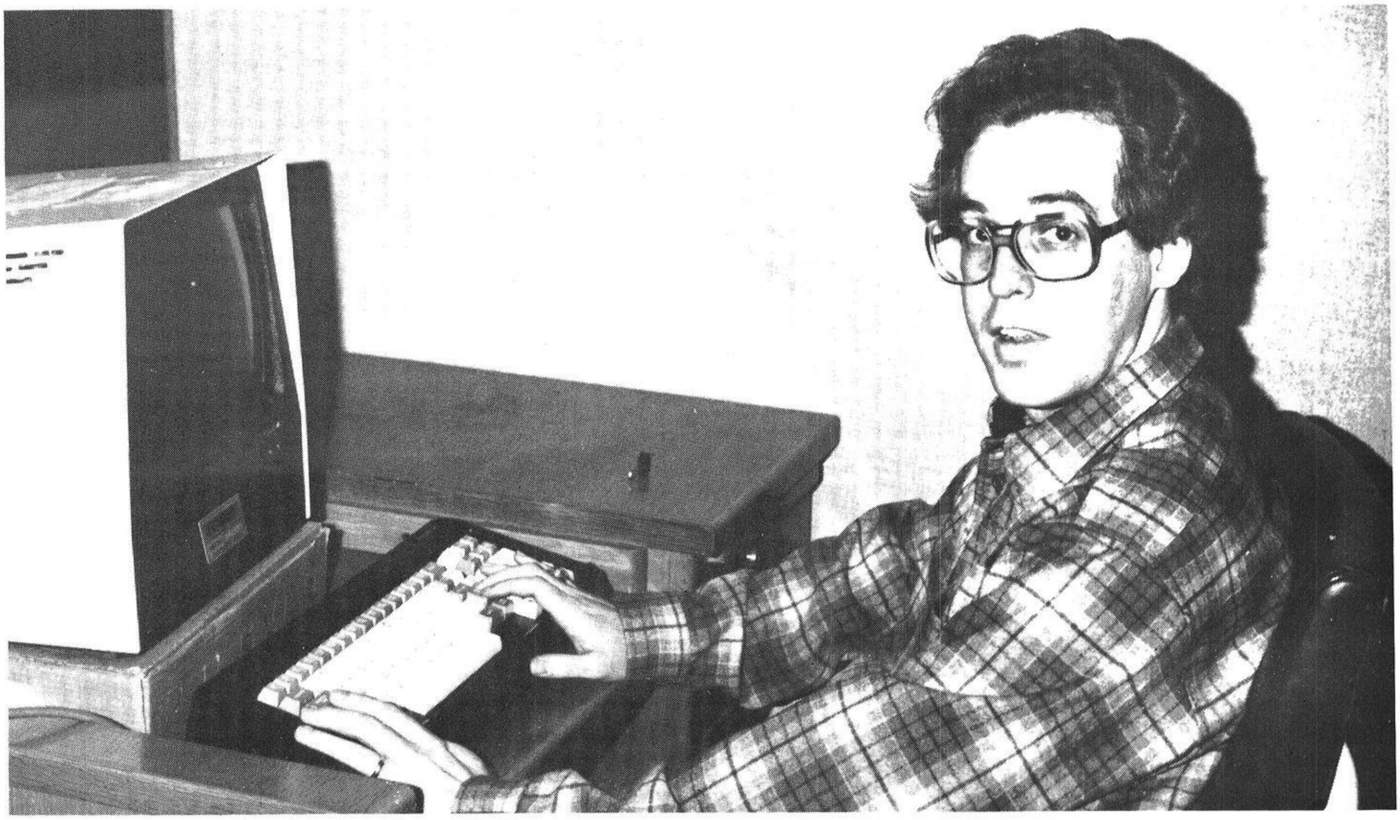
In a pilot study undertaken at the University of Wisconsin Hospital, computers are interviewing patients and diagnosing their psychiatrict problems. The program uses the CONVERSE Interview Driver System; the language is MIIS, a dialect of MUMPS. Computer interviews are made possible by the system's use of branching logic - the questions asked determine which particular decision tree will be followed to a diagnostic mode and, at the point where a necessary criterion is not met, that diagnostic direction is no longer pursued.

The computer program begins with a teaching section on simple terminal operation. Then the patient is asked a series of multiple choice and short answer questions about sleeping habits, drug and alcohol use, fears and other problems. If a patient answers "yes" to a question such as "Have you ever had trouble getting to sleep, staying asleep, or waking up early," the program elicits further information about the problem, when it occurred, its severity and duration. The computer then analyzes the information gathered and makes a diagnosis available to the clinician.

Dr. John Greist, of the Department of Psychiatry, believes that there are many benefits in computer interviewing. Computer interviewing is as accurate as that done by clinicians and is more reliable. The procedure is also very cost effective: the cost of a compu-

Photo by Matt Ledvina

University Hospitals, where computer interviewing and diagnosis of psychiatric patients is being studied.



Steven Sorrell, at work on his compliance studies.

ter interview is 1/90 of the cost of an interview conducted by a psychiatrist.

According to Dr. Greist, the computer technique might not work for all patients; for example, a manic patient might lack the concentration which the computer interview demands. But he does estimate that computer interviewing can be used in up to 75% of all cases.

Compliance

Steven Sorrell, of the Illinois Institute of Technology, is working with the Department of Psychiatry to determine the effect of computers on patients compliance with physicians' treatment instructions.

About 5-10% of the population suffers from a depressive disorder in any given year. Tricylic antidepressant drugs can effectively treat depression, yet 30%-50% of all outpatients fail to take these medications in the way prescribed.

This compliance rate may be low for several reasons:

1. Patients are uncertain of the correct way to take their medication.
2. Patients have negative attitudes towards the drugs - for example, they may fear addiction.
3. Patients may experience initial side effects which cause them to discontinue using the drug.

In Mr. Sorrell's study, the CONVERSE computer system provides patients with detailed instructions for taking medication, and answers questions about potential problems. Dispensing this information by computer should cost-effectively increase compliance rates, and so improve treatment effectiveness.

Computer Therapy

Paulette Selmi, also of the Illinois Institute of Technology, is working here at the University of Wisconsin to develop a computer-delivered cognitive-behavior therapy program for depressed patients. This type of therapy is based on the theory that depression can be caused by a patient's distorted cognitions. An example of a distorted thought pattern might be: 1, the patient greets a friend on the street, and the friend doesn't respond, 2. the patient assumes that the friend heard his greeting, but is snubbing him, 3. the patient overgeneralizes to conclude that all his friends dislike hime. Cognitive-behavior therapy teaches the patient to recognize these misinterpretations of events, and to replace them with more rational responses. Because of its educational approach, this type of therapy can be rather easily computerized. Ms. Selmi is using the CONVERSE system to present the patient with "case vignettes" and homework assignments which help the patient learn alternative, and less destructive ways of thinking.

Because the computer treatment developed here does not use artificial intelligence techniques, a therapist must integrate information received by the computer to deal with specific problems. However, computer-delivered therapy is beneficial in several ways:

1. Because the therapy can be standardized, its validity can be more easily tested.
2. Computer therapy costs much less than human treatment.
3. The computer can work odd hours and does not become tired, so therapy becomes much more accessible to those who need it.

Suicide Prediction and Prevention

Of the approximately 30,000 people who commit suicide yearly, three fourths confess their suicidal thoughts to a mental health worker. In order to prevent suicides, clinicians obviously need to improve their ability to distinguish between people who are seriously suicidal and those who are not so seriously "crying for help". David Gustafson, of the Department of Industrial Engineering and Preventive Medicine, has been developing a computer system which can help mental health workers more accurately predict suicide attempts by depressed patients.

In the first stage of the system's development, eight therapists were asked to estimate the likelihood that patients who would attempt suicide in the next three months would possess certain characteristics or display certain symptoms: out of 100 such patients, how many would be divorced? would be unemployed? would have made statements indicating hopelessness? These subjective probabilities were then stored in the computer.

In the next stage, patients who had expressed suicidal tendencies were interviewed at a terminal connected to a PDP-15 with MUMPS operating system. Their responses to both open-ended and multiple choice questions provided the computer with data on a variety of symptoms. Using Bayes theorem to process the data, the information about the patient was combined with stored prior probabilities to yield a posterior probability of the patients' attempting suicide.

Preliminary studies comparing clinicians and the computer system have supported the computer's increased accuracy. Clinicians are very accurate in predicting non-attempters among the depressed patients (94%), but their accuracy in pin-pointing those patients who will actually make a suicide attempt in the next few months is much lower (37-38%). The computer equals the clinicians' accuracy in correctly assessing non-attempters, while greatly exceeding their accuracy in predicting serious attempters (74%).

Using computers in the mental health field gives rise to many ethical questions. Will the confidentiality of patients be protected? How can computer therapies be judged and licensed?

