Wisconsin engineer. Vol. 71, No. 1 October 1966

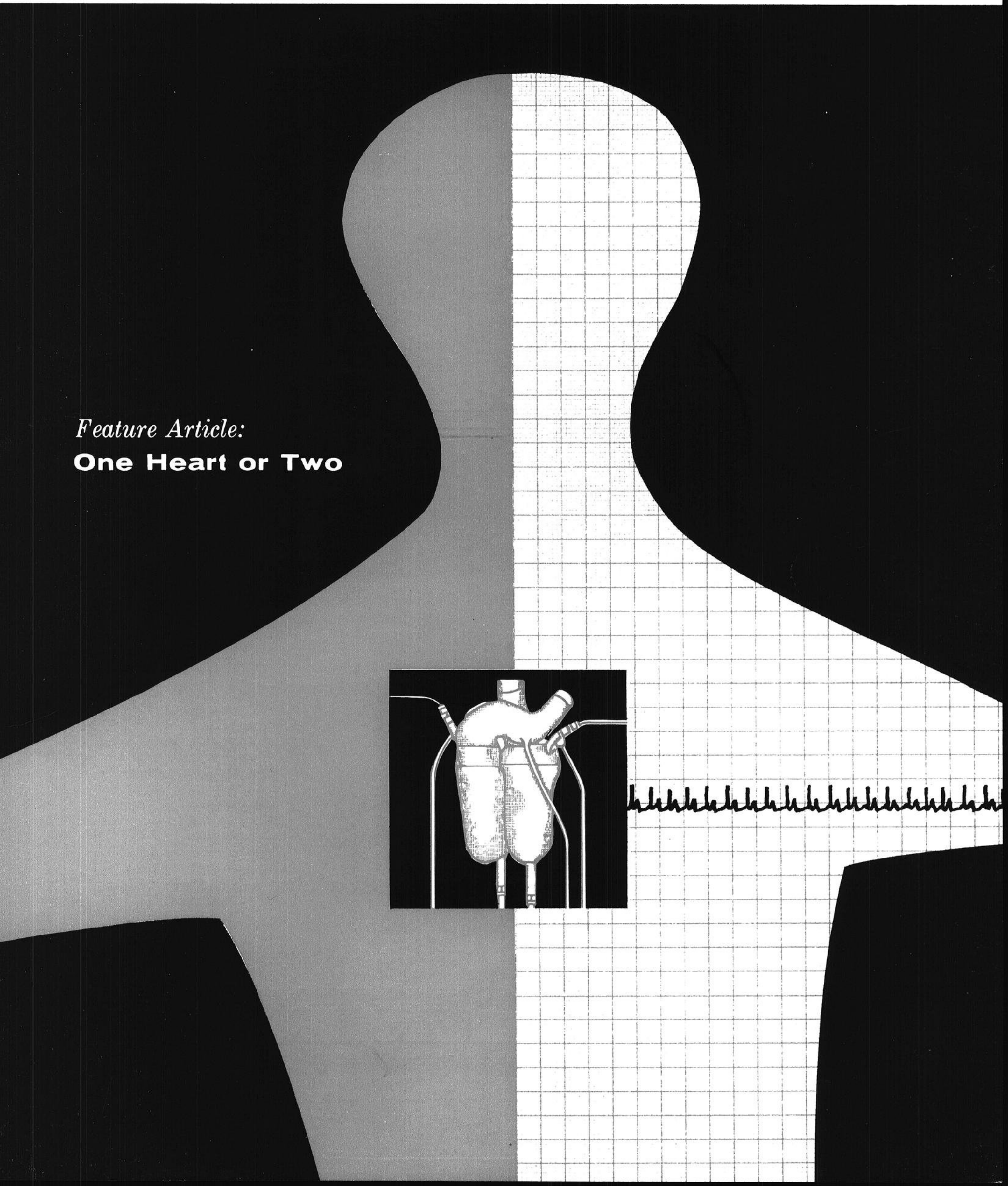
Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

VOL. 71, NO. 1
MEMBER ECMA

35 CENTS
OCTOBER 1966

wisconsin engineer

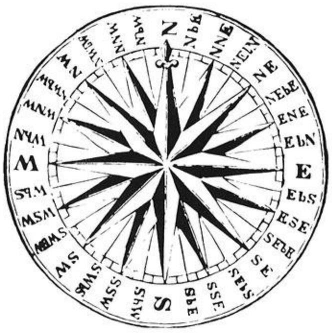


Feature Article:

One Heart or Two

Go Westinghouse, Young Man!

A modern fable with technical overtones.



Once upon a time there was a young senior in college named Jack who couldn't decide about his future.

He wanted to do something worthwhile after graduation.

But there were so many things to do, it was hard to decide. He could go on to graduate school, or join the CIA, or volunteer for social welfare service, or participate in a protest movement . . . or he could enter the business world.

Many of Jack's friends urged him to steer clear of big industry.

"There are no challenges in air-conditioned offices," they warned.

And it was a challenge Jack wanted — the kind of challenge his forefathers faced on the frontiers.

Then he met a Mr. Greeley.

Mr. Greeley recruited college students for Westinghouse Electric Corporation. He was a kindly man to whom Jack opened his heart.

Mr. Greeley described to Jack the exciting things being done by Westinghouse all over the world.* Jack was fascinated and asked many searching questions about the world's 21st largest corporation. At the end of an hour, Mr. Greeley advised Jack:

"Go Westinghouse, Young Man."

Jack did.

The first few weeks were difficult. There was so much to learn.

Jack was to discover that at Westinghouse, learning was a way of life, that a career with Westinghouse was one long process of education and re-education.

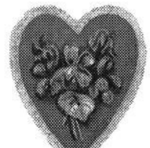
Later Jack was permitted to decide which of six big groups he would like to join.** Jack selected the Westinghouse Electric Utility Group.

With the Electric Utility Group Jack learned about water processing, about power generation, about underground distribution, and many other things. Jack had not realized how important to the survival of modern man is the world of electric utilities.

It was hard work. Sometimes after a particularly trying day Jack would get discouraged. Then he'd remember the warnings of his friends, back at college. And he'd wonder whether he had done the right thing.

Then came Jill. Pretty, intelligent, warmhearted Jill. Jack had met Jill at the drinking fountain in the Utility Group Water Province Department.

Jill was an engineer with Westinghouse (Editor's Note: Women are welcome at Westinghouse, an equal opportunity employer).



Although the work became more and more difficult and the hours longer, Jack with Jill at his side persevered.

Then came an assignment to join a team of Westinghouse engineers and scientists. The team was being sent to an underdeveloped nation in a faraway land to help rebuild a large coastal city.

Jack and Jill's assignment: Help build a power plant that would use nuclear fuel. (Nuclear fuel lasts longer than coal or oil. And it's cleaner.) Energy from the nuclear plant was used to change salt water from the nearby sea into fresh water that the poor people of this country could use as drinking water.

Working late one evening on the job site, Jack caught someone in the act of sabotaging the construction of an extra-high-voltage distribution system. This system would bring power from the nuclear plant hundreds of miles into the inland areas of the country.

After a dramatic chase through the winding streets of the city, a chase in which the international police and CIA participated, Jack captured the subversive agent. A grateful nation presented him with its highest award.

Finally, the project was completed. It was hard work but it was good work. Thanks to the Westinghouse team, millions of people would live better.

The citizens of the country were grateful. They wanted Jack and Jill and the others to stay . . . offered them more than their present salaries as an inducement . . . but Westinghouse fringe benefits more than offset this offer.

At the airport, where a sad but affectionate crowd of citizens gathered to see them off, Jack turned to Jill and asked:

"Will you marry me?"

Jill smiled and said: "I will if you promise to let me join you on other equally important turnkey projects that Westinghouse is coordinating in some of the major cities in the United States."

Jack promised, and they lived happily ever after.

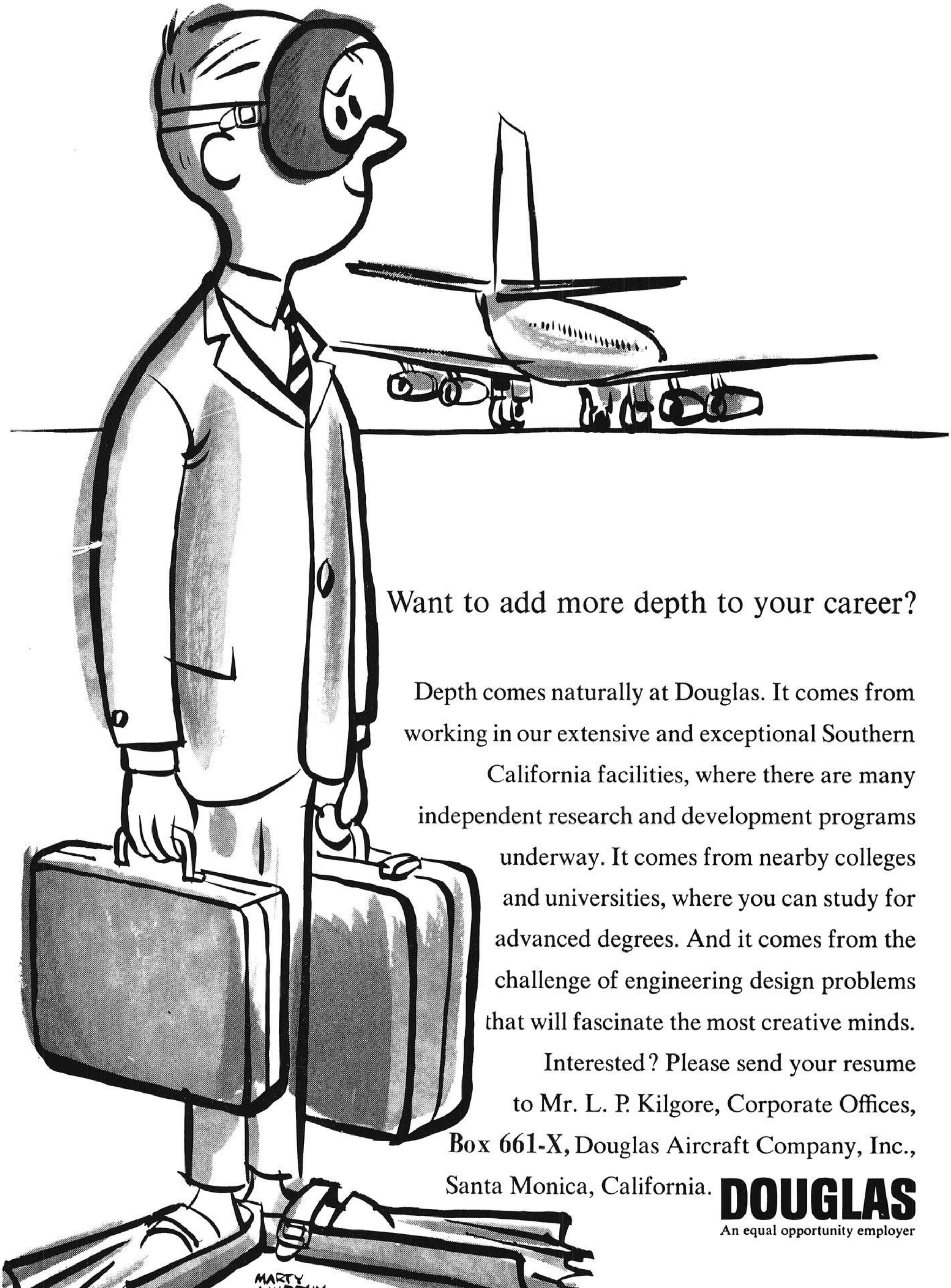
Moral: Awaiting you at Westinghouse are challenges, hard work, building block education, adventure, some travel and, yes, even romance.

You can be sure if it's Westinghouse

For further information, please contact: L. H. Noggle Westinghouse Educational Center, Pittsburgh, Pa. 15221.

*UNDERSEA EXPLORATION MASS TRANSIT WATER DESALTING AEROSPACE TRAVEL AUTOMATED PARKING GARAGES PROGRAMMED LEARNING TOTAL-ELECTRIC CITIES

**CONSUMER PRODUCTS INDUSTRIAL CONSTRUCTION ELECTRONIC COMPONENTS & SPECIALTY PRODUCTS ATOMIC, DEFENSE AND SPACE ELECTRIC UTILITY

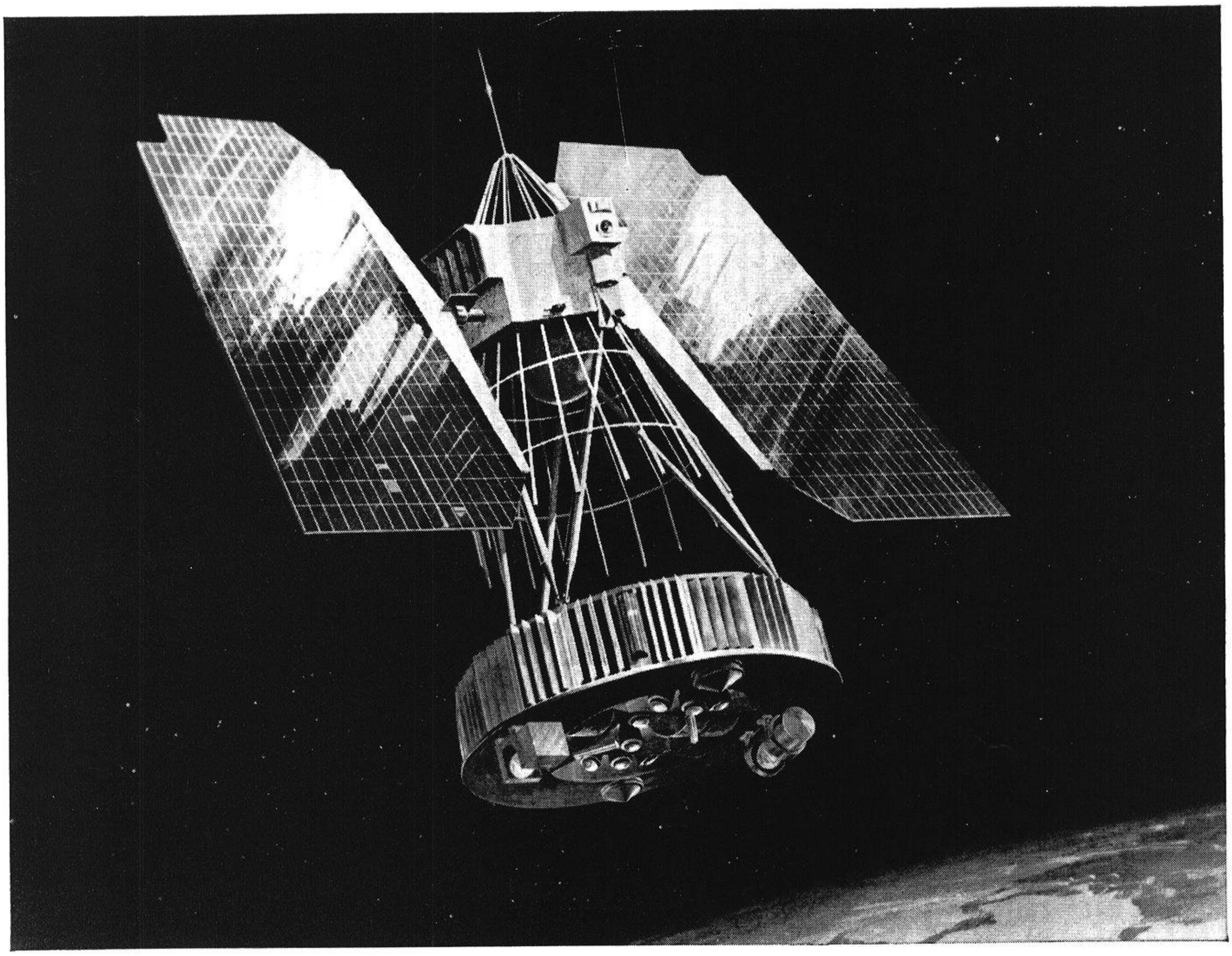


Want to add more depth to your career?

Depth comes naturally at Douglas. It comes from working in our extensive and exceptional Southern California facilities, where there are many independent research and development programs underway. It comes from nearby colleges and universities, where you can study for advanced degrees. And it comes from the challenge of engineering design problems that will fascinate the most creative minds. Interested? Please send your resume to Mr. L. P. Kilgore, Corporate Offices, **Box 661-X,** Douglas Aircraft Company, Inc., Santa Monica, California.

DOUGLAS

An equal opportunity employer



Engineering and Science at RCA

AVCS for NIMBUS and TIROS

NIMBUS—the research and development spacecraft in the weather satellite program of the National Aeronautics and Space Administration—utilized an Advanced Vidicon Camera Subsystem (AVCS) which represented a significant advance in space television cameras.

This AVCS, designed and built by RCA for the NASA Goddard Space Flight Center, comprised three separate one-inch vidicon camera tubes, each with a lens and electronics assembly. The cameras provided a picture resolution of 800 TV lines equivalent to an earth resolution of one-half mile for a 500-mile altitude. The dynamic range of AVCS was 0.4 to 0.004 foot-candle-seconds exclusive of an automatic iris control which could vary the light to the faceplate over a range of a factor of 16. The center camera looked straight down at the earth and the right and left cameras were canted to look 35-degrees away from the vertical axis. Each set of three pictures then formed a rectangular presentation of the earth about 1300 miles across (east to west) and 400 miles along (south to north) the orbit path.

During each orbital path over the sunlit side of the earth, the Nimbus AVCS took a total of 32 of these composite pictures. This set of pictures provided complete pole-to-pole meteorological coverage of the 1300-mile wide swath, with the rotation of the earth causing the swath to move to an adjacent, overlapping area during the next orbit. In this way, complete earth coverage was obtained each day.

The AVCS TV system was used on the second NIMBUS satellite also, and, in addition, with a slightly different configuration, on the TIROS Operational System (TOS) satellites.

The RCA TOS satellites are designed to provide similar full global weather coverage every day from a sun-synchronous, near-polar orbit. Each satellite will be oriented with its spin axis perpendicular to the orbit plane. In this position the satellite will be like a wheel rolling in the orbit path. Thus, AVCS continues to contribute to this nation's progress toward improved weather analysis and forecasting.

Reference: Max H. Mesner "Television in Space"—Electronics Vol. 38 No. 10, p. 80-90, May 17, 1965

M. Tepper and D. S. Johnson "Toward Operational Weather Satellite Systems" —Astronautics and Aeronautics, Vol. 3 No. 6, p. 16-26, 1965.

This is only one of the recent achievements which are indicative of the great range of activities in engineering and science at RCA. To learn more about the many scientific challenges awaiting bachelor and advanced degree candidates in EE, ME, IE, ChE, Physics or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

An Equal Opportunity Employer

RCA **The Most Trusted Name in Electronics**

wisconsin engineer

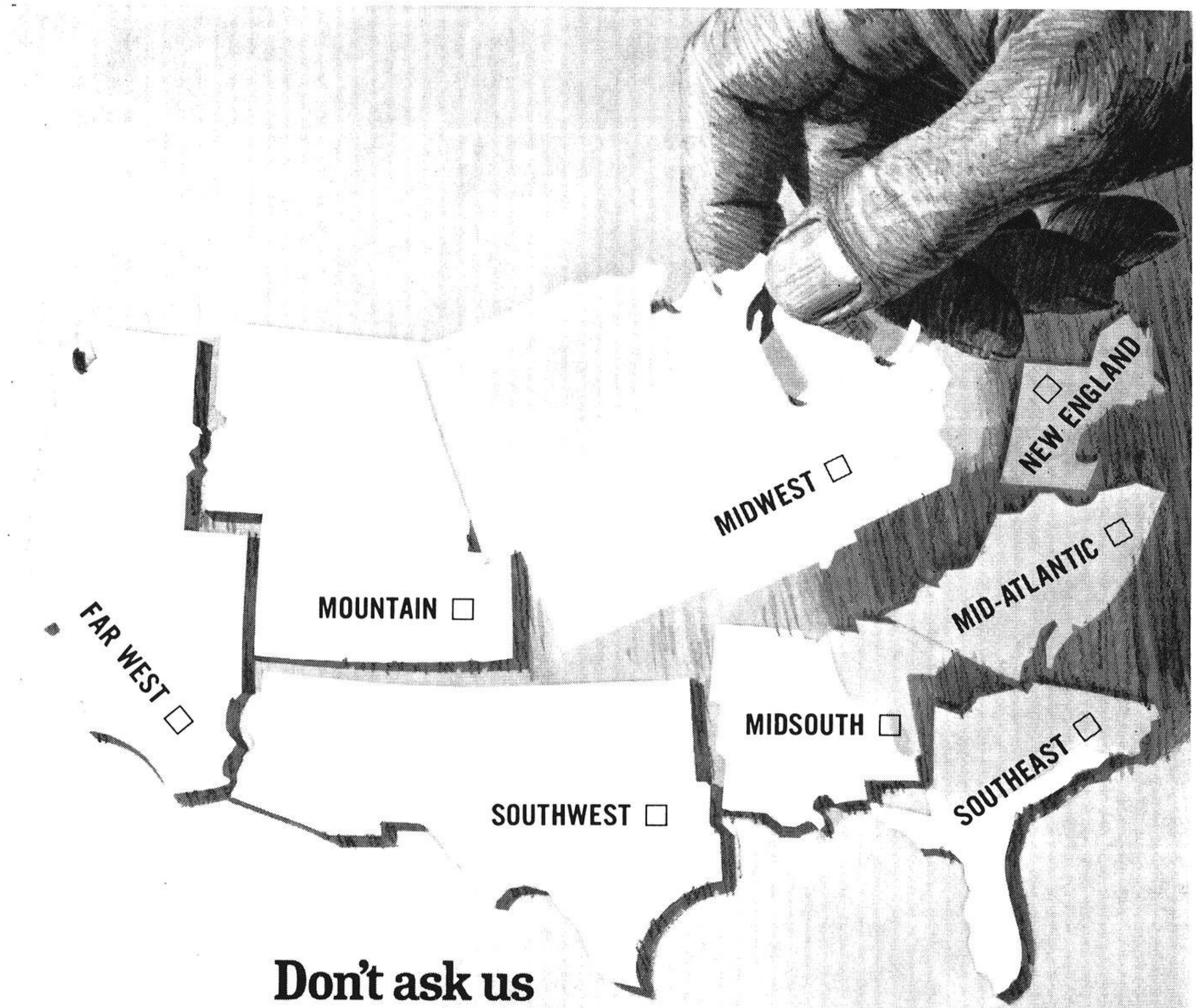
MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman: Prof. Howard J. Schwebke, Dept. of Engineering Graphics, University of Wisconsin, Madison, Wisconsin 53706.

