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# October 1965

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# THE WISCONSIN ENGINEER

Member E. C. M. A.

OCTOBER 1965

Vol. 70, No. 1

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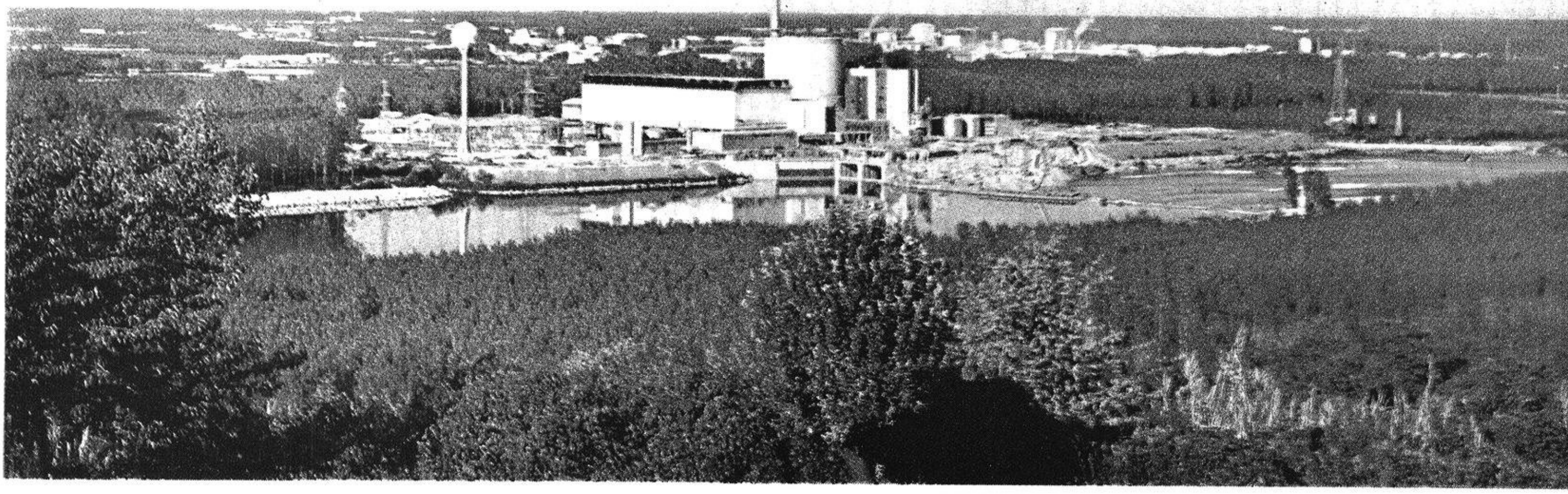

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# October Preview

Autumn has not been kind to Madison and environs. With this authentic excuse we regretfully inform you that the Girl-of-the-Month will not appear until November. Why? Our photographers tell us that the rain and cold have not created desirable conditions for bathing-suit scenes.

With the City of Madison contemplating the purchase of a computerized traffic-control system, you might inform yourself as to how it will work. Just thumb back to page 14 for the article by Bill Bauer. Bill tells us that Madison's system might have an attachment for automatically printing and mailing jay-walking tickets. (The rest of the jokes are on the last page).

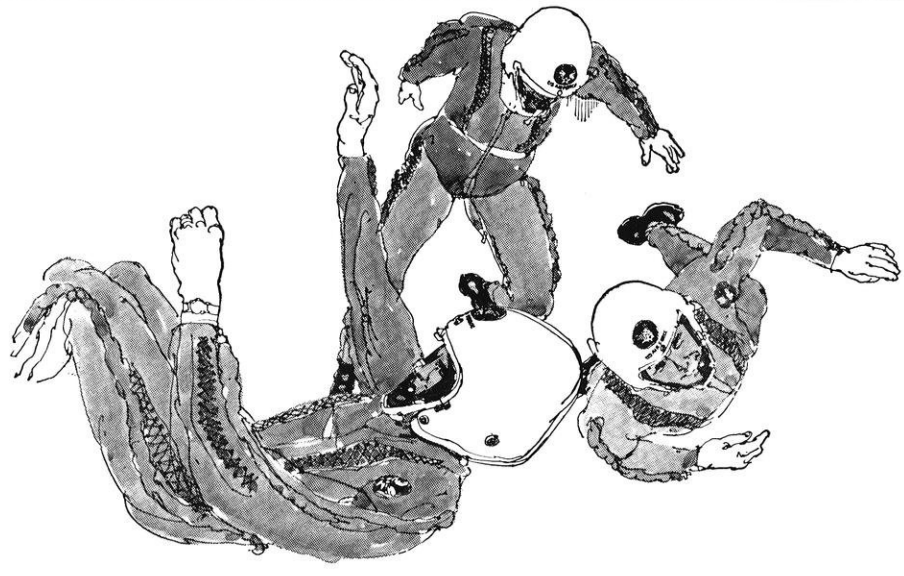
You armchair sailors should enjoy the article on OMNI Navigation beginning on page 18. Bob Trump explains the system in words and diagrams. To us it seems like a great way to get and stay un-lost.

Beginning on page 21 is a very special and important article. Professor Nadler, Chairman of the Industrial Engineering Curriculum Committee, has provided us with a very complete and thorough dissertation on IE at UW. Incidentally, reprints of this article will be available shortly.

For your convenience, the Fall Semester Interview Schedule is within, on pages 36 and 37.Also, Science Highlights has been expanded this year, and the jokes are generally brand new. Other goodies tucked away inside include a campus news section and an alumni page.

All organizations within the College of Engineering are invited to submit new items for publication. Why not let people know that you aren't just vegetating? Just leave the articles in our mailbox.

In conclusion, the staff of *The Wisconsin Engineer* extends a cordial welcome to the many freshman engineers. If you are interested in becoming a member of our staff, please do one of the following: Leave a note in our mailbox in the ME lobby, see Professor Schwebke in T-24, or stop by the office, 333 ME. Until we see you at Freshman Lectures next month, we have this one experienced word of advice: Study



**By solving problems in astronautics, U.S. Air Force scientists expand man's knowledge of the universe. Lt. Howard McKinley, M.A., tells about research careers on the Aerospace Team.**

(Lt. McKinley holds degrees in electronics and electrical engineering from the Georgia Institute of Technology and the Armed Forces Institute of Technology. He received the 1963 Air Force Research & Development Award for his work with inertial guidance components. Here he answers some frequently-asked questions about the place of college-trained men and women in the U.S. Air Force.)

**Is Air Force research really advanced, compared to what others are doing?**

It certainly is. As a matter of fact, much of the work being done right now in universities and industry had its beginnings in Air Force research and development projects. After all, when you're involved in the development of guidance systems for space vehicles—a current Air Force project in America's space program—you're working on the frontiers of knowledge.

**What areas do Air Force scientists get involved in?**

Practically any you can name. Of course the principal aim of Air Force research is to expand our aerospace capability. But in carrying out this general purpose, individual projects explore an extremely wide range of topics. "Side effects" of Air Force research are often as important, scientifically, as the main thrust.

**How important is the work a recent graduate can expect to do?**

It's just as important and exciting as his own knowledge and skill can make it. From my own experience, I can say that right from the start I was doing vital, absorbing research. That's one of the things that's so good about an Air Force career—it gives young people the chance to do meaningful work in the areas that really interest them.

**What non-scientific jobs does the Air Force offer?**

Of course the Air Force has a continuing need for rated officers—pilots and navigators. There are also many varied and challenging administrative-managerial positions. Remember, the Air Force is a vast and complex organization. It takes a great many different kinds of people to keep it running. But there are two uniform criteria: you've got to be intelligent, and you've got to be willing to work hard.

**What sort of future do I have in the Air Force?**

Just as big as you want to make it. In the Air Force, talent has a way of coming to the top. It has to be that way, if we're going to have the best people in the right places, keeping America strong and free.

**What's the best way to start an Air Force career?**

An excellent way—the way I started—is through Air Force Officer Training School. OTS is a three-month course, given at Lackland Air Force Base, near San Antonio, Texas, that's open to both men and women. You can apply when you're within 210 days of graduation, or after you've received your degree.

**How long will I be committed to serve?**

Four years from the time you graduate from OTS and receive your commission. If you go on to pilot or navigator training, the four years starts when you're awarded your wings.

**Are there other ways to become an Air Force officer?**

There's Air Force ROTC, active at many colleges and universities, and the Air Force Academy, where admission is by examination and Congressional appointment. If you'd like more information on any Air Force program, you can get it from the Professor of Aerospace Studies (if there's one on your campus) or from an Air Force recruiter.

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VOLUME 70, NUMBER 1 OCTOBER 1965

## ARTICLES



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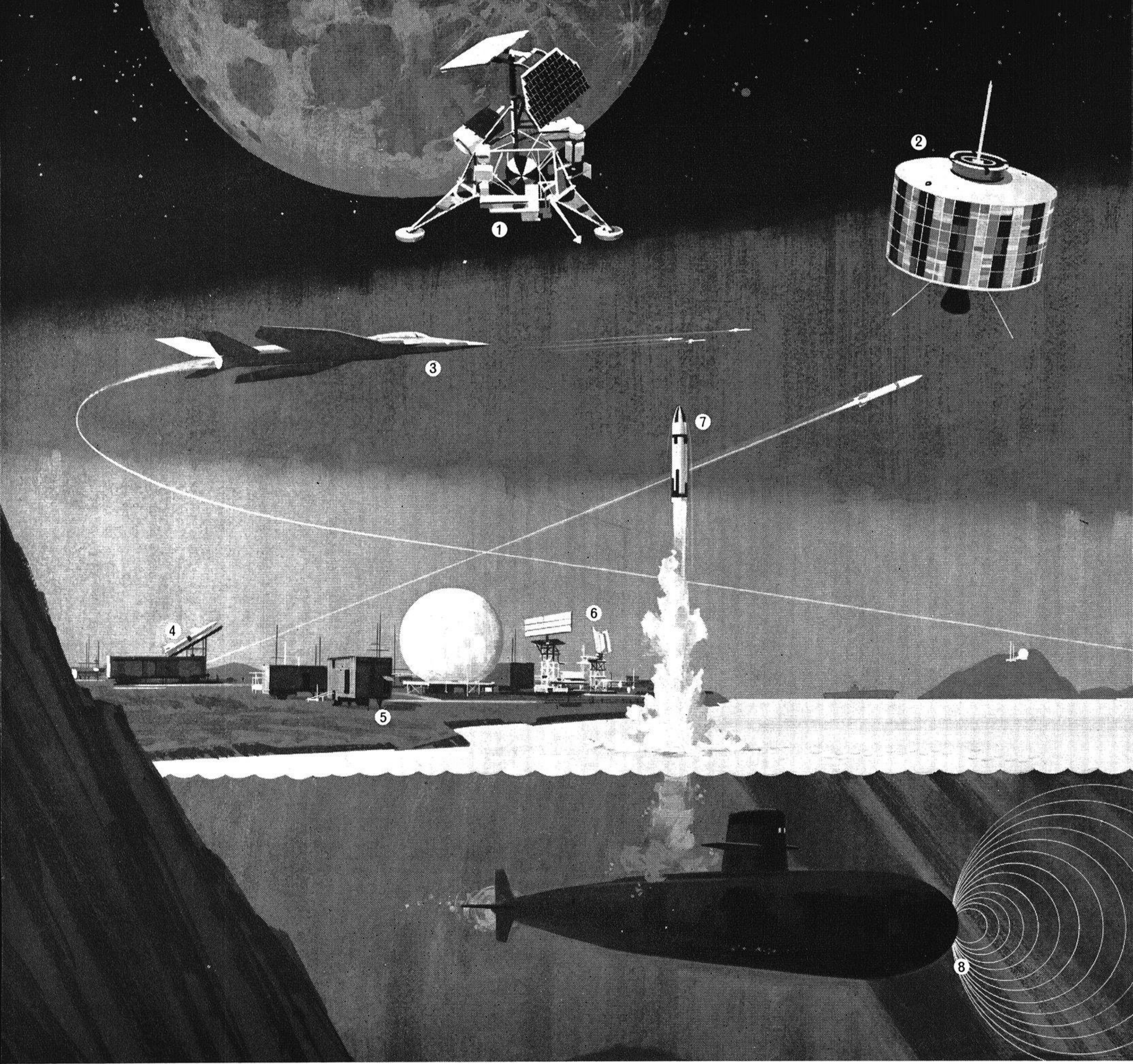

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## *Rambling with the Editor*

# "ONE WHO TEACHES"

Webster and the others define professor as "One who teaches, or professes special knowledge." Not a particularly profound statement until you think about it, is it? Recall briefly your past professors, taking note of the number of teachers in the array. Undoubtedly the percentage reflects a less than desirable situation —a condition demanding explanation and comment. Generally, a good teacher is well-trained and dedicated, vice being apathetic and overly-engrossed in research.

We've all had instructors (?)—TA's through full professors—who have been completely apathetic towards their primary occupation—teaching. They seem to regard it as an unnecessary burden which takes them away from their writing or lab work. Evidence of this includes unavailability for office hours (or rushing through them), stoic lectures (prepared either years ago or else five minutes before the class), and the complete lack of rapport between student and instructor. Some of our lectures have been like TV shows originating thousands of miles away.

Now there is something to be said *for* the under-paid over-worked professor, to be sure. His institution requires him to sit through the paper jungle of committee meetings. Gaining the earthly salvation called tenure requires years of writing, researching, and brown-nosing. What brings us to gripe like this is the example of many faculty members, including deans and department chairmen, who still *teach* undergrad courses; and teach them well, keeping in touch with the student—no easy task amidst administrative and other duties. We need many more people like this on the faculty.

Someone famous once said, "How nice it would be if teachers could simply teach and researchers research." This is obviously undesirable, but this magazine would like to suggest that the undergraduates of today are the researchers of tomorrow, and that the implications of this should be considered. It should follow that the better a man is educated today, the more valuable he will be tomorrow. There is a happy medium for the teaching researcher (or the researching teacher), for we see examples of it in practice daily.

Only a fraction of all college instructors have had any formal training in education. To expect effective teaching from them is ludicrous and getting it is sheer luck. And it is wasteful of time and money for an expert to merely *attempt* to convey his knowledge to others. We feel that a few credits in education should be required for all new university instructors, and that present faculty members be impressed into an institute on teaching methods. It would be well for instructors to know more about the nature of a student, planning, testing, lecturing, etc., etc., etc. Granted, these things can be learned, but only by long experience, at the expense of many students.

Commendations are in order for the many organizations that sponsor awards for good teaching, as well as congratulations for the recipients. For those that haven't gotten an award: "The First Session of the Better College Teaching Workshop will be held on . . ."

R. J. Smith

# Electronic Traffic Control

By WILLIAM A. BAUER, CIE-4

SINCE World War II, the number of vehicles on the highways and the mobility of the American public have increased at a prodigious rate. Passenger automobiles alone develop over 5000 passenger miles per person per year. Such phenomenal growth in highway traffic has brought to light serious problems in traffic control. How these problems are being solved with the use of modern electronic devices is the subject of this article.

Of the three elements of highway traffic problems: (1) human beings as road users, (2) vehicles with their loads, and (3) fixed facilities for traffic movement and storage, it is primarily human beings as road users that we will be concerned with here. The improvement of highways and the availability of more powerful vehicles has given the motorist more choice in the distances he can travel and the speeds which he may use. Therefore, most of our electronic devices are designed to either direct the driver or regulate his speed. The device the average motorist has the most direct contact with is radar. To give the layman an appreciation of this device, this article gives a semi-technical discussion of radar and a general description of the other major electronic traffic control devices: sonar, television and computers. An evaluation of a present day electronically controlled highway follows these descriptions.

## RADAR

### Development

The most widely used electronic traffic control device, and one of the most important because it automatically records vehicle speeds, employs a radar transmitter-receiver unit. Such equipment, utilizing the Doppler principle of frequency change in electromagnetic radio waves reflected from moving objects, was available in the United States before 1950. However, these early-type radar units had several short-comings, not the least of which was the fact that the transmitted beam had to be pointed directly down the path of oncoming traffic. It can readily be seen that this type of system is inaccurate when two or more vehicles are in the beam.

By early 1959, engineers working for The Marconi Company Ltd. of Great Britain had developed a prototype "PETA" (Portable Electronic Traffic Analyser) which was to be used as the basis for similar devices used by police forces and traffic engineering organizations throughout the world. The significant difference between the "PETA" and the earlier type of traffic radar is that the beam, emitted from a slotted waveguide, is angled across the road at 20° and is confined to a 4° horizontal beam width. Each car passes through the beam instead of along it, and vehicles more than eight feet apart will provide separate readings.

### Components

The standard unit is comprised of three major parts: the antenna, the power supply, and the meter and accompanying graphic recorder. The power supply unit draws current from a 12-volt car battery and provides power for both the transmitter and the antenna unit. This unit contains a receiver and a transmitter operating on a frequency band of 10,675 mc to 10,699 mc. Most American units operate at 2455 mc.

### Operation of a Radar Sensing Unit

The operating basis for the radar-sensing unit is the familiar Doppler principle. A vehicle coming into the radar beam reflects the high-frequency radio waves back to the receiver. Since the original, or transmitted frequency, is increased by an amount directly proportional to the vehicle's speed when reflected back, the operator can determine the speed by noting the interference beat formed by the transmitted and received frequencies. The frequency of the interference beat is an indication of the vehicle's speed and the number of beats determine the vehicle's length.