However, the projects undertaken at the University of Wisconsin indicate that computers can improve the quantity, quality, and cost-effectiveness of mental health services. And because the demand for these services can no longer be fulfilled by traditional methods, it would be "unethical" not to take advantage of the benefits computerization would provide to the field of psychiatric medicine. □

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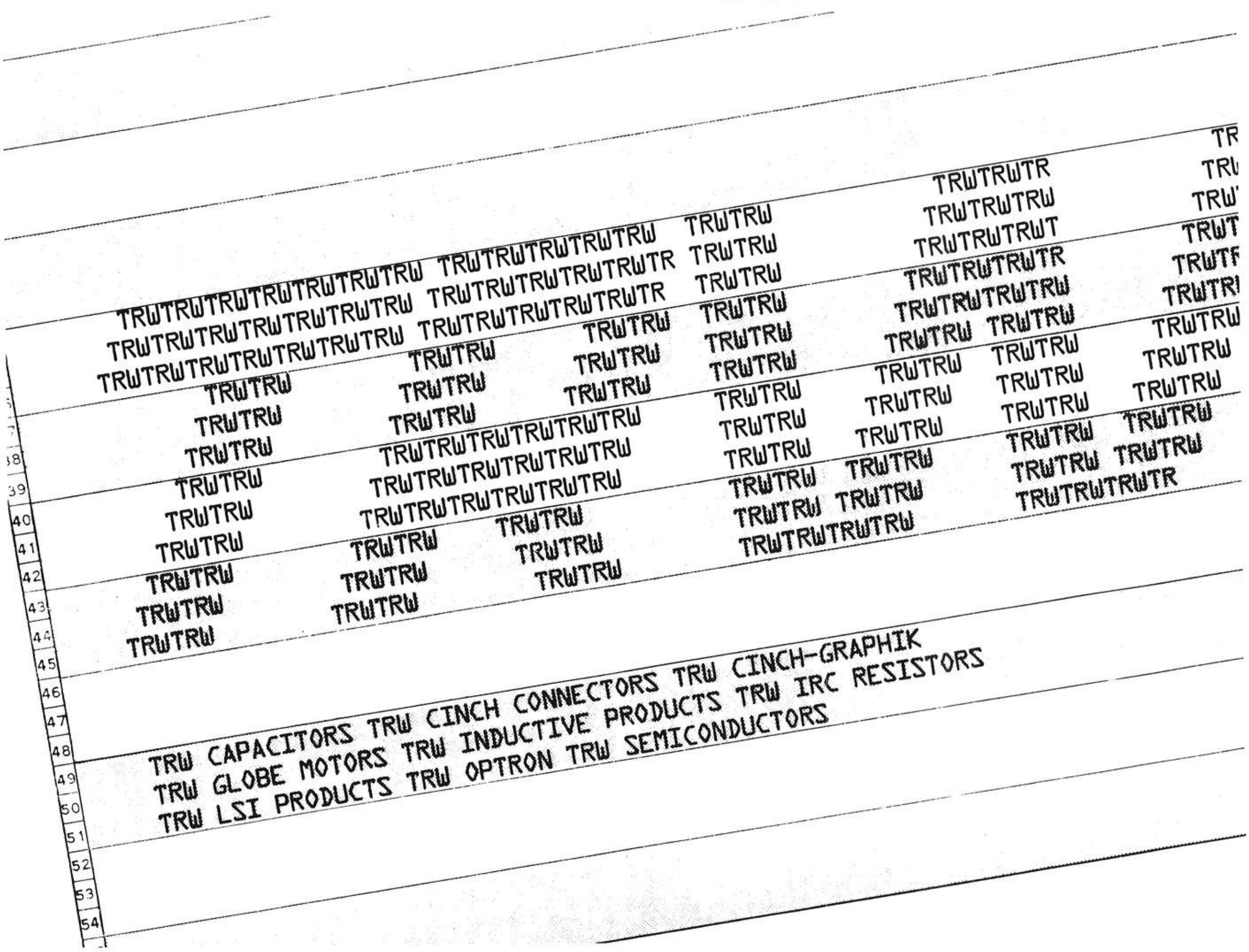


Three Home Computers

by David Fick
and Greg Watchmaker

*David Fick and Greg Watchmaker learned a great deal during their search for suitable home computers last fall, and have compiled the following review of three popular models. Greg is a freshman in the College of Letters and Science. Also freshman in the College of Letters and Science, Dave is a member of the **Badger Herald** staff.*

A decade ago, computers were large, expensive devices understood by a few and found only in large companies and universities. Today, technology has produced powerful computers that are small, understandable, and affordable. As these machines are now made for the home and business, the use must realize the advantages and limitations of popular available systems. They are the Apple II plus, the TRS-80 Model III (Radio Shack), and the IBM Personal Computer. These three systems are intended for the home and small business market. Four important points to consider when comparing these systems are: memory capabilities, accessories, graphics, software, and hardware configurations and their cost.

Memory is a very important part in computers. These machines contain two different types of memory. The first type is RAM, random access memory. As its name implies, RAM can store data or programs. The size is expressed as the number of words it can store. Longer programs can be run and more data stored on systems with larger RAM. Leading the way in this department is IBM which can hold a maximum of 256,000 words, more commonly expressed as 256K. This size memory is substantially larger than most programs require, but it does allow larger data bases to be stored in the computer. On the other hand, Apple has a maximum of 64K while TRS-80 has a maximum memory of only 48K. Though these systems have considerably less memory space than IBM, they are usually found adaquate for the home and small business user. The other principle internal memory is ROM, read only memory. ROM is not available for data or program storage. This memory information is permanently set in the computer when it is manufactured. It stores the Basic interpreter, which enables the computer to understand a program written in basic. IBM again leads the field with the largest ROM. The IBM's ROM allows an extensive instructive Basic set. The Apple and TRS-80 contain only about one-fifth the ROM size of IBM. Clearly, IBM's personal computer leads in memory capability, but a large memory is not always most important for the home and small business applications. Thus other factors are important when comparing these machines.

A computer's capabilities can be expanded by communicating with external accessories. These capabilities include: alternate output forms, graphics interaction, inter-computer communications, and added memory expansion. Expansion usually comes in the form of a disk drive or cassette recorder. All three computers are equipped to store and retrieve data from standard recorders. Recorders are inexpensive; however they have very limited storage.

A user requiring small or home application programs will usually require a disk drive. Disk drives provide faster information access and can store much more data than a recorder. Though all three computers can support disk drives, the Apple can communicate with six drives, the TRS-80 with four and, the IBM with only two.

To effectively communicate with their users, these computers can interface with printers and video display screens. Both the IBM and the Apple can respond with a standard television. The TRS-80, however, can only display on its built-in video screen. This is disadvantageous because a user can never upgrade his system with a better monitor.

Another expansion option is a modem. This allows inter-computer com-

The Radio Shack TRS-80. (Literature photo) munication across telephone lines. Using this allows access to other users and outside information sources. This option is available for all three machines. Other accessories include light screen pens and graphics drawing tablets. All external accessories increase the computer's capabilities.

Graphics capabilities are important for many applications in small business and personal computing. The video screen's resolution is determined by the computer. The computer displays graphics as points across and down the screen. The more points a computer can display on the screen the higher the resolution. IBM and Apple can also display different color dots. The computers differ greatly in graphics performance as shown in the table.

A computer cannot understand a task to perform unless it is instructed exactly what to do. A set of instructions that a computer is to perform is called software. Thus a computer's applicability is limited to the software available. Users of TRS-80 and Apple have a tremendous amount of home and business software to choose from. The IBM, though, since it is a relatively new computer, has limited software support. Language software is available for all three systems. This allows the user to communicate with the computer from languages such as Pascal, Cobol, Fortran and Assembler.

IBM, Radio Shack and Apple have all brought the sophistication and capabilities of large expansion computers to the home and small business environment. Users can now purchase a system ranging between $1000 and $4000, depending on the type of configuration and accessories desired. Though the IBM Personal Computer, TRS-80 Model III, and the Apple II plus are designed for the same users, they each put emphasis in different areas. As computers continue to develop they will find even greater applications in home and small business. □

The Apple II plus. (Literature photo)

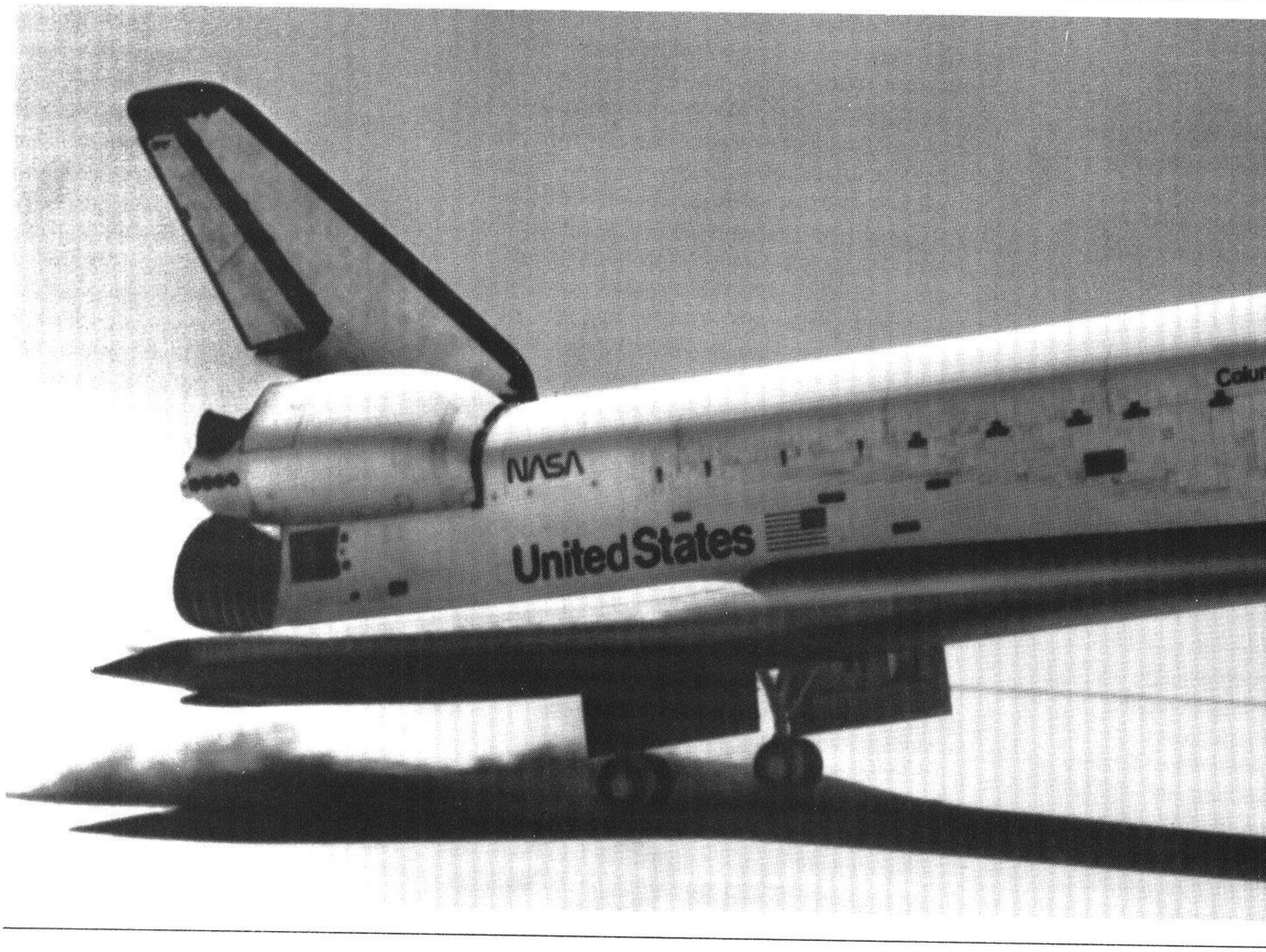
The IBM Personal Computer. (Literature photo)

Computer	Resolution (block/char)	Resolution (low)	Resolution (medium)	Resolution (high)
TRS-80	------	------	48x128 (b/w)	------
Apple	48x40 (15)	192x140 (6)	192x280 (b/w)	------
IBM	25x40 (16) 25x80 (16)	------	200x320 (4)	200x640 (b/w)

The number of colors is shown in parenthesis.