Publishers Representatives: Littell–Murray–Barnhill, Inc., 369 Lexington Avenue, New York, New York 10017.

Second Class Postage Paid at Madison, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act. of Oct. 3, 1917, authorized Oct. 21, 1918.

Published monthly from October to May inclusive by the Wisconsin Engineering Journal Association, 333 Mechanical Engineering Building, Madison, Wisconsin 53705. Editorial Office Hours 11:00–12:00 Monday, Wednesday and Friday. Office Phone (608) 262–3494.


FAR WEST ◇
MOUNTAIN □
MIDWEST □
NEW ENGLAND ◇
MID-ATLANTIC ◇
MIDSOUTH □
SOUTHWEST □
SOUTHEAST ◇

FROM THE OTHER SIDE

As you may or may not have noticed, this year's editor is a girl—namely me. That's why these comments are "from the other side". It's unfortunate that the other side isn't very big as yet, but the odds are nice.

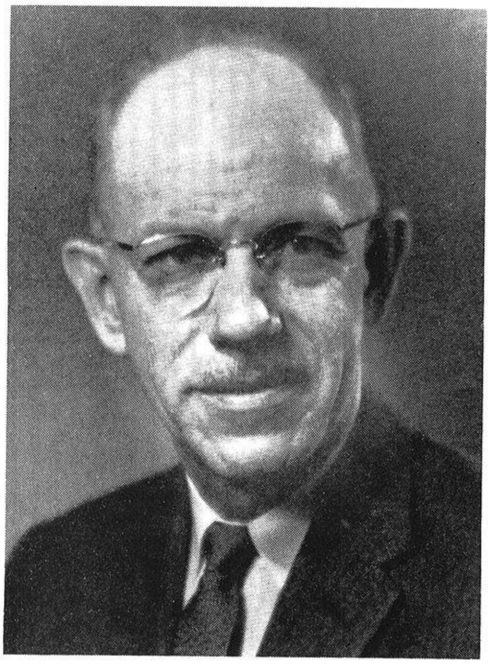
This year, the staff and I have a lot of great new ideas. We're expanding, revising, eliminating, and generally acquiring a new look which we hope you'll like. In brief, our "Miss Engineer" has become a regular feature, along with "Wisconsin's Album, Alumni and Campus News, the Fall Interview Schedule, a double-size joke page, and much more.

Not only is the magazine improving and enlarging, so is the staff! We have a new feature writer, a campus news man, a fraternity news man, a production man, and two new photographers. (The candid shots on the right are those photographers practicing.) Our business staff has grown with two new members too, so we're expecting big things in that area.

Another big change this year are our shiny new red circulation boxes which you'll find all over the engineering campus. Now everyone will be able to deposit their nominal fee and enjoy the *Wisconsin Engineer.*

The feature story this month deserves special notice, since the artificial heart, and in fact the whole bio-medical field, is a project near to the hearts of Wisconsin's engineers. Professor Ronald L. Daggett, of the Mechanical Engineering department, and Dr. Vincent L. Gott, formerly of Wisconsin and now head of Cardiovascular research at John's Hopkins, have done extensive work to develop the use of plastics in the medical field. In conjunction with this work, they devised a heart valve of the leaflet type mentioned in our feature. This valve is used to replace both the aortic and mitral valves of the human heart, and is being manufactured for researchers all over the country. Watch for the coming feature, "Wisconsin Goes Bio-Medical".

Mary E. Ingeman



FROM THE DEAN'S DESK

I am pleased to have this opportunity to extend a warm and sincere welcome to the campus and to the College of Engineering to a large and able group of new students and also to welcome back all returning students. I hope that the close and friendly cooperation between students, faculty, and administration that has developed over the years will continue to contribute to the growth and effectiveness of our programs.

To insure the maintenance of communications requires positive action on the part of all students. Get to know your instructors and professors. They will welcome you in their offices and laboratories, and will be glad to discuss your problems and your objectives. Also, join the professional society in your special field of interest, attend the meetings, and participate in the programs. Each society elects representatives to Polygon, the student governing group for the College of Engineering. Through Polygon, you have a direct and easily accessible channel for the coordination of student activities and for discussion of all matters affecting the student body with faculty and with the administration. The continued effectiveness of Polygon, however, depends upon your participation and your support.

We are looking forward to a year full of challenges and exciting developments. Many of you know that Polygon is again planning an Engineering Exposition to be held next April. The outstanding successes of previous expositions stand as a challenge to all of you to make the 1967 show a noteworthy production. Thousands of high school students, and additional thousands of adults from the campus, the city and the State look forward to this event and appreciate the opportunity to learn about the many new developments in engineering science and technology. Start to plan now as individuals and in your professional societies to support this college-wide student undertaking.

Plans for our new Engineering Research Building are progressing on schedule. This facility will provide much needed space for our rapidly expanding research programs in all fields of engineering. It is planned as a 14-story structure to be erected immediately east of the present Mechanical

Engineering Building, at a cost of over 5,600,000 dollars. Preliminary plans have been approved, working plans are nearing completion, and we hope to break ground in the spring. One of the new programs to be housed in this building is the Instrumentation Systems Center which will serve the needs of the entire University for research, development, and servicing of all types of instruments and instrumentation systems. Dr. Norman E. Huston, who came to us from the Atomics International Division of North American Aviation is directing this development and the project is temporarily housed on the ground floor of the Princeton House until the new bulding is ready for occupancy.

On the agenda for 1967–69 are three projects of direct interest to all engineers on the campus. Included in the recommendations to the Legislature are completion of the New Engineering Building through construction of the center portion of the building (Unit No. 4), construction of a West Side Union, and construction of a major Physical Sciences and Engineering Library. The latter two are planned for the block immediately east of the New Engineering Building. Dean Ratner is chairman of the building committee for Unit 4 of the Engineering Building, Prof. Higgins of the Electrical Engineering Department heads the planning group for the Library, and Prof. P. S. Myers of the Mechanical Engineering Department is chairman of the West Side Union Building Committee.

Plans also call for a major ramp parking structure to accommodate about 600 cars to be built adjacent to Breese Terrace and north of the Stadium.

Reports from our Placement office, under the direction of Prof. Marks, indicate that the demand for graduates in all fields of engineering and at all degree levels continues to increase. This means that the demand for qualified engineers will again far outstrip the supply. It is also of interest to note that summer job opportunities that combine excellent experience with highly satisfactory remuneration also are increasing. The Polygon Committee, working with Prof. Marks, has been effective in this area, and industry is recognizing the mutual benefits to be gained in a strong, coordinated summer employment program.

A number of changes have been made in the College administration as a result of the retirement of Dean Shiels and the shift of Dean Davidson from our campus to the chairmanship of the Civil Engineering Department at Washington State University. Assistant Dean Frederick O. Leidel is in charge of all freshmen and freshman programs; Assistant Dean Robert A. Ratner is in charge of general operations and fiscal control; Assistant Dean John L. Asmuth is responsible for student affairs; and Associate Dean W. R. Marshall continues his responsibilities for the Engineering Experiment Station and graduate studies. All of us are here to assist you and members of the faculty in every way possible. Do not hesitate to call upon us.

As you begin a new year of studies I wish for each of you every possible success and I trust that you will make it a year of satisfying and substantial accomplishment.

Kurt F. Wendt

Dean of the College of Engineering

INTERESTED IN A REWARDING CAREER IN AEROSPACE/ELECTRONICS?

You can **go forward, go fast, go far** . . . . at Hughes Field Service & Support Division.

If you are seeking a stimulating assignment where you can get in on the ground floor of the rapidly-expanding aerospace/electronics field, capitalize immediately on your background and training, and progress quickly toward your career goals—Hughes Field Service & Support Division in Southern California will welcome your inquiry.

Some of our current fields of interest include:

DESIGN ENGINEERING

Openings exist for Electrical and Mechanical Design Engineers in the development of Trainers & Simulators and in the design of checkout and test equipment for large missile and aerospace systems. These responsible positions require interest and/or experience in such design areas as: analog circuits, digital logic, switch/relay logic, electromechanical packaging, infrared testing, inertial guidance and Command/Control systems. Responsibilities will include all phases of development from concept to final fabrication and evaluation. B.S. degree is required in E.E., M.E. or Physics.

FIELD ENGINEERING

The Field Engineer's job ranges from complete contractor maintenance of electronic systems to technical assistance. His primary function is to help the customer become self-sufficient. Responsibilities include: providing maintenance, operational and technical assistance; formal and informal on-the-job training; logistic assistance and the investigation and solution of equipment problems experienced in the field. Domestic and overseas field assignments are available. Requirements include: B.S. degree in E.E. or Physics and experience with military fire control, radar or communications systems.

TECHNICAL TRAINING

Hughes Technical Training prepares both civilian and military personnel to efficiently operate and maintain advanced electronic systems. Technical Instructors conduct training classes at Hughes California sites and domestic field locations . . . and work directly with customers to evolve special training devices, plan field training programs and prepare courses for use at customer bases. Requirements include: B.S. degree in E.E. or Physics and experience in preparing and presenting technical electronics material in the classroom and laboratory.

ENGINEERING WRITING

Specialists in printed communications convert complex engineering data into simple, accurate, illustrated support publications, including technical manuals, orders, brochures, sales proposals, etc. Fields of interest include: digital computers, digital and voice communications systems . . . and many others. Requires a B.S. degree in E.E. or Physics.

CAMPUS INTERVIEWS

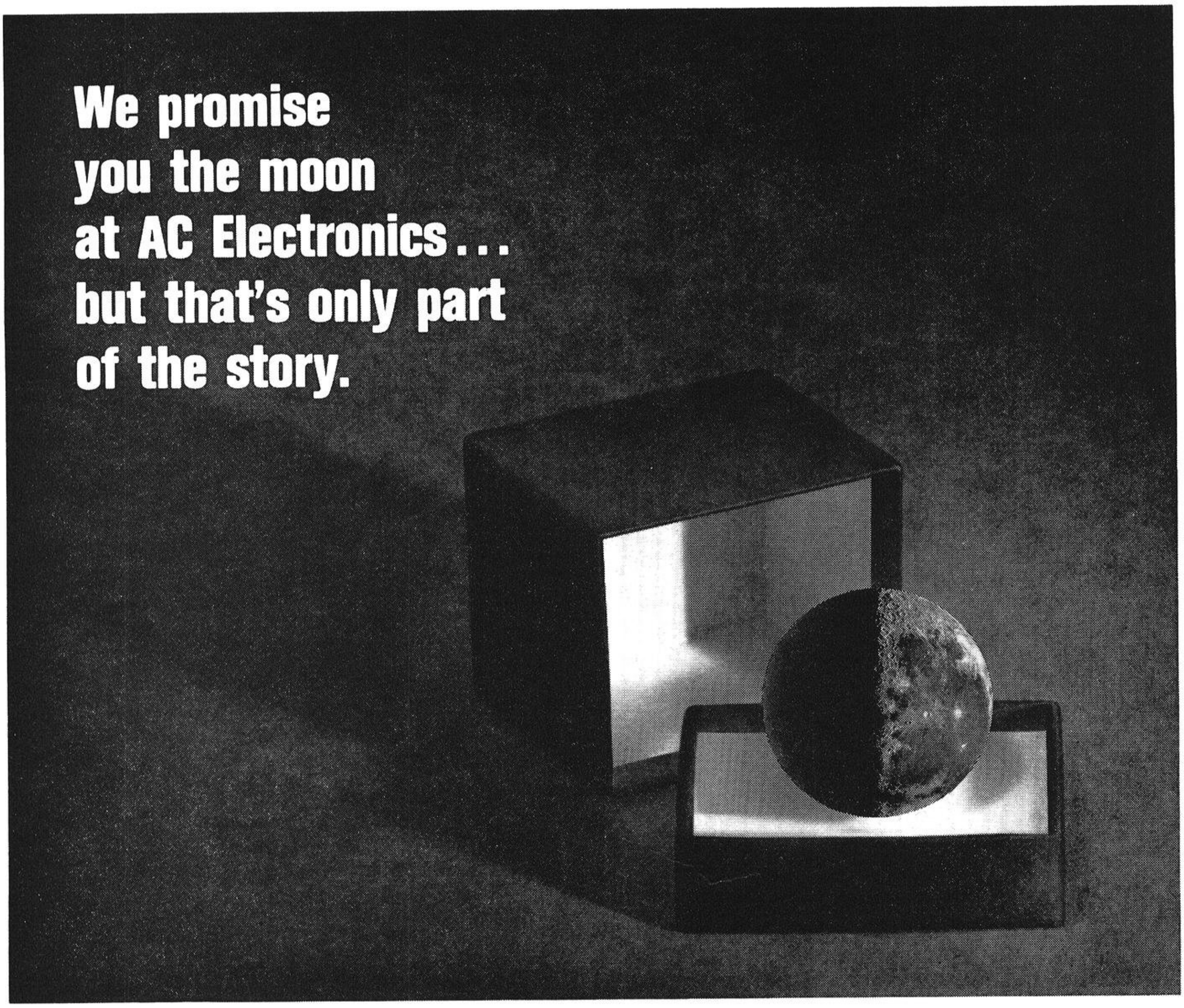
October 31

For additional information on the career opportunities available at Hughes Aircraft Company—and to make arrangements for a personal interview appointment with representatives of our Technical Staff, please contact your College Placement Office or write: Mr. B. P. Ramstack, Hughes Aircraft Company, P.O. Box 90515, Los Angeles, Calif. 90009.

HUGHES

HUGHES AIRCRAFT COMPANY
FIELD SERVICE & SUPPORT DIV.

An equal opportunity employer
U.S. citizenship required



Want to help land men on the moon? Fine. We're building the guidance/navigation system for the Apollo and LEM spacecraft that will put them there. But that's only a sample of the challenging and rewarding career opportunities waiting for you at AC Electronics . . . specialists in research, development and production of guidance, navigation and control systems for military, space and commercial applications.

You'll work in research, design and development on such advanced projects as the new Self-Aligning Boost and Reentry system for missiles (SABRE); Manned Orbiting Laboratory (MOL); a self-contained Navigation System for naval ships (SSCNS); Titan III-C Space Booster; on avionics systems for supersonic aircraft; and on a fire-control system for the new Main Battle Tank, a joint U.S.-Federal Republic of Germany program, and advanced digital computer development.

Your opportunities for growth and advancement in a career at AC are limited only by your own ability and initiative. Our Career Acceleration Program covering both technical and management preparation helps pave your way. Our Tuition Plan pays your tuition costs when you complete college-level courses. In addition, you enjoy full General Motors benefits.

If you are completing your B.S. or M.S. degree in EE, ME, Math or Physics, we invite you to inquire about opportunities at any of our three locations: AC in MILWAUKEE — our Main Research, Development and Manufacturing Facility; AC in BOSTON—our Research and Development Laboratory specializing in Advanced Inertial Components and Avionics Navigation/Guidance Systems; AC in LOS ANGELES — our Research and Development Laboratory specializing in Advanced Airborne Computers and Ballistic Missile and Space Booster Guidance/Navigation Systems.

PhDs, please note: Positions are available in all three AC locations for PhDs, depending upon concentration of study and area of interest.

For further information, see your college placement office about a General Motors/AC on-campus interview, or write directly to Mr. R. C. Schroeder, Director of Scientific & Professional Employment, Dept. 5753, General Motors Corporation, Milwaukee, Wis. 53201.

AC ELECTRONICS
DIVISION OF GENERAL MOTORS
An Equal Opportunity Employer
GM

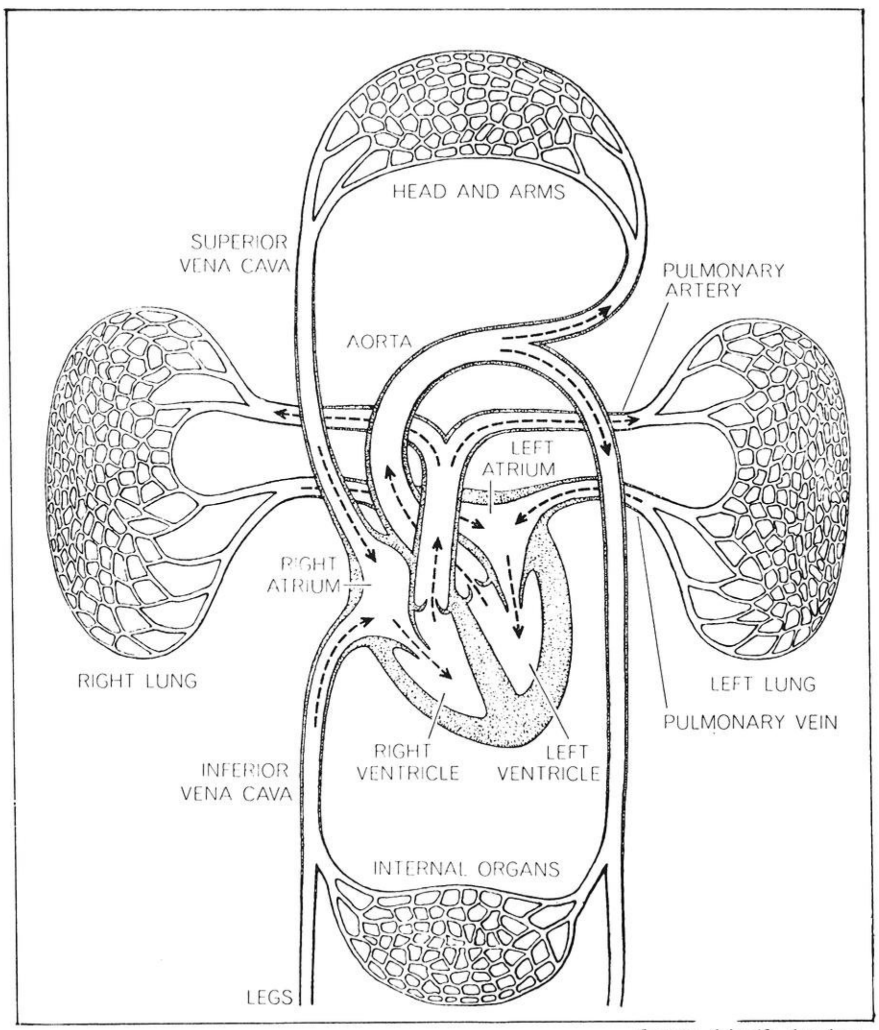
ONE HEART OR TWO?

by Richard A. Schunck

Through the ingenious efforts of engineers and doctors, an artificial heart sustained the life of a Texas woman this summer for ten days while her own heart healed its damaged muscles. Richard Schunck describes the "how" and "why" in his article, "One Heart or Two?"

THE natural heart is a pump controlled by nerve impulses, maintaining a continuous flow of blood within the body through the circulatory system. The basic parts of the heart are shown in Figure 1. Blood distributes food and oxygen to all parts of the body. It also carries carbon dioxide from all parts of the body to the lungs, where the carbon dioxide is replaced by oxygen.

The pumping cycle begins with a nerve (electrical) signal being sent from the brain to a node in the right atrium. This signal is rapidly transmitted to the left atrium and then to the ventricles. As the signal reaches each area, it causes contraction of the muscular heart wall. When simultaneously contracted, the atria force blood into the ventricles through the inlet valves. Both the ventricles simultaneously contract and force the blood out through the outlet valves. This completes the pumping cycle.



—Courtesy Scientific American

CIRCULATORY SYSTEM of a human being and its relation to the heart is outlined.

Valves

The four valves in the natural heart are gate-like flaps of tissue which open and close with the action of the ventricles, directing the flow of blood. All of the valves will handle flow in one direction only; that is, blood cannot flow out of an inlet valve, or vice-versa. The flow directions are shown in Figure 1.

Arteries and Veins

Arteries carry blood from the heart, and veins carry blood to the heart. Fresh, oxygenated blood flows from the lungs through veins to the left atrium of the heart. With pumping, this fresh blood leaves the left ventricle of the heart through an artery which divides to carry fresh blood to the head and arms and to the trunk and legs. Within the body parts, blood is distributed through small branch arteries into small capillary networks. It is in these capillaries that the body cells remove the oxygen by chemical means and give up their carbon dioxide into the de-oxygenated blood. The capillary network leads to small veins which in turn lead to larger veins to carry the stale blood to the right atrium of the heart. Pumping forces this blood through the heart's right ventricle and out into an artery which divides to carry blood to each lung. After the stale blood is oxygenated it is returned to the left atrium, and the cycle begins again. It should be remembered that the heart's normal cycle causes the left and right ventricles to pump simultaneously and both atria to fill and empty together.

The design requirements involved in creating an artificial heart which will fulfill the functions of the natural heart regularly and for long periods of time are numerous.

Design Requirements

The design of an artificial heart involves engineering solutions to a wide variety of difficult requirements imposed upon the design. These requirements are both operational and environmental.