It should be noted that most police forces do not use radar to "trap" the unwary motorist. Highways which are under radar surveillance are usually posted as such to forewarn road users; in short, the device is used as a deterrent. The detection of possible malfunctions was considered so extremely important during development of the system that measures were taken to enable the operator to immediately and clearly detect a faulty condition. To accomplish this, a wavemeter was incorporated into the system to check the transmitted frequency, and calibrating signals corresponding to 40 and 70 mph were provided so as to enable the equipment to be checked at any instant. In addition, it is customary for the police to carry out a "run through" with a patrol car traveling at a known speed before the start of a surveillance period and again at the end to ensure that the readings are accurate.

### Advantages and Disadvantages

There has been widespread publicity on the use of electronic devices to check speed, particularly the use of radar, but there is still some resistance to this method. However, the advantages of radar far outweigh its vulnerability to interference and relative high cost (approximately $1200 for a unit produced by Motorola, RCA, Philco, or Sylvania.) Over pneumatic tubes and other mechanical devices used for speed checks and traffic volume surveys, radar has these advantages:

1) Radar can discriminate between individual vehicles, even in dense traffic.
2) It has a range of 2 to 100 mph with an accuracy of $\pm$ 2 mph.
3) Little technical skill is needed to operate it because of its simplicity.
4) Radar can easily be installed with no traffic interruption or pavement cutting.
5) The site of installation can rapidly and easily be changed.

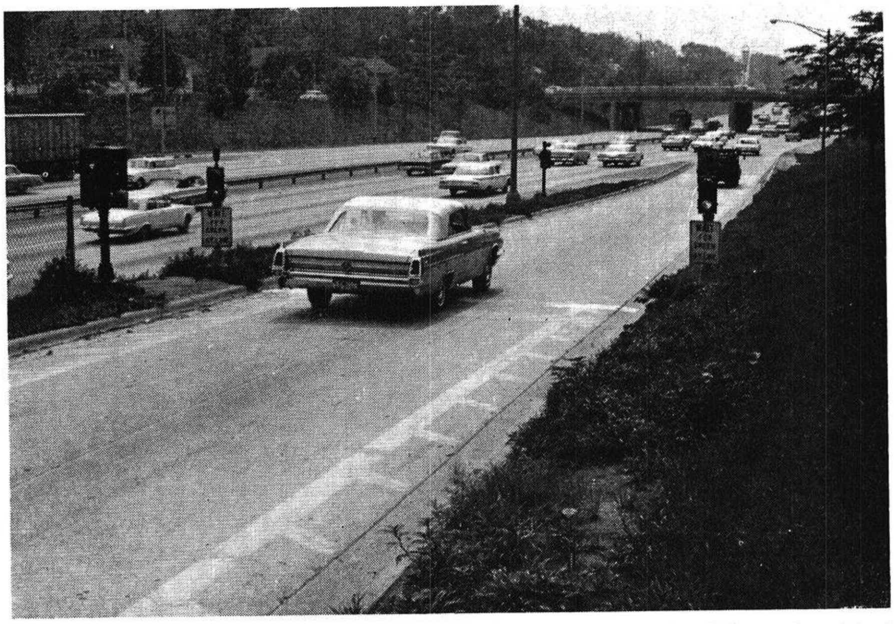

Figure 1.—This vehicle coming onto the Congress Expressway in Chicago is subject to surveillance and control. Signals help maintain maximum traffic flow.

6) The number of vehicles and not the number of axles is accurately counted.
7) Operations are independent of weather and road surface conditions.

### Radar Recording Units

While radar was designed for traffic surveillance and control through law enforcement, it can easily be seen that it is also possible for individual communities to use radar "traps" as a source of revenue. Because the public considers electronic devices infallible, very few persons challenge the validity of tickets issued by radar. However, communities using recording devices incorporated with the radar meter are well prepared to meet court cases brought by citizens apprehended by a radar unit. A visual record of the violation plus the use of accurate checks usually convince the people of the validity and accuracy of radar-sensing units, thus increasing their confidence in their police force.

Communities actually interested in efficient traffic control all use automatic recording devices. Graphs derived from these recorders provide traffic engineering divisions with accurate surveys of vehicle speeds and volumes at specific points. However, police departments using radar merely as a faster and easier way of apprehending motorists are interested in radar only as a source of revenue. Such usage needs to be curtailed if traffic engineers are to expect compliance from the citizens.

### SONAR

A few law enforcement organizations, desiring only speed determinations and not traffic volume surveys in a local area, are now using ultrasonic detectors instead of radar units. Similar to a radar meter, this device also operates on the Doppler principle, but employs inaudible sound waves as the detection medium instead of radio waves. Vehicles moving through the narrow detection beam cause a shift in the length of the reflected waves. The frequency of the returned audio waves is directly proportional to the speed of the observed vehicle. This speed can be read off an indicator coupled to the receiver.

Disadvantageous requirements for use include permanent installation and 115 volt alternating current. The antenna is attached about 15 feet above the highway on overhead arms or bridges. Directed at the oncoming traffic, the narrow beam permits the unit to provide a very sharp zone of detection. The sensing units are connected to the receiver by shielded cables and may be located up to 300 feet away from the transmitter-receiver. Since there is no contact between vehicle and detector, there is no deterioration from traffic wear.

### TELEVISION

In the past, traffic control has been a case of systems controlling traffic. The traffic engineer's goal is to eventually have the traffic controlling the systems. To do this he has developed several traffic sensing instruments, one of the most important being television. By means of closed-circuit television cameras feeding data into a receiver at the traffic control center, engineers can feel the demands of changing traffic volumes and adjust control systems to meet these demands. Most frequently, television monitoring can be used for overriding the central control of individual signals phases, holding green and amber phases as long as necessary. Where one man stationed at each intersection could control his one area, the use of television dispenses with manual police traffic control and adjusts the flow of traffic along an entire avenue to the rhythm of the green waves in the streets discharging traffic into it.

#### Mobile or Fixed Cameras

The application of television for traffic observation raises the question of whether mobile or fixed cameras are to be used. The decision depends on what is to be observed. With the mobile camera it is possible to watch a large area and at the same time observe distant points on approaching roads. A fixed camera makes possible the constant observation of traffic in a limited area, such as a village square or an important bottleneck, and requires no direct manual operation. The picture is always there, while a mobile camera must first be located through correct positioning.

#### Operation

Fixed cameras are usually mounted on poles 32 feet high and can be operated from the control room. By means of control column similar to an aircraft steering control, the camera may be positioned both laterally and vertically so that the desired sector can be brought under observation very quickly. The operator is also helped by his instinct since the movement of the control column produces an identical movement of the camera. In some cases two consecutive cameras may be hooked up to the same control column.

Rubber mounted lenses enable the views to be changed rapidly from wide angle to specific distances. This makes possible both general observation of an intersection or the control of traffic congestion at a distant bottleneck. When there are interruptions to the flow of traffic, the telescopic lenses enable the observer to determine if the delay is caused by stopped vehicles or an accident.

The transmission of pictures between the cameras and the control center is by coaxial cable for most fixed cameras. For some fixed cameras and all mobile cameras transmission is by a directional radio setup. There must be visual contact between the parabolic antennae of the transmitter and the control center receiver. Directional radio links are best suited for the greater distances. They have the advantage of not being confined to one place, but merely have to be re-directed when the location of the camera is changed.

The television eye has given good service even at dusk and at night. When visibility is poor the camera conveys a clearer picture of events by way of the television screen than an observer on the spot. The streets are clearly marked on the screen through street lighting, store windows, and advertising sings. The number of approaching automobiles can accurately be gauged by the vehicles' headlights.

#### Advantages

Traffic observation by means of television cameras has considerable advantages over direct, on-the-spot observation because there is no position on the street that could offer a comparable view. Observation on the spot is restricted in space, whereas television allows observation of considerable depth. Also, reports by individual observers are always influenced by the surrounding conditions, while at the traffic control center, away from the rush and tension of the traffic, a clear and objective view can be formed. Moreover, the few officers permanently on duty at the center have far greater experience and a better grasp of the pattern of traffic than any single man on street duty who is completely surrounded by vehicles and can see only his particular section.

A point of special importance for urban traffic control is the possibility of recognizing potential traffic jams by means of the television camera and taking prompt remedial action. In many of our metropolises the streets can no longer handle present traffic volumes, and even where the capacities of the streets just meet traffic needs under normal conditions, the slightest disturbance of the smooth flow of traffic leads immediately to major congestion and traffic jams which tend to spread with great speed. Television monitoring, combined with a good communications system and the use of traffic radio patrol cars, is effective in forming rapid countermeasures to remove the obstructions and keep traffic moving smoothly.

### COMPUTERS

The pilot study of automatic control of traffic by electronic computer was undertaken in Toronto, Canada in 1959. The computer proved to be so successful in providing a flexible, reliable, and coordinated signal system connected to an existing traffic signal network, that it was decided to install a digital computer on a permanent basis. Planning incorporated some 100 signalized intersections, three-quarters of which formed a small closed network in the downtown area with the remainder lying along two intersecting arteries.

#### Necessary Equipment

Most complex signal systems require installation of specialized and expensive equipment at both the central office and at each intersection, but this is not necessary for computer control, since any type or combination of types of existing local signal controllers can be used. To be operational, a computer controlled system requires:

1) A computer of adequate size for the assigned task, allowance being made for expansion of the system and its use for other work during hours it isn't needed for traffic control.
2) A communications network link the computer with the

various intersections and vehicle detectors.

3) A modification device on the existing signal controllers to allow the computer to take over.
4) A monitoring device to enable the computer to determine the signal indication showing at any time.
5) Vehicle detectors to indicate traffic patterns as well as volumes.

The modification unit, which allows the computer to take over and operate the existing local signal controller, consists of two relays, one of which deactivates the normal timing device and, at the same time, establishes a circuit whereby the other relay can activate the signal switch thus producing a change in phase. This allows the computer to switch the local controller from its automatic to its manual mode of operation and then change the signal display as required. While under computer control, the normal hand switch is disabled so that if, for any reason, manual control of the system should become necessary, permission must be obtained from the central supervisor who must drop that intersection out of the system. A pilot light is provided to advise police officers and others that the unit is under system control.

The monitor provides the computer with instantaneous information concerning the state of the signal. This provision simplifies the programming, since it would otherwise have to be given this information at the start of each period of system operation and would have to remember successive changes. The monitor also provides an automatic check on the system's operation by determining immediately whether or not an ordered signal change has taken place correctly. If it has not, the computer can take steps either to correct the error or to drop it out of the system and, at the same time, notify the operator of the need for service.

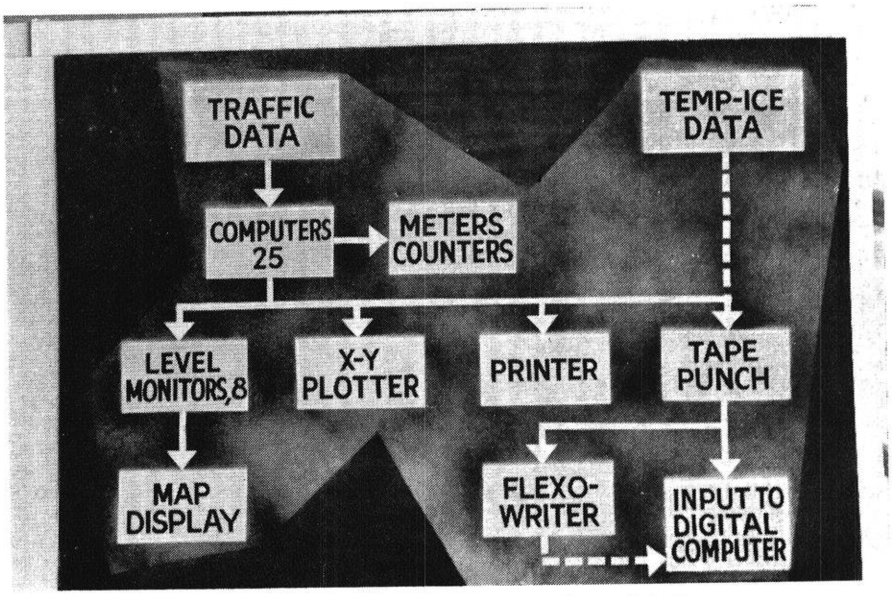


**Figure 2.—Typical inputs to a traffic-controlling digital computer.**

### Operation

The operation of the computer is governed by a master control program containing a large number of sub-programs, each designed for a specific purpose and capable of either manual or automatic selection. One of these sub-programs deals with the start of system operation, another with shut down, and the remainder with the selection and application of the various modes of control which may be applied to any signal or group of related signals.

To initiate system operation, a manual start order from the console selects the appropriate sub-program which then instructs the computer to begin reading in traffic data and information received from signal monitors. The program also specifies the order in which individual signals should be taken under control and the exact point in their normal cycle at which this should occur. By matching incoming information against its instructions, the computer can activate the "hold" circuit at the appropriate time for each signal, thus assuming control of the entire system in a matter of seconds.

Having assumed control of the system, the computer follows an operational plan which specifies for each individual intersection in turn the control sub-program to be used in determining the signal timing and also the constant characteristics, such as street widths, detector distances, turn prohibitions, parking restrictions, etc. required for computation. Many operational plans are available, with the one actually in use at any instant being chosen either manually or automatically by a special selection sub-program. If done automatically, different plans might be called for at different times of the day. Or the selection may be determined by actual traffic conditions so that, for example, all signals on a street carrying one-way traffic might be arranged for strict progressive movement. If the traffic pattern should become random, the operational plan may call for the formation of queues.

### Example

The use of a UNIVAC 1107 and its accessories as installed in Toronto is exemplary of the speed of a computer in controlling traffic signals. Though each signal is examined and adjusted on an individual basis, the working speed of the computer is such that the whole system comprising 1000 intersections is scanned once every second. In the approximately one millisecond devoted to each signal the computer must:

1) Read the vehicle detector inputs and update the counts stored in its memory.
2) Compute a traffic density factor.
3) Read the signal monitor inputs and update the elapsed time for whatever green in showing.
4) Check the operational plan in effect to determine the required control sub-program.
5) Compute from the control sub-program and the static intersection characteristics the correct length for the green interval.

*(Continued on page 42)*

# OMNI: Modern Marine Navigation

By ROBERT L. TRUMP, ME-4

WITH the development of a radio receiver by the Enac–Triton Corporation, yachts and commercial vessels can now use the aeronautical Omni system to pinpoint their position. The Onni system has been used for aircraft for over 15 years and was developed because of the need for improvement over older systems. The older, low frequency systems of radio direction finding were subject to static, bending of beams, false signals, and were not accurate or fast enough for modern aircraft. The Omni system does not depend upon skill or experience, and bearings can be determined quite rapidly.

With the Triton Marine Omigator the modern boatman can take advantage of the aeronautical Omni ranges for shortrange coastal navigation. It is the purpose of this article to give the boat owner enough information to decide whether the Omni system will be advantageous in his particular application. This report will be an explanation of the Omni system and a comparison between Omni and conventional RDF's and ADF's; however, it will not be an "Owners' Manual."

First, the operating equipment will be described and explained. The operation will then be described with several examples to compare Omni and conventional systems. Finally, the advantages and disadvantages of the Omni system will be discussed. After reading the report the boat owner will be able to decide whether he should have an Omnigator on his boat.

## OPERATING EQUIPMENT

In the mid 1940's planes were not only traveling very fast but their numbers were ever increasing. It soon became apparent that a new method of navigation was needed. The old "beam" was just not adequate for modern high speed aircraft. The "beam" was subject to static, bending, false signals, and was not fast enough. An accurate, multi-directional, system that did not depend upon skill or experience was needed. The system should also allow the pilot to determine exact position by taking cross bearings. After several years the Omni system was developed. It incorporated all these features and more.

Omni stands for visual Omni-directional Range (VOR). Instead of using a low frequency signal, the Omni system consists of more than 800 high frequency radio transmitters which blanket the United States in a pattern useful to air navigation. The operating frequencies are between 108 and 117.9 megacycles which are considered VHF just like television and FM radio stations. Like television, the reception is approximately "line of sight" which does not affect the reception in the air but does limit reception on land or water.

### Transmitting Equipment

Of the 800 stations now operating, more than 150 Omni stations are near enough shorelines of the Great Lakes and the coasts to be useful for marine navigation. As shown by Figure 1 most of the coastline of the United States and much of the Great Lakes is covered by the Omni broadcasting stations. Table I gives the location of the Omni stations that are close enough to the shoreline or high enough to be useful.

Approximately 400 more stations are being planned. Enough of these should be close enough to the Great Lakes and coastlines to give complete coverage in the near future.

The Omni stations broadcast a different signal in each of 360 different directions which correspond to the 360 degrees of a compass.

The signal received is the magnetic bearing of the station receiver is tuned to. Since only the proper signal can be received, there is no possibility for error and no skill is involved.

Each Omni station transmits a code and voice identification so there is no possibility of taking a bearing on the wrong station. Each station also broadcasts up-to-the-minute weather information, including wind speed and direction, barometer pressure, and any special weather bulletins that that would be useful for navigation in the area.