Graphics performance table.

American know-how is alive and well... and creating career opportunities every day at Rockwell International.



George Martin's Domestic Computer

by Bonnie Buhrow

06:45:00
Coffee pot ON.
07:00:00
Bedroom lamp ON.
07:00:00
Voice alarm ON.
"It is seven o'clock, George. Wake up. The temperature is 45 degrees Farenheit. Chance of measurable precipitation is 80%. Better bring your umbrella to work today."

No human hand has touched any switch.

The voice giving the speech is disembodied.

For George Martin, another computerized day is beginning.

George Martin is an assistant professor of forestry at UW-Madison. His initial contacts with computers took place in university courses and on the job. When he became interested in "learning what makes computers tick", he reasoned that the best way of doing just that would be to buy his own. His home microcomputer, a Cromenco Z-2, has a random access memory capacity of 48 kilobytes; however, the use of floppy discs for permanent storage makes its memory capacity almost infinite. In fact, the computer's capabilities are limited only by its user's imagination, and George Martin has been using his computer in some pretty imaginative ways.

For example, his computer can presently turn any appliance or light in the house on or off according to a preprogrammed schedule. The appliance is plugged into an appliance or lamp module which is set to a specific channel. This module can then be plugged into any standard outlet. When the arranged time arrives to turn anything - a radio, a T.V., a coffee pot, a light - on or off, an FM signal is sent through the electrical wiring of the house and the computer's mission is accomplished.

George has written many such appliance schedules: a "wake-up" schedule, which has the coffee perking before he gets out of bed; a "bedtime" schedule, which turns off the T.V. and the lights; even a schedule for giving his daughter her 2:00 a.m. feeding.

George is also planning on using his computer to provide personalized weather reports. By connecting instruments like a barometer, wind gauge, or thermometer to the antenna on his roof, weather data can be fed into the analog interface within the computer. The computer then translates this data into numbers: air pressure, wind velocity, temperature, and could possibly even make some short range forecasts.

The most interesting capability of George's computer is its ability to talk. Computer speech synthesis is a complex process using an electronic model of the human vocal apparatus to imitate the sounds of speech. Human speech can be divided into nine basic aspects: amplitude, pitch, three formanent frequencies (which mainly produce vowel sounds), aspiration (which produces the sound of the letter "H"), amplitude and frequency of frication (which produces the "F" and "S" sounds), and nasality. By continuously manipulating the levels of these nine variables, the computer can be made to "talk". Because these nine aspects are common to all human languages, George's computer is multilingual.

George demonstrated the computer's linguistic capabilities by typing a sentence on its terminal. The program first translates the words phonetically,

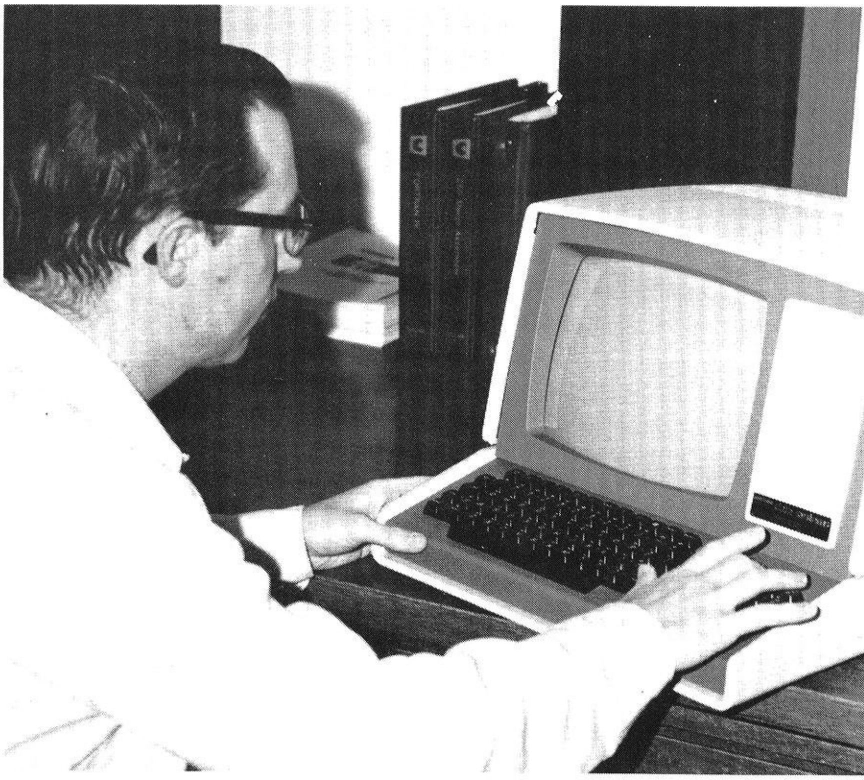


Photo by Matt Ledvina

George Martin at his computer terminal.

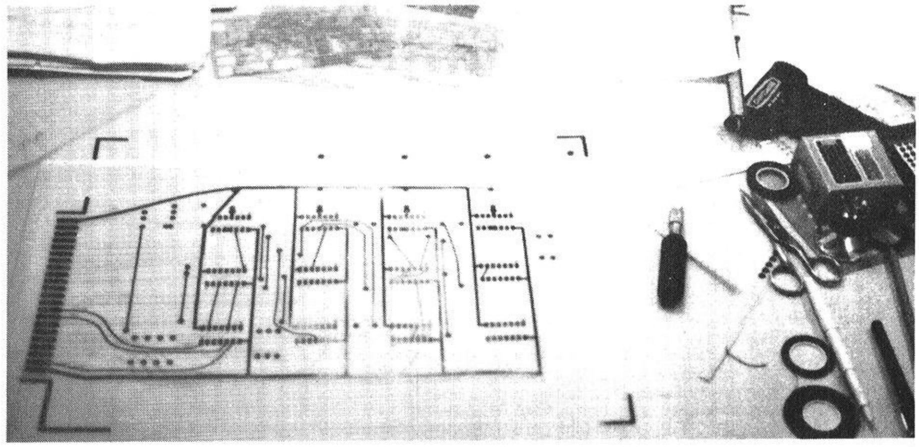
then imitates the sound which each phoneme symbolizes by manipulating strings of the nine speech variables. Word accents and sentence intonation are also built into the program.

The computer's speech approximates human speech surprisingly well, but it isn't perfect. At times, it sounds as though it has a slight speech impediment. It also slurs some sentences, almost as though it has had too much to drink.

Actually, what a computer needs to improve its speech is exactly what a child needs when it is first learning to talk - a lot of feedback on the correctness of the sounds it is making. This feedback could be greatly facilitated by introducing to the computer a "voice recognition" capability - the ability to "understand" what is spoken into an attached microphone just as it recognizes what is typed on a terminal. This capability would make correcting a computer mispronunciation much quicker and easier. When George's computer begins to "hear" George's voice (within the next year or two), it promises to become a very eloquent machine.

George's computer is not just a workhorse. It plays a mean game of chess (George has only beaten it once). And it has great musical capabilities.

Using no special hardware, George has programmed the computer to make

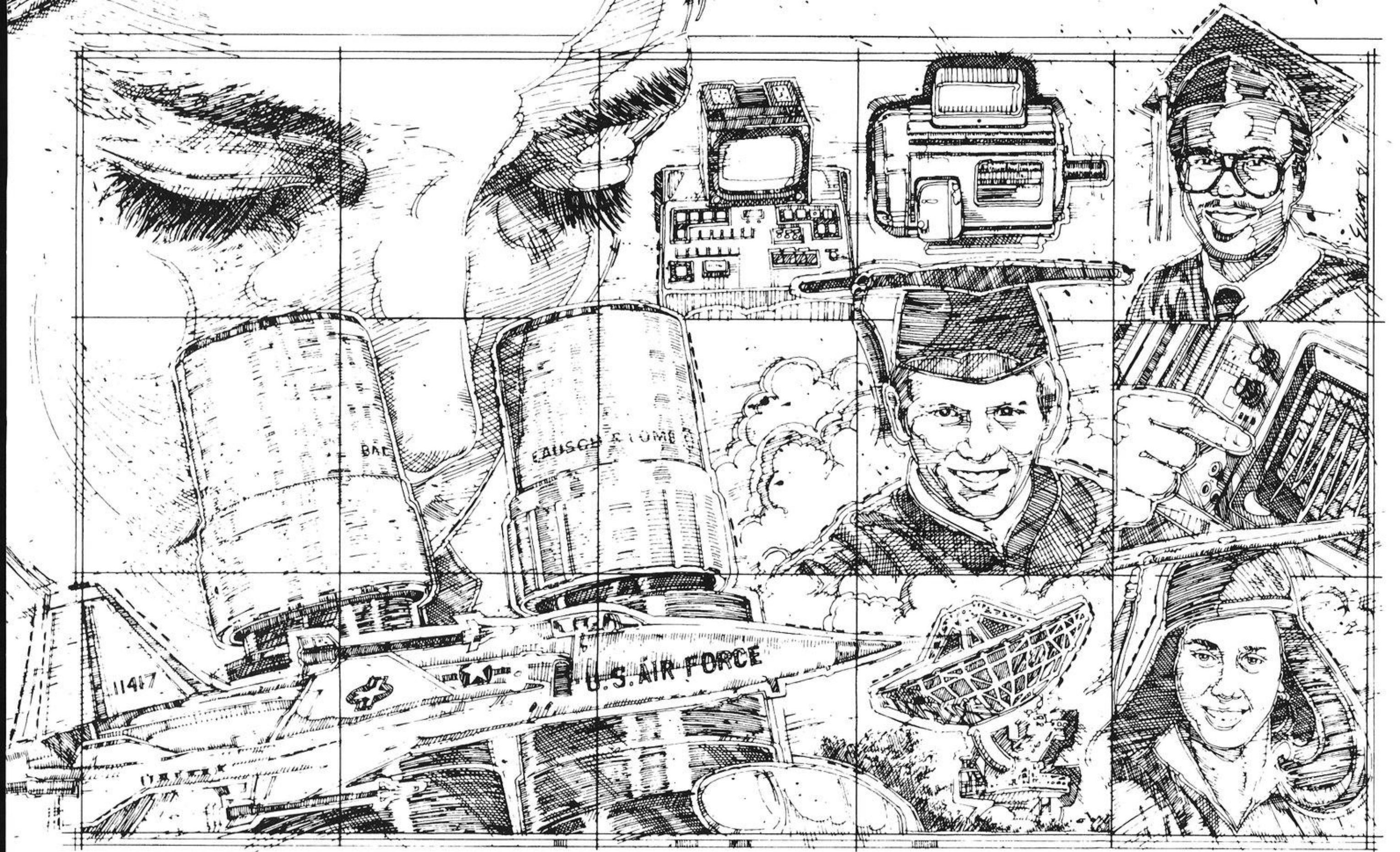


RMJ Photo

Home computers will give hobbiests the chance to create their own circuit board designs. *Courtesy of Mike Jensen, Reactor Lab.*