Operational Requirements

The operational parameters of the natural heart are mechanical, neural, electrical, and chemical. To date, these parameters are not fully understood. However, study has revealed some of the requirements imposed on the operation of an artificial human heart. These requirements can be divided into the five following categories:

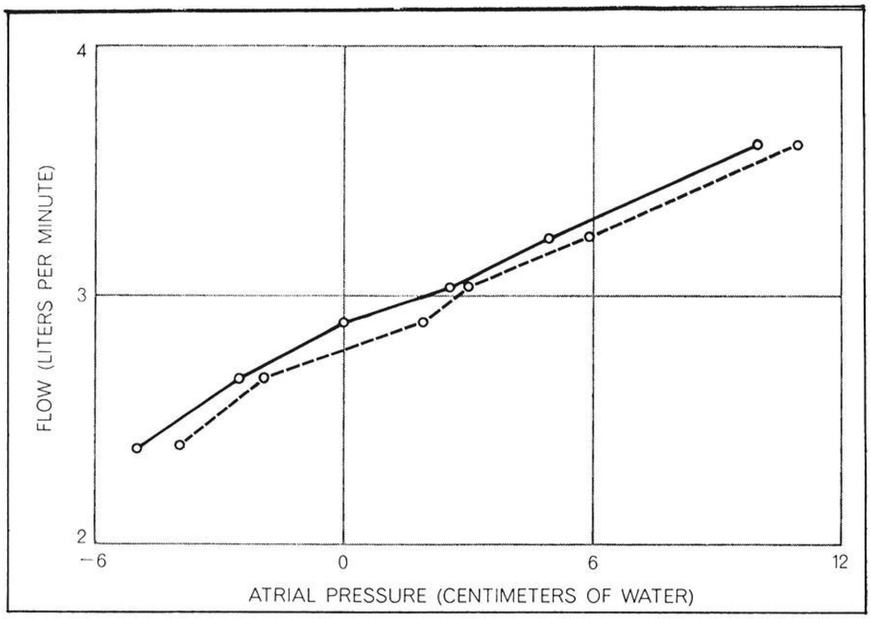
1. Pumping action
2. Flow capacity
3. Power
4. Control
5. Reliability

Pumping Action

The pumping action of an artificial heart must match that of the natural heart, because it will be placed in a system that is accustomed to the natural heart's pumping action. One of the major requirements is that the artificial heart, like the natural heart, produce a pulsating flow, as opposed to a steady flow. Secondly, the atria and ventricles have specific pumping functions. Although the atria do not have to contract, they should be collapsible to prevent a vacuum from developing when blood flows from the atria into the ventricles. The ventricles must also be collapsible and pump blood in varying amounts to avoid blood accumulation and excessive stress on the circulatory system. The artificial heart must also maintain the pressure which the circulatory system is accustomed to. Researchers have shown the pressures to be from —.40 to .65 in. mercury at the atria inputs, .80 and 3.20 in. mercury at the right ventricle output, and 4.70 and 7.10 in. mercury at the left ventricle output.

Flow Capacity

The best beat rate, or pulse, and the amount of blood flow are related to the heart capacity. The circulatory system is designed to handle between 60 and 120 beats per minute. This pulse limits the volume of blood pumped by the heart in a given time. Depending on human activity, the artificial heart must be able to pump approximately 1.25 and 9.80 gallons per minute. The blood flow rate is known as the cardiac output. Cardiac output is the researcher's basic measure of the heart's performance. The atrial pressures and cardiac output are related in a linear manner—the higher the atrial pressure, the greater the cardiac output. To maintain proper pulse and capacity, the artificial heart needs a source of power.



Courtesy Scientific American

STARLING'S LAW that the output of each ventricle depends on the amount of blood pushed into it from its atrium applies, as this graph shows, to artificial as well as real hearts. The curve reveals an almost linear relation between blood flow *(in liters per minute on the vertical axis)* and atrial pressure *(in centimeters of water on horizontal axis)*. It is based on data for flow from ventricle of an air-driven artificial heart tested in mock circulation.

Power

The average power requirement is 8 watts, depending on human activity. This power must be supplied for every beat of the heart without fail. The power, pumping action, and flow capacity are interrelated parameters in a control system.

Control

The natural heart is controlled by the brain through the use of electrical and neural signals. The signals induce contraction, and the strength and frequency of the contraction controls the pulse, which in turn controls the cardiac output. The cardiac output and pulse requirements of the heart vary according to the human life situation. Thus, an artificial heart must have a control system associated with it to change its output and pulse when required by neural stimulus. Since failure to respond to the neural stimuli would often mean death, the artificial heart must be reliable.

Reliability

An artificial heart must pump approximately 2 gal. per minute and beat 2-to-3 billion times in a lifetime. Although a lifetime is longer than the use of most artificial hearts, the ultimate goal is to make one that will last this long. Unforeseen failures would result in frequent repair operations and possibly death.

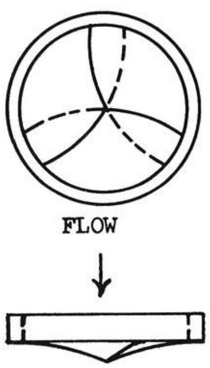
Environmental Requirements

An artificial heart must work *inside* the human body, as a part of the circulatory system. Environmental requirements can be divided into the following three categories:

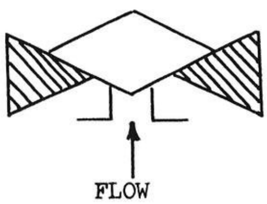
1. The blood
2. The circulatory system
3. The human body

Blood is a fluid containing various types of cells in suspension. To avoid harming the cells, the pumping action must involve gentle forces, minimal squeezing action, and little turbulence.

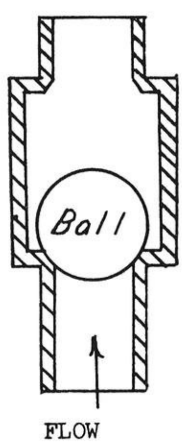
Since the artificial heart must become the major part of the circulatory system already existent in the body, familiar pressures, flows, and forces must be maintained. The physical connection to the body must conform to the locations of veins and arteries.



THE LEAF VALVE



THE TEARDROP VALVE



THE BALL-IN-CAGE

The human body itself limits the artificial heart. First, it must fit into the chest cavity. Secondly, at all points where contact is made between artificial and living tissues compatibility must exist. Because living tissues tend to reject non-living tissues, designers must use materials which the living tissues will accept.

Components of an Artificial Heart

The major components of the present artificial hearts are the ventricles, valves, and housing.

Ventricles

Many methods of ventricular contraction have been studied, but the most promising is an elastic sac controlled by external pressure. Figure 2 shows simplified sketches of two basic types.

The elastic diaphragm forces the blood out when air pressure is applied to one side of it. The diaphragm's operation is simple, but its life is short. The elastic sac expels blood by the same theory, but it tends to increase the life of the elastic material by reducing high pressure spots.

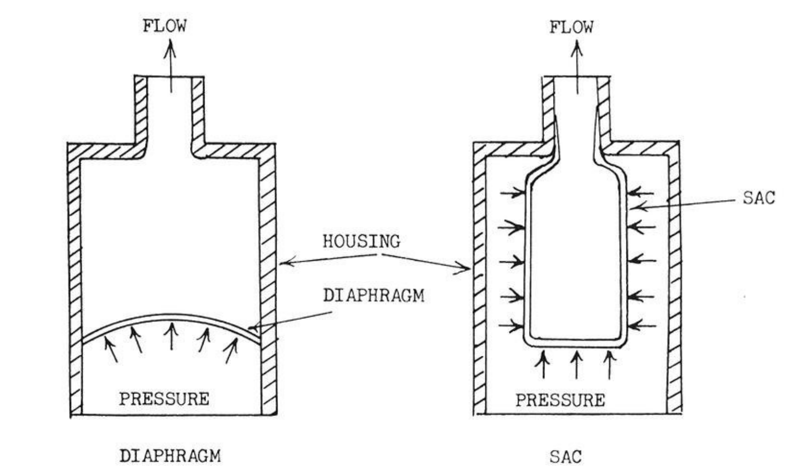
The major problem in designing ventricles is finding the right material for the sac or diaphragm. The elastic material must be strong, flexible, resistant to attack by body fluids and substances, and compatible with blood and body tissue. To date, the material coming closest to fulfilling these requirements is Silastic. Silastic is a form of silicone rubber manufactured by the Dow–Corning Corp. But this material has only a five or six year life under continuous operation, and the search for a better material goes on.

Valves

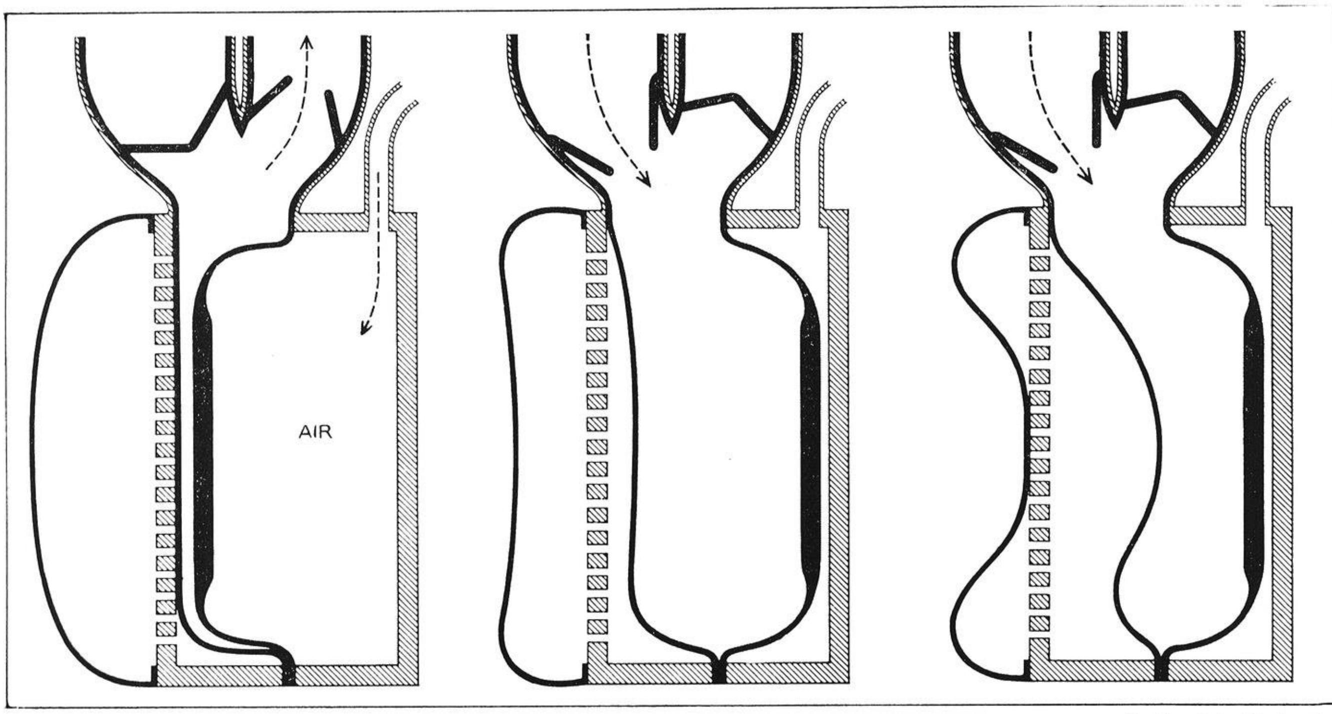
Four valves direct the flow of blood in and out of the artificial heart. Each valve flows in one direction, and blocks blood flow in the opposite direction. Three types of valves are used in artificial hearts: the leaf valve, the ball-in-cage valve, and the teardrop valve.

The leaf valve simulates the natural heart valve. It consists of three overlapping flaps which allow blood to flow, when they are forced open by the blood pressure. Various types of rubber have been used as the flap material, but material problems still exist. Rubber can cause blood clotting (thickening) under certain conditions, and it also fatigues readily once it becomes infiltrated with substances from the blood and begins to stiffen.

The ball-in-cage valve, most commonly used, consists of a Silastic ball surrounded by a highly polished metal cage. The ball rises when the blood pushes on it, allowing the blood to pass. This valve will take wear and tear, and is reliable. In improving the valve, attempts to minimize the ball



Two basic ventricle designs.



Courtesy Scientific American

ANTISUCTION BALLOON prevents harm to blood vessels caused by excessive suction when there is insufficient blood pressure to fill the ventricle of an artificial heart. Artificial heart equipped with balloon is shown in cross section during three phases. Normal systole is depicted at left. Ventricle is compressed and blood is expelled as chamber fills with air from tube at top right right. Normal diastole is depicted in center. Ventricle is entirely filled with blood from atrium at top left. When venous blood pressure is inadequate during diastole (as *in cross section at right)*, the balloon is sucked inward, preventing the creation of a vacuum inside the chamber.

travel led to the development of the teardrop valve.

A teardrop valve provides greater flow with less travel. Silastic is used for the teardrop, which seats against a stainless steel housing. Blood flows when the teardrop is forced from its seat. Stainless steel retaining feet aid the seating of the teardrop and prevent excessive teardrop travel.

Housing

The housing of an artificial heart must contain the atria, flow passages, and provision for power input, as well as the valves and ventricles. Housings are currently either Silastic, stiffened with Dacron mesh, or polyurethane, a thermosetting plastic. A smooth surface is safe from growth formation only where the blood flows rapidly over it. Therefore, all flow passages in the housing are "microsmooth" to prevent such growths. But major problems involved in housing design are those of physical size, compatibility with living tissue at the physical connections to the circulatory system, and a power source.

Types of Artificial Hearts

Artificial hearts are often classified by their power source. The majority of hearts fall into four categories, the air-driven heart, the electrical heart, the electromagnetic heart, and the nuclear heart.

Air-Driven

The air-driven heart is the most popular today. An air compressor, located outside the body, forces the air through small plastic tubes into the body and to the heart, where the pressure controls the pumping cycle. Figure 5 shows an air-driven heart that was developed for use in a calf. It is similar to those planned for human use.

The air-driven heart has a rigid housing with non-collapsible atria, sac-type ventricles and either ball-in-cage or teardrop valves. Pumping begins when the air pressure compresses both elastic ventricles simultaneously. The pressure built up in the circulatory system forces blood into the atria. Pressure on the ventricles is then removed, and they are allowed to fill, completing the pumping cycle. A vacuum may be supplied to the ventricles to aid the filling.

The air-driven heart has the advantage of being relatively small, cool operating, and powerful; but, it must depend on a power source outside the body. This creates problems of human immobility, possible failure of the outside power source, and non-compatibility and irritation caused by the tubes running into the body through living tissue. Despite these difficulties, the air-driven heart is the most developed of the existing artificial hearts.

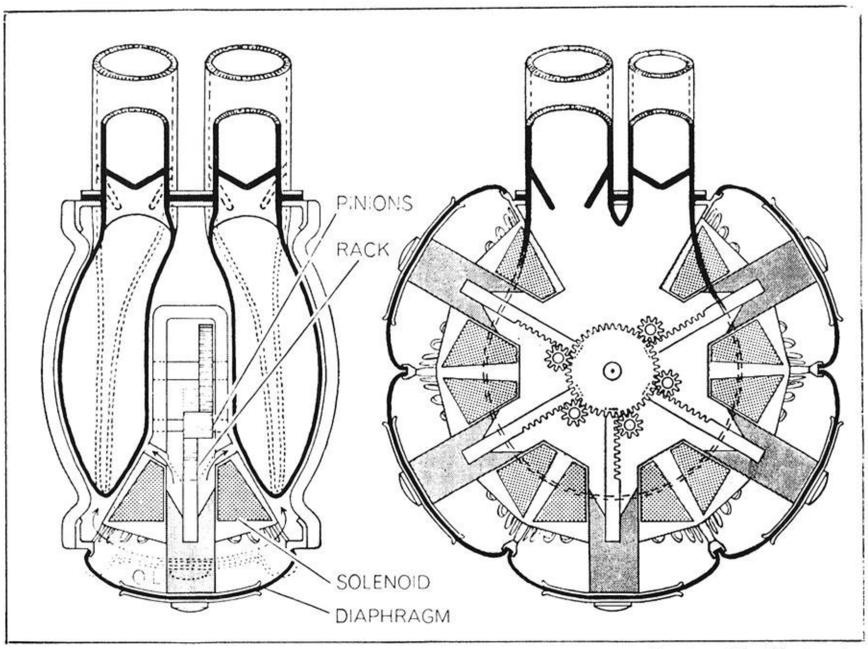
Electrical

The electrical heart uses a small electric motor to drive a mechanical pump. Extensive work has been done to develop an electrical power source for the motor. Both batteries and the human body itself are under consideration.

Batteries may power an electrical heart from either inside or outside of the body. They are portable and capable of supplying sufficient power, but they must be periodically replaced, and their life cannot be accurately predicted.

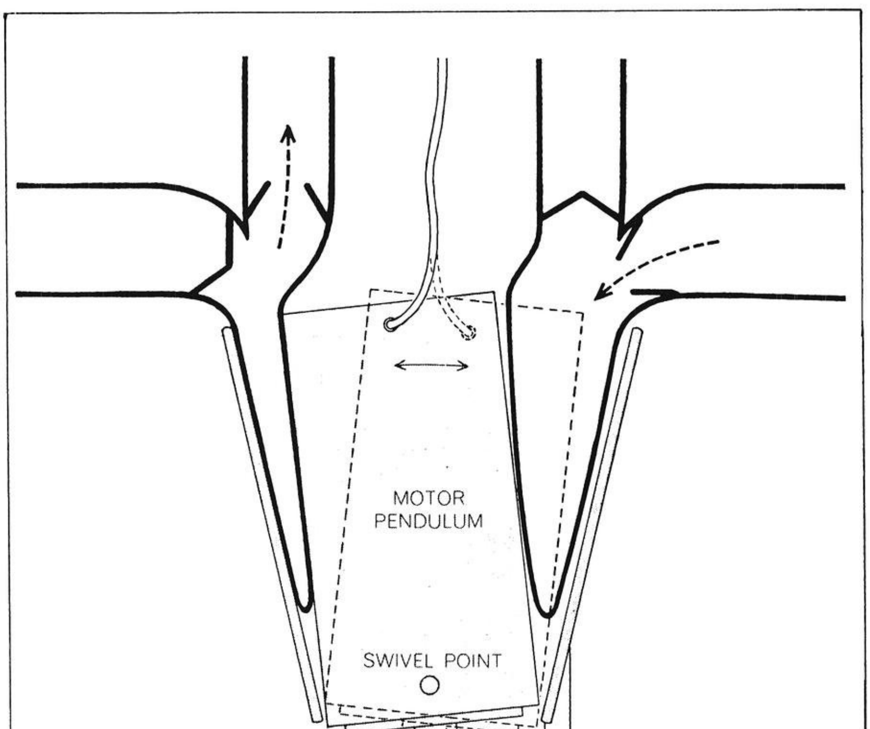
Two approaches have been developed for securing electrical energy from the human body. Mechanical motion within the body may be converted to electricity through the use of a piezoelectric crystal, or transducer, but coupling the transducer to the motion is difficult. Another possibility is a fuel cell operating within the body, using the waste gases of some bacteria in the body in chemical reactions that generate electricity. However, a large amount of equipment must be installed within the body.

Once a power source is found, the electric motor can be used in several ways. One method uses the motor as a pendulum (Figure 6). As the shaft turns, the lever arm forces it to swing back and forth about the swivel point, alternately compressing the ventricles. In another heart, a roller powered by an electric motor passes over the sac ventricle and flattens it, forcing the blood out. Excessive heat is a major drawback, and the most feasible place to deposit this heat is the blood stream, but any appreciable heating of the blood destroys or alters its contents.



Courtesy Scientific American

EARLY ARTIFICIAL HEART has pumping units run by electromagnetic power *(section at left)*. Current in the solenoid (coil around cylinder) pushes diaphragm inward. Pressure transferred by hydraulic fluid forces ventricle sacs to contract and expel blood through tubes at top. Five solenoid pistons are coordinated *(section at right)* to exert equal pressure.



Courtesy Scientific American

ANOTHER EARLY HEART uses the back-and-forth swing of a pendulum to expel blood from left and right ventricle sacs. The pendulum is the metal casing in which an electric motor is contained. An advantage of this scheme is that circulating blood cools the motor.

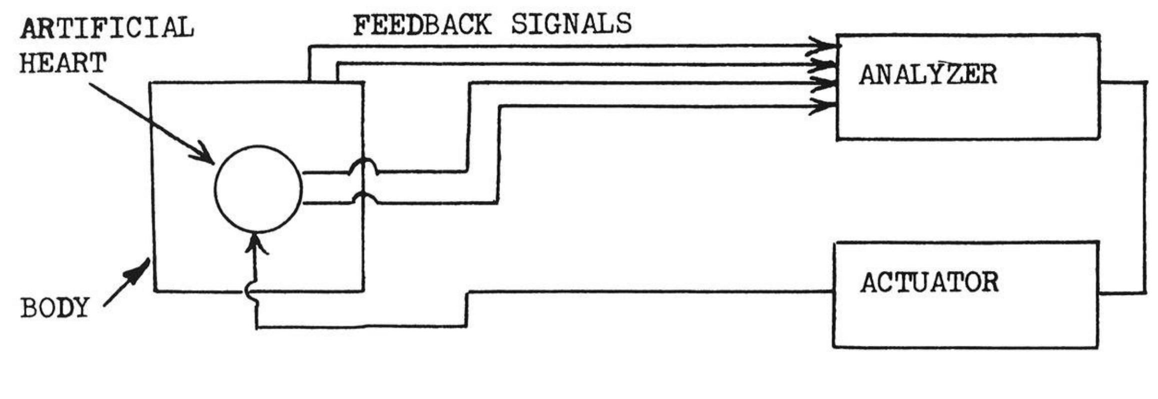
Electromagnetic

The energy source of an electromagnetic heart is outside the body. The electromagnetic energy is converted to electrical energy in three ways.

The first way (Figure 7) uses an external electrical source. An electrical signal activates electromagnets within the heart which push against the blood-filled ventricles, and the blood is forced out. This heart has the desired simultaneous ventricle pumping and relatively small size. However, wires must pass into the body from the outside and the electromagnets generate a high degree of heat.