**Figure 1.—Omni coverage on U. S. coasts.**

### Receiving Equipment

The Omni signal is received by the Marine navigator by using a "Triton Marine Omnigator." This is a specially designed radio receiver built by Triton, a division of the National Aeronautical Corporation, a company that has been building fine airbourne electrical equipment for many years. Triton has recently redesigned a conventional aircraft Omni receiver to make it useful for marine use. In order to do this it was necessary to redesign the circuitry to extend the reception range of the VHF signals. With the improved reception range the Marine Omnigator receives signals 50 to 100 miles from a station, depending upon the location and elevation of a station.

The Omni receiver is basically a very sensitive FM receiver which enables the navigator to determine which of the 360 radials from a given station he is on. The receiver weighs about 13 pounds and uses about 30 watts of electrical power. The antenna is a very simple, lightweight dipole antenna which can be mounted almost anywhere, since the VHF signal is not very susceptible to interference. For maximum range, however, the antenna should be mounted as high as possible. The receiver can be mounted overhead or on a shelf and is connected to the antenna with a thin coaxial cable.

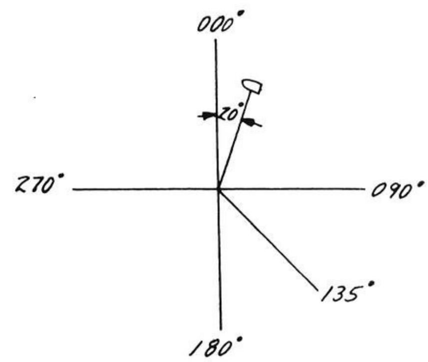


**Figure 2.—Omni radials. Ship bears 20° true from transmitter.**

### OPERATION

When using a conventional radio direction finder (RDF) the operator tunes in a broadcast band radio station as exactly as he can, either by ear or sometimes with the aid of a meter. He then rotates the loop antenna until a null, or point of no signal, is determined. The bearing of the station is then read off of a dial below the loop antenna.

With the Omni system the bearing is determined by the transmitting station. A different signal is sent out for every degree. Several different radials are shown in Figure 2. The ship shown can only receive the signal corresponding to the 20 degree radial and therefore there can be no doubt that its bearing is 20 degrees.

The operation of the Triton Marine Omnigator is quite simple. The set is first turned on and the station is selected in a similar manner to selecting a television channel. To make absolutely sure the receiver is on the correct station the identifying code or the voice identification may be heard by turning the volume up.

### TABLE 1.—OMNI STATIONS CURRENTLY IN USE

**ATLANTIC COAST (North to South)**

Brunswick, Me.
Kennebunk, Me.
Portsmouth, N.H.
Boston, Mass.
Falmouth, Mass.
Hyannis, Mass.
Nantucket, Mass.
Martha's Vineyard, Mass.
Providence, R.I.
Quonset Pt., R.I.

**LONG ISLAND SOUND**
Norwich, Conn.
Groton, Conn.
Madison, Conn.
Bridgeport, Conn.
LaGuardia Field, N.Y.
Deer Park, L.I.
Riverhead, L.I.

East Hampton, L.I.
Westhampton Beach, L.I.
Kennedy International Airport
Colt's Neck, N.J.
Belmar, N.J.
Barnegat, N.J.
Sea Isle (Cape May), N.J.

**DELAWARE BAY**
Waterloo (Rehoboth), Del.
Kenton (Dover), Del.
New Castle, Del.

**CHESAPEAKE BAY**
Cape Charles, Va.
Norfolk, Va.
Hampton, Va.
Patuxent, Md.
Baltimore, Md.

Wilmington, N.C.
Myrtle Beach, S.C.
Charleston, S.C.
Brunswick, Ga.
Jacksonville, Fla.
Daytona Beach, Fla.
Vero Beach, Fla.
W. Palm Beach, Fla.
Ft. Lauderdale, Fla.
Biscayne Bay, Fla.
Key West, Fla.

**BAHAMAS**
Bimini
Andros
Nassau

**GULF COAST (East to West)**

Ft. Myers, Fla.
Sarasota, Fla.
St. Petersburg, Fla.
Panama City, Fla.
Valparaiso, Fla.
Pensacola, Fla.
Mobile, Ala.
Gulfport, Miss.
White Lake, La.
Sabine Pass, Tex.
Galveston, Tex.
Palacios, Tex.
Corpus Christi, Tex.
Navy Corpus, Tex.
Brownsville, Tex.

**PACIFIC COAST (North to South)**

**PUGET SOUND**
Vancouver, B.C.
Bellingham, Wash.
Port Angeles, Wash.
Everett, Wash.
Seattle, Wash.

Hoquiam, Wash.
Astoria, Ore.
Newport, Ore.
North Bend, Ore.
Crescent City, Cal.
Fortuna, Cal.
Point Reyes, Cal.

**SAN FRANCISCO BAY**
Sausalito, Cal.
Hamilton Field, Cal.
Napa, Cal.
San Francisco, Cal.
Oakland, Cal.
San Jose, Cal.

Big Sur, Cal.
San Luis Obispo, Cal.
Santa Maria, Cal.
Vandenberg AFB, Cal.
Goviato, Cal.
Santa Barbara, Cal.
Ventura, Cal.
Santa Monica, Cal.
LA International Airport
Long Beach, Cal.
Santa Catalina, Cal.
Oceanside, Cal.
San Diego, Cal.
Lindbergh Field, Cal.

**GREAT LAKES**

**LAKE ONTARIO**
Watertown, N.Y.
Rochester, N.Y.
Toronto, Ont.
Stirling, Ont.

**LAKE MICHIGAN**
Pellston, Mich.
Menominee, Wisc.
Escanaba, Mich.
Pulliman, Mich.
Northbrook, Ill.
Milwaukee, Wisc.

**LAKE HURON**
Wharton, Ont.
Oscoda, Mich.
Peck, Mich.
Saginaw, Mich.

**LAKE SUPERIOR**
Whitefish, Mich.
Marquette, Mich.
Houghton, Mich.
Ft. William, Ont.
Duluth, Minn.

**LAKE ERIE**
Dunkirk, N.Y.
Erie, Pa.
Aylmer, Ont.
Lost Nation, Ohio
Cleveland, Ohio
Sandusky, Ohio

Note: In certain areas where only one Omni station is within range, the Omni bearing can be crossed with a DF bearing or Loran LOP.

With the desired station tuned in, an azimuth wheel is turned until the needle above it is centered. With the needle centered the reading on the azimuth wheel is then the magnetic bearing of the station. A "to-from" indicator shows if the bearing is to or from the station. If the navigator wants to steer a course toward the station he uses the "to" reading. If he wants to travel directly away from the station he merely rotates the azimuth wheel until "from" is indicated and he can read the proper course directly.

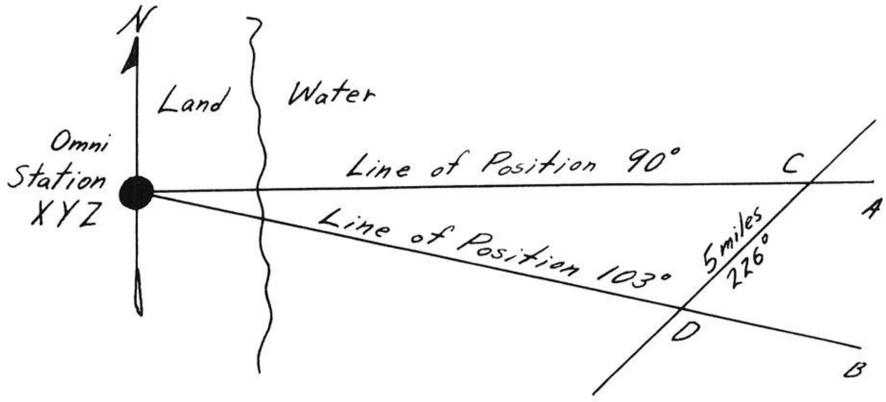


**Figure 3.—Determining position using a single Omni station.**

### EXAMPLES

Two examples of the use of OMNI will now be considered and compared to conventional navigational practices. First, let us assume we are about 25 miles from shore and we can only pick up one Omni station. We would like to determine our position and since we can only receive one station we can't determine our position by cross bearings. Let us also assume our course is 226° and our bearing on station XYZ is 90° as shown in Figure 3.

We then travel for 30 minutes at a speed of 10 knots. We know that we have travelled 5 miles and we find that our final bearing is 103° from station XYZ. We would draw lines A and B on our chart which are our two Omni bearings. Then with a parallel ruler and set of dividers we would determine a line that is parallel to 226° and the distance along it and between lines A and B is equivalent to five miles. Since only one line CD can be drawn that is 5 miles long we know that C was our starting point and D is our position now.

Can the same procedure be used with the conventional system? Yes, but it would take quite a bit longer, and since conventional navigation is hindered by some of the problems mentioned earlier, the position would not be nearly as accurate.

Let us now consider a navigation problem around Santa Catalina Island which is shown in Figure 4. Under normal conditions this would be no problem. However, in a fog the boatman would have to rely entirely on radio bear-

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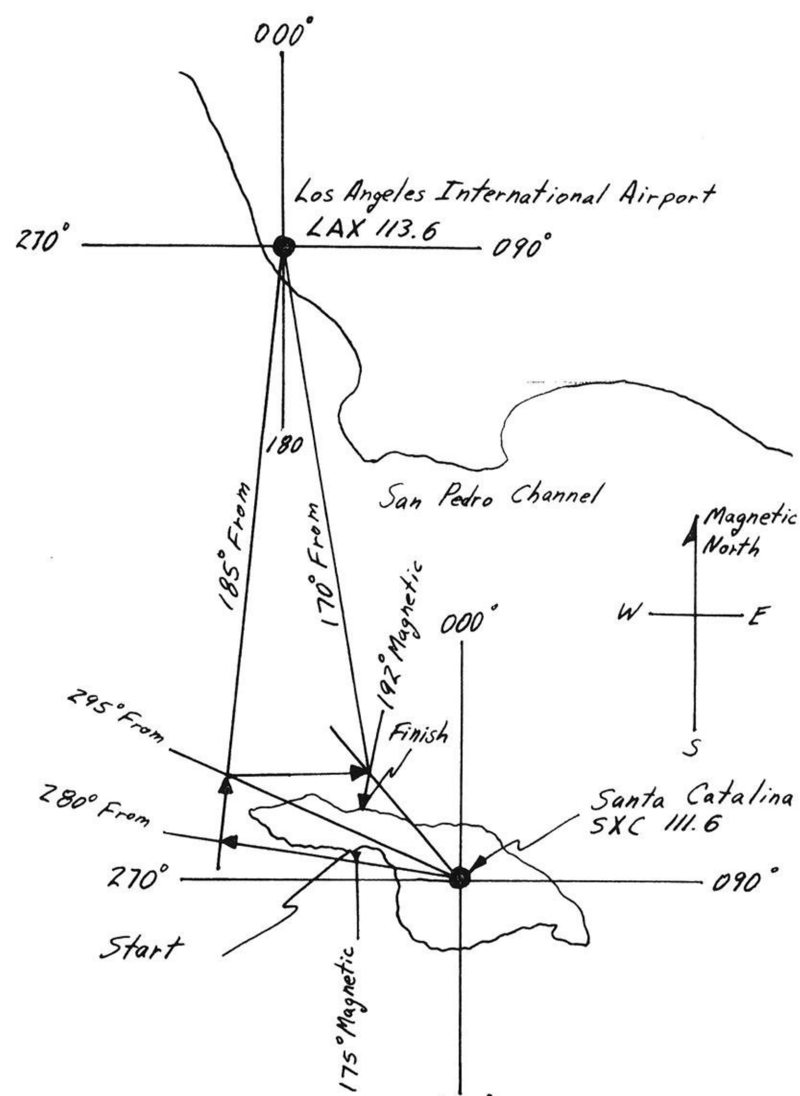


**Figure 4.—An example of a navigation problem in a fog from Catalina harbor to Isthmus Cove.**

# New Industrial Engineering Program at the University of Wisconsin

By PROFESSOR GERALD NADLER

THE College of Engineering at The University of Wisconsin has offered some traditional Industrial Engineering courses as part of the Mechanical Engineering curriculum for some time. However, the increasing complexity of real-life systems, the great demand for Industrial Engineers in industry and education, and the growing bodies of knowledge in Industrial Engineering have created a need for the development of a new and expanded program in Industrial Engineering at The University of Wisconsin.

To implement this program, Master and Doctorate degree programs in Industrial Engineering were offered as of September 1965 and an undergraduate program is being planned for September 1966.

The development of a distinctive and long range view of what IE should be and the resultant programs, both undergraduate and graduate, are the themes of this article.

### What Is Industrial Engineering?

All IE's agree that the profession started with Frederick Taylor's scientific management, but the unanimity stops there. Some feel IE is the set of tools, albeit changed and improved with new ideas and mathematics, developed by Taylor and the early pioneers—the time studies, plant layouts, methods studies, incentives, production controls, and quality controls. Others feel it is the study of production and manufacturing processes, especially metal working, to achieve greater productivity. A recent group feels IE is the new set of tools developed since World War II—computers, linear programming, queuing theory, inventory models, and game theory.

But the program at Wisconsin asks why should the limitations of specific techniques or specific realms of study limit the range of IE? Is there a concept of IE that has intellectual foundation, states a role in our society, and utilizes old and new sciences and techniques as needed for its role? The University of Wisconsin believes that IE can be freed from its limitations, and given a significant direction.

At The University of Wisconsin, *professional Industrial Engineering is the discipline responsible for the design of management systems.* This design is accomplished by the application of scientific, engineer ing, quantitative, and social knowledge to increase productivity, encourage individual enterprise, and enhance human dignity.

### What Is Meant by a Management System?

A management system is two or more human and/or physical resources that are effectively coordinated or interrelated to achieve a function or purpose. They exist in any kind of organization. Examples of management systems, thus illustrating the scope of IE are: medication administration in a hospital; automatic die casting, inspection, machining, and finishing production line for precision pulleys; service orders system for a telephone company; plant layout and materials handling system for a storm door, window and screen manufacturer; checking and marking system for a large department store; preventative maintenance system for missiles in underground silos; inventory and production control system for a multiplant, multi-warehouse garment manufacturer; and a planning and control system for a research and development project for an electric control manufacturer.

### What Is Meant by Design?

Design has as its main purpose the multi-dimensional specification of the precise conditions for each system characteristic (function, input, output, sequence, environment, equipment, and method). It also includes the steps of system identification, development of sys-

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tem alternatives, information gathering, system selection, and system installation. Design of management systems can take place when it is necessary to solve a problem or eliminate a difficulty with an existing system, when an organization has a planned program to better already satisfactory existing systems, and when a new system is needed for presently nonexisting products or services.

### What Is the Relationship of IE to Other Engineering?

Industrial Engineering takes on a role that is directly comparable to other branches of engineering. The electric engineer designs network and radar systems; the mechanical engineer machine and energy conversion systems; the civil engineer, vehicular transportation and building systems; the chemical engineer, organic and inorganic chemical processing systems; and the industrial engineer, management systems. Management systems design (MSD) is quite distinct from management, which is the operation and control of the management system. This relationship is identical to other engineering where the machine system is operated by a machinist, not the mechanical engineer designer, the radar system by a technician, not the electrical engineer designer, and so forth. Although each type of engineer consults with and seeks ideas from the operator (s) of his present or proposed system, the roles are quite different.

Engineering is defined in many ways. Two definitions should suffice. The dictionary says "the art or science of making practical application of the knowledge of pure sciences such as physics, chemistry, biology, etc." The Engineers Council for Professional Development says "engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind."

There are apparently three basic considerations in these definitions: *design* systems for the benefit of mankind, *application of sciences* related to physical phenomena and energy, and *utilization or resources.* By such definitions, IE is engineering: It designs real systems, the management systems illustrated above. It applies physical and engineering sciences and energy concepts, and also applies the new sciences concerning the physical behavior and attributes of human beings, operations research, and administrative sciences, thus slightly increasing the spectrum of sciences that engineering uses. It utilizes the resources of nature by optimally relating physical items and energy and human capabilities and energies into management systems, thus slightly increasing the spectrum of resources that engineering should utilize. IE is the particular exploitation of organizational, human factors, and management control concepts, but every assignment needs full reliance on the engineering sciences used by all engineers.

Industrial Engineering is recognized as a full partner in nearly sixty ECPD accredited institutions. In addition, the American Institute of Industrial Engineers is now a constituent member of the ECPD, the first addition in almost thirty years.

The development of new technologies and the complexities of management systems mean that evolution of management systems ("grow like Topsy") needs to be replaced by design of management systems. The day is past when an organization could assume that its new or existing products, services, outputs, and systems would emerge into better states to meet cost competition or provide greater service per dollar of input. The need is to study and design the integrating systems in an organization rather than merely permitting them to emerge.

### Why Is Industrial Engineering Needed?

In addition, the development of scientific and mathematical models for such situations has created a demand for engineers to design those integrating relationships and transformations that will effectively utilize human and physical resources within our society. This is best understood by noting that many basic laws, models, and theories represent the resources involved in a given management system. Thus a management system can involve an individual human being (pertinent theories are psychological and physiological), a single machine (mechanics, physics, etc. are pertinent), groups of people (sociology and administrative sciences), or many machines (operations research, cybernetics, and control theory).