music directly from its central processing unit. The computer generates various frequencies to reproduce the notes in a musical composition. The program also tells the computer the duration of each individual tone, and the tempo of the entire musical piece. The computer is a talented musician. It has a three octave range, can play two-part harmony, and has an unlimited repertoire. The music it makes can not be produced by any single contemporary instrument. If you can imagine "Row, Row, Row Your Boat" being played by minstrels on medieval wind instruments, you'll have some idea of how this computer's music sounds.

Both the present and future capabilities of George's machine eventually bring to mind ominous Hollywood visions of the computer running his household and taking it over, as HAL did to the spaceship in the movie *2001: A Space Odyssey*. George swears that his computer is totally benign. It has stimulated his interest in such diverse subjects as linguistics, weather prediction, and music; and has provided him with an endlessly creative outlet. "In the movies," he says, "computers always go berserk. But the worst thing this machine can do is steal your time." □



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Logistics			●				●	
Computer Applications	●							●
Finance						●	●	
Planning		●	●				●	
Administration							●	
Quality Assurance	●	●						
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The Era of Mechanical Computation

by Don Leick

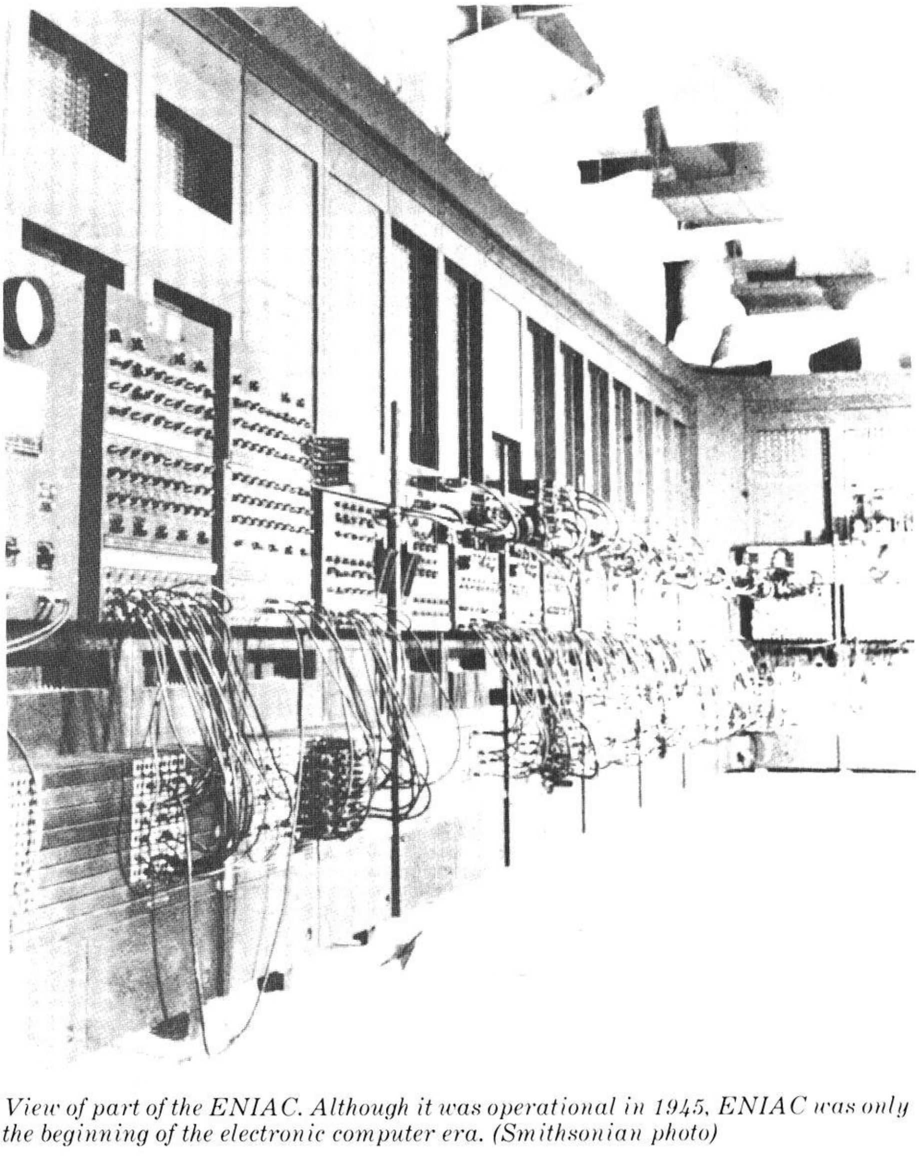
Don Leick received a B.S. degree in Industrial Engineering last December, slipping this last article under our door en route to the commencement ceremonies. Don's sense of history and talent for writing will be missed by the ***Wisconsin Engineer.***

I believe most engineering students are vaguely aware that the first electronic computer was developed around the time of World War II. Most students are also aware that this computer used vacuum tubes, since transistors had not yet been invented. The trivia buffs might even recall that it was mercifully known as ENIAC (Electronic Numerical Integrator and Calculator). However, it is little known that although ENIAC was the first **electronic** computer, it was not the first computer.

ENIAC was not the beginning of the development of the computer; it was only the beginning of the electronic era. The development of the computer can be broken down into two stages: electronic and pre-electronic (mechanical). The electronic stage is what is most familiar to us. This is understandable, since the computer became important during this stage. After ENIAC, computer technology advanced rapidly. The creators of ENIAC, J.W. Mauchly and J. Presper Eckert, were working on new and better versions of the computer before it was even completed.

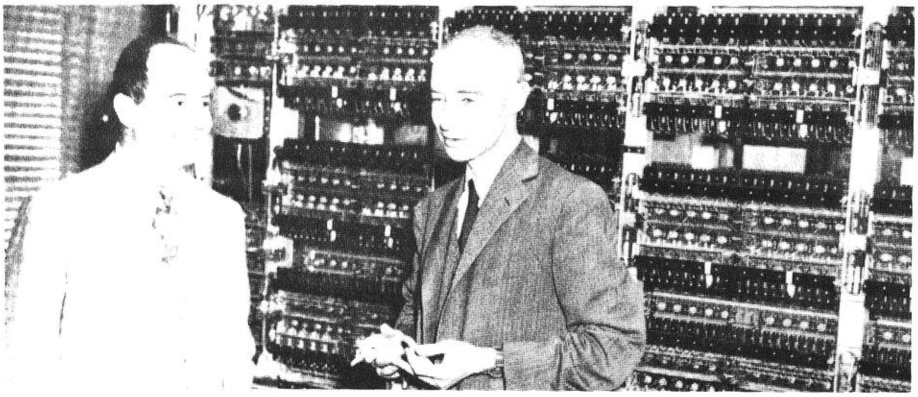
In labs all over the country, computers based on their design were soon being constructed. In the next thirty-five years we experienced a deluge of inventions and innovations. Binary logic, transistors, and magnetic core memories were introduced. Programming languages made programming easier, and time-sharing systems made computing time more accessible. Integrated circuits and the microchip made computing cheaper, faster, and more powerful.

Although the computer became important in the electronic stage, many important developments occurred during the mechanical stage of computing. Many of the basic concepts of modern computers were developed during this stage. One machine was even constructed which was truly a computer in the modern sense of the word, but whose workings were mostly mechanical. This was the culmination of the mechanical stage. Its beginnings



View of part of the ENIAC. Although it was operational in 1945, ENIAC was only the beginning of the electronic computer era. (Smithsonian photo) were much humbler. If one ignores the abacus and digital computing (counting on your fingers), then the era of mechanical computing began in 1643.

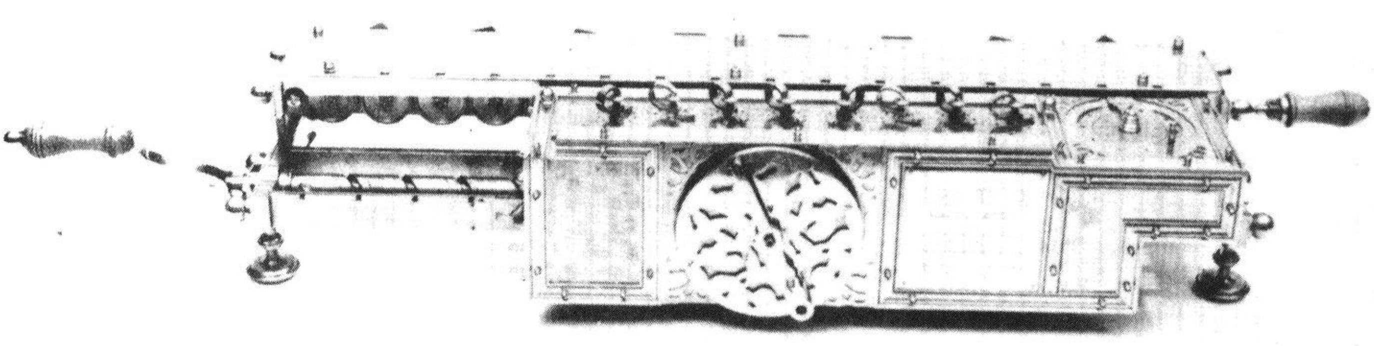
In 1643 the Frenchman Blaise Pascal built the first successful mechanical calculator. The precocious Pascal, scientist, mathematician, and theologian, completed his "calculating engine" when he was only twenty. He



"In 1643 the Frenchman Blaise Pascal built the first successful mechanical calculator...dubbed the 'pascaline' (pictured above). Of course this was a calculator, not a computer, but here lies the origin of the computer." (IBM photo)

dubbed it the "pascaline." Of course this was a calculator, not a computer, but here lies the origin of the computer.