The second type transmits electromagnetic energy through the chest wall without the use of wires. A flat, pancake-shaped coil is placed on the outside of the chest wall, and a similar coil is placed on the inside. Direct current from a battery located outside of the body is converted to alternating current, passed through the discs, and then converted back to direct current to drive an electric pump for an artificial heart. This system, however, needs a large amount of equipment. Also, continuous exposure of living tissue to an electromagnetic field may damage the tissue.

The third type of electromagnetic heart uses radio signals to sustain rotation of an electric motor. The signals are sent from outside the body and received inside, like a common radio receives signals from a broadcasting station. Wires passing into the body are eliminated and mobility is provided within the range of the radio signals. Unfortunately, this method



THE ARTIFICIAL HEART'S CONTROL SYSTEM

also uses a considerable amount of equipment inside the body.

Nuclear

A nuclear-powered heart uses a radioisotope fuel consumed in a small nuclear heat source (reactor). The heat is used with a working fluid for the operation of a miniature reciprocating engine, converting heat energy to mechanical energy. The engine drives a mechanical blood pump. The heat source is mounted on the hip bone, and tubes run within the body to the heart. This system has the advantage of a relatively permanent, efficient power source within the body, but living tissues are affected by the radioactivity and considerable heat is generated.

Artificial Heart Control System

Given an artificial heart operating adequately within the human body, it must still be told what pulse and cardiac output to maintain. The system must examine the heart's performance and the body's requirements and inform the heart what pulse and cardiac output to maintain. This is the feedback control system used in the air-driven heart.

Feedback Signals

In general, feedback signals either describe the operation of the artificial heart (heart signals) or the state of the human body (body signals), as indicated by nerves and various glands. Currently, researchers are investigating the relationship between the heart and the rest of the body to determine what parameters can be measured and used as body signals.

Several heart signals can be measured and transmitted. The pulse can be obtained with a transducer located at an area of motion in the air-driven heart. This motion is representative of the pulse. Transducers placed in the ventricles of an air-driven heart will transmit the cardiac output.

Analyzer

The analyzer receives the feedback signals, analyzes them, determines what the heart must do to meet the body's requirements, and transmits a signal. The frequency of the signal represents the pulse and the strength represents the cardiac output.

Actuator

The actuator input is the actuation signal, and its output is a driving signal to the artificial heart. It converts the actuation signal into power for pumping the artificial heart.

BIBLIOGRAPHY

"Air Pumps." *Product Engineering, 36* (June 7, 1965), 75.

"Artificial Heart." *Electronics, 38* (Oct. 4, 1965), 48–44.

"Artificial Heart.' *'Product Engineering, 34* (Dec. 23, 1963), 32.

Davis, John F. "Medical Engineering." *International Science and Technology, 33* (Sept. 1964), 18–32.

Kolff, William J. "An Artificial Heart Inside the Body." *Scientific American, 213* (Nov. 1965), 36–46.

Lindgren, Nilo. "The Artificial Heart–Exempler of Medical Engineering Enterprise." *I.E.E.E. Spectrum, 2* (Sept., 1965), 67–83.

"Off the Shelf: The Mechanical Heart." *Machine Design, 33* (Feb. 16, 1961), 28–29.

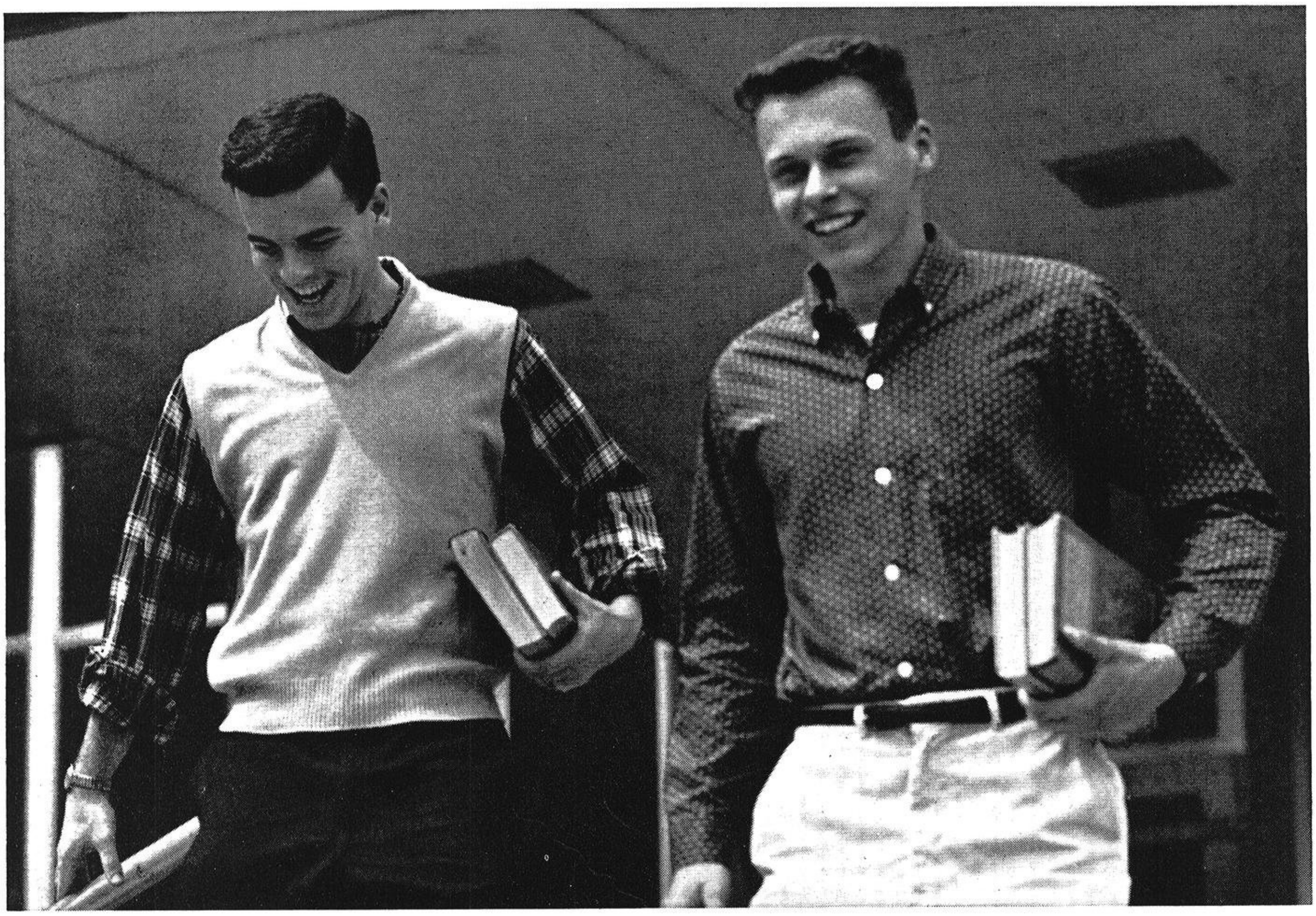
Popovitz, Seymour. "Electrical Power from the Human Body." *I.E.E.E. Student Journal, 2* (Nov., 1964), 2–9.

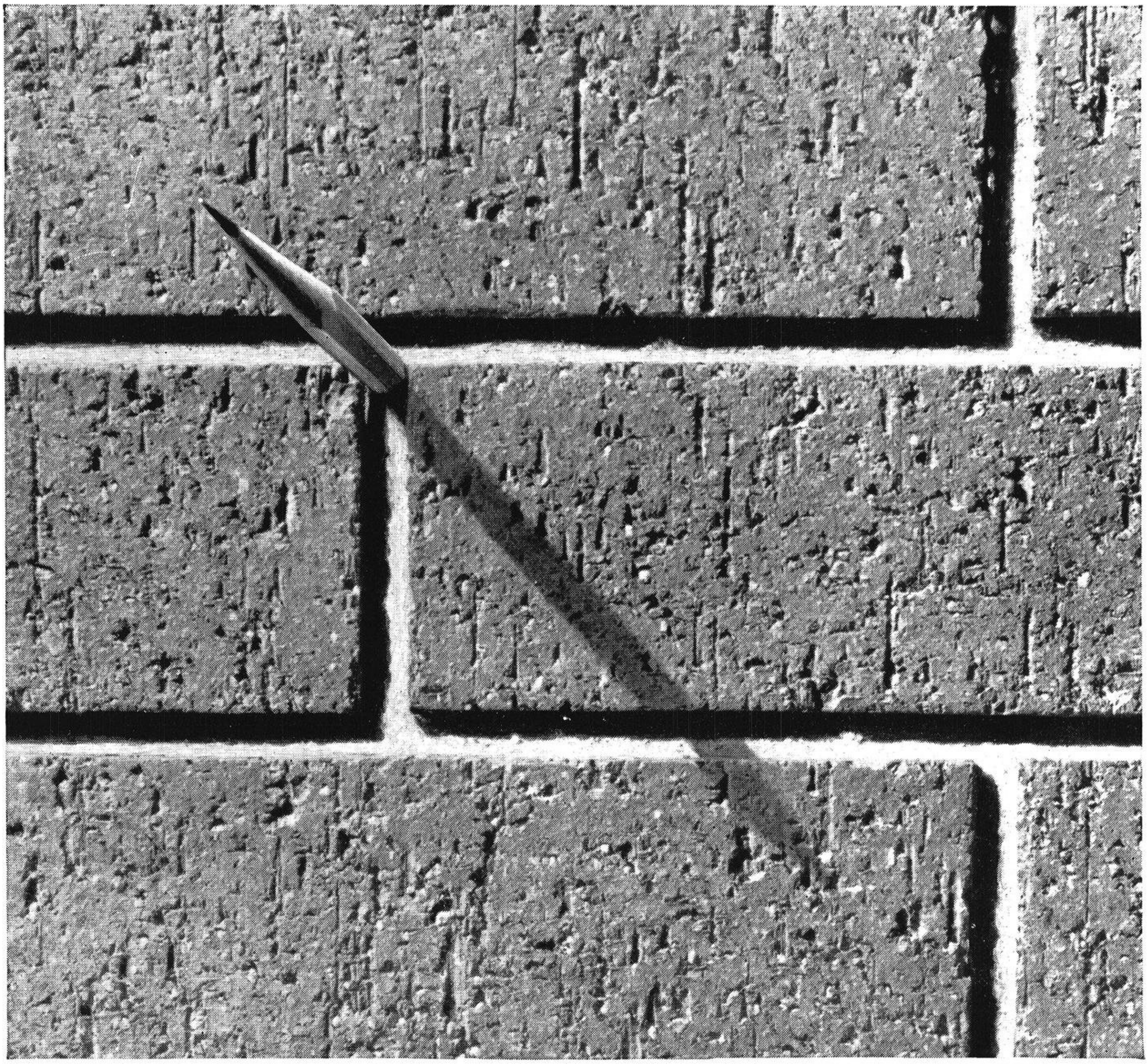
"Rubber: Key to Heart Research." *Rubber World, 152* (May, 1965), 24–26.

Schmeck, Harold M., Jr. *The Semi-Artificial Man.* New York: Walker and Co., 1965.

Warshofsky, Fred. *The Rebuilt Man.* New York: Thomas L. Crowell Co., 1965.

"Will R–f Control Artificial Hearts?" *Electronics, 36* (June 21, 1963), 86–88.





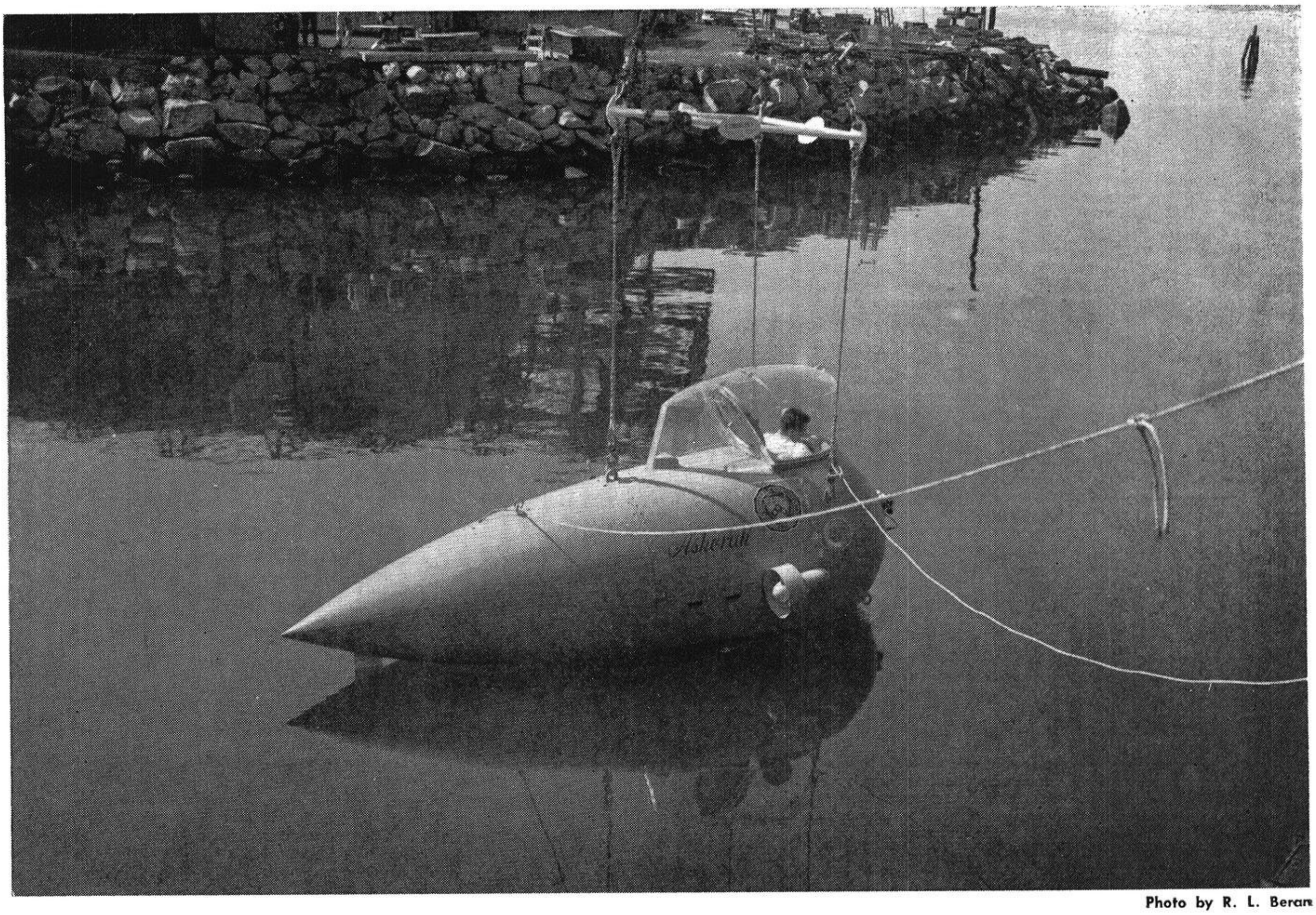


Photo by R. L. Beran

"SUB-IT YOURSELF" OR THE ASHERAH MINI-SUB

by Robert L. Beran

SUBMARINES enable man to dive beneath the surface of the ocean, the "Last Frontier". The Asherah, one of a growing number of manned research submersibles, was designed to supplement underwater archeological activities in the Aegean Sea off the coast of Turkey.

The proper mechanical design is important for two reasons—(1) for effectively carrying out the intended operations, and (2) for the safety of the operators. But the Asherah goes further than the general mechanical construction with new innovations not common to other submarines of this type.

Construction Requirements

Submarine requirements determine how the submarine is built, along with the operating conditions of the specific craft.

Submarine Criteria

The Asherah was to operate in water that was seldom greater than 300 feet, but was designed for a maximum depth of 600 feet for possible future sites. The submarine had to carry a crew of two, since the presence of a Turkish government official was required on each dive to safeguard their national interests.

One-knot bottom currents and choppy surface waves that sometimes exceeded a height of three feet, required a highly maneuverable vehicle that could withstand the elements. The submarine must be streamlined to increase its speed and range and to reduce the power requirements.

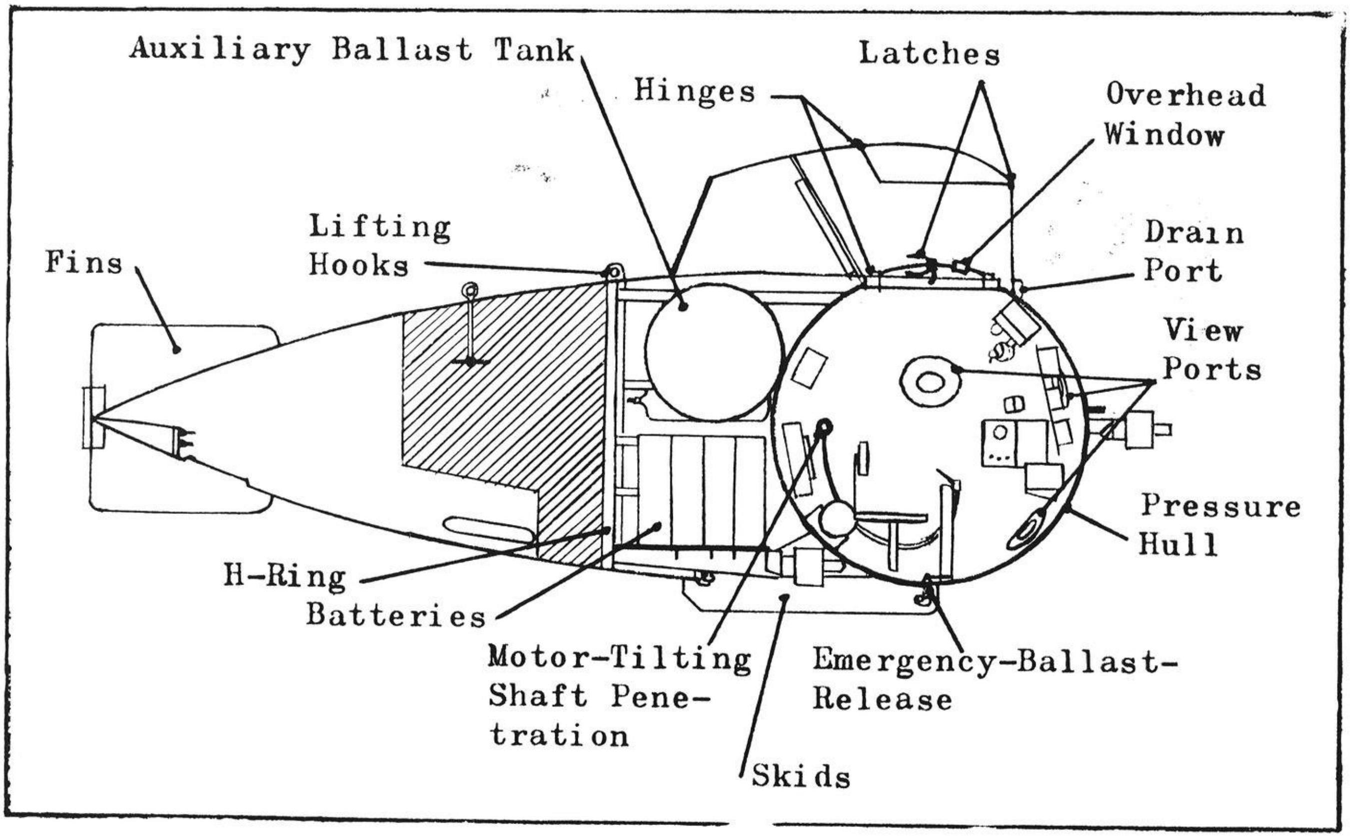
Construction was to remain economical and simple, since a building schedule of only 5 months preceded delivery to Turkey.

Asherah Design

Good mechanical design began in the pressurized and external supporting structures of the Asherah. Features of the complete structure are illustrated in the cross-section in Fig. 1.

Hull Design

To accommodate the two men plus manual and electrical equipment, a 5 foot diameter sphere was used as the pressure hull. The spherical configuration is best suited for resisting hydrostatic



The Asherah cross-section.

forces, and the hull was designed in accordance with the ASME Boiler Code, Section VIII.

The hull consists of two hemispherical heads. Time and expense were minimized by spinning the heads, since it was not necessary to have them machined to an exact thickness after spinning. The spinning process produces some irregularities, but allowances were made to ensure a minimum design thickness of ⅝ in.

The mild steel, A212 Grade B, was used for the hull because it is easily worked and welded and has a high strength-to-weight ratio. Mild steel is excellent for this application, since it does not develop high stress concentrations near discontinuities when the submarine is hydrostatically compressed.

To provide the hull with crack-free welds, the heads were heated to 300°F before welding. All finished welds were ground smooth and x-rayed for unwanted porosity. The welds proved to be satisfactory.

Orifice Design. There are four types of openings that must be cut in the pressure hull—shaft penetrations, electrical penetrations, hatch, and window. These openings tend to weaken the hull, but reinforcements compensate for the resulting weakness and aid in the function of the orifice.

For electrical penetration reinforcements, the pipes running through the hull were fillet welded, both on the inside and outside. Emergency-ballast-release and motor-tilting-shaft reinforcements served as seats for the 0-ring seals. The latter reinforcement housed shaft bearings and had full penetration welds and extra trussing to withstand impact loading should the motors be bumped.

The hatch reinforcement ring was cut from stainless steel to provide a corrosion-free surface for the hatch 0-ring seal. Since welding produces some distortion in stainless steel, an even seating surface was obtained by machining it *after* welding into the hull.

Machining of a reinforcement while in place in the hull is costly, and due to a relatively large number of windows (six), stainless steel was not used for window reinforcement. Instead, a mild steel which undergoes little distortion when welded was used, and the machining was done before placing them in the hull.