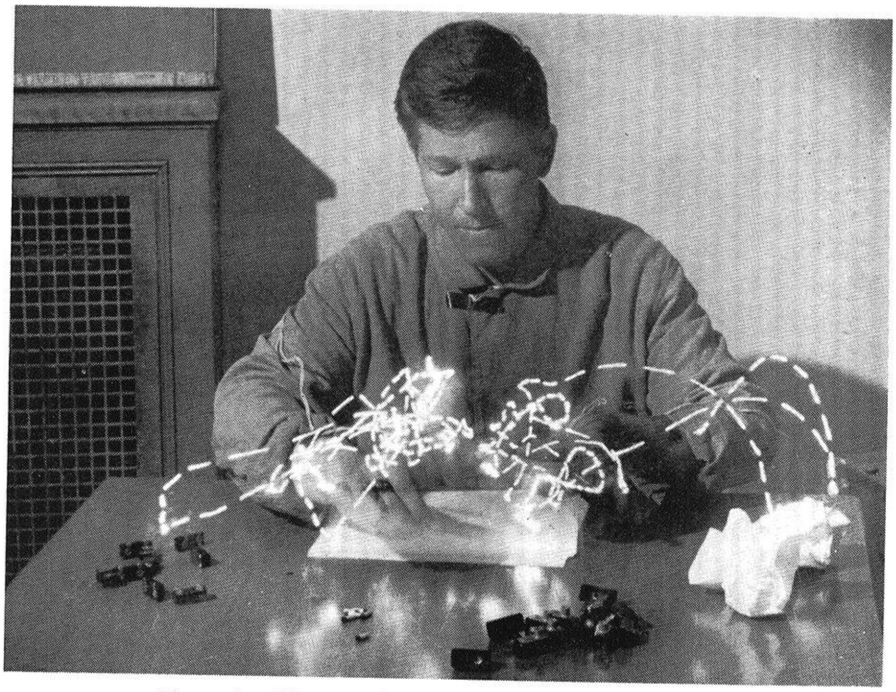


**Figure 1.—Chronocyclegraph analysis of assembly task.**

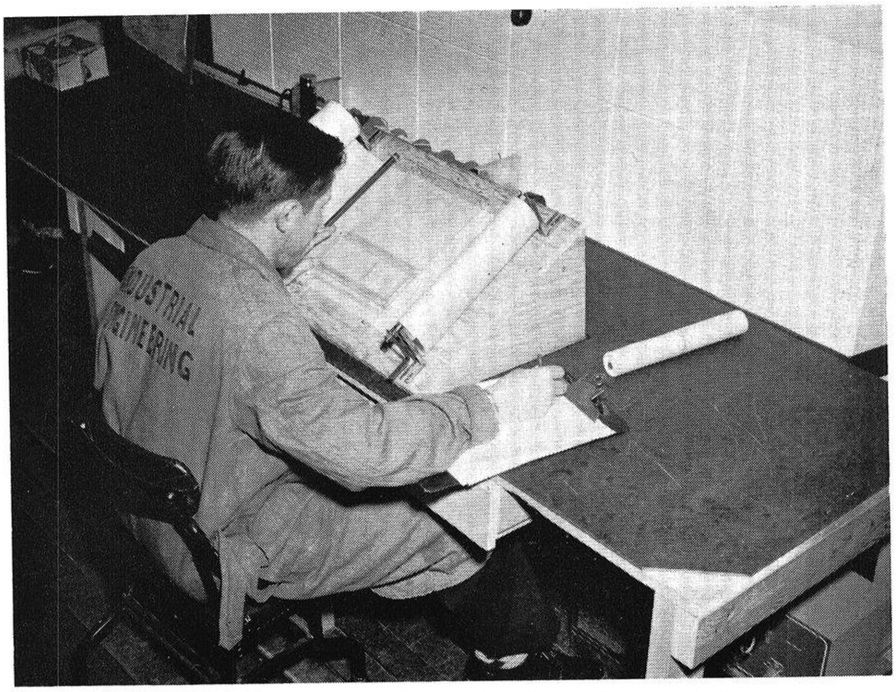



**Figure 2.—Special data analysis of oscillographic records from a system research project.**

The key engineering question is to find the means of transforming these basic laws, models, and theories into significant interrelating models. For example, a scientific finding is the 6½ and 7 bit per second information processing rate of human beings, but this needs to be tarnsformed into particular job design specificantions. Industrial Engineering research has done this by developing a thirteen factor model method to measure during design the amount of information to be included in a task.

Another illustration concerns the scientific availability of a basic queuing law or model to describe storage requirements between stations on a sequential production line. This model cannot, however, be solved. Thus, the IE in designing the system, needs to develop an algorithm, an heuristic approach, or a simulation model based on the queuing law.

#### What Are the Employment Opportunities?

Project directors, personnel directors, and managers of industrial and other types of organizations increasingly seek Industrial Engineers. They send many requests to the University of Wisconsin and many others for Industrial Engineering students. They advertize extensively for Industrial Engineers in professional, technical, and business publications.

These people also recognize the extent to which the demand for Industrial Engineers has mushroomed. Hospitals have indicated their needs for Industrial Engineers by fostering the formation of a separate Hospital Management Systems Society. The federal Civil Service has established a definition of Industrial Engineering to aid government agencies in hiring this kind of person. Defense establishments have many divisions and sections of Industrial Engineers. Industrial countries of the world seek many more trained Industrial Engineers. The activities of the American Institute of Industrial Engineers indicate the great growth in numbers of Industrial Engineers.

The demand far outstrips the supply, and the needs for IE appear to be growing geometrically while the supply increases linearly. The directions one can pursue in IE are also very broad: practitioners in any kind of industry; researcher into operating and management systems; consultant to various organizations, or even to the management of one organization; teachers in universities, technical institutes, and industry; and administrators of the IE function and Research and Development activities.

#### What Are the Bodies of Knowledge in the New IE Program?

The MSD approach requires several areas that effectively bring together old and new techniques in IE, drawing on the merits of each, into logical groupings regarding the objectives:

*Systems* concepts involve three broad ideas: design strategies (system design approach, effectiveness measures, system characteristics and theory), system evaluation (economic evaluation, decision theory), and system optimization (deterministic and stochastic, allocations, simulation).

*Management Control* concepts include three areas: control theory (feedback, adaptive, cybernetics), engineering statistics (sampling, experimental design, Bayesian analysis), and control system applications (cost, production, budget, inventory, quality).

*Organization* concepts involve such areas as organization theory, communication links and networks, group behavior, information processing, planning theory, information retrieval, material management, organization for automation, research and development theory, and technical project planning.

*Human Factors* concepts include man-machine systems, human work models, physiological cost models, work measurement, human information processing, and human performance studies.

The type of organization in which the Industrial Engineer will work—manufacturing, hospitals, agriculture, food processing, marketing, etc.—involves a fifth body of knowledge. Because there is no way of predicting the type of industry where each student will work, courses in this area of study will be optional. The student may use his elective hours if he does want courses concerning a specific technology for a type of organization. The Engineering College at Wisconsin, for example, has two strong programs in production and materials processing and others in hospital finance, agriculture, urban planning, and so forth are equally as valuable.

### What Principles Are Used in Developing Undergraduate and Graduate Programs in IE?

The new IE definitions must be supplemented with a broad view of total education. A sophisticated insight into IE shows how programs can be developed for the benefit of the *student*, not just for a narrow technical job. Every IE student at Wisconsin, at all levels, will receive:

*A fundamental education.* The subject matter will have wide applicability, not related to just one vocational pursuit. The faculty will not try to map its own interests or professional activities onto the student. The student should be able to apply his knowledge in any type of organization rather than in just one. No one knows the kinds of management systems that will need to be designed even ten years from now, so fundamentals are essential in the IE program. Thus basic engineering, as well as social and mathematical sciences are stressed.

*A broad education.* Teaching objectives will be to develop the abilities of the student/s mind in whatever direction it seeks. Many academic areas are available from which the student can select his program. All University resources, including the liberal arts, will be involved.

*A flexible education.* A minimal fixed program will be required of undergraduates, leaving many credits for free electives. Although a particular course or two might be required of all graduate students, all programs will be arranged to suit the interests and background of each student.

*An objective or engineering oriented education.* Both design and application are worthy pursuits. They constitute reduction-to-practice which is one of the three intellectual activities—analysis, synthesis, and reduction-to-practice. The virtues of design objectives will be maintained even though graduate level education introduces more research emphasis. There is no need to apologize to science and research, and engineers should use research when needed within a design program. This emphasis will help to design the simplest possible systems when hypercomplexity is a rampant characteristic of design in today's world. Engineers should seek to measure the simplicity index of a system.

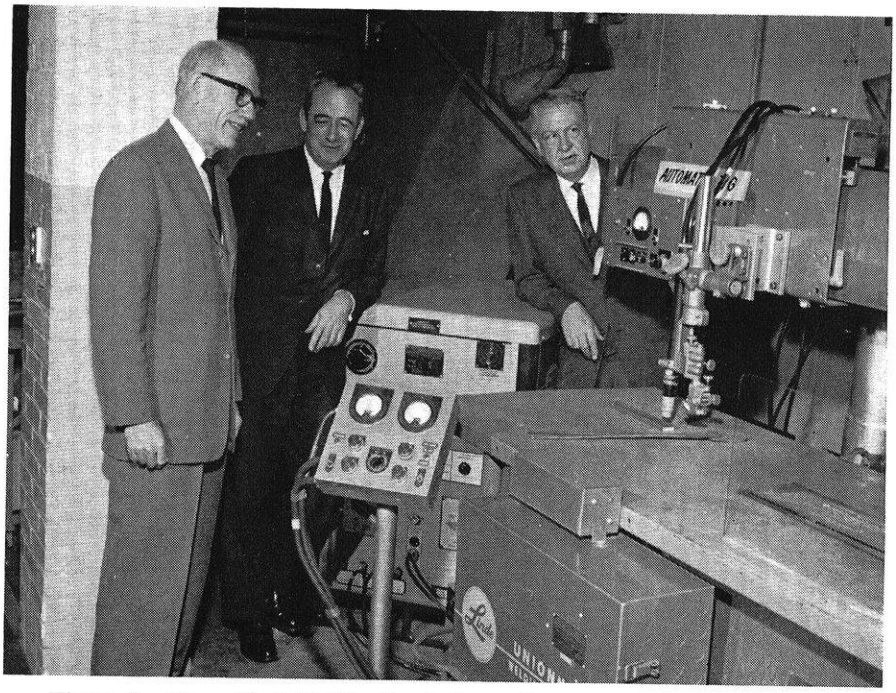



**Figure 3.—Dean Kurt F. Wendt of the College of Engineering, left, inspects equipment granted to IE Division, with Mr. Kenneth Noslandes, Director of Manufacturing for Union Carbide's Linde Division, and Professor E. H. Obert, chairman of the Mechanical Engineering Department.**

*An emphasis on courses as the start, rather than the completion, of education.* Life-long learning is an absolute must in today's changing technology. Every course will provide a vivid portrayal of unsolved problems and directions as well as the basic tools to be used in eventual solution of such problems.

*An emphasis on multi-variable decision processes.* Design objectives go beyond strict dollars and cents. After all, Russia is as interested in the objective of increasing productivity as is the United States. The difference between efficiency, the greatest technical output for a given input, and effectiveness, the optimum arrangement of *all* variables that will produce a more successful system than the technically efficient system, will be stressed. The latest techniques—computers, operations research and management sciences—are thus brought to play in the IE education.

### Are Interdisciplinary Programs Available?

The traditional freedoms for faculty and students at the University of Wisconsin have encouraged many joint programs. The new IE programs will follow in this pattern and provide many avenues for a student to follow: commerce, statistics, computer science, operations research, administrative science, industrial relations, and many other combinations. Several university-wide committees in which IE is active already exist to aid in developing such programs; for example, the Operations Research and Administrative Science Committee, Industrial Relations Research Institute, and the Social Systems Research Institute.

Thus, interdisciplinary efforts are a natural result of the IE role. *Internal* to engineering there are many possible ties in content and joint appointments: One electrical engineer received his MSEE with a thesis that concerned an IE instrumentation need. PERT and similar controls are fundamental theories to IE and important areas of application to CE. Process systems design in ChE and IE optimization developments in dynamic programming are finding great compatibility. Mass transit models developed by IE are simulated and used by traffic and transportation studies in CE. Production processing courses for the Milwaukee graduate program will be developed in cooperation with MME. A systems committee in the Engineering College involves IE with other branches in other joint programs. *External* to engineering, IE will have the usual engineering relationships and possible joint appointments with its science areas: Research into efficiency of simulation is conducted partly by consultations with operations research specialists. Experimental design and response surface research and teaching are joint efforts with statistics. Heat transfer and metallurgical structure bring physics and chemistry to IE. Econometrics and organization concepts in IE will work together in modelling staffing patterns and systems. Response and transfer characteristics of human beings bring psychologists and IE together. Computer Sciences and IE, along with EE, will need to interrelate in the growing area of information processing and retrieval.

### What Are the Specific Areas of Study in Which a Student May Concentrate?

As a summary, the graduate student may major in the concept areas—systems, management control, organization, and human factors, a combination of two or three of these, or in one of the interdisciplinary fields mentioned above. In this latter category, there are five specific interdisciplinary fields already available where an IE division staff member can be the major advisor in administrating a student's graduate program: Operations Research and Administrative Science, Engineering Statistics, Production Processes, Engineering Management, and Industrial Relations. Other interdisciplinary combinations can be arranged as needed for a specific student.

The undergraduate student will get a core engineering education (mathematics and statistics, sciences and computers, engineering sciences, and humanities) with approximately two courses in each of the four concept areas of IE. Several free elective courses will be available for him to pursue his own interests, which may take him into other fields of study or into greater depth in a specific field.

### Is Industrial Engineering the Best Name for What Is Offered?

There have been several suggestions to use names like Management Engineering, Management System Engineering, and Managerial Engineering to replace Industrial Engineering. Perhaps it is true that Management Systems Engineering best describes what is being done.

However, the "industrial" in IE must be interpreted on a broad basis, not just manufacturing. There are many industries other than manufacturing—telephone companies, meat processing, hospitals, department stores, government agencies, agriculture, nonprofit associations, defense bases, etc.—where management systems design or IE is essential, now being used, and receiving increased demands for service. "Engineering" also signifies design and the attendant responsibilities within design.

Therefore, Industrial Engineering is returned and is considered best because the term industry is and can be applied to large segments of common activity. IE is a recognized branch of engineering at many universities and IE is now a constituent part of ECPD. It is better to change the concept of Industrial Engineering as we are doing at Wisconsin than to develop a new name. This accords with what happens in each engineering branch when it periodically changes its emphasis yet retains its old name.

### What Is the Difference Between a High Quality Business Administration School and Industrial Engineering?

The outstanding business administration programs are integrating significant mathematical techniques within each of their areas—finance, marketing, production, personnel, insurance, real estate, legal, etc.—and requiring higher mathematical admission levels for students. Although quite helpful for them, their emphasis and objectives are still quite different—*operation* of a management system or organization compared with *design* for industrial engineering. The management group at Wisconsin's Commerce School agrees that even a specific course, like production planning and control, would have a completely different emphasis in IE than in Commerce, even though some of the same techniques might be involved. PERT, for example, would illustrate in the Commerce School how a manager could make operating decisions to reduce activity times in the critical path when a crisis arises, whereas PERT in industrial engineering is a network control system to be designed by using appropriate statistical concepts. Thus much more time would be spent on PERT in Commerce emphasizing the algorithms without exploring the rationale of the technique. Another example concerns inventory control where IE would design the decision rules concerning reorder points, order quantities, and safety stock, whereas commerce seeks to operate such systems with their decision rules, based on a good understanding of the mathematical foundations.

### What Type of Research Would Be Done?

Several broad categories of research will be involved in Industrial Engineering. Several examples of categories should illustrate this direction.

*Experimental research.* Determining the effects of various lubricating oils on tool life, establishing basic equations of human motions, controlled experiences of different design methodologies, collecting data on group decisions-making, etc.

*Analytical.* Developing models for straight line production facilities, establishing effective simulation procedures, developing search techniques for determining where to sample the ocean bottom for deposited minerals, investigating response services applicability, etc.

*Field.* Determining the operating characteristics of an inventory control system, establishing models for mass transit, determining re-

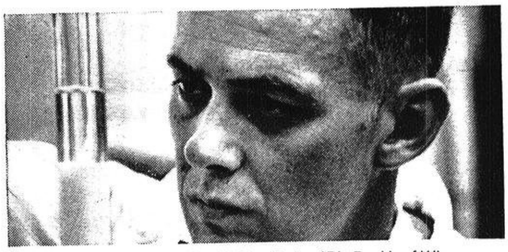
*(Continued on page 47)*

# This is Olin.

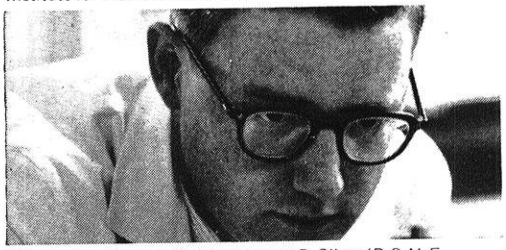
**Who is Olin?** Olin is a world-wide company with 39,000 employees developing, producing and marketing products from eight divisions: Squibb, Winchester-Western, Chemicals, Metals, Agricultural, Ecusta, Film, and Forest Products. With corporate offices in New York City, the firm operates 60 plants in 30 states with plants and affiliates in 37 foreign countries.