The pascaline was about the size and shape of two cigar boxes laid end-to-end. On its top surface it had a row of six disks, each disk bearing the numbers one to nine on its circumference. Each disk was geared to another num-



With Leibniz's calculating machine, the user could multiply (calculated by repeated addition) and literally "crank" out solutions by turning the arm on the left. (IBM photo)

bered disk which acted as a counter. At any time, just one digit of the counter disk would be visible through a window. From right to left, the first disk represented ones, the second tens, the third hundreds, and so on. With the six disks, one could go up to 999,999. The disks were spring-loaded, and numbers were entered in a manner similar to dialing numbers on the telephone. For example, to enter the number 30, a stylus would be inserted into a small hole at the number 3 on the tens disk. The disk would be turned clock-wise three-tenths of a turn, a bar preventing the stylus from going any further.

Of course, the machine had to be able to "carry" digits from one counter to the next. Pascal accomplished this through a clever ratchet arrangement. A ratchet arm attached to each counter disk would gradually rise as the counter went from 0 to 9. When the counter passed nine, the ratchet arm dropped, turning the counter disk to the left one-tenth of a turn.

The machine could perform the four basic arithmetic functions: addition, subtraction, multiplication, and division. Multiplication could be performed through repeated addition. To multiply 327 by 54, 327 would be entered 4 times on the ones disk and 5 times on the tens disk. Subtraction and division were essentially accomplished through reversing the addition and multiplication processes.

The pascaline astounded the scientists and mechanics of the time. Pascal attempted to market his device, but cost, repair difficulties, and the fear that too many bookkeepers would be left without a livelihood kept it from being a success.

In 1694, Leibniz constructed a workable calculating machine. (This was "stepped wheels." The stepped wheel who developed calculus, concurrent with, and independent of, Sir Isaac Newton.) Like Pascal, Leibniz had desired to build a machine to obtain relief from burdensome calculations, which he deemed to be unproductive use of a creative, scientific mind.

Leibniz studied Pascal's design and replaced the numbered disks with "stepped wheels". The stepped wheel was a cylinder which had nine ribs (gear teeth of various lengths). The ribs could engage with a nine-toothed second gear, thus turning cogs and a numbered dial. The second gear could be shifted along the axis of the stepped wheel, so as to engage with one rib, all nine ribs, or any number in between. Turning the cylinder one revolution could result in any number from one to nine being entered, depending upon the position of the second gear. Of course, Leibniz's calculating engine consisted of many such stepped wheels in series of parallel. The stepped wheels were set on shafts, all turned by a hand crank which allowed one to literally "crank out" solutions.

Leibniz's calculator worked, but was not commercially practical. It is significant in that it introduced mechanical ideas utilized by later practical machines.

Others built upon the designs of Pascal and Leibnitz, introducing innovations of their own. Yet these were still just calculators; they had no memory and could not perform logic operations.

Charles Babbage, an English mathematician born in 1791, devoted his life to the designing of calculating machines. Babbage was frustrated by the tedium of producing mathematical tables. Even with the greatest care, errors were inevitable. In Babbage's day, mathematical tables were essential in surveying, astronomy, architecture, navigations, and many other areas. Governments, at great expense, commissioned the compiling of tables of astronomical positions, logarithms, square roots, interest, and so on. Babbage felt that mechanization of calculation was the solution. The human being, that error-inducing agent, had to be eliminated.

Babbage devised a machine which could compile mathematical tables whose terms could be represented as polynomial series. He called his machine the difference engine, since it employed the method of differences in making calculations.

Babbage made detailed plans for larger difference engines with greater capabilities, but dropped them in favor of an even grander vision. He saw that he might be able to make a machine which could do more than just calculate tables, one which would actually do general problem solving. Because he felt that such a machine would redirect the whole course of mathematical analysis, Babbage called his new machine the analytical engine.

The analytical engine foreshadowed the essential concepts of a modern computer. It had an arithmetic unit for performing calculations, a memory unit for storing intermediate results and instructions, and input and output devices.

The input devices of the analytical engine were particularly interesting. Babbage borrowed an idea that had been applied to weaving looms. In order to weave intricate patterns, punched press-board cards were used as "programs".

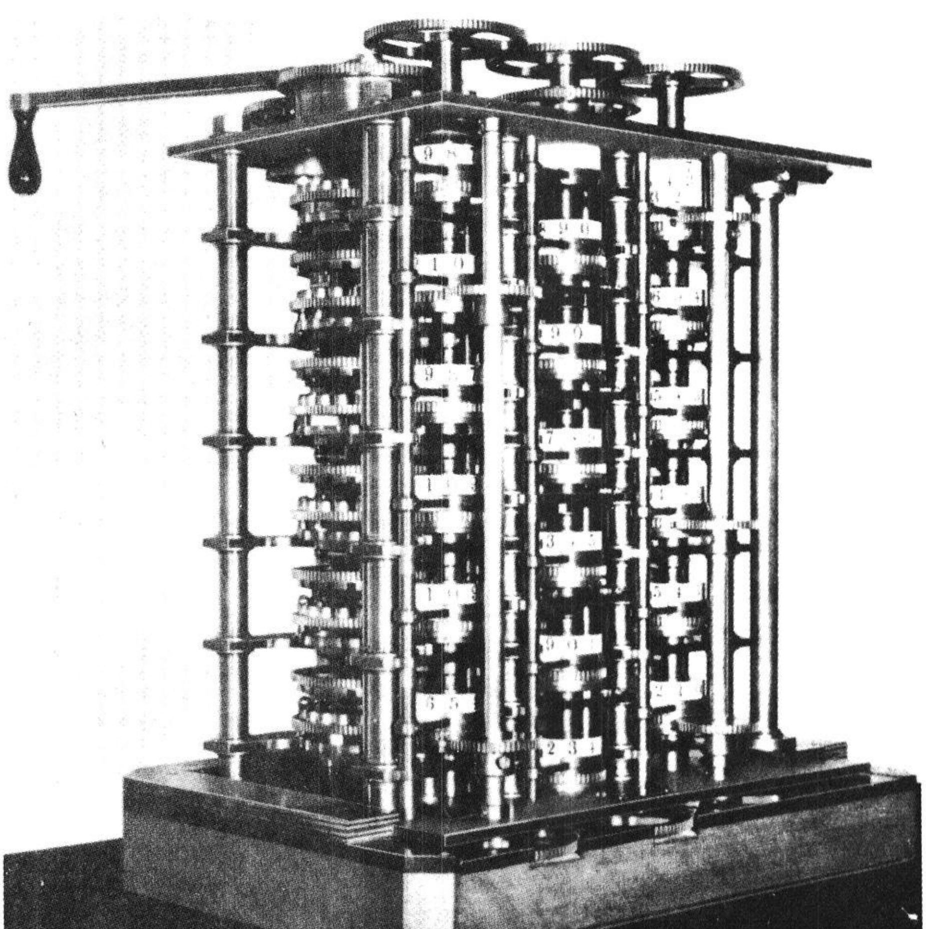
Though Babbage made detailed drawings and explanations for both his difference and analytical engines, nothing was built. Babbage's designs were just infeasible for his day; he was ahead of his time. His designs demanded tolerances never before attempted. His analytical engine would have required several tons of intricate clockwork. Even with a large inheritance from his father and support from the English government, he was never able to put together enough money to see his designs beyond the blueprint stage. Babbage died an embittered man.

Babbage's work was well known and generally well received. A colleague inspired by Babbage, L.F. Menabrea, wrote: "Who can foresee the consequences of such an invention? In truth, how many precious observations remain practically barren for the progress of the sciences, because there are not powers sufficient for computing the results! The idea of constructing an apparatus capable of aiding human weakness in such researches is a conception which, being realized, would mark a glorious epoch in the history of the sciences."

Several developments were necessary before the "glorious epoch" began 75 years later with ENIAC. The work of an American named Herman Hollerith was of great importance. Hollerith was an engineer involved in developing census statistics for the federal government. The 1880 census had taken eight years to complete, and it was predicted that the 1890 census would take more than ten. Hollerith received the inspriation for a solution from the same punched card looms that Charles Babbage had studied.

On dollar bill sized cards, Hollerith punched holes in predetermined positions indicating sex, age, race, and other census information. The card was then set in a holder. A matrix of electrified wires was passed over the card. Where a hole was encountered, a wire would go through making contact with the mercury in a cup below. The resulting electrical signal would actuate a counter. With Hollerith's punched card tabulator, the 1890 census was completed in two years. This was the prelude to automated data processing.

At about this time, technology began to advance more rapidly. Key-driven adding machines and cash registers became hot items. They provided the start of two well-known computer companies of today: the Burroughs Corporation and IBM. Now the high quality gears and cams which Babbage needed so badly were being mass-produced. Several scaled-down versions of the difference engine were constructed. They caused quite a stir and found useful applications compiling astronomical tables, actuarial tables, and the like. *continued on page 31*



Charles Babbage's "Difference Engine". (IBM photo)

Computer Aided Design (CAD)

by Eric Loucks
and Mike Hanizeski

Eric Loucks wrote this article after consolidating information from Mike Hanizeski's M.E. 397 paper on CAD-CAM. Eric is a graduate teaching assistant in Civil Engineering, and Mike is a junior in Mechanical Engineering.