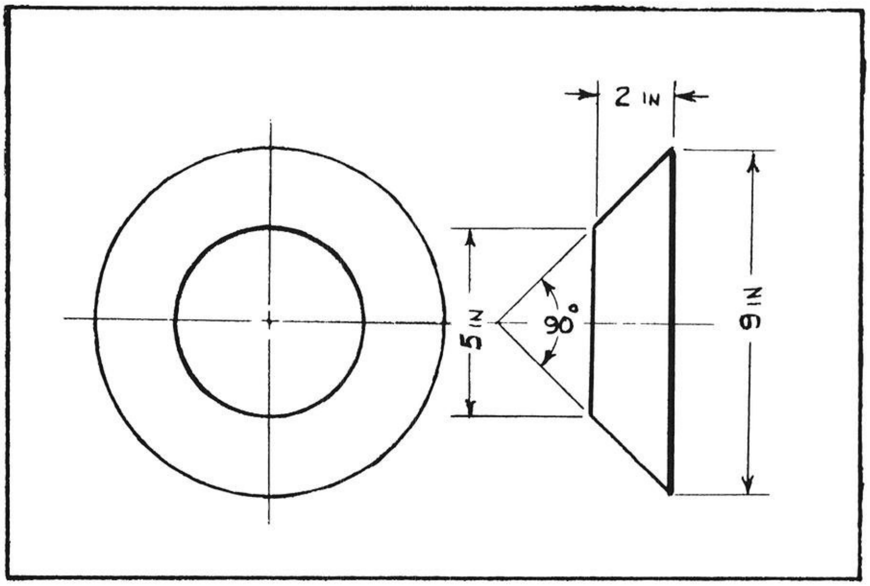
Hatch. The hatch dome was made from the material removed from the hull when making the hatch orifice. It has a stainless steel reinforcement ring which has a machined dovetail groove to accommodate a ¼ inch 0-ring seal. To provide overhead visibility, a small window was inserted in the dome.

The effort required to open the steel hatch is reduced by offsetting 50 per cent of the hatch weight with the use of two helical torsion springs placed in the hinge area.

The latch system is a toggle mechanism which drives two tapered pins into mating holes, one in each side of the hull-reinforcement ring. The mechanism can be actuated from inside or outside the hull. A quarter turn of the handle engages the pins, locking the hatch and compressing the 0-ring sufficiently to seal out the water.

Windows. The windows were machined from 2 inch cast acrylic blocks. To provide optimum visibility and simple insertion into the hull, each window was shaped as a truncated cone, with the smaller diameter base facing inward and the larger diameter base outward. The window geometry is shown in Fig. 2. Testing of a similar window configuration showed that a pressure failure would occur at a depth of 4000 ft, indicating a high factor of safety.

Before window placement, water-insoluble grease was applied to the window seats. Each window is held in place by a single bolt-on retaining ring which also compresses an 0-ring seal to prevent water seepage. The retaining ring does not resist hydrostatic forces but merely serves to prevent the window from coming loose when no water pressure is present. When the submarine is submerged, water pressure alone is sufficient to hold the window in the seating.



The Window Geometry

Window Guards. Window guards were installed after a collision with the bottom that resulted in a cracked window. The guards are metal rods placed out in front of each window with the ends welded to the hull.

Guards were put on with hesitation, however, since snagging the rods and being caught on a submerged object could be hazardous.

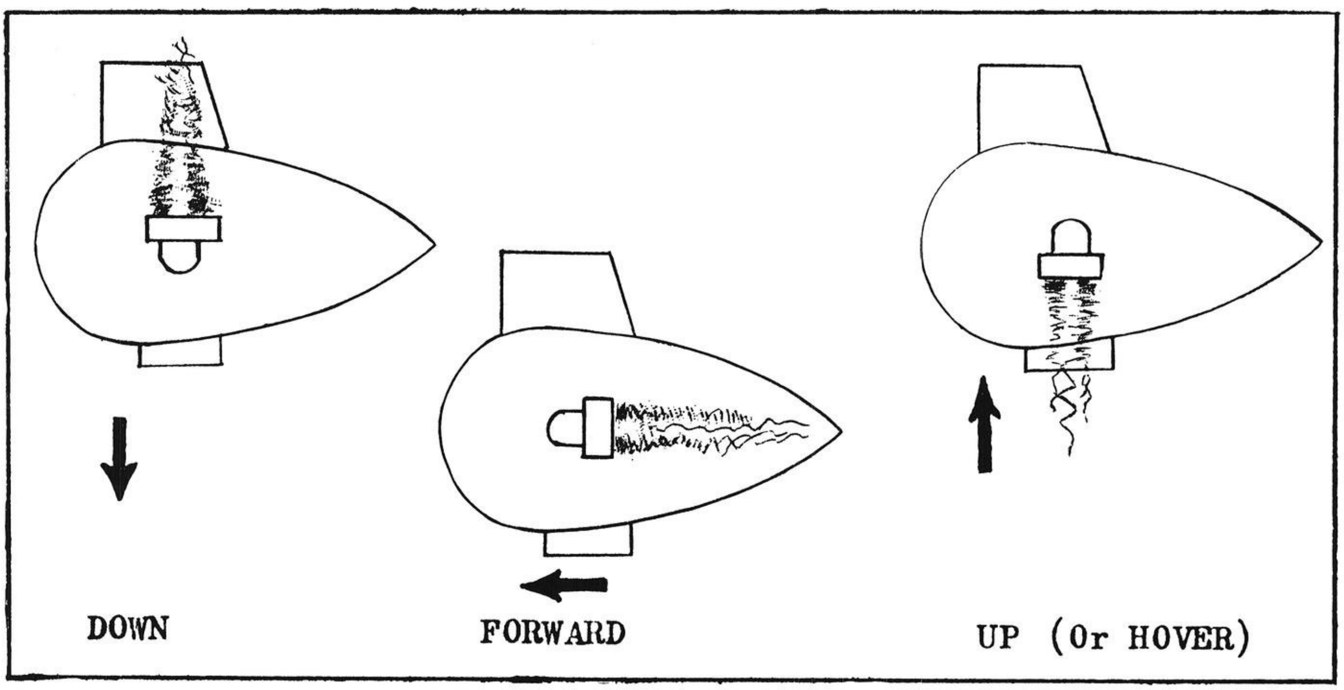
Tilting Motors. The tilting motors, one on each side of the hull and independently operated, give the submarine outstanding maneuverability. Three general movements that Asherah executes easily with its tilt-motor design are shown in Fig. 3.

Speed control is infinitely variable and the motors can rotate through 340 degrees. Tilting is done manually with a pair of cranks connected to flexible shafts. These shafts transfer crank motion in a 1:1 ratio to the motor-tilting shaft that is welded directly to the motor. Power is supplied to the motors with electrical conductors traveling through the center of the tilt-shaft.

External Apparatus

The external apparatus consists of supports for the ballast tanks, batteries, and tail section. Included is the external shell and canopy, and that which is not part of the actual hull.

Supporting Structure. The supporting structures are mild-steel beams attached to the hull. The two main cantilever beams run



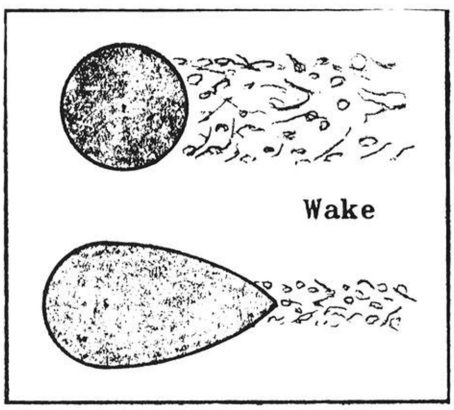
The Asherah's Maneuverability

parallel from low on the hull to a large circular H-ring in the rear. The battery tray, made of small steel angles, is supported by the two main beams. Near the top of the hull, two parallel pipe cantilevers run back to the H-ring. The H-ring is used primarily for connecting the tail section and the mid-section shells to maintain longitudinal rigidity.

The structures do not resist hydrostatic forces, but were designed for loads due to the weight of the tail section and impact loadings from being dropped quickly into the water.

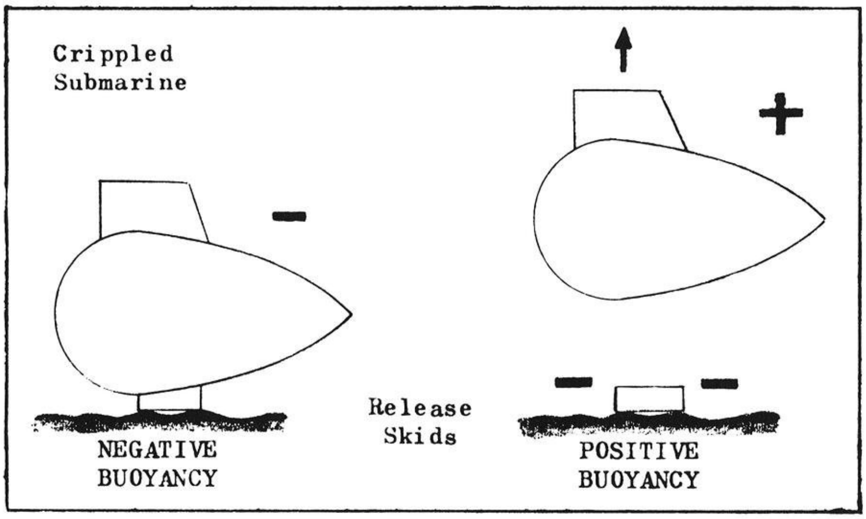
Lifting Hooks. The submarine is small enough to be lifted into and from the water with a dockside crane. To facilitate handling, lifting hooks were welded onto strategic locations on the submarine. One hook is connected to the H-ring and two others are located high on the pressure hull. Other hooks near the bottom of the hull are for guide lines used during the lifting operation.

Fairings. The fairings are the external shells (skin) of the submarine and are streamlined to reduce the wake. See Fig. 5. Reduction of the wake results in less drag; hence, a streamlined body requires less power for propulsion. In the Asherah, streamlining resulted in a reduction of cumbersome batteries.



Wake Reduction

The hull fairing consists of 1/8 inch molded polyester fiber glass. Fairing thickness near bolted regions was doubled for strength.



Crippled Submarine

The tail section contains flotation material—syntactic foam—for added buoyancy.

Fins were attached soon after the first sea trials. Before fin installation, marked instability was observed for speeds greater than 1-knot. The fins provide adequate stability for speeds up to 4-knots. Since top speed for the submarine is about 4-knots, instability is no longer a problem. Only when the submarine is towed at speeds greater than 4-knots is instability encountered.

The fairing over the hatch was molded from acrylic sheets. The sides are 1/2-inch thick and the bottom edge is bolted to a close fitting steel foundation on the top of the hull. The 3/8-inch thick top has a hinged cover that can be locked from the inside or outside. The transparent fairing provides the operator with excellent visibility when the craft is surfaced, but the main purpose of the canopy is to prevent large waves from washing into the hull when the hatch is open.

A heavy acrylic bulkhead separates the canopy into two compartments. The rear compartment is open along the bottom edge of the fairing to let water completely fill the canopy when diving. The bulkhead has a large flood hole so the front compartment can also fill with water. When surfacing, the water runs back out the flood hole and out the rear compartment. The water that is below the flood hole level in the front compartment runs out through one-way drain ports in the front of the canopy. When the hatch is opened, it rests against the bulkhead. The hatch completely covers the flood hole, making the front compartment water-tight.

Ballast Tanks. The auxiliary ballast tank is a 26 inch diameter mild-steel sphere. Its design is similar to that of the hull, since it also undergoes high pressure. The ballast tank acts as a reservoir for taking on or releasing water to attain three possible states of submarine buoyancy—slightly negative, neutral, or slightly positive. Placing the ballast tank near the center of gravity prevents the submarine from "nosing up" or "nosing down" while the buoyancy is changed.

To operate, the pressurized air enters the tank from the top and forces the water out the bottom through a drain pipe. To flood, a valve at the top of the tank is opened and air is released, allowing water to enter from the bottom. Control of the upper valve is done manually with a long valve stem that enters the hull.

The main ballast tank provides added buoyancy when the submarine is surfaced. This raises the boat slightly to allow easier boarding.

The main ballast tank is actually the upper half of the fiber glass fairing—between the H-ring and hull—which is sealed to prevent air leakage. To increase buoyancy, air is let into the tank and water simply flows out the open bottom. As a result of the open bottom, outside and inside pressures are nearly the same, so the main tank strength is much less than that needed for the auxiliary tank. Valve control in the main ballast tank is similar to that of the auxiliary tank.

Safety Features. In the event that the ballast tanks become inoperable while the Asherah is submerged, the two skids can be manually released from the frame with a quarter turn of the emergency-ballast-release handle located inside on the bottom of the hull. Without the skids, the submarine has a positive buoyancy and performs a powerless ascent to the surface. (See Fig. 6.)

Predetermined weight accounts indicate that the submarine is buoyant without the skids even when the ballast tanks are completely filled with water. Should the pressure hull also become filled with water, releasing the skids would not guarantee an ascent. If all available means for surfacing the submarine fail, it would become necessary to "abandon ship". Before attempting a free ascent, it is necessary to flood the hull to equalize inside and outside pressures. After complete flooding, the hatch can be opened. Flooding is performed manually by opening the interior flood valves.

Performance

The Asherah design successfully fulfilled the requirements for the marine archaeology expedition, performing well when taking pictures and searching for new objects. The Asherah has proved to be a versatile tool and is being used in many other areas of underwater research.

INFORMATION ON BUILDING OR BUYING A SUBMERSIBLE MAY BE OBTAINED FROM WILLIAM BERAN, CHIEF DESIGN ENGINEER OF THE ASHERAH.

Summary of Technical Information of Asherah

Maximum Operating Depth (feet)	600
Speed (knots)	0–4
Range (miles)	9
Submerged endurance (hours)	10
Size (feet)	
Length	16
Diam. Beam	5
Weight (tons)	3.5
Propulsion	2 motors/ 2 hp each
Crew	2
Remarks	Built for University of Pennsylvania Museum for marine archaeology exploration.

Alphabetical Listing of All Con

Abbott Labs . . . . Nov. 14–16
Acax Amer. Brake Shoe . . . . . . Nov. 29
AC Electronics . . . . Nov. 1–4
AT&T . . . . Nov. 30–Dec. 1
Adv. Scient. Instruments . . . . Dec. 1
Alcoa . . . . Dec. 2
All Steel Equipment . . . . Oct. 10
Allegheny Ludlum . . . . Nov. 9
Allen Bradley . . . . Oct. 24
Allied Chemical . . . . Oct. 18
Allied Chemical—PhD's . . . . . . Oct. 18
Louis Allis . . . . Nov. 8
Allis Chalmers . . . . Nov. 14–16
Amana Refrigeration . . . . Dec. 1
Amer. Agr. Chemical . . . . Oct. 19
Amer. Air Filter . . . . Oct. 12
Amer. Appraisal . . . . Oct. 14
Amer. Can Co. . . . . Nov. 1–3
Amer. Cyanamid . . . . Oct. 27–28
Amer. Electric Power . . . . Nov. 9
Amer. Oil (Chicago) . . . . Oct. 10
Amer. Oil (Indiana) . . . . . . Oct. 20–21
Amer. Oil & Amoco Chem. . . . . Nov. 9
Amer. Potash . . . . Dec. 1
Amoco Chemicals . . . . Oct. 14
Ampex Corp. . . . . Oct. 14
Amphenol Borg . . . . Oct. 25–26
Amsted Industries . . . . Nov. 29–30
Anaconda . . . . Dec. 2
Arthur Andersen . . . . Dec. 6
Anderson Clayton & Co. . . . Oct. 27–28
Anheuser Busch . . . . Oct. 17
Applied Physics Labs. . . . . . Nov. 15–16
Aqua Chem Inc. . . . . Nov. 17
Archer Daniels Midland . . . . . . Nov. 7–8
Argonne National Labs . . . . Nov. 18
Armco Steel . . . . Oct. 19
Armour Ind. Chemicals . . . . Oct. 14
Atlantic Refining . . . . Nov. 14–15
Atlantic Research . . . . Nov. 16–17
Atlas Chemicals . . . . Nov. 18
Automatic Electric . . . . Nov. 15
Avco Lycoming . . . . Nov. 15

Babcock & Wilcox . . . . Nov. 1
Barber Comman . . . . Oct. 12
Bechtel Corp. . . . . Nov. 9
Belden Mfg. . . . . Nov. 30
Bell System . . . . Oct. 25–27
Belle City Malleable . . . . Oct. 21
Beloit Corp. . . . . Oct. 28
Bemis Co. . . . . Nov. 30
Bendix Corp. (4 divs.) . . . . Oct. 10
Bergstrom Paper . . . . Oct. 26–27
Bessemer & Lake Erie RR. . . . . . Nov. 1
Bio-Rad Labs. . . . . Oct. 19
Boeing . . . . Oct. 31–Nov. 1
Brunswick Corp. . . . . Nov. 10–11
Bucyrus Erie Co. . . . . Nov. 30
Burroughs Corp. . . . . Nov. 10

Cabot Corp. . . . . Dec. 7
Calif. State Govt. . . . . Oct. 12
Campbell Soup . . . . Dec. 1
Carnes Corp. . . . . Oct. 12
Carrier Air Cond. . . . . Nov. 30
J. I. Case Co. . . . . Nov. 17
Caterpillar Tractor . . . . Nov. 8–9
Ceco Corp. . . . . Nov. 1–2
Celanese Corp. . . . . Nov. 10
Celotex . . . . Nov. 3
Central Ill. Electric . . . . Oct. 12
Chamberlain Corp. . . . . Dec. 6
Charmin Paper . . . . Nov. 8–9
Cherry Burrell . . . . Oct. 19

Chevron Research . . . . Oct. 24–25
Chicago Bridge & Iron . . . . Nov. 8
Chicago, Milwaukee & St. Paul . Oct. 28
Chrysler Corp. . . . . Nov. 29
City of Detroit . . . . Dec. 1
City of Los Angeles . . . . Oct. 17
City of Milwaukee . . . . Oct. 31
City of Minneapolis . . . . Nov. 16
City of Philadelphia . . . . Nov. 18
City of Rockford . . . . Nov. 30
Clark, Dietz, Painter . . . . Nov. 15
Clark Equipment . . . . Oct. 25–26
Clark Oil & Refining . . . . Dec. 5
Climax Molybdenum . . . . Nov. 29
Collins Radio . . . . Oct. 10–11
Columbia Caron . . . . Oct. 12
Commonwealth Associates . . . . . Oct. 14
Commonwealth Edison . . . . Nov. 3
Consolidated Papers . . . . Nov. 15–16
Consumers Power . . . . Oct. 18
Container Corp. of America . . Nov. 9–11
Continental Can . . . . Dec. 1
Continental Oil . . . . Oct. 19–20
Continental Oil—Texas . . . . . . Nov. 30
Control Data . . . . Nov. 18
Copolymer Rubber . . . . Dec. 7–8
Corn Products . . . . Oct. 21
Cornell Aeronautical Labs. . . . . Nov. 10
Corning Glass . . . . Oct. 12–13
Corning Glass—PhD's . . . . Oct. 12
Crane . . . . Oct. 24
Crown Zellerbach . . . . Oct. 24
Cummins Engine . . . . Nov. 11
Cutler Hammer . . . . Nov. 29

Dames & Moore . . . . Oct. 10
Danly Machine . . . . Oct. 19
Deere & Co. . . . . Oct. 24
Deering Milliken . . . . Oct. 31
DeSoto Chemicals . . . . Nov. 7
Diamond Alkali . . . . Dec. 1
DoAll . . . . Dec. 6
R. R. Donnelley . . . . . . Nov. 29–Dec. 1
Douglas Aircraft . . . . Nov. 17–18
Dow Chemical . . . . Oct. 17–21
Dow International . . . . Oct. 17–18
Dow Corning . . . . Oct. 24–25
DuPont . . . . Oct. 18–21
DuPont–PhD's . . . . Oct. 10–14

Eastman Kodak . . . . Oct. 31–Nov. 1
Eaton, Yale & Towne . . . . Nov. 2
Elgin Joliet & East. RR. . . . . . . Nov. 1
Elliott Co. . . . . Nov. 9
Emerson Electric . . . . Oct. 14
Esso Res. & Engr.—Humble Oil
. . . . Oct. 25–28
Ethyl Corp. . . . . Nov. 7–8

FMC—American Viscose . . Nov. 14–15
FMC—Canning Machine . . . . . Nov. 30
FMC—Chemical . . . . Nov. 30
FMC—Hudson Sharp . . . . Oct. 20
Fabri Tek Inc. . . . . Oct. 20
Factory Mutual . . . . Nov. 9
Fairbanks Morse . . . . Oct. 17
Fairbanks Morse—Colt Ind. . . . Oct. 24
Fairchild Semiconductor . . . . Dec. 1
Falk Corp. . . . . Nov. 16
Fansteel Metallurgical . . . . . . Oct. 20–21
Firestone Tire—PhD's . . . . . Nov. 10–11
Firestone Tire . . . . Nov. 8–10
Fisher Governor . . . . Nov. 1
Ford Motor . . . . Nov. 7–10
Freeman Chemical . . . . Dec. 1
George A. Fuller . . . . Oct. 21
Furnas Electric . . . . Oct. 20