**What are the types of work at Olin?** Olin's great diversity provides a broad range of opportunities in the technical science and engineering fields. Emphasis is placed on the B.S. and M.S. chemical, industrial, mechanical and metallurgical engineering student for assignments in plant operations, process control, product development, quality control, production and marketing. Advanced degree M.S. and Ph.D. chemists and metallurgists work in central research and development improving existing products and developing new ones. Men with liberal arts and business backgrounds find rewarding career opportunities in the administrative functions, marketing, and some areas of manufacturing.

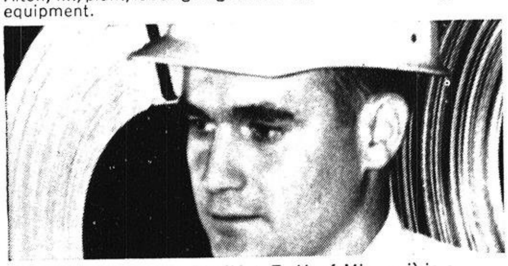
**What are the opportunities at Olin?** Olin recognizes people as its greatest asset. Your future growth and career is as important to the company as it is to you. You will be given thorough on-the-job training in your first job to prepare you to accomplish your career objective. You will learn and progress, according to your ability, working with skilled and experienced men in various assignments. For additional information about Olin, please contact your Placement Office or write Mr. Monte H. Jacoby, College Relations Officer, Olin, 460 Park Avenue, New York, N.Y. 10022.



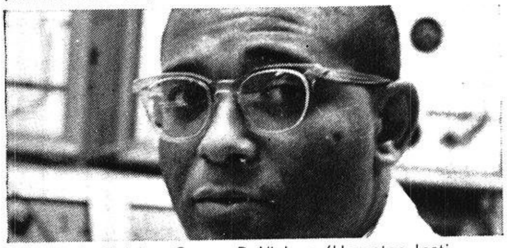
Squibb Division: Malcolm H. Von Salza (Ph.D., U. of Wisconsin) is a Senior Research Scientist at the Squibb Institute for Medical Research.



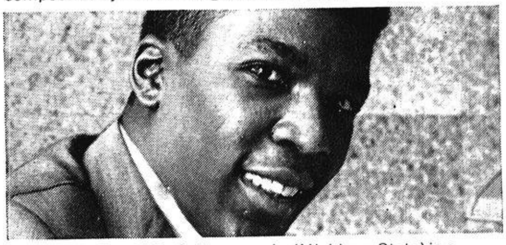
Winchester-Western Division: James P. Silver (B.S.M.E., Washington U.), a Senior Machine Designer at the East Alton, Ill., plant, is designing ammunition manufacturing equipment.



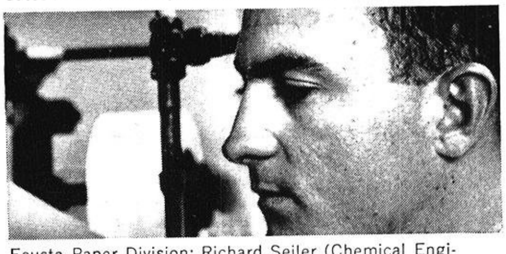
Metals Division: Larry Dix (Met. E., U. of Missouri) is a Senior Laboratory Metallurgist at the Brass Operations plant in East Alton, Ill.



Chemicals Division: George D. Vickers (Hampton Institute), research analyst at the Research Laboratories in New Haven, Conn. is studying the structure of organic compounds by nuclear magnetic resonance.



Corporate: Errold D. Collymore, Jr. (Michigan State) is a personnel staff assistant. He selects, screens, tests, evaluates and interviews professional job candidates.



Ecusta Paper Division: Richard Seiler (Chemical Engineering, Louisiana Poly.) is a Senior Chemical Engineer at the Research and Development laboratory in Pisgah Forest, N.C.

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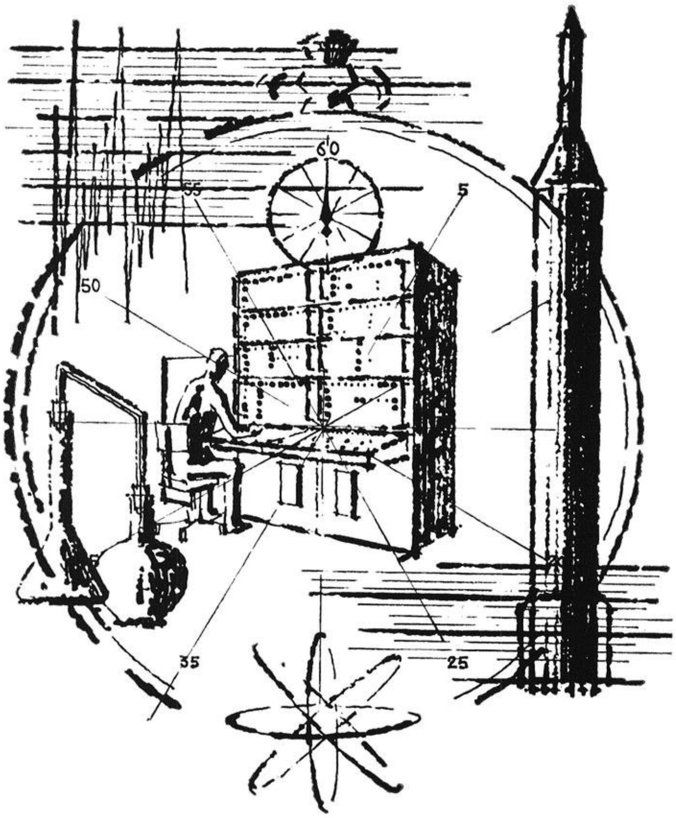


# SCIENCE HIGHLIGHTS

**Compiled by the Staff**

### DRAWING AID SAMPLES FOR ENGINEERS AND DRAFTSMEN

Cello–Tak, specialists in precision-fabricated graphic arts requirements, is offering a package of drawing aid samples to engineers and draftsmen at no charge. The package includes samples of transparent, self-adhering, micro-thin, matte-finish sheets of Cello–Tak Shading Film, Color Film and Transfer Type, as well as useful, informative booklets.

Cello–Tak Shading Film is used in the preparation of mechanical drawings and artwork requiring screen or shading effects. The shading film allows the artist to pre-select screen and tone without having to rely on word description, to printer or engraver, which, ordinarily, can be misinterpreted. The film, engineered for sharpness, opacity and uniformity, offers the opportunity to see, in advance, what a particular screen and tone will look like before reproduction. The acetate sheets are printed on micro-thin, transparent, matte-finish film with "touch and stick" pressure-sensitive, heat-resistant adhesive backing that is easy and clean to work with.

The film takes pencil, ink and water color smoothly, without crawling and can be used in any printing process, including blue-print and ozalid methods. The sheets are available in a complete range of screens, tones, patterns, textures, lines and symbols from a 10 line screen to an 85 line screen, in tones from 10% to 60% in each line screen, in jumbo 13″ x 20″ sheets, priced at $1.10 each, or 10″ x 13″ half-sheets, at 60¢ each.

Cello–Tak Color Film is used to add matched, standard printing ink colors to layouts, drawings and


final art, without the danger of specifying colors not available to printers and they ensure an accurate preview of what color will look like before a plate is made or color proofs are pulled. The Color Film is supplied on micro-thin, matte-finish acetate, featuring Cello–Tak's unique "touch and stick" pressure-sensitive, adhesive backing and comes in 220 colors and tints. Sheet sizes range from 9″ x 12″, at 60¢ a sheet, to 12″ x 18″, at $1.00 a sheet or in large 18″ x 24″ sheets at $2.00 each. Gold, silver and fluorescent colors are slightly higher.

Cello–Tak Transfer Type is utilized for meticulous lettering with a maximum of clarity, a minimum of work and it provides the least expensive way to add type, or hand-lettering, to mechanical drawings, layouts, presentations, exhibits or any art medium.

The letters can be applied to practically any smooth surface, such as wood, paper, cardboard, plastic, glass, metal or acetate photos and become part of the finished work simply by lightly rubbing them down with a pencil point or stylus.

The sheet is transparent and easy to handle. If an error is made, the letters can be removed with masking tape and guide lines can be erased with a kneaded eraser without harming the lettering.

The sample package of Cello–Tak shading Film, Color Film and Transfer Type, with booklets, can be obtained at no charge to engineers and draftsmen by requesting them from your art supply dealer or by writing Cello–Tak Mfg. Inc., c/o Sample Package Dept., 35 Alabama Ave., Island Park, L.I., N.Y.

## NASA ASKS SCIENTISTS TO PROPOSE SPACE FLIGHT REQUIREMENTS

A major portion of the National Aeronautics and Space Administration's semi-annual publication inviting scientists to propose space flight experiments is devoted to Apollo manned missions, some of which are under study.

The publication, "Opportunities for Participation in Space Flight Investigations," gives 44 of its 107 pages to the Apollo missions.

Detailed descriptions and timetables covering a wide range of NASA flight projects, manned and unmanned, are provided in the publication. It is prepared and distributed domestically by the NASA Office of Space Science and Applications and distributed internationally by the NASA Office of International Affairs.

Copies are available from the Superintendent of Documents, US. Government Printing Office, Washington, D.C., 20402, for 60 cents.

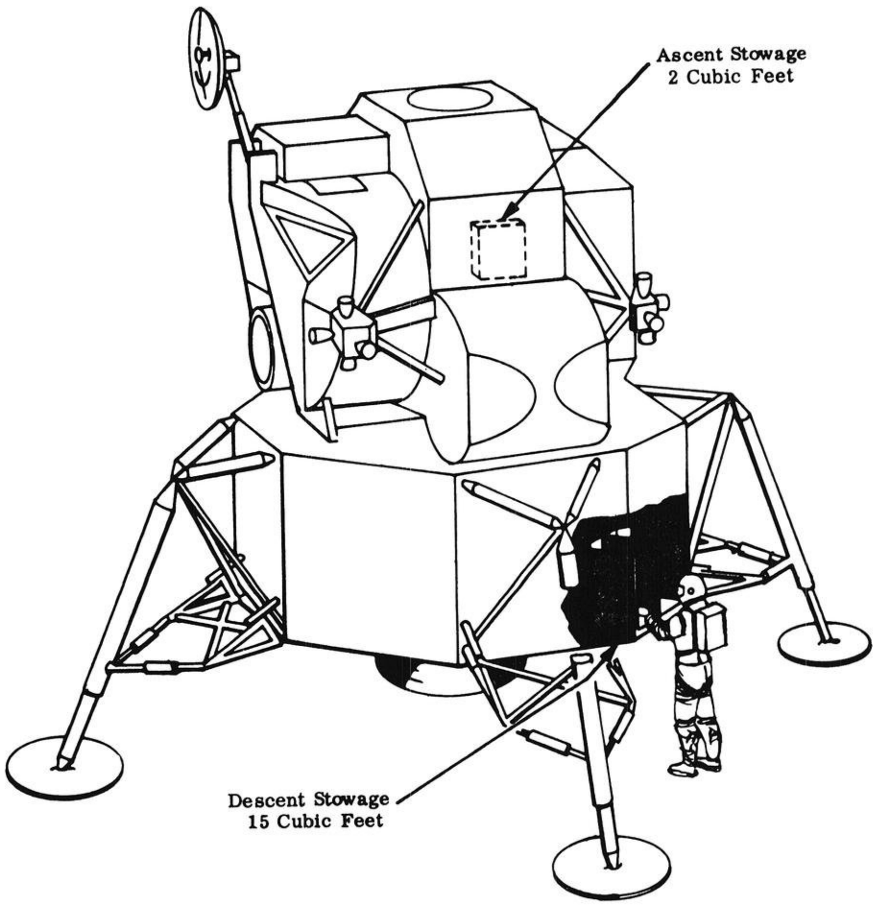
The opportunities include placing scientific instruments in available space on unmanned satellites and orbiting observatories, sounding rockets, balloons, the NASA Convair 990 and X-15-A2 research planes, lunar and Martian exploratory missions.

Proposals are sought for including experiments on spacecraft in such major NASA projects as Lunar Orbiter, Surveyor, Voyager, Orbiting Solar Observatory, Advanced Orbiting Solar Observatory, TIROS, Nimbus, Explorers and a joint U.S.–Canadian satellite, ISIS.

Flight dates generally cover the period from 1966 through 1972. Deadlines for proposals vary according to each project.

While the publication describes opportunities on missions planned for the near future, the scientific community is invited to also propose investigations which would require missions not presently planned and to submit design studies for future scientific investigations.

Proposals are reviewed and evaluated from the standpoint of scientific merit and technological feasibility, the competence and experience of the investigator, assurance of institutional support, and the scientific adequacy of whatever apparatus is proposed.




This National Aeronautics and Space Administration sketch shows areas where scientists may pack experiments aboard the Lunar Excursion Module of the Apollo manned lunar landing mission. The 17 cubic feet of space available for scientific equipment is divided between the descent stage (15 cubic feet) and the ascent stage (two cubic feet). The two cubic feet are reserved for lunar samples that will be returned to Earth. The descent stage and its stowed equipment will be left on the Moon. Various small spaces on the ascent stage may allow a total of about one cubic foot for the return of other equipment.

## NEW STRUCTURAL DESIGN TECHNIQUE PROMISES SAVINGS IN BUILDING CONSTRUCTION

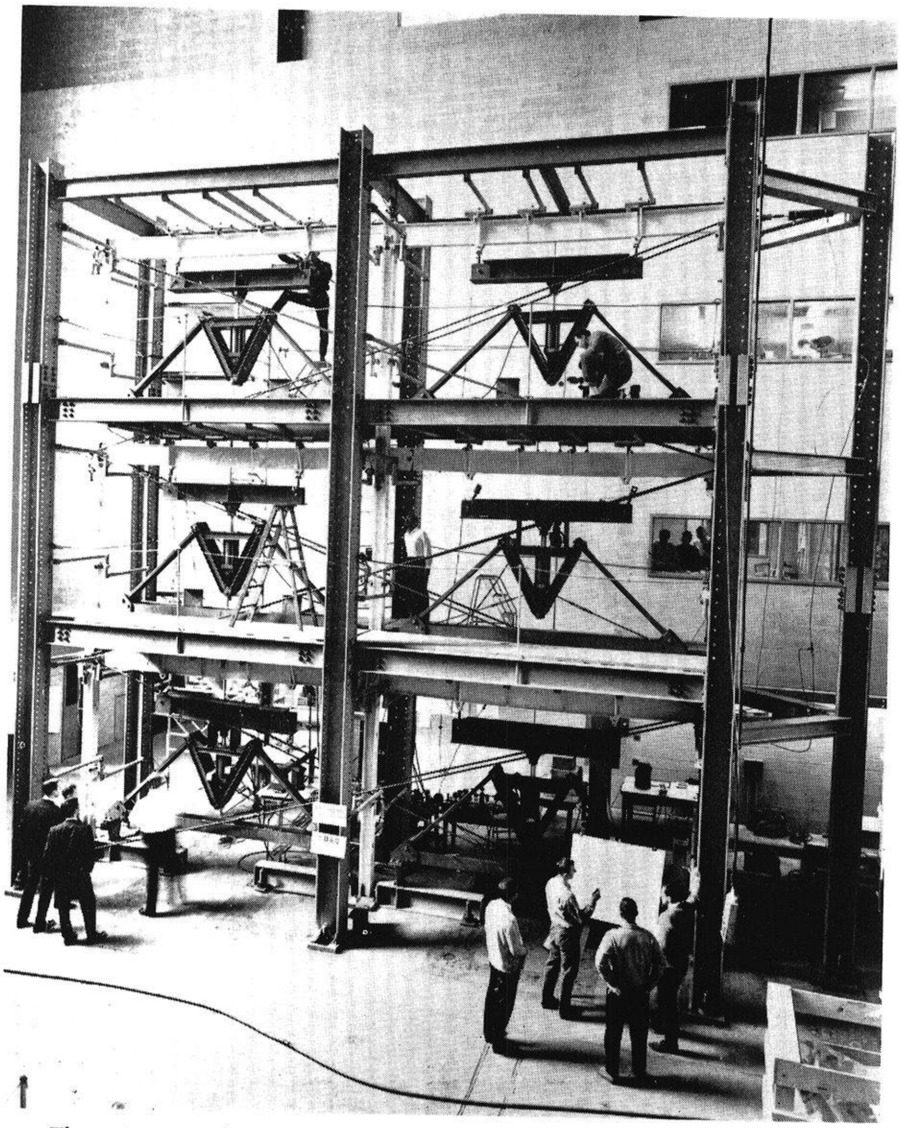
Improved designs are now possible in construction of steel-frame high-rise buildings as a result of recently completed research on plastic design—an improved structural analysis technique that takes advantage of the substantial reserve strength of steel beyond its yield point.

A primary advantage of plastic design is that it gives a designer a more realistic understanding of how a building's complete structural system responds to the loads it must carry.

Several economies can be gained with plastic design, including cost savings resulting from greater freedom this technique gives the designer to select members that produce a balanced, economical design. It is expected that savings resulting from plastic design will be approximately 10 to 20% of unfabricated materials cost.