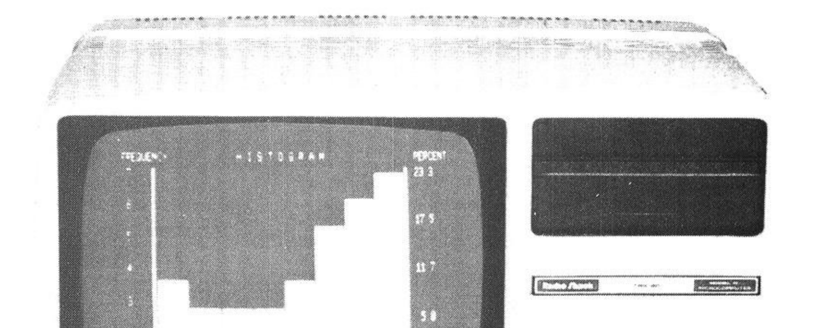
These days, it is not uncommon to tour an engineering firm and observe the draftspeople working at computer keyboards rather than drawing tables. There are a number of ways to input the shape and dimensions of an object into the computer. Mistakes don't require laborous erasing; errant lines are simply zapped from memory. Once a description of the object's shape has been keyed in or 'digitized', it can be displayed on the screen of a graphics terminal as viewed from any direction, in any perspective. Say the inside and outside dimensions of a house were digitized: modern graphics software could take you in the front door, up the stairs, and display an orthogonal view of the back bedroom. Any display on the screen can be printed by a process suitable for engineering plans. These capacities are found in typical automated drafting systems that are available for as little as $30,000.

An automated drafting system is the key component of sophisticated computer aided design (CAD) systems. A CAD processor uses the automated drafting system's visual model to create a digital physical model that can be dynamically analyzed under simulated working conditions. It is possible for a design engineer to investigate the load bearing characteristics of a shape without ever building a prototype.

State-of-the-art CAD systems cost more than half a million dollars. Still, large manufacturers find that they can recover their investment in two years or less in research and development savings. Designers are freed from concern over technical details such as the standard sizing of bolts and other components. Draftspeople can turn out quality drawings twice as fast, and corrections take minutes instead of days. Though CAD does not eliminate laboratory testing of prototypes, the quantity of laboratory analysis is greatly reduced because final designs can be arrived at more expediently.

Within the next few years, it is expected that it will be possible to have direct communication between CAD systems and the manufacturing process with the development of computer aided manufacturing (CAM) software. A CAM computer would be able to use the final design stored by the automated drafting system to indentify the materials to remove from stock and determine the machining procedure. CAM would also allow cutting or drilling to be monitored and controlled from a computer terminal.

The full potential of digitized models has yet to be discovered. Automated drafting has been available for about five years, while CAD and CAM systems are just now emerging onto the market. Development will be slow at first while research and development groups evaluate how CAD or CAM can fulfill their individual needs. Clearly these systems are powerful tools that are likely to gain importance in many branches of engineering. □



"Though CAD does not eliminate laboratory testing of prototypes, the quantity of laboratory analysis is greatly reduced." (Literature photo)

(cont. from page 8)

speeds can be used for fuel efficiency. Electronic systems are also used on some cars to control the mechanical lock-up points on automatic transmissions, also in the interest of fuel efficiency.

Another interesting application was introduced on 1981 Cadillacs equipped with the variable-displacement V8-6-4 engine. The V8-6-4 name was derived from the computer's ability to disable the valve systems of two or four cylinders, effectively transforming the V-8 into a V-6 or V-4 under light engine loads. Tests of the engine indicate that the displacement change was hardly noticeable, and fuel economy rose when the car was driven conservatively. However, the engine has since been replaced by a new 4.2 liter V-8.

Cadillac also uses microcomputer technology in a drive information system it introduced on 1978 Sevilles as the "Tripmaster". The system consists of a digital display showing instantaneous and average fuel economy, estimated arrival time, engine speed, coolant temperature, and a variety of other information. Lincoln and Chrysler later introduced similar systems on luxury models. In addition, certain Lincolns and Fords have computer-controlled door locks activated by a code panel on the door. The computerized information systems can be bought on the automotive aftermarket for use in gasoline-powered cars.

Some familar engine components are being made obsolete by the power of automotive engine computers. One example is the carburetor, which is about to be replaced in many applications by throttle-body injection (TBI). TBI consists of a fuel injection which sprays fuel under electronic control into a throttle body atop the intake manifold. The TBI unit is simpler, lighter, and more precise than a comparable carburetor and offers a number of advantages. Pontiac installs TBI on 1982 2.5 liter engines and has realized economy gains of 4 to 6 mpg, a cleaner exhaust, a 7 percent horsepower increase, and improved drivability over the 1981 powerplants. Other manufacturers have installed their own versions of TBI on luxury models and interest in the system is growing.

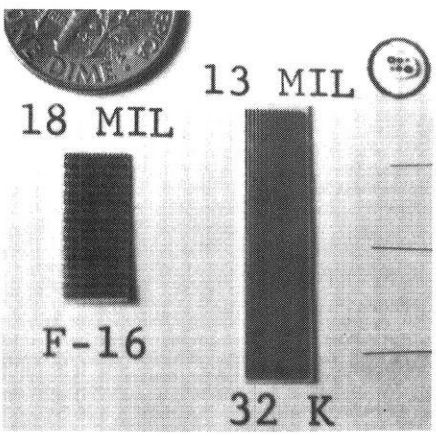
Some industry officials suggest that the computerization of the engine will not stop at the carburetor. The ignition distributor may be replaced by a computer since it could easily perform the distributor's ignition firing and timing duties. Even the accelerator pedal may lose its direct authority over throttle position: the pedal could be connected to a computer through an appropriate interface, and the computer would change the throttle position within the limits of low emissions and good fuel economy.

Detroit's switch to computer-controlled systems has not been without problems and setbacks. With the new technology come additional materials and development costs the consumer must accept in the form of higher car prices. Furthermore, service technicians need company training and special diagnostic equipment to diagnose ailing computer systems. Many private service stations and do-it-yourselfers have neither the training nor the equipment for the task, thus narrowing the consumer's choice for service. In any case, new computer applications will decline considerably if sensor/transducer technology is not developed quickly, since a computer is usually useless without sensory data.

Despite these problems, there are predictions that electronics will be used in automotive applications more sophisticated than those used today. Radar braking has been proposed as a safety feature which could "see" obstacles and apply the brakes automatically to avoid them. However, systems like radar braking will not be developed in the near future, at least not on a large scale. There are formidable technical barriers to their development, and auto industry officials are not anxious to add more costly features to cars because consumer price resistance is already high.

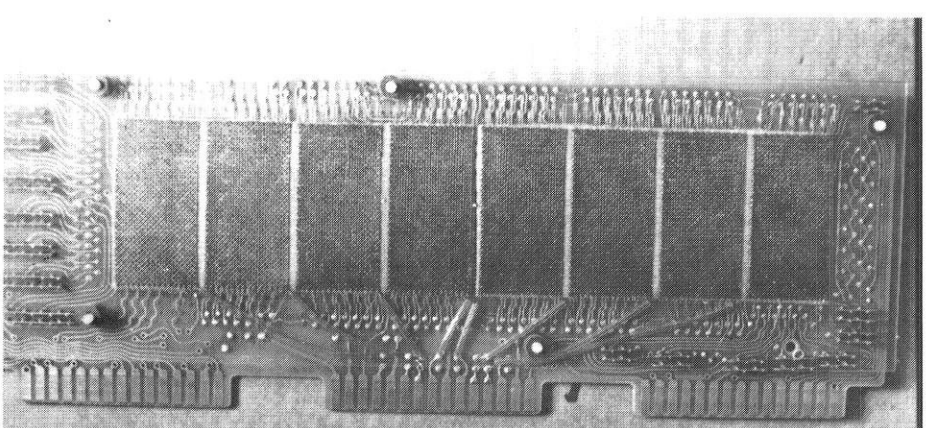
Today's automobile owner may never want to drive a totally computer-controlled car, but he or she should realize that computerization, although not inexpensive, has had many positive effects. It has made automotive design and research more effective and less expensive. It has made automobile production more efficient and tightened quality control. Computer-controlled engines are more efficient than their predecessors and emit fewer pollutants than thought possible ten years ago.

At the same time, the shift to computer technology will demand more of those in planning to work in industry. As computer-controlled robots are developed, it will become harder for unskilled workers to find employment. Thus, technical and vocational education will become very important. In addition, automakers will be forced to make large investments in computerized equipment if they wish to remain competitive with foreign corporations. □



RMJ Photo

The miniaturization of the chip has greatly facilitated today's automobile computers. Compare the sizes of the 9-inch long 32k memory made in 1968 (below) and the 32k core memory used in 1980 engine computers (above).



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State-of-the-Art Programmables

by Ron Meyer and John Wengler

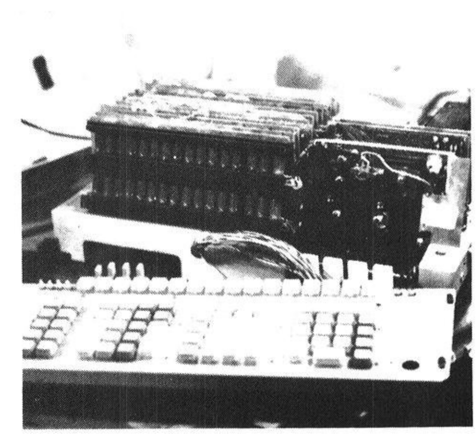
The proud owner of a Casio FX-602P, Ron Meyer believes in the worth of a programmable calculator for the engineering student. John Wengler, of our editorial staff, wrote with Ron this review of programmable models HP-41 and FX-602P.