Gen. Amer. Res. . . . . Nov. 16
General Atomic . . . . Nov. 7
General Dynamics—El. Boat . . . Dec. 1
General Dyn.—Liquid Carb. . . Nov. 29
General Electric . . . . Oct. 11–12
General Electric—PhD's . . . Oct. 17–18
General Engr. . . . . Nov. 29
General Foods . . . . Nov. 3
General Mills . . . . Oct. 13–14
General Motors . . . . Nov. 1–4
General Telephone . . . . . . Nov. 7–9–11
Giffels & Rossetti . . . . Nov. 8
Globe Union . . . . Oct. 28
Goodman Mfg. . . . . Oct. 13
B. F. Goodrich . . . . Oct. 27–28
B. F. Goodrich Res. . . . . Oct. 27
Goodyear Aerospace . . . . . . Oct. 27–28
Goodyear Tire & Rubber . . . Oct. 27–28
Goss Co. . . . . Oct. 18
W. R. Grace Co. . . . . Oct. 20–21
Grede Foundries . . . . Dec. 7
Green Bay Pkg. . . . . Oct. 21
Gulf Res. & Dev. . . . . Nov. 4

Hamilton Standard . . . . Oct. 18–19
Harnischfeger . . . . Nov. 16–17
Harper Wyman . . . . Oct. 10
Harris Trust & Savings . . Oct. 31—Bas &
Nov. 1—Com.
Harvard University—Grad. Sch. . Nov. 17
Heil Co. . . . . Nov. 1–2
Henningson, Durham & Richardson
. . . . Oct. 19
Hewlett Packard . . . . Oct. 14
Hercules Powder—PhD's . . . . Oct. 3
Hoffman LaRoche . . . . . Oct. 25 in Bas.,
Pharm. & Com.
Honeywell . . . . Oct. 27–28
Hooker Chemical . . . . Oct. 31
George A. Hormel . . . . Oct. 19–20
Hughes Aircraft . . . . Oct. 31
Hupp Corp. . . . . Oct. 14
Hydrotechnic . . . . Dec. 1
Humble Oil—Esso Res. . . . . Oct. 25–28

Ill. Dept. Public Works . . . . . . Oct. 19
Ill. Div. Highways . . . . Nov. 30
Illinois Tool . . . . Dec. 2
Ind. Dept. Natural Res. . . . . . . Oct. 26
Industrial Nucleonics . . . . Nov. 18
Industrial Res. Prods. . . . . Nov. 30
Ingersoll Milling Machine . . . . . Oct. 12
Ingersoll Rand . . . . Nov. 7
Ingersoll Res. Center . . . . Oct. 17
Inland Steel . . . . Oct. 14
Inst. Paper Chemistry . . . . Oct. 11
Inst. Paper Chemistry . . . . Oct. 28
Interlake Steel . . . . Oct. 25–26
Int'l. Bus. Machines . . . . Oct. 13–14
Int'l. Harvester . . . . Oct. 31–Nov. 3
Int'l. Minerals & Chemicals . . . Dec. 1–2
Int'l. Nickel—Huntington Alloy . Dec. 6
Interstate Power . . . . Oct. 21
Iowa Ill. Gas . . . . Oct. 25

Jefferson Chemicals . . . . Dec. 2
Jet Propulsion Labs. . . . . Nov. 7–8
Johns Manville Prods. . . . . Nov. 11
Johnson & Johnson . . . . Nov. 9–10
Johnson Service . . . . Oct. 17
E. F. Johnson . . . . Dec. 2
S. C. Johnson & Son . . . . Nov. 17
Joslyn Mfg. & Supply . . . . Nov. 30

Kearney & Trecker . . . . Oct. 12–13
M. W. Kellogg Co. . . . . Nov. 15
Peter Kiewit & Sons . . . . Dec. 8
Kimberly Clark . . . . Nov. 15–18
Koehring . . . . Oct. 31
Kohler Co. . . . . Oct. 18–19
Kroger . . . . Oct. 18–19

ies Interviewing on Campus This Year

Ladish Co. .... Oct. 14
E. J. Lavino .... Nov. 11
Lawrence Radiation Labs. .... Oct. 31
LeTourneau Westinghouse ..... Dec. 9
Eli Lilly & Co. .... Nov. 2–3
Lincoln Labs.—MIT .... Oct. 21
Line Material .... Nov. 8
Ling Temco Vought (Dallas) . Oct. 31
Ling Temco Vought (Michigan) Nov. 30
Link Belt Co. .... Oct. 11
Litton Systems—Guidance & Control .... Oct. 12
Los Alamos Scientific ...... Nov. 17–18
Los Angeles County .... Nov. 11
Los Angeles Dept. Water ...... Dec. 2

Mallinckrodt Chemicals .... Oct. 24–26
Manitowoc Engr. .... Oct. 14
Marathon Electric .... Dec. 2
Marathon Oil .... Dec. 6
Marquardt Corp. .... Nov. 18
Martin Co. (Baltimore) .... Oct. 11–12
Martin Co. (Denver) ...... Oct. 11–12
Martin Co. (Orlando) ..... Oct. 11–12
Mason & Hanger .... Nov. 18
Oscar Mayer .... Nov. 17
Maytag .... Dec. 2
McDonnell Aircraft .... Oct. 27–28
McGill Mfg. Co. .... Nov. 16
Mead Corp. .... Nov. 10–11
Mead Johnson .... Oct. 24–26
Merck & Co. .... Oct. 20–21
Wm. S. Merrell Co. .... Oct. 24–25
Mid-City Foundry .... Nov. 17
Miehle Co. .... Nov. 30
Milwaukee Co. Civil Service .. Nov. 16
Minnesota Civil Service ......
Minnesota Highway .... Nov. 3
Minn. Mining & Mfg. ..... Nov. 15–18
Mitre Corp. .... Oct. 27
Mobil Oil .... Nov. 17–18
Modine Mfg. .... Oct. 21
Monsanto Chemical .... Nov. 14–15
Montana Highway Com. .... Dec. 1
Motorola Inc. .... Oct. 18–19

National Cash Register .... Nov. 9
National Castings .... Dec. 2
National Lead .... Nov. 29
Nekoosa Edwards .... Oct. 13
N. Y. Central RR. .... Oct. 26–27
N. Y. University Nov. 7—Bascom & Com.
Newport News Shipbldg. ...... Oct. 19
North American Aviation— 5 divisions .... Oct. 11–12
Northern Ill. Gas Co. .... Nov. 16
Northern States Power .... Oct. 20
Northwest Paper .... Dec. 6
Northwestern University ...... Oct. 26

Oak Mfg.—Oak Electro-netics . Oct. 14
Ohio Dept. Highways .... Dec. 8
Oilgear Co. .... Oct. 12
Olin .... Nov. 18
John Oster Mfg. .... Oct. 17
Outboard Marine .... Nov. 29
Owens Corning Fiberglas ...... Nov. 7
Owens Illinois .... Nov. 10

Parke Davis & Co. .... Nov. 10–11
Parker Hannifin .... Dec. 2
Penberthy Mfg. .... Dec. 9
Perfex Corp. .... Oct. 10
Peoples Gas Light .... Oct. 18
Perkin Elmer .... Dec. 2
Chas. Pfizer .... Oct. 31
Philco Aeronutronics .... Nov. 18
Phillips Petroleum .... Nov. 14–15
Pickands Mather (Erie Mining) Nov. 29

Pillsbury Co. .... Nov. 7–9
Pittsburgh Plate Glass .... Oct. 20
Pitts. Plate—Chemical .... Oct. 25
Pratt & Whitney Aircraft ...... Oct. 24
Procter & Gamble .... Nov. 10–11
Public Service El. & Gas ...... Dec. 2
Pure Oil Co.—Union Oil ..... Nov. 29

Quaker Oats .... Nov. 29

RCA .... Nov. 14–15
RCA—PhD's .... Nov. 2
Raychem Corp. .... Oct. 24
Raytheon .... Oct. 17–18
Regal Paper .... Dec. 7
Republic Steel .... Oct. 19–20
Republic Steel Res. .... Oct. 20
Rex Chainbelt .... Dec. 1
Rex Chainbelt Tech. Ctr. ..... Nov. 29
Reynolds Metals .... Oct. 20–21
Rockwell Standard .... Dec. 2
Rohm & Haas Co. .... Oct. 10–11
Rohr Corp. .... Oct. 14
Ryerson Steel .... Oct. 14
St. Regis Paper .... Oct. 21
Dr. Salisburys Labs. .... Oct. 27
Sangamo Electric .... Nov. 30
Schlumberger Ltd. .... Dec. 6
Schlumberger Well Service .... Dec. 6
Scott Paper .... Oct. 27–28
O. M. Scott & Sons .... Oct. 17
Service Bureau Corp. .... Oct. 21
Shell Companies .... Nov. 2–3
Shell Development (Calif.) .... Oct. 17
Shell Devel. (Texas) .. Oct. 31–Nov. 1
Sherwin Williams .... Nov. 16
Shure Bros. Incorp. .... Dec. 1
Sinclair Cos. .... Oct. 24–25
A. O. Smith .... Nov. 17
Snap On Tools .... Nov. 9
Sparton Electronics .... Dec. 6
Sperry Phoenix .... Nov. 8
Square D .... Nov. 1–12
A. E. Staley .... Nov. 15–16
Standard Brands .... Nov. 30
Std. Oil Calif. .... Oct. 24–28
St. Oil Ohio .... Oct. 31–Nov. 1
Stanford U Grad. School ...... Dec. 8
Stanley Engr. .... Nov. 30
Stauffer Chemicals .... Oct. 13
Stauffer Chem—PhD's ...... Oct. 28 in Chemistry
Strasenbrugh Labs. .... Nov. 2
Sun Oil .... Nov. 11
Sunbeam Corp. .... Oct. 17
Sundstrand Corp. .... Nov. 15–16
Swift & Co. .... Nov. 14–15
Swift & Co. Res. .... Nov. 1–12
Symington Wayne .... Dec. 6

Tektronix .... Oct. 28
Texaco .... Nov. 9
Texaco .... Nov. 15
Texas Instruments ..... Nov. 30–Dec. 1
Thor Power .... Dec. 2
Timken Roller Bearing .... Nov. 3
Torrington Co. .... Oct. 27
Trane Co. .... Nov. 15–17
TransWorld .... Oct. 20

Uarco .... Nov. 18
Underwriters .... Oct. 19
Unilver Ltd. .... Nov. 28
UCC—Group I .... Nov. 7–8
UCC—Carbon Products .... Oct. 13–14
UCC—Chicago .... Dec. 6
UCC—Linde Division ..... Nov. 10–11
UCC—Mining and Metals .... Nov. 14
UCC—PhD's .... Nov. 14–15

UCC—Stellite .... Nov. 18
Union Oil .... Nov. 29
Union Tank .... Oct. 31
UniRoyal .... Oct. 11
United Air Lines .... Oct. 24
United Aircraft Corp. Systems Center .... Dec. 6
United Aircraft Res. .... Oct. 10–11
United Aircraft Res. .... Nov. 9
U. S. Ind. Chemicals .... Dec. 7
U. S. Rubber .... Oct. 11–12
U. S. Rubber Research ...... Nov. 1–2
U. S. Steel Co. .... Oct. 13
Univac—Defense & Data Processing .... Nov. 30–Dec. 1
Universal Oil Products .... Nov. 14
University of Ill. Grad. Sh. .... Nov. 3
University of Michigan .... Dec. 7
Upjohn Co. .... Oct. 17

Vanity Fair .... Oct. 17
Vickers .... Dec. 7

Wagner Castings .... Dec. 1
Walker Mfg. .... Oct. 13
Warwick Electronics .... Oct. 13
Washington State Highway ... Nov. 29
Waukesha Motor .... Nov. 10
Wayne Co. Road Com. .... Dec. 2
West Bend Co. .... Oct. 26
W. Va. Pulp & Paper .... Nov. 15
W. Va. State Road Com. ...... Nov. 2
Western Union .... Nov. 29
Westinghouse Electric ..... Oct. 20–21
Whirlpool Corp. .... Nov. 3–4
Wis. Electric Power .... Dec. 2
Wisconsin Gas .... Oct. 12
Wis. Power & Light Co. ..... Nov. 7–8
Wis. Public Service .... Oct. 26
Wis. State Highway .... Nov. 9
Worthington .... Dec. 6
Wyandotte Chemicals .... Nov. 11

Xerox Corp. .... Nov. 10

Youngstown Sheet & Tube R&D . Oct. 21
Youngstown Sheet .... Nov. 14

Zenith Radio .... Nov. 17
Zimpro Div. .... Nov. 7

U. S. Geological .... Oct. 28
Dept. Navy—Mgmt. Internship Nov. 30 in Bascom & Commerce
U. S. Air Force .... Nov. 8–9
U. S. Army Engr. Dist. ...... Oct. 13
U. S. Army Materiel Com. . Nov. 16–17
U. S. Naval Ordn Test .... Oct. 31
U. S. Patent Office .... Nov. 14–15
Bureau of Reclamation ..... Oct. 10–11
Bureau of Ships .... Dec. 8
Env. Science Services—Coast & Geodetic .... Oct. 17
Env. Science Services .... Nov. 2
NASA—Ames Res. .... Nov. 18
NASA—Geo. C. Marshall ...... Nov. 1
NASA—Lewis Res. Ctr. ... Nov. 17–18
NASA—Goddard Space .... Dec. 8
USDA—Soil Conservation ..... Oct. 14
NSA .... Dec. 5–9
Bureau of Yards—Navy Dept. Dec. 1–2
Naval Officers Training .... Oct. 12–14 Nov. 16–18
CIA .... Oct. 18–21
Federal Power Com. .... Nov. 7
U. S. Forest .... Dec. 6
Fed. Water Pollution .... Dec. 6
U. S. Marines .... Oct. 3–5 Dec. 5–7


DR. E.V.A.
Extra Vehicular
Activity Research
and Development
CAPTAIN
CRUSADER
F8 CRUSADER
VSTOL
XC-142A V/STOL
SCOUT
space launch
vehicle
THE
SCOUT
SIR LANCE
LANCE Missile

Interview Schedu

MONDAY, OCTOBER 24

Allen Bradley
Chevron Research
Crane
Crown Zellerbach
Deere & Co.
Dow Corning
Colt Industries–Fairbanks Morse
Mallinckrodt Chemicals
Mead Johnson
Pratt & Whitney
Raychem
Sinclair Companies
Standard Oil of California
United Air Lines

TUESDAY, OCTOBER 25

Amphenol Borg
Bell System
Esso Res. & Engr. & Humble Oil
Hoffman LaRoche
Interlake Steel
Iowa Ill. Gas & Electric
Mallinckrodt
Wm. S. Merrell
Pittsburgh Plate Glass–Chemical Div.
Sinclair Companies
Std. Oil of California and Chevron Research

WEDNESDAY, OCTOBER 26

Bergstrom Paper
Bell System
Clark Equipment
Esso Res. & Engr. and Humble Oil
Indiana Dept. Natural Resources
New York Central Railroad
Northwestern University
Standard Oil of California
West Bend Co.
Wisconsin Public Service

THURSDAY, OCTOBER 27

American Nickeloid
Anderson Clayton
Esso Res. & Engr. and Humble Oil
B. F. Goodrich
B. F. Goodrich Research
Goodyear Aerospace
Goodyear Tire & Rubber
Honeywell
Mitre
Dr. Salisbury's Labs
Scott Paper
Standard Oil of California
Torrington

FRIDAY, OCTOBER 28

American Cyanamid
Beloit Corporation
Chicago, Milwaukee St. Paul RR
Globe Union
Goodyear Tire & Rubber
Honeywell
Institute of Paper Chemistry
McDonnell Aircraft
New York U
Scott Paper
Standard Oil of California
Stauffer Chemicals—PhD's
Tektronix
U. S. Geological Survey

MONDAY, OCTOBER 31

Boeing Co.
City of Milwaukee
Deering Milliken
Eastman Kodak
Harris Trust & Savings
Hooker Chemical
Hughes Aircraft
International Harvester
Koehring
Lawrence Radiation
Ling Temco Vought
Chas. Pfizer & Co.
Rohr Co.
Shell Development (Texas)
Standard Oil of Ohio
Union Tank
U. S. Naval Ordn. Test, China Lake

TUESDAY, NOVEMBER 1

American Can
Babcock & Wilcox
Bessemer and Lake Erie
Boeing Co.
Ceco Corp.
Eastman Kodak
Elgin Joliet & Eastern RR
Fisher Governor
General Motors Corp.
Harris Trust & Savings
International Harvester
Square D
Standard Oil Ohio
U. S. Rubber Research
NASA—George Marshall Space

WEDNESDAY, NOVEMBER 2

AC Electronics
American Can
Eaton, Yale & Towne
General Motors
Heil Co.
RCA—PhD's
Shell Companies
Square D
Swift & Co. Res.
West Virginia State Road Commission
Environmental Science Service Adm.

THURSDAY, NOVEMBER 3

AC Electronics
American Can
Celotex
Commonwealth Edison
General Foods
General Motors
Eli Lilly
Shell Companies
Timken Roller Bearing
University of Illinois
Whirlpool

FRIDAY, NOVEMBER 4

AC Electronics
General Motors—All divisions
Gulf Corporation
Gulf Res. & Development

MONDAY, NOVEMBER 7

Archer Daniels Midland
DeSoto Chemicals
Ethyl Corp.
Ford Motor
General Atomics
General Telephone
Ingersoll Rand
Jet Propulsion Labs—Calif. Inst. of Technology
New York University
Owens Corning Fiberglas
Pillsbury
UCC—Group I
Wisconsin Power & Light
Zimpro
Federal Power Commission

TUESDAY, NOVEMBER 8

Louis Allis
Caterpillar Tractor
Charmin Paper
Chicago Bridge & Iron
Ethyl Corporation
Ford Motor
Giffels & Rossetti
Goodyear Atomic
Jet Propulsion
Line Material
Sperry Phoenix
UCC—Group I

WEDNESDAY, NOVEMBER 9

Allegheny Ludlum Steel
American Electric Power
Amoco Chemicals (American Oil)
Bechtel
Caterpillar Tractor
Container Corp. of America
Elliott
Factory Mutual Engr. Div.
Firestone
National Cash Register
Snap on Tools
Texaco
United Aircraft Research
Wisconsin State Highway
U. S. Air Force

THURSDAY, NOVEMBER 10

Burroughs
Celanese Corp.
Cornell Aeron. Labs
Firestone Tire & Rubber Res.—PhD's
Firestone
Johnson & Johnson
Owens Illinois
Procter & Gamble
UCC—Linde Division
Waukesha Motor
Xerox Corporation

FRIDAY, NOVEMBER 11

Brunswick
Cummins Engine
Johns Manville
Lavino
Los Angeles County
Mead Corporation
Owens Illinois
Parke Davis & Co.
Procter & Gamble
Sun Oil
UCC—Linde Division
Westenhoff & Novick Inc.
Wyandotte Chemicals
Aeron. Chart & Information Center

October-December 1966

MONDAY, NOVEMBER 14

Abbott Labs.
Allis Chalmers
Atlantic Refining
FMC—American Viscose
Monsanto Chemicals
Phillips Petroleum
RCA
Swift & Co.
UCC—Mining and Metals
Universal Oil Products
Youngstown Sheet & Tube Res. & Dev.
U. S. Patent

TUESDAY, NOVEMBER 15

Allis Chalmers
Atlantic Refining
Applied Physics
Avco Lycoming
Automatic Electric
Clark Dietz & Associates
Consolidated Papers
M. W. Kellogg
Monsanto Chemicals
RCA
A. E. Staley
Sundstrand
Texaco
Trane Co.
UCC—PhD's
West Virginia Pulp and Paper

WEDNESDAY, NOVEMBER 16

Alcoa
Applied Physics
Atlantic Research
Chem Plex
City of Minneapolis
Falk Corp.
General American Transportation
Harnischfeger
McGill Mfg.
Milwaukee Co. Civil Service
Northern Illinois Gas
Sherwin Williams
Sundstrand
Trane Co.
U. S. Army Materiel

THURSDAY, NOVEMBER 17

Aqua Chem
J. I. Case
Douglas Aircraft
Harvard University Grad. School
S. C. Johnson
Kimberly Clark
Oscar Mayer
Mid City Foundry
Minnesota Mining & Mfg.
Olin
A. O. Smith and Clark Control
Trane
Zenith Radio
NASA—Lewis Res. Center

FRIDAY, NOVEMBER 18

Argonne National Labs
Atlas Chemicals
City of Philadelphia
Control Data
Douglas Aircraft
Industrial Nucleonics
Los Alamos Scientific Labs
Marquardt Corp.
Mason and Hanger
Minnesota Mining and Mfg.
Mobil
Olin
Philco Corp.—Aeronutronics
Uarco
Union Carbide—Stellite Div.
NASA—Ames Research
Naval Res. Training Corps.

NO INTERVIEWS BETWEEN NOVEMBER 21 AND 28 BECAUSE OF THANKSGIVING VACATION

MONDAY, NOVEMBER 28

Unilver Ltd.

TUESDAY, NOVEMBER 29

Abex—American Brake Shoe Co.
Amsted Industries
Chrysler Corp.
Climax Molybdenum
Cutler Hammer
General Dynamics—Liquid Carbonics
General Engineering
National Lead
Outboard Marine
Pickands Mather—Erie Mining
Pure Oil—Union Oil
Quaker Oats
Rex Chainbelt Technical Center
Stephens Adamson Mfg.
Washington State Highway
Western Union Telegraph

WEDNESDAY, NOVEMBER 30

AT&T
Belden Mfg.
Bemix Co.
Bucyrus Erie
Carrier Air Conditioning
City of Rockford
Continental Oil (Texas)
Edgerton, Germeshausen & Grier
FMC—Canning Machine
FMC—Chemical Division
Illinois Div. Highways
Industrial Research
Joslyn Mfg. & Supply
Ling Temco Vought
Miehle
Sangamo Electric
Standard Brands
Stanley Engineering
Univac—Data Processing and Defense
Dept. Navy—Mgmt. Internship

THURSDAY, DECEMBER 1

Adv. Scientific Labs
AT&T
American Potash
Amana Refrigeration
Campbell Soup
City of Detroit
Continental Can—Metals Division
Diamond Alkali
R. R. Donnelley
Fairchild Semiconductors
Freeman Chemicals
General Dynamics—Electric Boat
Hydrotechnica
Montana Highway Commission
Rex Chainbelt
Shure Brothers
Texas Instruments
Wagner Castings
Bureau of Yards & Docks (Navy Dept.)