Until 10 years ago steel-frame buildings were designed on the basis of "elastic theory". In this, engineers design a building's structural members such as beams and columns so that stresses are kept below specified limits in the elastic range of the material.

Beyond this elastic range, steel deforms at a higher strain rate but still has a substantial capacity to carry additional loads. Plastic design recognizes this reserve strength and uses it to advantage in selecting the sizes of beams and columns in a structure. Conse-



Three-story, two-bay test frame was used during research on plastic design of multi-story buildings conducted at Fritz Engineering Laboratory, Lehigh University, under the sponsorship of American Iron and Steel Institute and other organizations. The test frame is 30 ft. high and 30 ft. wide and is constructed of 12B16.5 beams, 6WF20 columns at each end and 6WF25 column in the middle. Hydraulic gravity-load simulators mounted in a special support structure apply loads to the frame while more than 100 strain gages and other instruments detect and record reactions for later analysis.

quently all structural members are designed so that they work together at their maximum strength.

Another advantage of plastic design is a substantial potential reduction in design time. And where plastic design results in less weight for a building, further economies can be gained in steel transportation and handling costs and in foundation construction costs.

Owners, builders and financers of high-rise buildings such as offices, apartments, hotels, hospitals and educational facilities will benefit from plastic design as engineers and architects become familiar with this technique and apply it in their designs. A special conference will be held at Lehigh University, Bethlehem, Pa., this summer for practicing engineers and engineering educators to acquaint them with the new design theories and with practical methods for applying them.

Research in plastic design at Lehigh began in 1947. By the mid-1950's enough tests had been performed and enough information accumulated to formulate plastic design methods for one and two-story buildings. In 1958, building codes in the U.S. were revised to permit plastic design in such buildings.

The recently completed research at Lehigh University, sponsored by American Iron and Steel Institute and other organizations, has produced additional information from which new structural design concepts were evolved. These new data now makes it possible to extend the plastic theory to the design of multi-story steel-frame buildings.

The economic benefits offered by plastic design will be important in the construction of commercial and institutional buildings as well as structures for industrial use, public utilities, government and other public buildings, research facilities and parking structures.

### TALK TO THE 1620

Communicating with computers is the theme of an International Student Essay Contest sponsored by SIGPLAN, the Special Interest Group on Programming Languages of the Los Angeles Chapter of the Association for Computing Machinery. The Group is offering a $100 first prize, a $50 second prize, and a $25 third prize. The contest rules are:

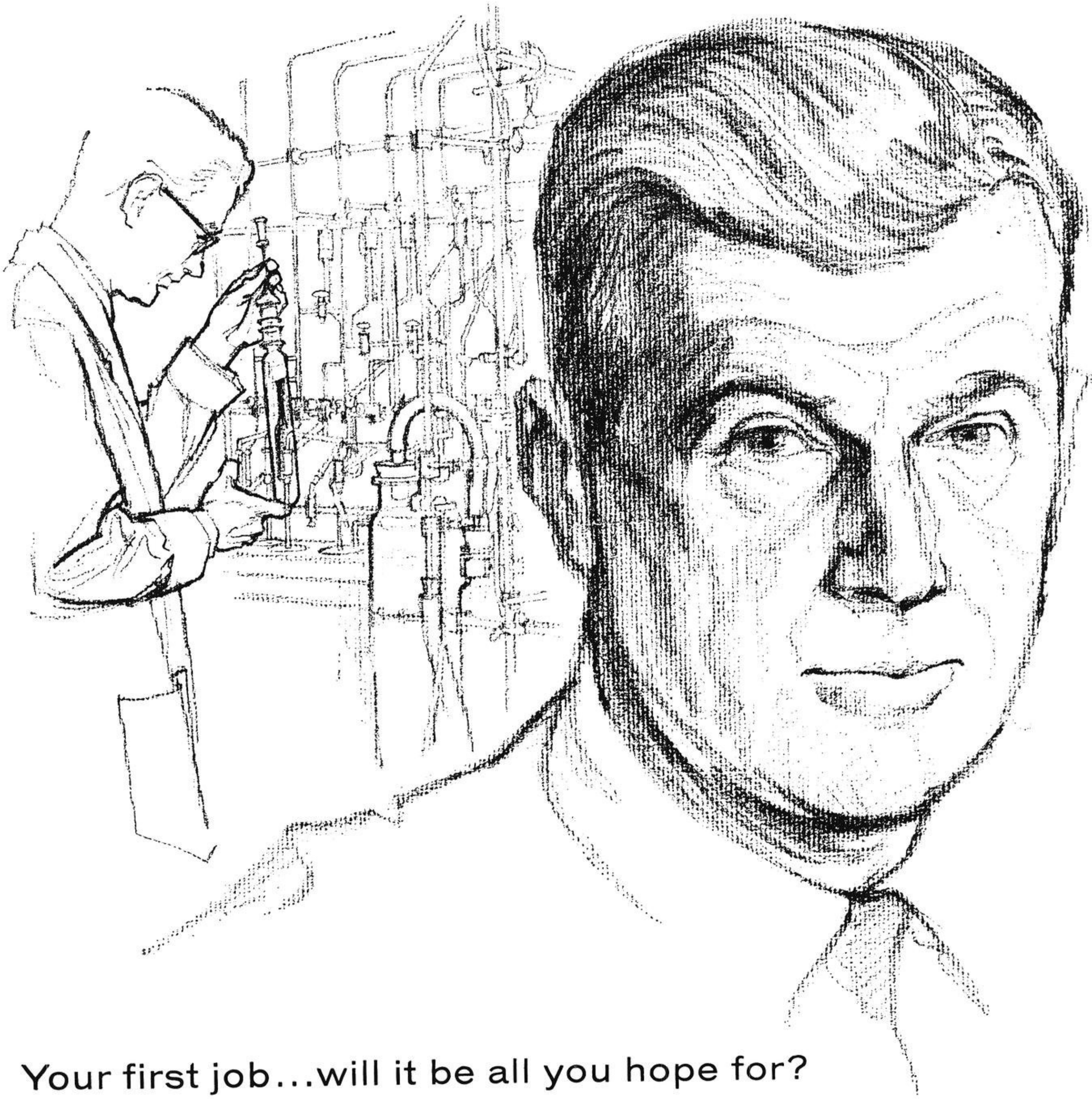
Any full-time college or university student, graduate or undergraduate, may enter.

Entries must be in English, and should deal with the technical, philosophical, or social aspects of communicating with digital computers, with emphasis on the languages that may be used to direct or control the computer's operation. Entries must be legible (preferably typewritten) and may be any length up to ten thousand words. Entries must not have been previously published, but they need not report original research.

Entries will be judged on interest, originality, and clarity of thought and style. Duplicate prizes will not be awarded.

Entries must be received by the contest chairman no later than 3 January 1966. Awards will be made in February 1966 and will be publicly announced as soon thereafter as possible. Only the winners will be individually notified, and no entries will be returned unless accompanied by an addressed-to-self, stamped envelope.

For more information, write, or send your entry to: Chairman, SIGPLAN Essay Contest, Los Angeles Chapter, ACM, P.O. Box 892, Pacific Palisades, California 90272.



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# BIG OPPORTUNITIES

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The diversity of Shell's interests is highlighted by several recent achievements of Shell people in providing new products, processes and techniques in the petroleum and chemical industries. These include: a method of drilling and completing wells in water more than 1,000 feet deep; a medicine for the rapidly expanding animal health field; a synthetic rubber having both the resilient qualities of rubber and the manufacturing versatility of plastic; a retail marketing installation, the Shell Motorlab, for the precise diagnosis of automobile ailments; and a catalyst for rocket fuels.

Shell is experiencing such dynamic growth that it has become the fourteenth largest industrial corporation in the United States in terms of sales. Growth is bringing a host of new challenges—and opportunities—for those who set for themselves the highest standards of performance. At Shell, they include graduates in many disciplines, particularly engineering, chemistry, geophysics, physics, geology, mathematics and business administration.

Shell representatives will be glad to answer your questions about the Shell Companies when they visit your campus. You also will receive full consideration if you send a résumé to Manager, Recruitment Division, The Shell Companies, Dept. E , 50 West 50th Street, New York, N.Y. 10020. *An Equal Opportunity Employer*

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# ON THE CAMPUS

### FORTY ENROLLED IN AIM

Wisconsin engineers who want to up-date their professional training while they stay on the job are taking four new off-campus courses this fall under the University of Wisconsin AIM mechanical engineering program.

The AIM (Articulated Instructional Media) classes, which began in September, include automatic controls, advanced thermodynamics, graduate heat transfer, and advanced heat transfer.

"We hope to reach engineers in every company in the state with our expanded program this fall," said Prof. George Sell of the UW mechanical engineering department.

"By up-dating engineers on the job we are promoting both the engineering field and Wisconsin business and industry," Prof. Sell said. "Too often Wisconsin engineers have had to leave their jobs to attend on-campus classes or have had to move to jobs out of state where graduate classes were available at nearby schools."

Under the AIM mechanical engineering program, students complete assignments at home and mail them to Madison for correction by University professors. Students take mid-semester and final examinations at Madison with resident students enrolled in the same classes.

A weekly telephone hookup and visits by instructors to the student's community are regular features of the AIM Program. Each AIM student also is given personal counseling by his major professor.

The AIM mechanical engineering program grew out of a class begun in 1963 at the Trane Company in La Crosse and was expanded last spring to provide offerings to students throughout the state. At the present time some 40 engineers are taking graduate classes through the program.

For more information, write Prof. Edward Obert, Chairman, Mechanical Engineering Department, 1513 University Avenue, University of Wisconsin, Madison 53705.

### WISCONSIN–MONTERREY EXCHANGE PROGRAM BEGINS FIFTH YEAR

Six undergraduate engineering students from the University of Wisconsin will spend the coming year studying "south of the border" in Monterrey, Mexico.

Two students and two faculty members from the Instituto Tecnologico y de Estudios Superiores in Monterrey will spend the 1965–66 academic year at the UW College of Engineering as part of the exchange program.

Four of the Wisconsin students are from the University's Madison campus and two from the Milwaukee campus. This is the first year that students from UWM have participated in the cooperative program.

The Wisconsin students who left in July to spend their junior year in Monterrey are: Fred Krautkramer, Thiensville, and Thomas Pierce, Milwaukee, both studying electrical engineering on the University's Milwaukee campus; and James Drost, New Auburn, and Richard Robert, Madison, both metallurgical engineering, and Charles Meyer, Colby, nuclear engineering, and Ross Wilcox, New York, chemical engineering, all from the Madison campus.

Coming to Wisconsin this year will be Monterrey engineering students Paul Tellez and Jose Usabiaga, both mechanical engineers, and faculty members Carlos Trevino, electrical engineering, and Jose Manrique, mechanical engineering.

The Wisconsin–Monterrey exchange program, inaugurated in 1961 under a Carnegie Corporation grant, is the first cooperative venture in engineering education between the U.S. and Mexico. In the past four years 24 UW engineering students have spent a year at Monterrey and 10 students and faculty members in engineering at Monterrey have studied and done research at the University in Madison.

# CHRONOLOGICAL LISTING OF COMPANIES INT

*Interviews held in Rooms 1148 A–M, unless otherwise noted. (Specific room assignments will be posted on the day of the interview on the Placement Office bulletin board, which is located between Rooms 1144 and 1148.)*

*NOTE: This list is subject to change. Be sure to check the Engineering Placement Office bulletin boards for latest information. Notices will be placed on these bulletin boards one week in advance of a company's visit. Company folders likewise are placed in the racks in the Engineering Placement Office, Room 1150, one week in advance of their visit.*

**Monday, October 11**

All Steel Equipment P.M.
DuPont (1 of 5 days) PhD's
Fisher Governor
Hercules Powder, Allegany Ballistics
Illinois State Dept. of Public Works
Martin—Denver & Baltimore
Pittsburgh Plate Glass (Chemicals)
Rohn & Haas A.M. (1 of 2)
Stanley Engineering P.H.
United Aircraft Research (1 of 2)
United States Steel (1½ sch. A.M.)
Bureau of Reclamation (1 of 2 days)

**Tuesday, October 12**

Barber Colman
PMC—Hudson Sharp P.M.
General Electric (1 of 2)
Goodyear—Phd's
Hamilton Standard (1 of 2)
Link Belt
Oilgear
Raytheon (1 of 2)
Swift & Co. P.M. (1 of 2)
Bureau of Reclamation (2 of 2)

**Wednesday, October 13**

Allied Chemical—PhD's
California State Government
Carnes P.M.
Central Illinois Gas P.M.
Continental Oil (1 of 2)
Firestone Tire & Rubber Research—PhD's P.M.
General Electric (2 of 2) A.M.
Hamilton Standard (2 of 2)
Institute of Paper Chemistry P.M.
Iowa Illinois Gas
Kelsey Hayes
Raytheon (2 of 2) A.M.
United Airlines
Wayne County Road Commission P.M.

**Thursday, October 14**

Bendix
Collins Radio (1 of 2)
Corning Glass—PhD's A.M.
Corning Glass (1 of 2)
Fairbanks Morse
Caeral Millis (1 of 2)
Goodman Mfg. P.M.
Nekoosa Edwards
Republic Steel (1 of 2)
Republic Steel Research (1 of 2)
University of Illinois Grad. School A.M.
Youngstown Research & Development
U.S. Army Engr. District

**Friday, October 15**

American Appraisal
Amoco Chemicals Corp.
Anheuser Busch A.M.
Belle City Malleable
Collins Radio (2 of 2)
Corning Glass (2of 2)
Hupp Corp.—Richard Wilcox P.M.
Roy C. Ingersoll Research A.M.
Inland Steel Co.
Johns Mansville
Johnson Wax
John Oster Mfg. P.M.
Ryerson P.M.
Republic Steel Research (2 of 2)
Whirlpool (2 of 2)

**Monday, October 18**

Charmin Paper (1 of 2)
Crane
Crown Zellerbach
General Dynamica—Electric Boat Div.
Johnson Service
Kearaey & Tracker
Motorola (1 of 2)
Richfield Oil (1 of 2) P.M.
Scotts P.M.
Shell Development (Calif.) A.M.
Secony Mobil (1 of 2)
Sunbeam
Upjohn (1 of 2)
Coast & Geodetic A.M.

**Tuesday, October 19**

Boeing (1 of 2)
Charmin Paper (2 of 2)
Consumers Power A.M.
Dow Chemical (1 of 4)
DuPont (1 of 4)
General Dynamics
Kohler (1 of 2) P.M.
Motorola (2 of 2) A.M.
Shell Oil Development (Texas) (2 of 2)
Stauffer Chemicals A.M.
U.S. Rubber Research P.H.
Newport News Shipbldg.

**Wednesday, October 20**

American Oil ($ of 2)
Amoco Chemicals
Boeing (2 of 2)
Continental Can Res. A.M.
Dow Chemical (2 of 4)
Kaiser Chemicals A.M.
M.I.T. Lincoln Labs
Pan American Res. P.M.
Parker Hannifia P.M.
Philco (Ford Aeronutronics)
Phillips Petroleum (1 of 2)
Pure Oil (1 of 3)
Rockwell Standard P.M.
Underwriters Labs

**Thursday, October 21**

Amer. Agr. Chem. P.M.
American Oil (2 of 2) if needed
Dayton Power & Light
Dow Chemicals (3 of 4)
Dow International
DuPont (3 of 4)
Eastman Kodak—PhD's
International Nickel (Huntington Alloy
Mitro Corp. P.M.
Northern States Power
Phillips Petroleum (2 of 2) A.M.
Pittsburgh Plate Glass (a.) (1 of 2)
Raychem Corp.
Westinghouse (1 of 2)

**Friday, October 22**

Battelle Memorial (2 of 2) A.M.
Dow Chemical (4 of 4) A.M.
DuPont (4 of 4) A.M.
Ethyl Corp. (1 of 2)
Globe Union
Green Bay Pkg. P.M.
Ingersoll Rand
Interstate Power P.M.
Koehring
Los Angeles County
Mead Johnson (2 of 3)
Merck & Co. P.M.
United Technology
Vilter Mfg. P.M.
Westinghouse (2 of 2)

**Monday, October 25**

Abbott Labs (1 of 2) P.M.
Allen Braddley
American Oil
Chemical Abstract Service A.M. Chemistry; P.M. & P.M. Bascom
Deere & Co. P.M.
Dow Corning (1 of 2)
Ethyl Corp. (2 of 2)
General Electric (1 of 2) PhD's
Goodyear Aerospace (1 of 2)
Goodyear Tire & Rubber (1 of 2)
Ingersoll Milling Machine P.M.
Johnson & Johnson (1 of 2) A. M.
Mallinckrodt Chemicals (1 of 3)
Perfex P.M.
U.S. Rubber (1 of 2) P.M.
Woodward Governor A.M.
N.A.S.A. Ames Res. A.M.

**Tuesday, October 26**

Alcoa
Amphenol Corp. (1 of 2)
Bell System (1 of 3)
  AT&T
  Bell Labs
  Sandia
  Western Electric
  Wisconsin Telephone
Esso Research & Engr. (1 of 4)
Goodyear Aerospace A.M. (2 of 4)
Goodyear Tire & Rubber (2 of 2) A.M.
Mallinckrodt Chemicale (2 of 3) A.M.
Standard Oil of California (1 of 4)
Sundstrand (1 of 2)

**Wednesday, October 27**

Bell System (2 of 3)
Esso Research & Engr. (2 of 4)
Goss Co. P.M.
Sinclair (1 of 2)
Standard Oil of Calif. (2 of 4)
Sundstrand (2 of 2) A.M.
West Bend Co.