Ron is a junior in Mechanical Engineering and is a member of Pi Tau Sigma honor fraternity. John is a sophomore in Civil Engineering and the associate editor of the ***Wisconsin Engineer.***

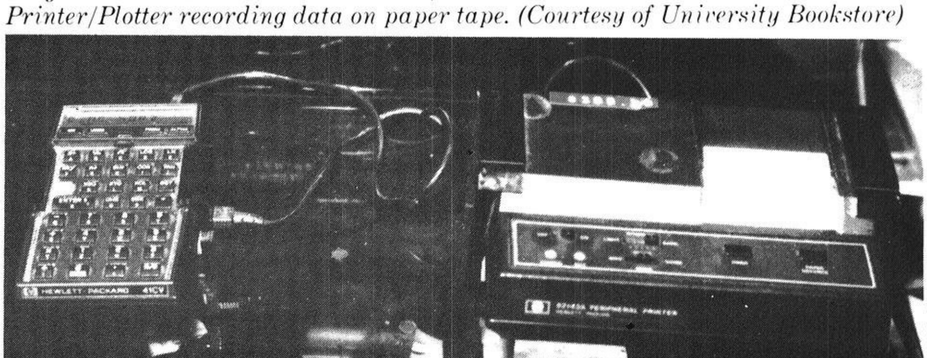
Two state-of-the-art programmables, the Hewlett Packard HP-41C and the Casio FX-602P, are considered the most sophisticated calculators, falling just short of computers. By programming his calculator, the student can solve quadratic and cubic equations, 4x4 determinates, and interpolate by simply entering data points. The Casio FX-602P and HP-41 can also compute definite integrals with programs incorporating Simpson's Rule. The student saves time by writing a program for a equation which must be evaluated many times for different values. Often, in a lab situation, the student is compelled to use trial and error to solve problems. By writing a program and then changing data values, the student may narrow in on an answer with minimal time and effort. In additional to the standard statistical functions, both the FX-602P and the HP-41 can generate random numbers.

A feature that distinguishes the FX-602P and HP-41 from other programmables is their alphanumeric capacity. (A calculator with alphanumerics can display both letters and numbers.) Alphanumerics make the calculator easier to use by showing messages in English that help pin-point operating errors. It is common for equations to use certain letters for a given quantity (e.g., t=time), which are confusing to a student even when he has a book in front of him. The programmer with an alphanumeric calculator can assign unique, distinguishable variable names like "mass" and "friction", and have the calculator display the solution to the equation as a distinguishable answer such as "velocity=20". The user can be prompted by alphanumeric flags: the calculator might display "mass?" after the user has entered his response to "friction?". This is a distinct advantage over regular programmables with which the user must take pains to follow written flow-charts to enter the correct data at the right time.

Yesterday's programmables were capable of storing only a few programs. Although these programmables expedited the user's calculations, he or she often needed to erase important and lengthy programs due to storage limitations. The FX-602P and HP-41 have unique program recording accessories that have limitless storage capacities. By using the special jack and the Magnetic Tape Interface, programs from the Casio FX-602P can be recorded on any tape player, from portable to the finest home deck. The HP-41 records its programs on small magnetic tapes when interfaced with its special card reader. The HP card reader reads programs faster than the Casio sys-



Above left: *The printer for the Casio FX-602P in use; the printer may also be interfaced with other Casio models, as exhibited here using the FX-702P, a hand-held computer. (Courtesy of Richard Cashwell, Reactor Lab Director.)* ***Above right:*** *Any contemporary programmable can match the capabilities of this WANG 720C Programmable Calculator which cost $2000 in 1968.* ***Below:*** *The HP-41C and its Printer/Plotter recording data on paper tape. (Courtesy of University Bookstore)*



RMJ Photos

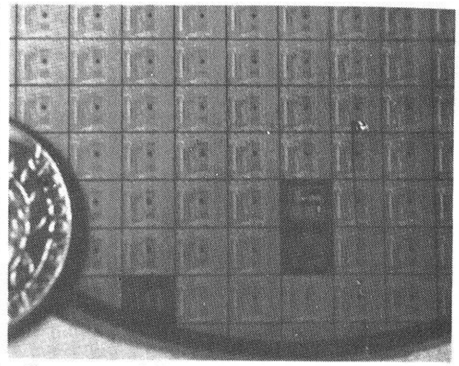
tem, and individual program cards may be exchanged easier with associates than programs on tapes. Both companies sell program books and special appliation, pre-recorded cards or tapes. The owner keeps a program log of his own so he may always find the program to solve his problem.

Accessories available for the FX-602P and HP-41 add greater dimensions as professional investments. Both offer attachable printers on which intermediate values may be printed. Programs may be printed on the Casio so that they may be exchanged with other FX-602P programmers. The HP is actually a printer/plotter capable of printing graphs of data created from its programs. HP offers many other accessories, including a bar-code reading wand, and special application and additional memory modules that may be attached to the HP-41.

Both the Casio FX-602P and HP-41 have functions to entertain the student. Programmable games, such as a numeric "Master Mind", Hidden Gopher game, and Secret Number game, are amusing and challenging to all ages. (The programs have adjustable ability levels.) The Casio also has a special music capability consisting of three octaves in true pitch, while allowing for a full range of sixteenth to whole notes. Lastly, the alphanumerics allow a command over the English language that far excells the old trick of entering "01134" and turning the calculator upside down to read "hello" on its display.

Investing in either of the calculators depends on the purchaser's needs and budget. The FX-602P is considered to be priced within the student budget range, while the more sophisticated HP-41 costs much more. The HP-41 is preferred by professionals; the calculator was chosen to be used on the space shuttle mission. Casio is known for its durability even when carried in backpacks. Many a consumer has been amazed by Casio salesmen hurling demonstration models (often in the process of calculations) against walls demonstrating this famed durability.

Though the student may make it through college with an ordinary scientific calculator, much time can be saved and accuracy ensured through the ownership of today's state-of-the-art programmable. □



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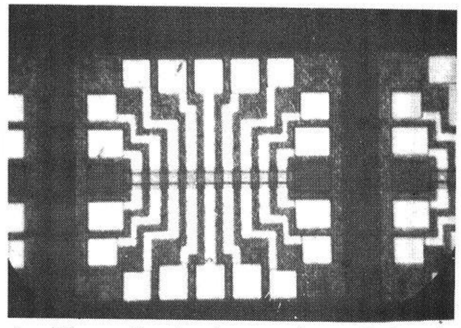
Courtesy of Dean Leidel



Wis. Eng. Photo

A silicon disc is shown above. Below is one chip from the disc magnigied 80 times.

The heart of modern high speed computers and micro-processors is the integrated circuit. Miniaturization by combining complex electronic and logic functions into tiny chips has allowed reduction in physical size and power use, as well as increasing speed due to the shorter distance a given signal must travel. The mass production of chips made the calculator lighter and less expensive in the 1970's.

Near perfect cylindrical silicon crystals, inches in diameter, are synthetically grown under high pressure to eliminate dependence on mother nature for size and purity (a problem faced in early development). The crystals are sliced into very thin discs, then doped (coated) with layers of chemical impurities such as arsenic and boron. These layers are only microns thick and have differing conductivities.

A light sensitive material is spread on the disc, which is then exposed like a photograph, with the circuit design as the negative. The discs are etched to allow contact with the different layers, and then cut into quarter-inch square chips. The chips are **burnt in** by testing at extremes of voltage and current. The unit is then wrapped in plastic, exposing only the contact points which allow the chip to be mounted on a circuit board. □

(cont. from page 23)

The invention of the differential analyzer by Vannevar Bush at MIT was another important development which occured between the two World Wars. The differential analyzer was a gigantic analog computer for solving differential equations. The machine was a huge assembly of gears, cams, and differentials which simulated mechanically the various functions in a differential equation. Finally, the culmination of the mechanical stage of computing development was at hand.

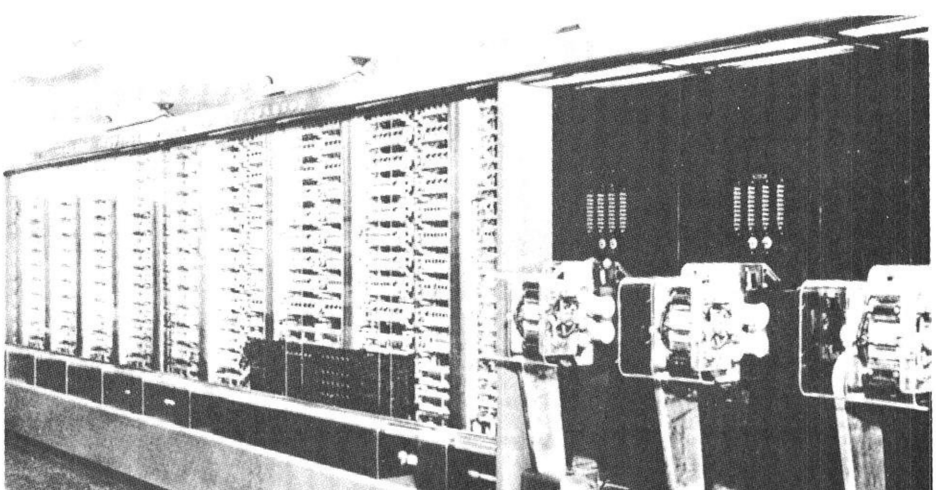
In 1939, IBM, in conjunction with Howard Aiken at Harvard University, began work on a general purpose electromechanical computer. It was completed in 1944. Aiken hailed it "Babbage's dream come true". The computer was called the Automated Sequence Controlled Calculator, more popularly known as Mark 1.

Mark 1 had more than 750,000 parts and 500 miles of wiring. Numbers were represented by the positions of wheels. When a clutch was engaged, each wheel could be rotated by a continuously rotating shaft. The wheels were aligned so as to make electrical connections at appropriate points. Through the electrical connections the clutches of other wheels were actuated. In this manner numerical operations were performed. Input was entered through punched paper tape and cards.

Output was via printer or punched cards. Mark 1 was quite a monster. When in operation, Mark 1's gently clicking relays were said to sound like "a roomful of ladies knitting". Mark 1 was expensive to operate, slow, and prone to breakdown. Still, Mark 1 was in productive operation for fifteen years at Harvard before it was retired in 1959.