FRIDAY, DECEMBER 2

Aerospace
Anaconda Wire & Cable
Illinois Tool
IIT Res. Institute
Int. Minerals and Chemicals
Jefferson Chemicals
E. F. Johnson
L. A. Dept. Water & Power
Marathon Electric
Maytag
National Castings
Parker Hannifin
Perkin Elmer
Public Service Electric & Gas
Rockwell Standard
Thor Power Tool
Wayne Co. Road Commission
Wisconsin Electric Power

MONDAY, DECEMBER 5

Clark Oil & Refining
National Security Agency
U. S. Marines
U. S. Geological Survey (Missouri)

TUESDAY, DECEMBER 6

Arthur Anderson
Chamberlain Corp.
DoAll Co.
Huntington Alloy Products—International Nickel
Marathon Oil
Northwest Paper
Schlumberger Ltd.
Schlumberger Well Service
Sparton Electronics
Symington Wayne Corp.
UCC—Foods Products
United Aircraft Corp. Systems
Worthington
Federal Water Pollution
U. S. Forest Service

WEDNESDAY, DECEMBER 7

Cabot Corporation
Copolymer Rubber & Chemicals
Detroit Edison
Grede Foundries
Riegel Paper
Vickers
Wheelabrator
U. S. Industrial Chemicals
University of Michigan—Inst. Science & Technology
Vickers

THURSDAY, DECEMBER 8

Peter Kiewitt
Ohio Dept. Highways
Stanford University
NASA—Goddard Space Flight
Bureau of Ships
U. S. Army Electronics Command

FRIDAY, DECEMBER 9

LeTourneau Westinghouse
Penberthy Mfg.

Donald L. Crain, Section Manager, Olefin Synthesis (Ph. D., Purdue 1958)

"What's different about Phillips? Growth. Breadth of research.

This company is on the move."

"As a research chemist, two things stand out to me about Phillips.

"First is our broad spectrum of disciplines.

"Second is the tremendous potential for growth . . . for the company and for its people.

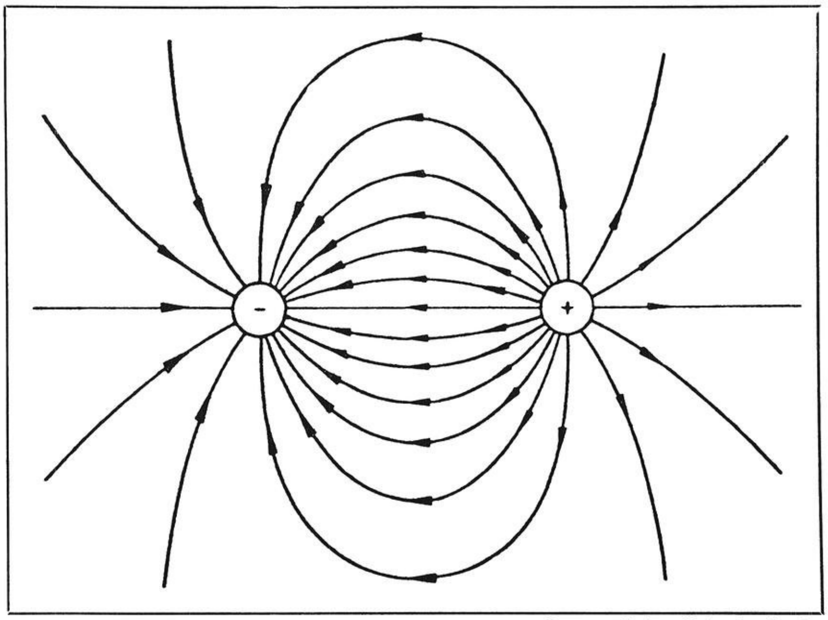
"Our research here is close to fundamental. Free inquiry into the nature of things. You can often originate your own projects, and always originate the way you'll pursue them. We're not limited in disciplines or areas of exploration . . . we have physicists, analytical chemists, organic chemists, engineers and others, working on problems that may have to do with plastics, elastomers, organic intermediates, hydrocarbons, or basic experiments with reactions and compounds. Studies like these may lead to products or processes 5 or 10 years later . . . or simply contribute to the broad body of scientific knowledge.

"As to growth, this company occupies a unique position. Phillips has grown to major rank in the oil industry in fifty years. We're second in our industry in number of patents issued, and we lead it in such products as nitrogen fertilizers, rubber chemicals, LP-gas, and cyclohexane to make nylon. The way we're moving, we'll soon lead in a lot more."

To learn more about Research or any other department of Phillips, write James P. Jones, Phillips Petroleum Company, 104 F. P. Bldg., Bartlesville, Oklahoma 74003.

AN EQUAL OPPORTUNITY EMPLOYER

PHILLIPS 66



Courtesy Modern University Physics

PROGRESS 1966— MAN'S WAR WITH THE INSECTS

by Thomas Stiefvater

MODERN man is living in an age of chemical control. Chemicals are called upon in increasing amounts to help provide food for expanding populations. American farmers are already cultivating up to 85 per cent of the farmland, and increased production efficiency is vital to an increased food supply. Agriculture relies heavily on chemical pesticides to increase both the quantity and quality of harvested crops.

Modern pesticides are distributed in two ways—ground and aerial. Granular and liquid insecticides are applied from the ground, while dust is best distributed from the air.

A recent development is the electrostatic charging of liquid and dust pesticide particles. Extensive research on charging began around 1950. The high cost of equipment and limited initial success delayed the farmers' acceptance. However manufacturers can now provide electrostatic dusting equipment at $200 and $300 per unit. Texas cotton growers are successfully using dusting to control the cotton boll weevil. As researchers improve electrostatic charging methods and equipment, considerable increase in the use of charged pesticides is expected.

The Need for Insect Control

Plant insect damage and disease reduced American farmers' annual income by three billion dollars for the years from 1942 through 1951. Various cultural control practices had been used to control insect and disease damage, but they were inadequate as the sole means of control. Chemicals were introduced as a further means of insect control.

Cultural Controls Used

Before turning to chemicals, farmers had tried cultural control practices such as (1) appropriate tillage, (2) crop sanitation, (3) observance of planting dates that would be unfavorable for specific insects, and (4) planting insect-resistant crop varieties.

Health Hazards of Chemical Control

Finding cultural controls inadequate, farmers began to use chemicals in the war on bugs. As a result, American agriculture today is in an age of chemical insect control. Rachel Carson, in *Silent Spring,* attacks the widespread use of chemicals for insect control because the residues left by these pesticides constitute a public health hazard. As a result, insecticide usage was reviewed by the World Health Organization, the United States Public Health Service, and the Food Protection Committee of the National Research Council. The conclusion was that "large-scale usage of insecticides in the manner recommended by the manufacturers and consistent with existing laws would not be inconsistent with public health programs." The reports also imply, however, that irresponsible pesticide usage could lead to *future* contamination of soil and water.

Advantages of Chemical Control

Chemical pesticides are necessary to curb disease and insect damage, to control the amount and quality of harvested crops, and the storability and keeping quality of the produce as well. Without chemical control, insect damage would reduce cotton yields by 30 per cent and cereal and forage crops by 25 per cent. The supply of fruits and vegetables would become so limited that only a small fraction of our population could afford them. For example, studies have shown that apples produced without pesticide protection would be 40 to 80 per cent damaged by the codling moth alone, and other insects would cause an equal amount of harm.

The Advantages of Charged Pesticides

The widespread use of pesticides in modern agriculture makes application efficiency of primary concern. High application efficiency reduces the cost and decreases the health hazards to the general public. In general, application efficiency includes deposition efficiency (amount reaching plants compared to total amount sprayed), uniformity in plant coverage, and particle size.

Increased Deposition Efficiency

Electrostatic charging almost doubles deposition efficiency. Uncharged particles have a deposition ratio (ratio of material deposited on the plant surfaces to total material delivered by the distribution equipment) of about ten per cent. Electrostatic charging doubles this deposition ratio. This halves pesticide costs to farmers and reduces harmful soil residues from 90 per cent to 80 per cent of total pesticides handled.

Increased Uniformity in Plant Coverage

Electrostatic charging also produces more uniform plant coverage. With uncharged nozzles, the quantity of insecticide found on the under surfaces of the leaves represented about 11 per cent of the total on both upper and lower surfaces, while with the charged nozzles the under surface held over 25 per cent of the total.

Decreased Particle Size Possible

Decreased particle size is another advantage to charging pesticides. Charged pesticide dust particles can have their size reduced to one-fortieth that of uncharged dust particles and yet present negligible drift problems. Since greater surface area (per pound of pesticide) is obtained with smaller particles, one pound of charged pesticide can theoretically replace twenty pounds of uncharged pesticide.

Theory of Electrostatics

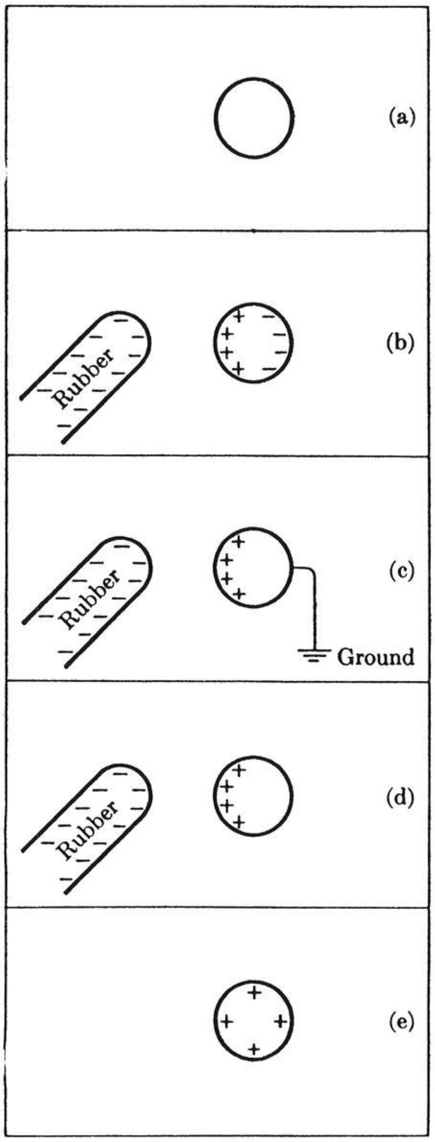
Two basic laws of electrostatic theory apply to the charging of these particles:

Law 1: Opposite charges attract and like charges repel each other.

Law 2: A charged body induces an opposite but equal charge on a nearby conductor (see Fig. 1).

Charging Techniques

The three methods used in charging pesticide particles are frictional charging, ionized field charging, and charging by induction.



Courtesy Modern University Physics

Fig. 1. Charging a single metal sphere by induction.

Frictional Charging

Charging by friction is the oldest and simplest method of inducing a charge. Frictional charging or "static electricity" occurs when electrons are transferred from one material to the other and a potential gradient is set up between the charged and uncharged bodies. The same effect occurs when liquids are broken up into fine droplets or when dust material is dispersed. This appears to be a very simple, inexpensive method of charging pesticide particles. Two problems, however, exist:

1. Charges of both signs are produced when different types of material are mixed. As these charged particles are dispersed as charged clouds over the plants, the oppositely-charged particles attract and neutralize each other.

2. Frictional charging depends on weather conditions. Changes in humidity or temperature cause varying amounts of charge to be produced. Hence, effective pesticide application depends on ideal weather conditions.

Ionic Charging

Ionic field charging is more dependable than frictional charging. Paint is applied by electrostatic spraying and is found to give a 97 per cent deposition. In pesticide application, the dust particles are carried by an air stream through an ionized gas moving across the flow of the dust-air suspension. At the center of the nozzle a positively charged electrode is kept at ten thousand volts potential with respect to the nozzle wall. The intense potential at the tip of the wire causes a corona discharge. The dust is forced through this region of positively-charged ions and is positively charged itself, independent of temperature or relative humidity. However, the potential difference between the center electrode and the nozzle wall must be closely controlled: (1) to get an initial controlled corona discharge, and (2) to limit the corona discharge area to a region closely surrounding the wire. Accumulation of positively-charged dust particles on the inside surface of the nozzle wall would reduce the potential between the nozzle wall and the center wire, preventing ionization of the gas molecules. The average potential of the ionized dust particles produced by this nozzle is 1,000 volts. The effective range of the particles is approximately 30 feet.

Induction Charging

Induction charging is the most recent method of charging pesticide and is still in the experimental stage. A cone-shaped sheet of liquid is emitted from the nozzle, and friction effects cause the sheet to break into tiny droplets. The size of the droplets depends on the velocity and pressure of the liquid. The positively charged electrode in the center of the cone-shaped pattern "induces" electrons to come from the ground through the nozzle and liquid and onto the spray droplets. No contact between the liquid and the electrode is required for the success of this charging. The liquid droplets are initially directed outward in a tangential direction. Their linear momentum is sufficient to guide them in a straight path and thus avoid being attracted to the oppositely charged electrode. The spray droplets form a negatively-charged cloud over the plants.

Deposition on Plants

Both the positive, ionic-charged clouds and the negative, induction-charged clouds are attracted by the plants which are at zero potential.

Influence of Electrical Forces on Particles

As the charged particle approaches the plant, curved lines of electric flux develop between the plant, at zero charge, ann the charged particle. These flux lines are analogous to magnetic "pole-lines". These curved lines of force allow all sides of the plant to be covered in one dusting.

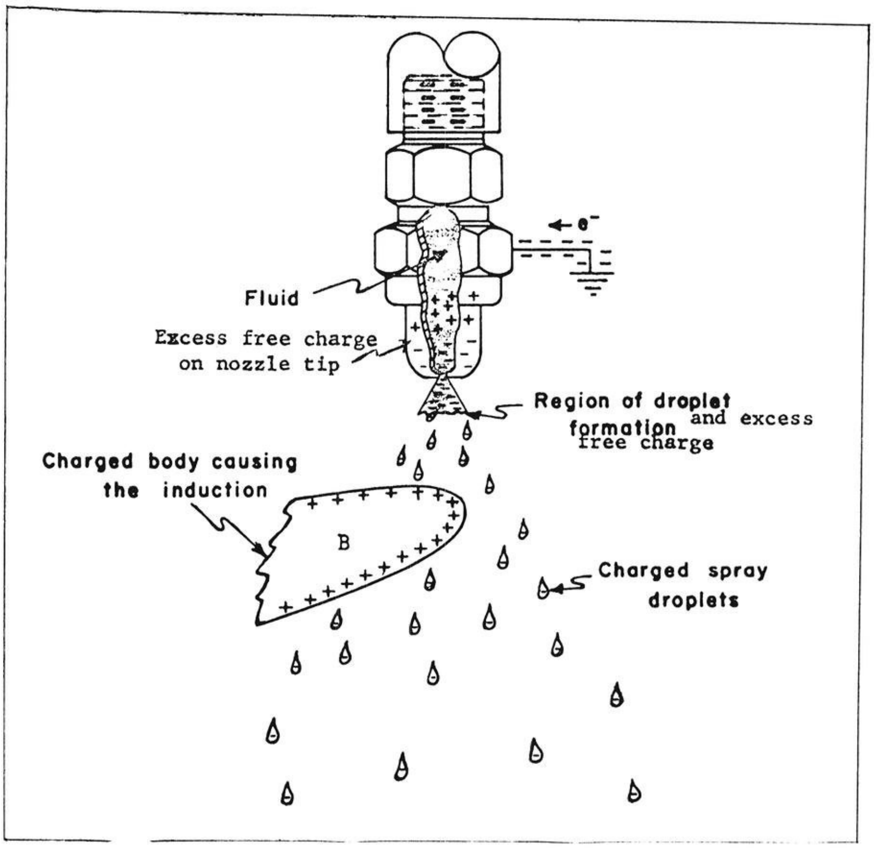
Two electrical forces act on the charged particles. The first is created by the electric field of each particle. The force is approximately equal to the gravitational force on the particle at a distance of 0.1 mm from the plant surface.

$$F = \frac{Q^2}{8\pi d^2}$$

This force is effective only at extremely close range. The second force is the external field acting on the field of the individual particles.

$$F = E \cdot Q$$

E represents the field or cloud intensity and Q represents the charge on the pesticide particle. This is the force that increases the deposition of the charged particles. The attraction between the charged particle and the plant reduces the drift caused by air currents, so charged particles may be only one-fortieth the size of uncharged particles.



Courtesy ASAE Paper No. 65–160

Fig. 2. Induction charging of spray showing charge distribution for a conducting nozzle-spray system

Effect of Artificial Precipitation Field

So far, the plant has been considered to be at ground potential, but a charge can be induced on the plant. A charged conductor is placed close to the plant with the same sign as the pesticide. The induced charge of opposite sign which is set up on the leaf edges attracts charged dust and spray particles to these areas. Although charging the plant surfaces increases the percentage of particles deposited on leaf surfaces, the effect is often harmful. The outer edges of the plant receive heavy pesticide deposits while very little reaches the center areas. Researchers at Michigan State concluded that although low efficiency results with a natural gradient, the method produces a more homogeneous distribution.

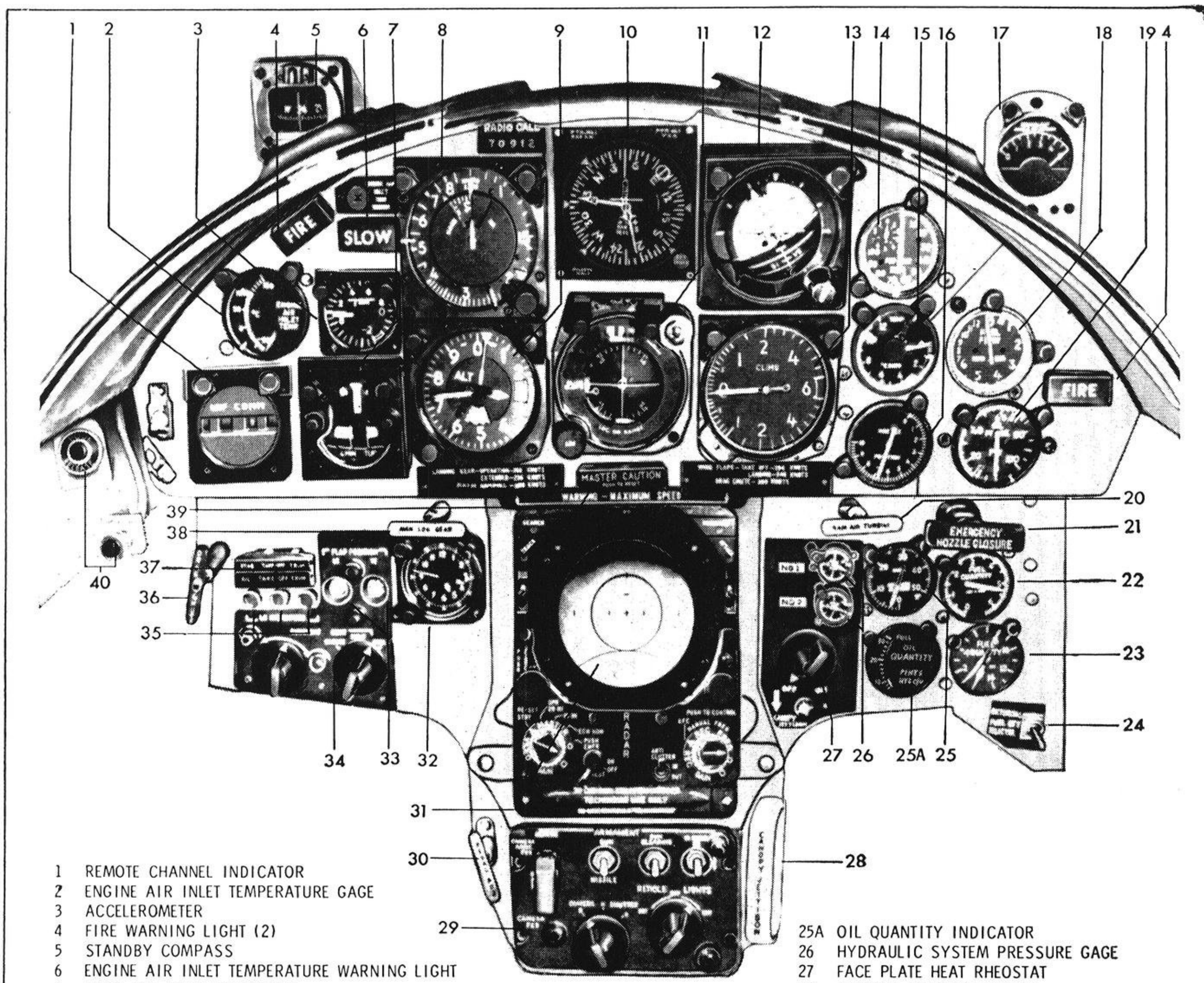
Laboratory vs. Field Testing

Pesticide application faces varied problems. Laboratory tests indicated a 5:1 ratio when comparing charged deposition to uncharged. Field tests, however, indicated only a 2:1 gain in deposition. Mainly this discrepancy is caused by:

1. The high voltage required by the field equipment.
2. No signals warn the user that the electrical apparatus has failed.
3. Wind conditions and variations in foliage growth and density led to nonuniformity in the field applications.

Conclusion

The use of an electric field force to increase the deposition is in an early stage. Studies indicate that it will be important in depositing particles in the one micron size range, significantly reducing the drift problem. If the farmer can apply a control agent uniformly, he can determine higher levels of pest control at lower dosages.