**Thursday, October 28**

American Cyanamid (1 of 2) A. M.
Esso Research & Engr. (3 of 4)

## …EWING ON CAMPUS, FIRST SEMESTER, 1965–66

B. F. Goodrich
Honeywell (1 of 2)
International Harvester (3 of 4)
Marathon Electric P.M.
Sinclair (2 of 2)
Standard Oil of Calif. (3 of 4)
Torrington
Wisconsin Public Service

**Friday, October 29**

Armco Steel
Beloit Corp.
Cornell Aeronautical P.M.
Falk Corp.
Honeywell (2 of 2)
Institute of Paper Chemistry P.M.
International Harvester (4 of 4)
McDonnell Aircraft (2 of 2)
Peoples Gas & Light A.M.
Pillsbury A.M.
Standard Oil of California (4 of 4)
Stauffer Chemicals—PhD's—Chemistry

**Monday, November 1**

Bemis Bros. Bag
Container Corp. of America (1 of 2) P.M.
Corn Products (1 of 2) P.M.
Douglas Aircraft & Missiles (1 of 2)
General Telephone (1 of 3) A.M.
Rocker Chemical
Hughes Aircraft
Shell Companies (1 of 3)
Texas Instruments (1 of 2)
U.S. Naval Ordnance A.M. (China Lake)

**Tuesday, November 2**

Louis Allis Co.
American Can (1 of 3)
Chryster Outboard P.M.
Douglas Aircraft & Missiles (2 of 2) A.M.
Firestone Tire & Rubber (2 of 3)
General Motors Corp. (1 of 4)
Hail Co. (1 of 2)
Shell Companies (2 of 3)
Swift & Co. Research (1 of 2) P.M.
U.S. Navy—Bureau of Yards & Docks A.M.

**Wednesday, November 3**

A.C. Spark (2 of 4)
American Can (2 of 3)
City of Milwaukee
Firestone Tire & Rubber (3 of 3) A.M.
General Motors (2 of 4)
Interlake Steel A.M.
I.B.M. (1 of 2)
Eli Lilly (1 of 2) P.M.
Minnesota State Highway
Outboard Marine
Applied Physics Labs (1 of 2) P.M.

**Thursday, November 4**

A. C. Spark (3 of 4)
Applied Physics (2 of 2)
American Can (3 of 3) A.M.
Baxter Labs (2 of 2) A.M.
Commonwealth Edison P.M.
Congolium Mairn P.M.
Eaton Mfg. A.M.
Fansteel Matallurgical (1 of 2)
General Foods
General Motors (3 of 4)
Indiana Flood Control A.M.
I.B.M. (2 of 2)
Seeburg P.M.

**Friday, November 5**

A. C. Spark Plug (4 of 4)
DeSoto Chemicals A.M.
General Motors (4 of 4)
Manitowoc Engineering P.M.

**Monday, November 8**

Argonne Labs P.M.
Atlantic Refining (1 of 2)
General Atomic
Hewlett Packard
Lubrisol P.M.
National Distillers
Radio Corp. of America (1 of 2)
Reynolds Metals (1 of 2)
Socony Research (N.J.) (1 of 3)
Union Carbide Chemicals (1 of 2)
Wisconsin Power & Light (1 of 2)
Wisconsin State Highway

**Tuesday, November 9**

Archer Daniels Midland (1 of 3)
Babcock & Wilcox
Caterpiller (1 of 2)
Chicago Bridge & Iron
Emerson Electric
RCA (2 of 2) A.M.
Reynalds Metals (2 of 2) A.M.
Square D (1 of 2)
A. E. Staley P.M. (2 of 2)
Union Carbide Chemicals (2 of 2)

**Wednesday, November 10**

American Electric Power
Caterpillar (2 of 2)
Owens Corning Fiberglass A.M.
Snap-on-Tools
Square D (2 of 2)
Texaco Univac (1 of 2)
Xerox P.M.
U.S.D.A.—Soil Conservation P.M.
U.S. Air Force (2 of 2)
Anderson Clayton

**Thursday, November 11**

Amsted Industries (1 of 2) P.M.
Atlantic Research (1 of 2)
Burroughs
Chevron Research (1 of 2)
Celanese Corp. P.M.
Ford Motor (1 of 2)
Jet Propulsion Labs A.M.
Jostens P.M.
Owens Illinois (1 of 2)
Parke Davis (1 of 2) A.M.
Procter & Gamble (1 of 2)
Scott Paper (1 of 2)
UCC—Linde Div. (1 of 2)
Central Intelligence Agency (3 of 3)

**Friday, November 12**

Allis Chalmers
Bechtel
Brunswick (2 of 2) P.M.
Chevron Research (2 of 2)
Ford Motor (2 of 2)
Mead Corp. (2 of 2) P.M.
Northern Natural Gas
Owens Illinois (2 of 2) if needed
Procter & Gamble (2 of 2)
Scott Paper (2 of 2) A.M.
UCC—Linde Div. A.M. (2 of 2)
Waukesha Motors
Wyandotte Chemicals A.M.

**Monday, November 15**

Automatic Electric
Automatic Electric Labs
City of Detroit (1 of 2) A.M.
Clark Dietz Painter & Assoc.
Consolidated Papers (1 of 2)
FMC—American Viscose (1 of 2) A.M.
Arthur D. Little A.M.
Monsanto Chemicals (1 of 2)
North American Aviation (1 of 3) P.M.
Atomics
Autonetics
Los Angeles
Rocketdyne
Space & Information
Malco Chemicals A.M. (1 of 2)
Universal Oil Products
UCC—Chemicals—PhD's (1 of 2)
West Virginia Pulp & paper

**Tuesday, November 16**

Chrysler (2 divisions)
Eastman Kodak (1 of 2)
Gulf Research & Development
M.W. Kellogg P.M.
Minnesota Mining & Mfg. (1 of 4)
Monsanto Chemicals (2 of 2)
Nalco Chemicals (2 of 2) if needed
National Cash Register A.M.
North American Aviation (2 of 3) 5 divisions

**Wednesday, November 17**

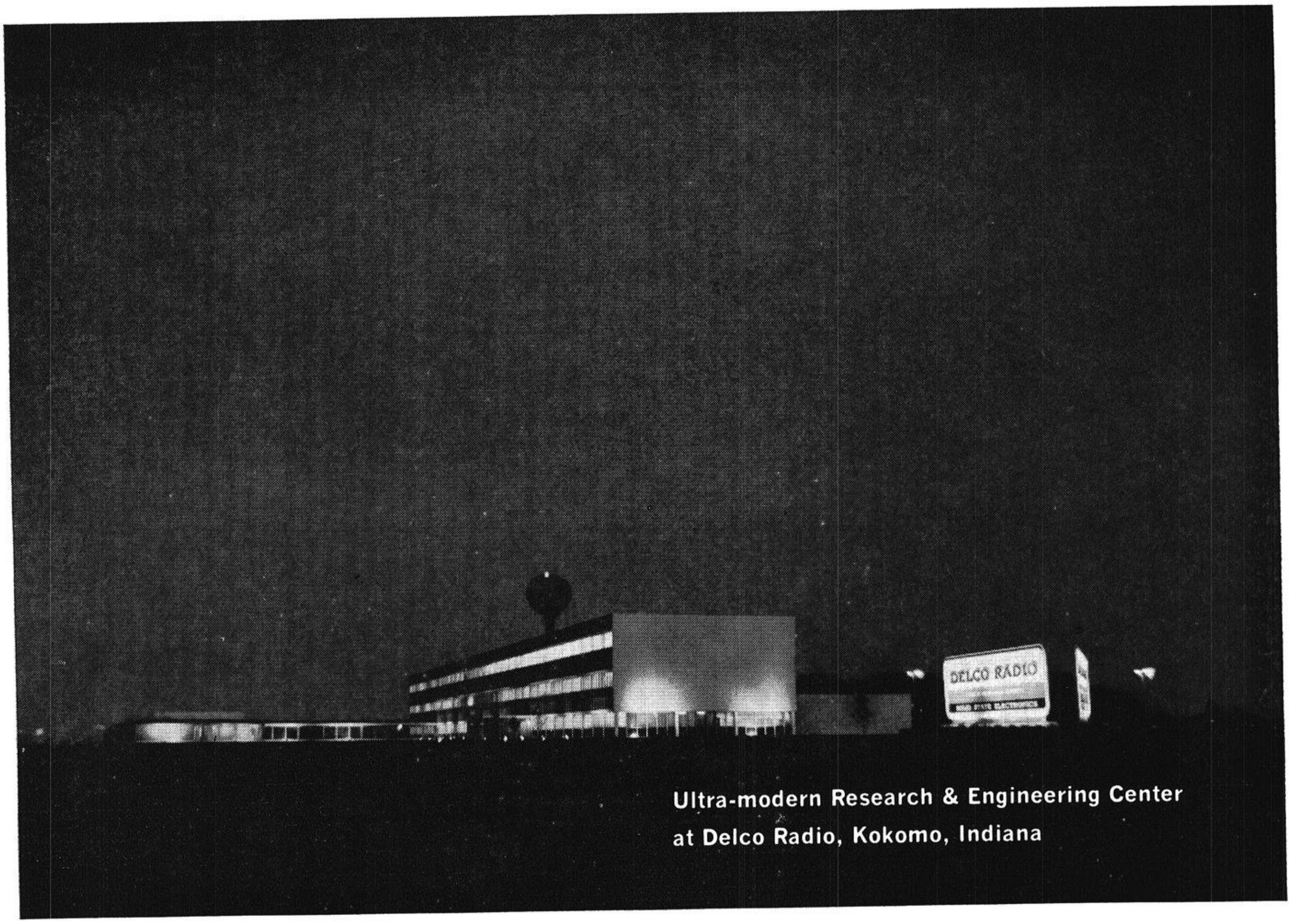
American Air Filter
Clinton Corn Processing P.M.
Eastman Kodak (2 of 2)
Factory Mutual Engr.
Harnischfeger (2 of 2)
Geo. A. Hormel (2 of 2) A.M.
International Minerals (2 of 2) A.M.
Minnesota Mining & Mfg. (2 of 4)
North American Aviation—PhD's 5 divisions (3 of 3)
Trane Co. (1 of 3)
Zenith

**Thursday, November 18**

Continental Oil Co.
Control Data
Fabri-Tek A.M.
Illinois Tool A.M.
Kimberly Clark (3 of 4)
New York Central RR P.M.
Olin (1 of 2)
Sherwin Williams P.M.
Trane Co. (2 of 3)
Uarco P.M.
N.A.S.A.—Lewis Research (1 of 2)
St. Regis Paper

**Friday, November 19**

Aerospace Corp. A.M.
Kimberly Clark (4 of 4)
U.S. Geological Survey




Ultra-modern Research & Engineering Center at Delco Radio, Kokomo, Indiana

# To Continue To Learn And Grow . . .

. . . is a basic management philosophy at Delco Radio Division, General Motors Corporation. Since its inception in 1936, Delco Radio has continually expanded and improved its managerial skills, research facilities, and scientific and engineering team.

At Delco Radio, the college graduate is encouraged to maintain and broaden his knowledge and skills through continued education. Toward this purpose, Delco maintains a Tuition Refund Program. Designed to fit the individual, the plan makes it possible for an eligible employee to be reimbursed for tuition costs of spare time courses studied at the university or college level. Both Indiana University and Purdue University offer educational programs in Kokomo. In-plant graduate training programs are maintained through the off-campus facilities of Purdue University and available to employes through the popular Tuition Refund Program.

College graduates will find exciting and challenging programs in the development of germanium and silicon devices, ferrites, solid state diffusion, creative packaging of semiconductor products, development of laboratory equipment, reliability techniques, and applications and manufacturing engineering.

If your interests and qualifications lie in any of these areas, you're invited to write for our brochure detailing the opportunities to share in forging the future of electronics with this outstanding Delco-GM team. Watch for Delco interview dates on your campus, or write to Mr. C. D. Longshore, Dept. 135A, Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

*An equal opportunity employer*

**solid state electronics**

DELCO RADIO DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA

# ALUMNI NOTES

*William B. Winter, University of Wisconsin engineering graduate has taken over the position of vice-president manufacturing at Bucyrus–Erie Company, effective August 31, 1965.*

*Glen R. Schaefer has been assigned to serve aboard the ship Surveyor after being commissioned an Ensign in the Environmental Science Services Administration, U.S. Department of Commerce.*

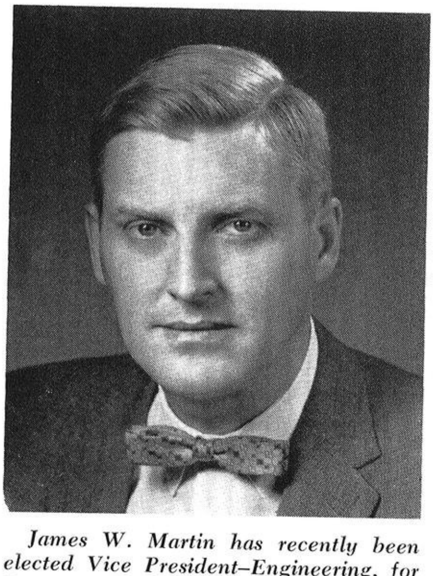
*James L. Murphy will serve aboard the ship Explorer, which will be engaged in a year long study dealing with actions of the Gulf stream.*

*Bengt H. Mattson, staff engineer for the Bureau of Yards and Docks, recently passed the state examination necessary for recognition as a Wisconsin registered engineer.*

## J. L. BUCKMASTER, CE '27 GIVEN SERVICE AWARD

*James L. Buckmaster, a Civil Engineering graduate of the class of 1927, was recently presented with a distinguished service award by Secretary Udall of the Department of Interior.*

*He received this award upon retirement after completing 36 years of outstanding contributions to the United Geological Survey and surveying and mapping instrumentation field. The award is the highest honor given by the Geological Survey.*



*James W. Martin has recently been elected Vice President–Engineering, for Bucyrus–Erie Company, South Milwaukee, Wisconsin.*

## Electronic Traffic Control

*(Continued from page 17)*

6) Compare the computed and elapsed green times and if they are equal, send out the necessary pulse to change the signal. If they are not equal, pass on to the next intersection.
7) If a signal change was ordered, check the monitor to make sure it took place. If it did not, repeat the order and, if still no result, return the signal to local control and notify the operator.

Fortunately, one feature of computer control is that it is very largely self evaluating. Since all incoming information and outgoing instructions are recorded, these can later be analysed to give close estimates of travel time, delays and congestion, and traffic volumes. These computed results can be confirmed from time to time by speed and delay and other studies carried out on a routine basis at selected locations.

### APPLICATION OF AN ELECTRONICALLY CONTROLLED TRAFFIC CONTROL SYSTEM

Because of the great expense and inaccurate results obtained by manual methods the New Jersey Turnpike Authority is now using electronics for traffic surveillance. Radar, instead of the human eye, counts and determines the speed of vehicles traveling the busy tollway. At the New Jersey Turnpike Authority headquarters building in New Brunswick, direct reading meters display the speed and volume of traffic as well as accumulated total number of hours of certain preselected traffic volumes.

Three radar sensing units, one suspended over each of the three southbound lanes of the turnpike near Linden, New Jersey, count the number of vehicles traveling in their respective lanes and also report the speed of these vehicles. This information is transmitted over leased telephone circuits in the form of audio tones to the turnpike headquarters building. In the headquarters building three Electro-Matic Traffic Monitors, one for each lane, receive the data and graphically record the traffic volume and average vehicle speed for each lane.

Instead of having to use tedious manual methods to determine how many hours per year traffic volume reached capacity, or even overload conditions, this information is obtained by merely reading the numbers on the elapsed time meters. Thus, traffic volume information, up to date as of the moment, may be obtained without any manual calculations or guesses. It is continuously available and without errors since it misses no vehicles at all. Such information is especially valuable to traffic engineers for determining where, when, and if a specific road should be widened or otherwise improved to expedite the flow of traffic. Since a road is usually designed to accommodate the anticipated traffic volume that would exist during the 30th busiest hour of a year, when the meter shows more than 29 accumulated hours when traffic volume was in excess of 100% capacity, it is an indication that the road is inadequate under present standards.

While the New Jersey Turnpike Authority uses only radar sensing units and computers in its traffic monitoring system, it is quite possible that television will be put into use where the turnpikes go through metropolitan areas. Such an addition will give America its first fully electronically controlled highway and further expansion will largely depend on the success achieved here.