Work on ENIAC was just beginning when construction of Mark 1 was near completion. The era of modern electrical computing had begun. □

Herman Hollerith's Census tabulating equipment. (IBM photo)



Mark I. (IBM photo)

Bits & Threads

Columnist Tom Frisbie, of the Chicago Sun-Times, has proposed a solution to the financial problems facing Chicago's Deep Tunnel Project (see Wisconsin Engineer, Dec. 81.) Mr. Frisbie has suggested that the Chicago Metropolitan Sanitary District (MSD) "should offer to allow our nation's armed forces to put MX missiles into the Deep Tunnel subway in exchange for enough money to complete the project." The exchange would benefit both parties. The MSD would have enough money to complete its project and the military establishment would have a suitable home for the MXs. However, a few design changes will be needed. "For one thing," Frisbie discloses, "the MSD missile would have to be redesigned so it could carry an effective warhead and yet be thin enough to be launched from a standard-sized manhole. Also, the Joint Chiefs of Staff would have to allow the Cook County Democrats to aim the weapons at all uncooperative alien powers, such as the Republicans in Springfield."

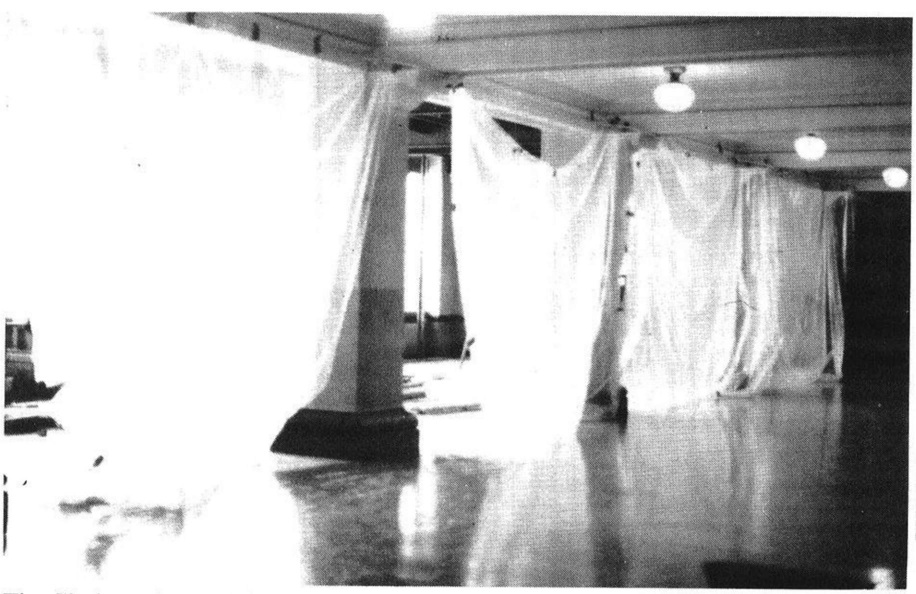
Tasmanians have voted in favor of a controversial hydro-electric plan to dam the Franklin River, destroying an area of outstanding natural beauty.

The referendum issue has split the state's ruling Labour Government, forcing the resignation of the former leader, Mr. Lowe, and putting the Tasmanian Labour Party in conflict with the Federal Party, which opposes flooding the Franklin.

A decision to press ahead with the Franklin scheme would embarrass the Federal Government which recently nominated the southwest of Tasmania, including the area which would be flooded, for the World Heritage list.

Opposition to the plan to flood the Franklin River began in 1976. Sir Edmund Hillary called it "one of the last great wilderness areas in the world", while the British botanist, Dr. David Bellamy, said that to destroy the area would be "an act of international vandalism."

The result showed that 38.4 percent voted for "no dams", 52.5 percent for the Franklin scheme, and 8.9 percent for an alternative scheme. —*The Manchester Guardian.*



RMJ Photo

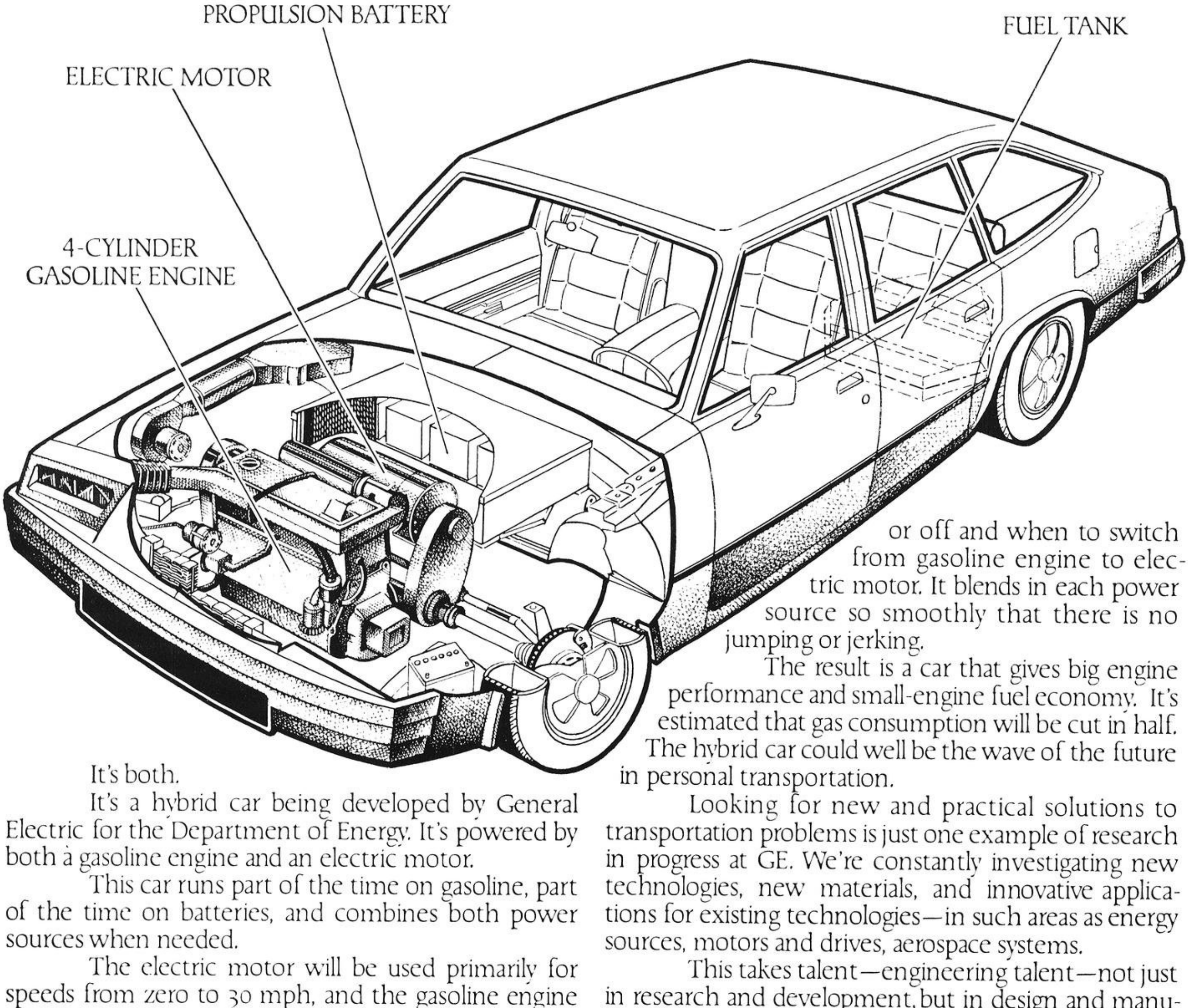
The Christo photo exhibit "Running Fence" at the Madison Civic Center has been extended to veil lobby renovations in the Mechanical Engineering Building.

In the day of rising concern about the dangers of chemical and nuclear waste disposal, researchers have discovered that even "non-hazardous" materials can cause substantial groundwater contamination. When rain water percolates through a garbage landfill, it can dissolve gasses, salts, and oxides and form leachate. At an experimental fill at Penn. State University, a bed of concrete one foot thick was laid down before dumping began. A year later, when the garbage was cleared off, there was no concrete to be found. It had been eaten away by the acid that had dripped down on to it. —*The Progressive.*

The number one best-selling book for 1981 was reported to be "The Solution of Rubic's Cube", published by Bantam Books. —*Paul Harvey News.*

President Reagan's plan to assist the nuclear industry was announced last fall. Included in the President's proposals were an end to the Carter imposed ban on reprocessing spent fuel; a streamlined procedure for licensing nuclear power plants; and completion of the Clinch River Breeder Reactor. The Washington Post reported that the Department of Energy is planning a multi-million dollar campaign to win support for the President's plan to promote commercial nuclear power. The source of the Post's story was Representative Richard L. Ottinger (D-N.Y.), Chairman of the House Energy Conservation and Power Subcommittee. Ottinger said that a wide range of public relations activities was recommended in an internal memo to Assistant Secretary Shelby Brewer. These include appearances by department officials assisted by outside public relations agents; a $200,000 study by the Scientists and Engineers for Secure Energy (a group the memo describes as "a pro-nuclear organization organized to offset the anti-nuclear Union of Concerned Scientists"); giving official interviews to national columnists thought to favor the plan; and hiring writers to prepare articles in support of nuclear energy under the names of department officials. Ottinger called the plan "a blatant propaganda campaign for the nuclear power industry that will cost the American taxpayer millions of dollars."
—*Environment*

Is it an electric car that runs on gasoline, or a gasoline car that runs on electricity?



It's both.

It's a hybrid car being developed by General Electric for the Department of Energy. It's powered by both a gasoline engine and an electric motor.

This car runs part of the time on gasoline, part of the time on batteries, and combines both power sources when needed.

The electric motor will be used primarily for speeds from zero to 30 mph, and the gasoline engine for most highway driving. When you need extra power for passing, the electric motor automatically kicks in to boost the power.

The key to the operation of this vehicle is a GE-designed microcomputer. This computer, about the size of a cigar box, continually receives signals from more than three dozen sensors, measuring all the functions of the vehicle.

The microcomputer takes this information and determines the amount of power needed to meet the driver's command when he presses on the accelerator or brake pedal. It then decides when to turn power on or off and when to switch from gasoline engine to electric motor. It blends in each power source so smoothly that there is no jumping or jerking.

The result is a car that gives big engine performance and small-engine fuel economy. It's estimated that gas consumption will be cut in half. The hybrid car could well be the wave of the future in personal transportation.

Looking for new and practical solutions to transportation problems is just one example of research in progress at GE. We're constantly investigating new technologies, new materials, and innovative applications for existing technologies—in such areas as energy sources, motors and drives, aerospace systems.

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