END

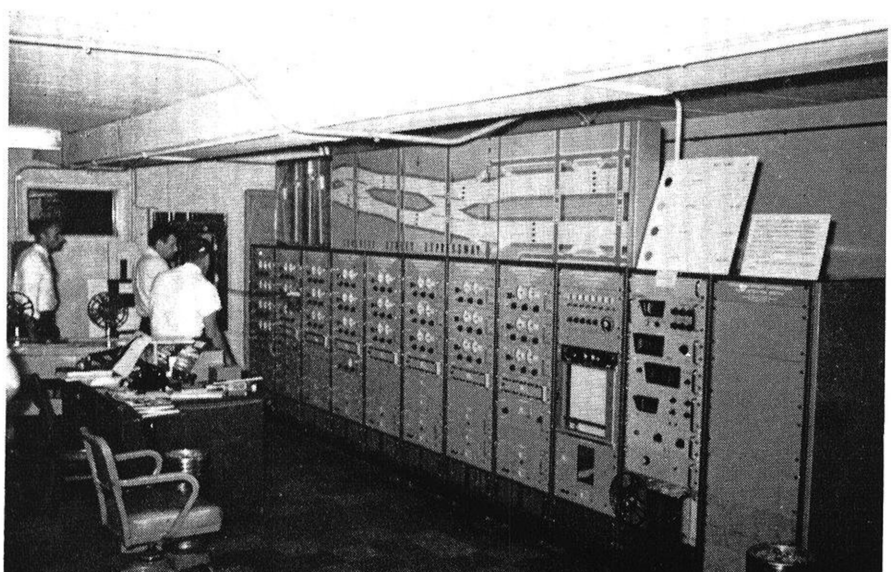


**Figure 3.—Computer center for Congress Expressway in Chicago.**

## Omni Navigation

*(Continued from page 20)*

ings. Suppose we were starting from Catalina harbor and traveling to Isthmus Cove. We would first set a course of 175° out of Catalina Harbor. We would then tune our Omnigator to station SXC at 111.6 mc on Catalina Island. When we intersected radial 280 we would sail directly along this radial until we intersected radial 185 from station LAX (113.6) which is located at Los Angeles International Airport. We would then sail along this radial until radial 295 from Santa Catalina was intersected. From this point a course of 90°, or directly east, would be steered.

The 90° course would be held until the 320 radial from Catalina was intersected. From this point a course of 192° would bring us directly into anchorage in Isthmus Cove. Again this navigation could have been done with a conventional direction finder. However, it could not have been done as quickly, safely and as easily. Catalina has a daytime radio station and a low-power radio beacon on the far side of the island. Due to the terrain of the island both of these would be inaccurate and averaging would have to be done to get reliable bearings. The high frequency Omni signals are line of sight and could be blocked at times by the terrain. However, they are much less susceptible to bending and interference and would be much more reliable.

### ADVANTAGES AND LIMITATIONS OF OMNI

In the two previous examples it has been shown that the Omni system is more accurate, easier and faster to operate, and can be generally more effective than conventional navigation. The Omni has other advantages that have only been touched upon and also some limitations.

The Omni stations send out a very high frequency signal which limits the range of Omni to 50 to 100 miles from shore depending upon the height of the station. The line of sight transmissions can't penetrate rough terrain like that found on Catalina Island. On the other hand, the high frequency of Omni eliminated such problems known as shoreline effect, sky efect, and night effect, which are all beam bending problems. With an RDF the bearings must be averaged as mentioned in the example. With Omni this is unnecessary.

As in the first example, it is not necessary to maintain an exact course. Using Omni the boat's position can easily be determined even when only one Omni station can be received. Since the bearing is determined by the station, yawing, rolling, or changes in course have no effect on the bearing. Also, since high frequencies are not effected by metal masts or rigging and generator or other electrical interference, the bearings will be more accurate than conventional bearings.

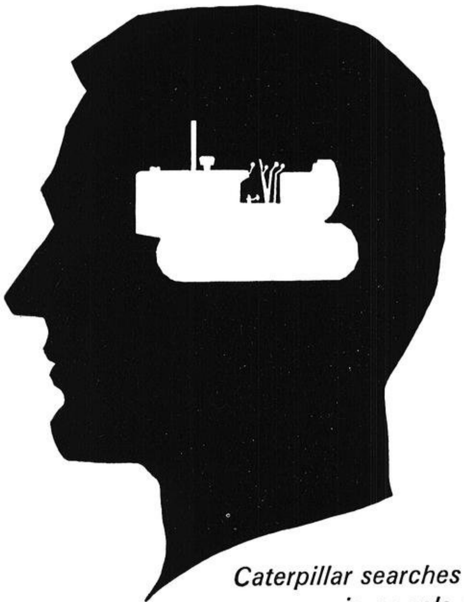
The greatest limitation of Omni would be its range. It would be useless to someone who navigates more than 100 miles from shore and in some cases more than 50 miles from shore. Also, it is not possible to take a bearing on another ship and there is no broadcast band for entertainment or additional weather information.

The final consideration is that of charts. No special charts are needed since the location of Omni stations can be marked on any marine chart from the information on Aeronautical Sectional Charts, which are available at any airport. Lines of position can easily be plotted on the charts by use of a transparent azimuth circle which is supplied by Triton.

### CONCLUSION

At this point it is up to reader to decide whether the Omni system offers enough advantages to offset the cost of $895. For the boatman who operates his boat on the coastlines or on the Great Lakes—Omni might be just what he needs.

In many areas where the Omni system offers complete coverage of the shoreline the Triton Marine Omnigator could be used by itself. In other areas where coverage is sparse the Omnigator could be used in conjunction with a RDF with very good results. In the near future the Omni system will offer complete coverage up to 100 miles from shore. Then the Omni system will truly be a modern navigation system for boatmen. END



*Caterpillar searches for uncommon quality...*
*in people and products.*

# What do you really know about Caterpillar?

You think of Caterpillar as a yellow machine, crawling along a muddy road. That's *all?* Think again.

Put 49,000 skilled people on that machine. Add 16 manufacturing plants, in *both* hemispheres, to your image.

Still not close enough.

Make that muddy road ten thousand roads. Mountainous. Jungle. Desert. Snow-covered. Base camp bouncers in Africa. Nation spanners in South America. Hill-and-dalers across Canada. Construction site hair-raisers, so far beyond the reach of cities that only the Cat representative bothers to describe them.

Not one yellow machine. Thousands. Not one Cat representative. An army of them. And a world-wide network of parts suppliers.

You've got to think of design. Manufacturing. Sales. And research—an average of $40 million a year, spent on research. (In 1964 it was $45 million). Big testing ground facilities. Technical centers, among the most modern in the world.

You've got to imagine engineers, too. Mechanical, chemical, industrial, metallurgical, agricultural, electrical, civil . . . every kind of engineer good schools produce. Caterpillar has an important position for all of them.

You might check into Caterpillar leadership in the world's business community. We stood 48th on the latest list of "500 largest manufacturers," and we're one of the top five exporters in the United States.

Ask your placement office for information on Caterpillar. Find out about some of the many contributions Cat research engineers have made in many more fields than earthmoving.

Got it? There's a scope of operations here that makes Caterpillar a good place to put your life. If you agree, get in touch. We certainly need what *you* have to offer!

**CATERPILLAR**



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### Industrial Engineering

*(Continued from page 25)*

sponses for communication patterns, industrial dynamic simulation of organizational activities, etc.

*Computer as a laboratory.* Information processing, heuristic line balancing, etc.

Students will be motivated in their research by the reality of the management system classification with which they are dealing even though their research may not always involve direct physical experimentation.

#### What Is Wisconsin Doing in IE for the First Time, Applying Broader Sciences, or Unifying the Professional Objective as Management Systems Design?

The latter, creating a unified professional objective of management systems design. Other outstanding institutions are teaching, in addition to the engineering sciences, systems, and mathematics, the new sciences in human factors, operations research, and organization and administrative sciences. They do this as a series of techniques and theories without relation to a basic objective. A student (usually at the graduate level) may still obtain his *education* through the IE program at Wisconsin in any of these specific techniques or bodies of knowledge, although the professional practitioner of IE (usually at the undergraduate level) will be oriented toward MSD.

In addition, IE in the past has more often proclaimed rather than demonstrated the basic sciences and theories that underly its activity. This is not true today, especially for the program at Wisconsin. Here the program will clearly utilize fundamental yet broad scientific and engineering principles.

Industrial Engineering has traditionally conjured an image of manufacturing whereas management systems occur everywhere and include manufacturing systems. Thus breadth through a unified objective is obtained.

Further details about the IE program may be obtained by contacting the Chairman, Industrial Engineering Division, University of Wisconsin, 1513 University Ave., Madison, Wisconsin 53705.

# Index of Advertisers

# BARREL THE OF BOTTOM

"I shall now illustrate what I have on my mind," said the E.E. Prof. as he erased the board.

° ° °

**MOTTOS:**

**Freshman Girl: Mother knows best.**

**Sophomore Girl: Death before dishonor.**

**Junior Girl: Nothing ventured, nothing gained.**

**Senior Girl: Boys will be boys.**

° ° °

Angry Father: "What do you mean by bringing my daughter home at this hour of the morning?"

Engineer: "Have to be in class by eight."

° ° °

**A drunk fell on his pocket flask and smashed it, naturally lacerating his rear end. Upon arriving home, he was afraid to awaken his wife, so he procured band-aids and mirror and proceeded to apply first aid. Came dawn, and his wife shook him and shouted: "Were you drunk last night?"**

**"Why no!" reassured her soggy spouse.**

**"Oh, yeah?" yelled the wife. "Then what are the band-aids doing on the mirror?"**

° ° °

Police Sergeant: "College student, eh?"

Prisoner: "Yes, sir."

Patrolman: "It's a stall. I searched his pockets and found money in them."

° ° °

**After feeling his way around the lamp post a few times, the sozzled student muttered, "It's no use, I'm walled in."**

° ° °

Two young sisters had been given parts in a Christmas play at school. At dinner that night they got into an argument as to who had the most important role. Jody, aged 11, was very superior.

"Why, of course mine's the biggest part," she told five-year-old Lucy. "Anybody'll tell you its much harder to be a virgin than an angel."

° ° °

**A Boston spinster was shocked by the language used by workmen repairing telephone wires near her home, so she wrote to the telephone company. The manager immediately asked the foreman on the job to make a report and here's what the foreman said:**

**"Spike Williams and me were on this job. I was up on the pole and accidentally let the hot lead fall on Spike—and it went down his neck. Then Spike looked up at me and said: 'Really, Harry, you must be more careful.' "**

° ° °

"Gee Mom," he complained, "None of the other guys are wearing lipstick!"

"Be quiet, stupid! We're almost at the draft board."

° ° °

**Papa Bear: "Who's been drinking my beer?"**

**Mama Bear: "Who's been drinking my beer?"**

**Baby Bear: "Barf."**

° ° °

There's one consolation: If a girl doesn't like her own figure she can always lump it.

° ° °

**The boss was chasing his secretary as usual. He suggested, "Let's go up to my apartment tonight."**

**She answered, "I am very didactic and pithy in my refusal of your very derogatory vituperative and vitriolic proposition."**

**He said, "I don't get it."**

**She answered, "That's what I've been trying to tell you."**

° ° °

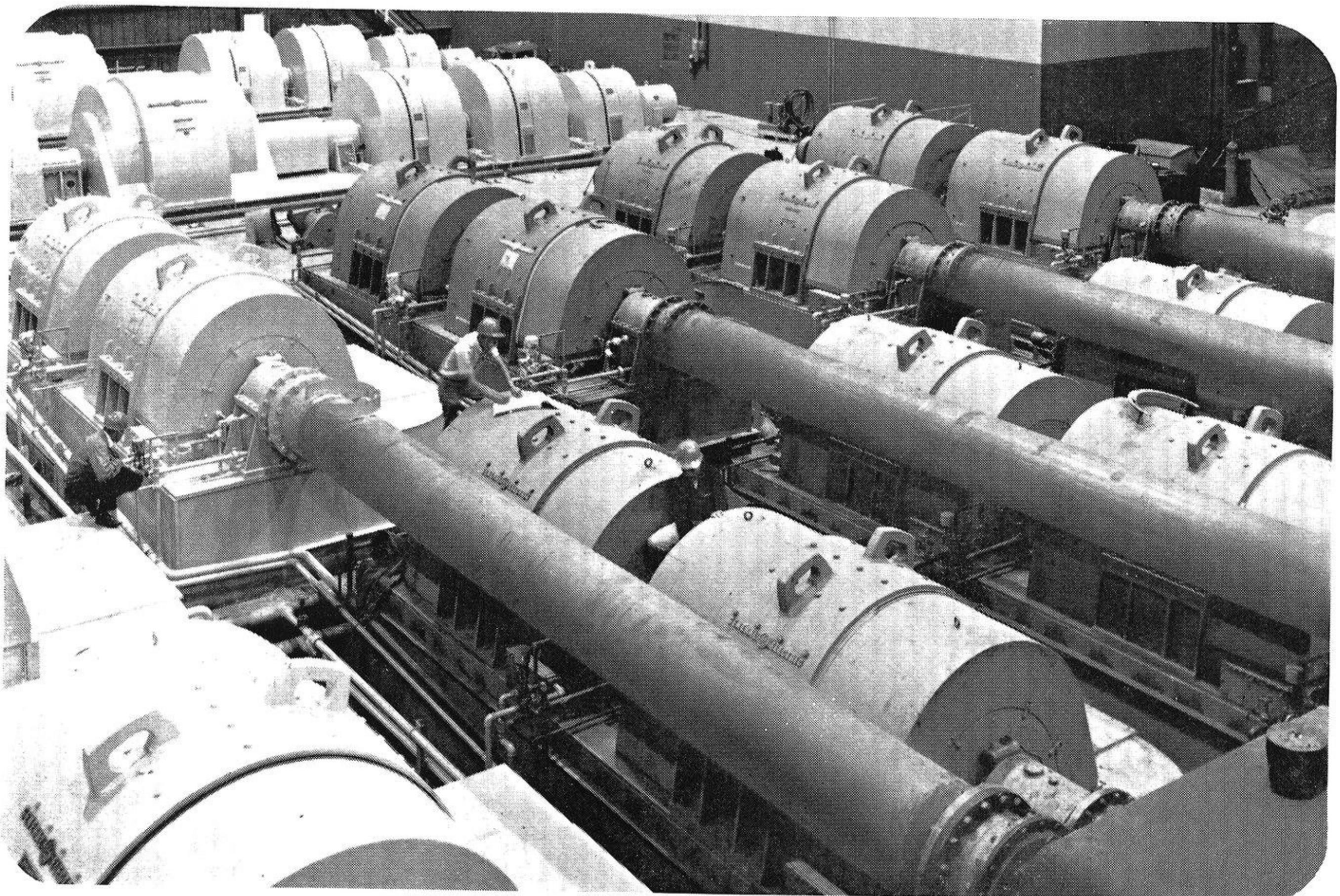
Found on a fall registration card of a freshman engineering student:

Name of Parents: Mommy and Daddy.

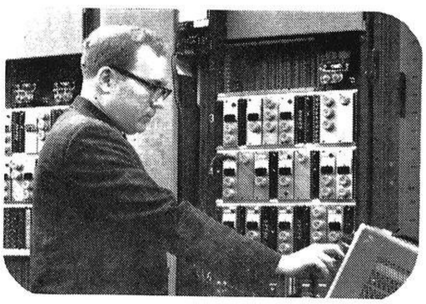
° ° °

**A woman got on the train with three sets of twins. When the conductor came by for the tickets he look at them in astonishment. "Do you mean to say you get twins every time?" he asked.**

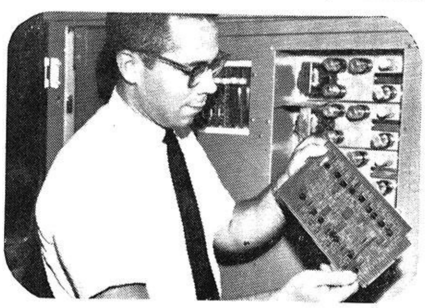
**"Oh, no," she replied. "Hundreds of times we don't get anything."**



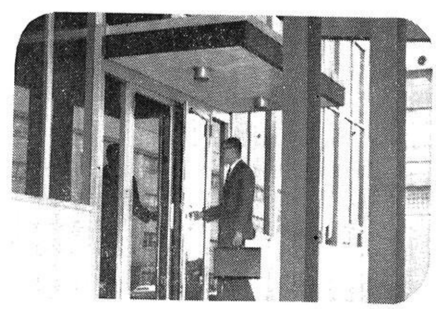
**DRIVE POWER** by General Electric: one section of Bethlehem Steel Corporation's new mill at Burns Harbor, Indiana.



**INDUSTRY CONTROL** engineer Bob Vaughn, Virginia Polytechnic Inst., worked on drives, control and the new SCR armature regulator, from design through installation.



**PRINTED CIRCUIT PROCESS** heart of automatic control, was checked by Glenn Keller, Lehigh U., on the Manufacturing Program at Specialty Control Department.



**CUSTOMER REQUIREMENTS** for d-c motors were met by Jim Johnson, U. of Cincinnati, on a Technical Marketing Program assignment at Large Generator & Motor Department.

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# Automating a Complete Steel Mill

The automation of Bethlehem Steel Corporation's new Burns Harbor, Indiana, cold rolled and plate mills is another giant step toward meeting the demands for stepped-up steel production. General Electric is uniquely equipped to supply all the bits and pieces of automation, and to call on and integrate the skills of more than 120 business departments —-skills that run the gamut of specialized and systems engineering, manufacturing and technical marketing. Whatever the projects at General Electric, and they are legion, a small-company atmosphere is maintained, so that individual contributions are quickly recognized. And, these become starting points to new discoveries and opportunities. Write us now—or talk with your placement officer—to define your career interest with General Electric. Section 699-14, Schenectady, N. Y. (An Equal Opportunity Employer)

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