1 REMOTE CHANNEL INDICATOR
2 ENGINE AIR INLET TEMPERATURE GAGE
3 ACCELEROMETER
4 FIRE WARNING LIGHT (2)
5 STANDBY COMPASS
6 ENGINE AIR INLET TEMPERATURE WARNING LIGHT
7 TURN-AND-SLIP INDICATOR
8 AIRSPEED AND MACH NUMBER INDICATOR
9 ALTIMETER
10 BEARING DISTANCE HEADING INDICATOR ID-526 BDHI
11 COURSE INDICATOR (ID-249)
12 ATTITUDE INDICATOR
13 VERTICAL VELOCITY INDICATOR
14 TACHOMETER
15 EXHAUST GAS TEMPERATURE GAGE
16 EXHAUST NOZZLE POSITION INDICATOR
17 AUTOMATIC PITCH CONTROL INDICATOR
18 FUEL FLOW INDICATOR
19 OIL PRESSURE GAGE
20 RAM AIR TURBINE EXTENSION HANDLE
21 EMERGENCY NOZZLE CLOSURE HANDLE
22 INTERNAL FUEL QUANTITY INDICATOR
23 EXTERNAL FUEL QUANTITY INDICATOR
24 EXTERNAL FUEL QUANTITY SELECTOR SWITCH
25 CABIN ALTIMETER
25A OIL QUANTITY INDICATOR
26 HYDRAULIC SYSTEM PRESSURE GAGE
27 FACE PLATE HEAT RHEOSTAT
28 CANOPY JETTISON HANDLE
29 ARMAMENT CONTROL PANEL
30 RUDDER PEDAL ADJUSTMENT HANDLE
31 RADAR SCOPE AND CONTROL PANEL
32 CLOCK
33 WING FLAP POSITION INDICATORS
34 GUNSIGHT CONTROL SWITCH
35 LANDING GEAR POSITION INDICATOR LIGHTS
36 DRAG CHUTE HANDLE
37 STABILIZER AND AILERON TAKEOFF TRIM INDICATOR LIGHTS
38 MANUAL LANDING GEAR RELEASE HANDLE
39 MASTER CAUTION LIGHT AND RESET BAR
40 ARRESTING HOOK RELEASE BUTTON AND ARRESTING HOOK DOWN WARNING LIGHT

So you want to be a pilot?

It's not as hard as it looks. It's harder.

The days of flying by the seat of your pants are gone forever. Now you have to know an awful lot about things like aerodynamics, electronics, and celestial navigation.

Does that mean that flying in the Air Force has become "automated"? It does not.

Any pilot will tell you that flying is still a great adventure. The split second when a man leaves the runway solo for the first time is still one of the most exciting moments of his life.

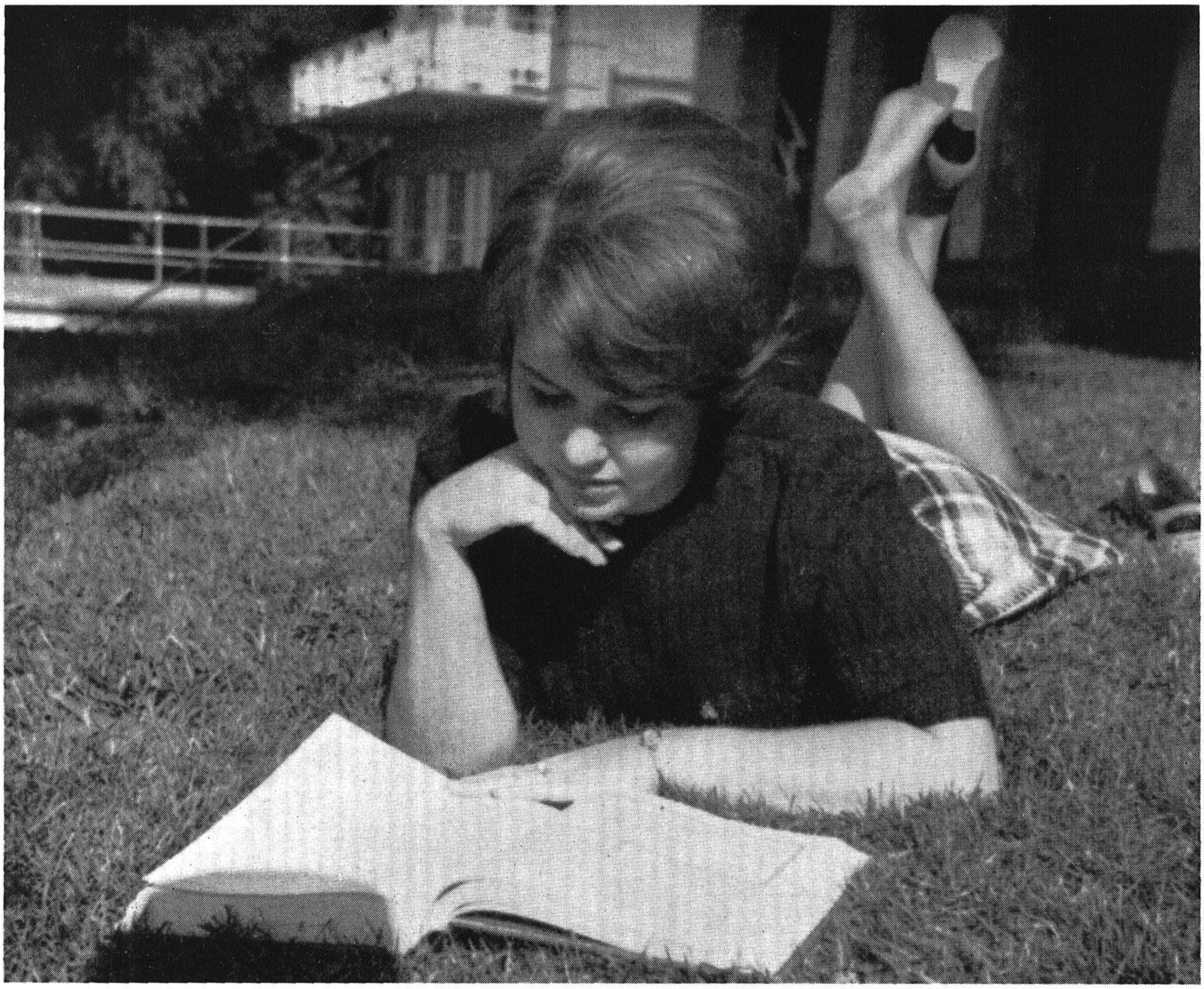
If you'd like to earn your wings, one of the best ways is through Air Force ROTC. For details, contact the Professor of Aerospace Studies, an Air Force representative, or mail the coupon.

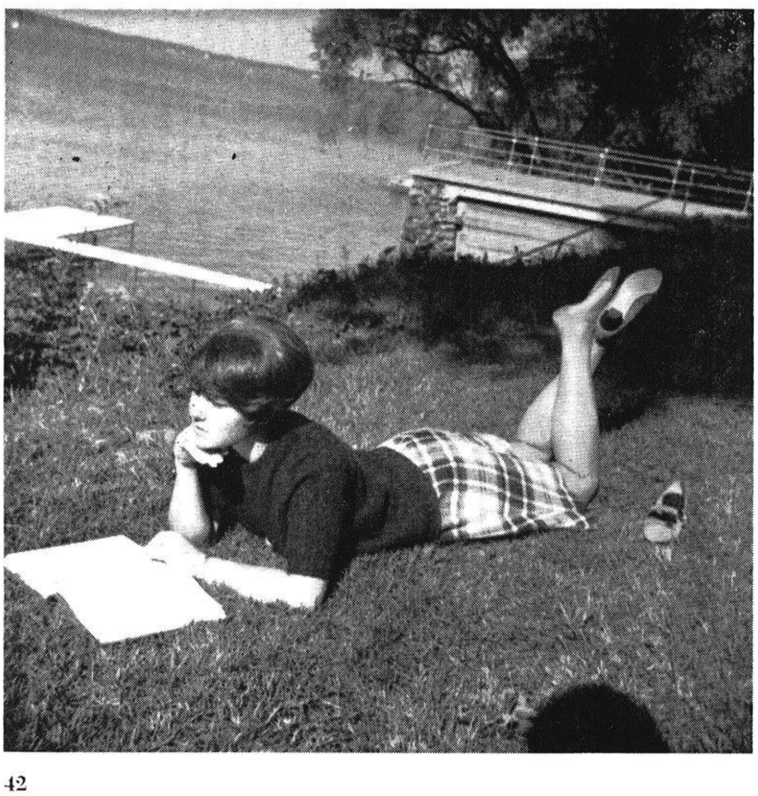
UNITED STATES AIR FORCE
Box A, Dept. ECM610
Randolph Air Force Base, Texas 78148

Name__________
(please print)
College__________ Class__________
Address__________
City__________ State__________ ZIP__________

WISCONSIN'S FINEST

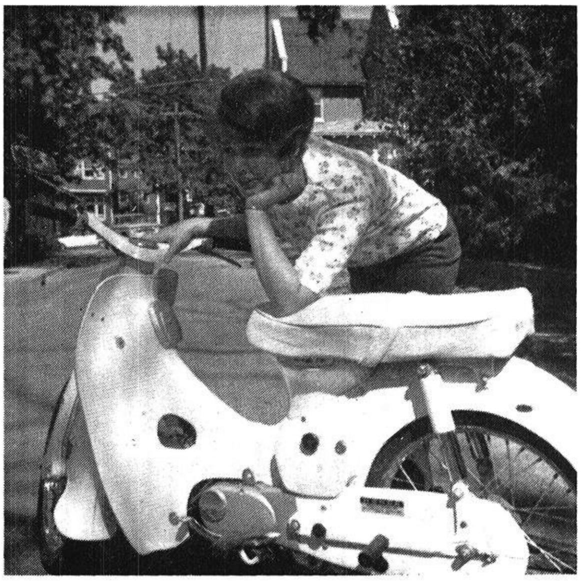
. . . an engineering tradition

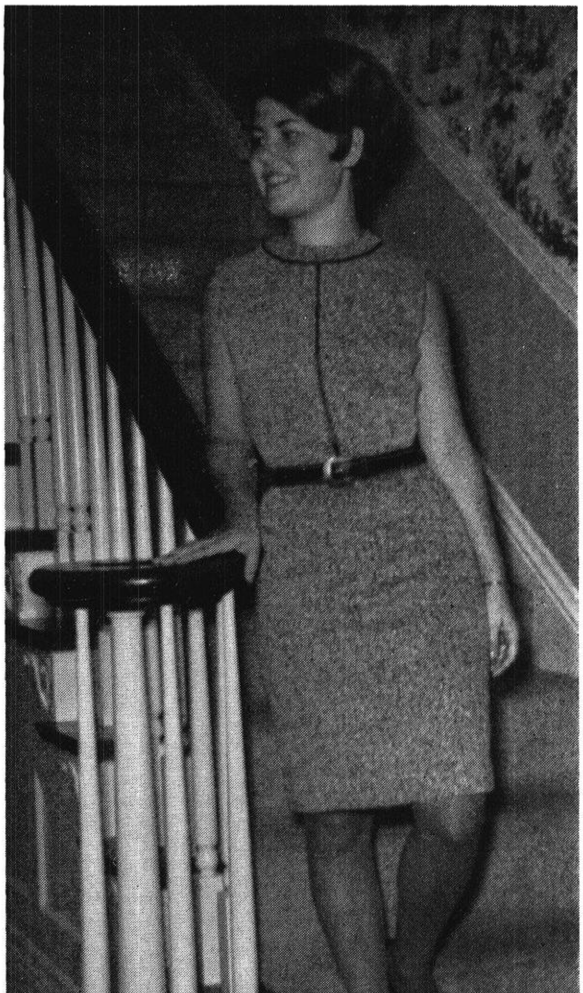


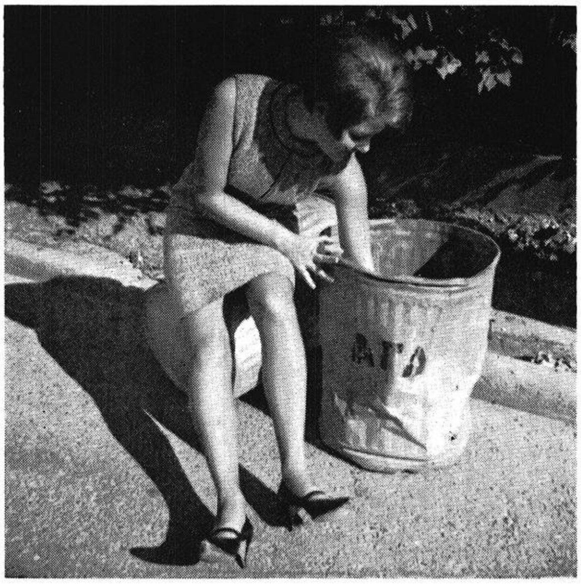


October's "Miss Engineer" is pretty, petite Miss Gail Behrens of Alpha Gamma Delta sorority. She is nineteen, a demure 5′4″, and —privately speaking—we would like to say that her statistics are great. (Though due to censorship we can't repeat.) Gail's unusual major, Latin, has earned her a trip to Rome (as in Italy) this spring semester, where she hopes to learn more about lots of things. During the camera session, we thought she might pose in some engineering surroundings, but she just couldn't get too fond of that earthmover. But, in her case that's forgivable, and we're sure you engineers will like her even if she can't run that machine.

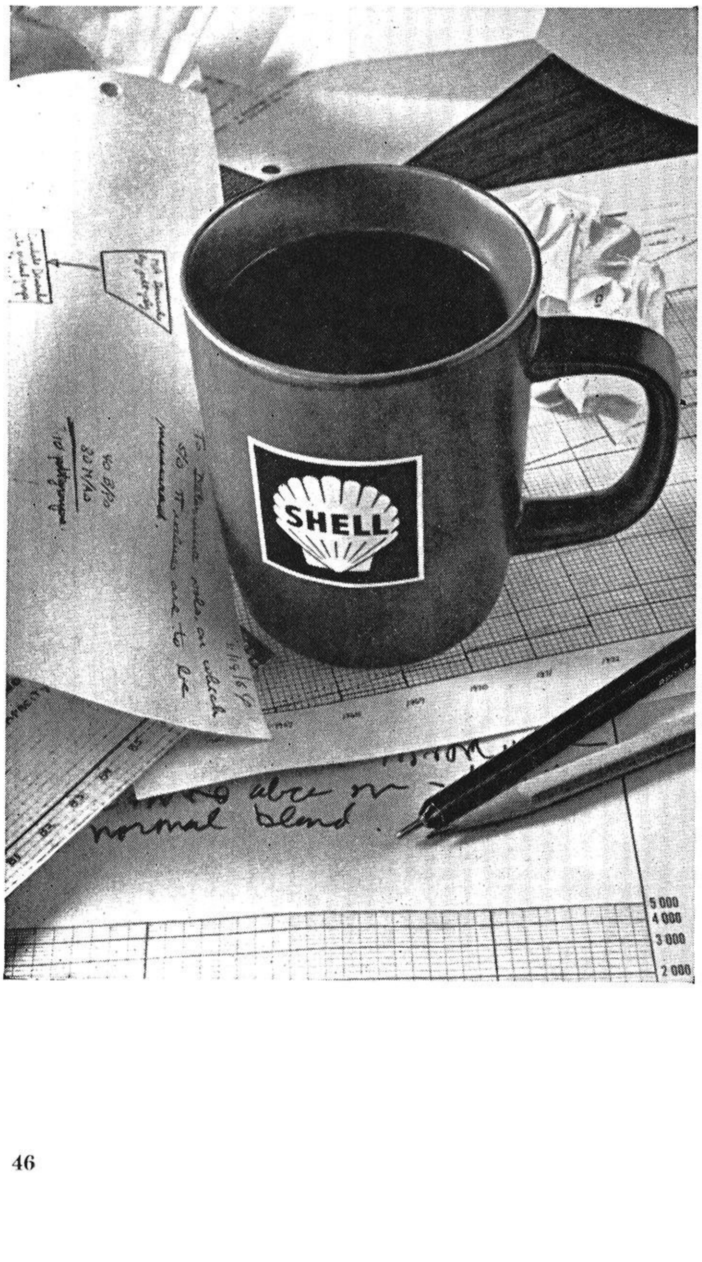
(pictures by Gail R. Mulhollam)







IF YOU WORK WITH US YOU'LL WORK HARDER THAN YOU'VE EVER WORKED IN YOUR LIFE.



WHY? Because applying your knowledge and stretching your imagination are the hardest—but most satisfying—kinds of work there are.

And we have a whole grab-bag of problems that will challenge your abilities and stimulate your professional growth.

...For example, we designed and built an automated drilling vessel that allows us to drill for oil and gas in water up to 4,000 feet deep.

...Our research has given us a new synthetic elastomer—with the resiliency of rubber and the manufacturing versatility of plastic—which does not require vulcanization.

...We've developed a new hydrocracking process for vastly increasing the gasoline yield from a barrel of crude oil.

We've solved these problems.

But we've got many others.

Would you like to consider helping us solve them?

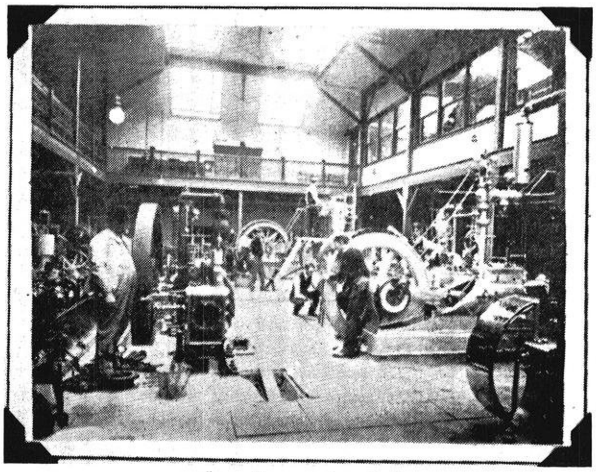
If so, talk with the Shell representative who will be on your campus soon. Or send a résumé to Manager, Recruitment Division, The Shell Companies, Department E, 50 West 50th Street, New York, N.Y. 10020.

THE SHELL COMPANIES • Shell Oil Company Shell Chemical Company • Shell Development Company • Shell Pipe Line Corporation

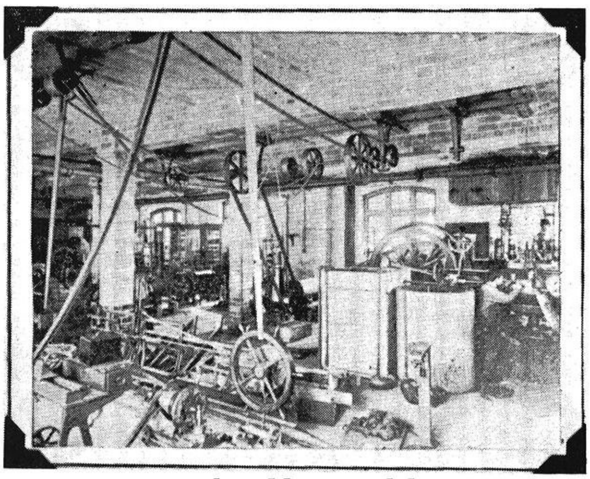
An Equal Opportunity Employer

WISCONSIN'S ALBUM

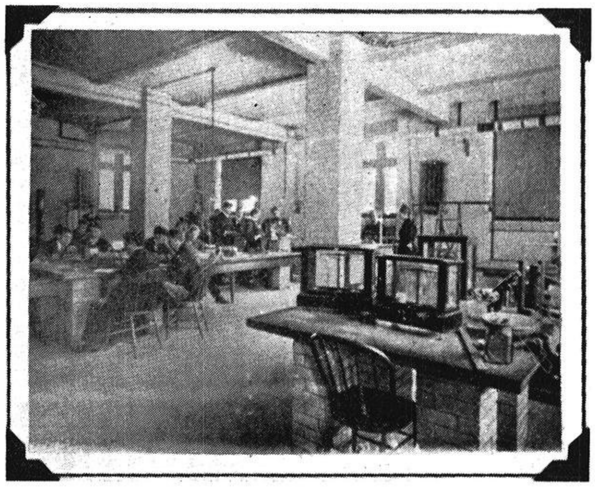
if you think those engineering labs are bad now, you should have been a Badger back in the 1920's . . .



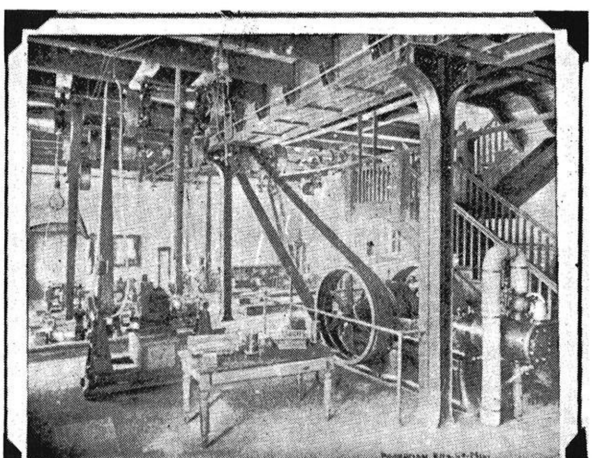
the dynamics lab



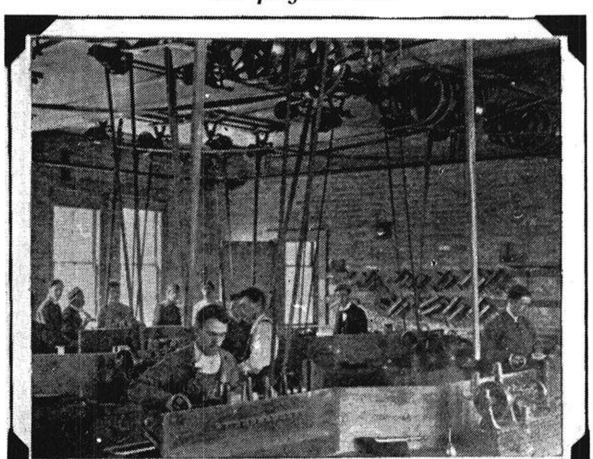
the old steam lab



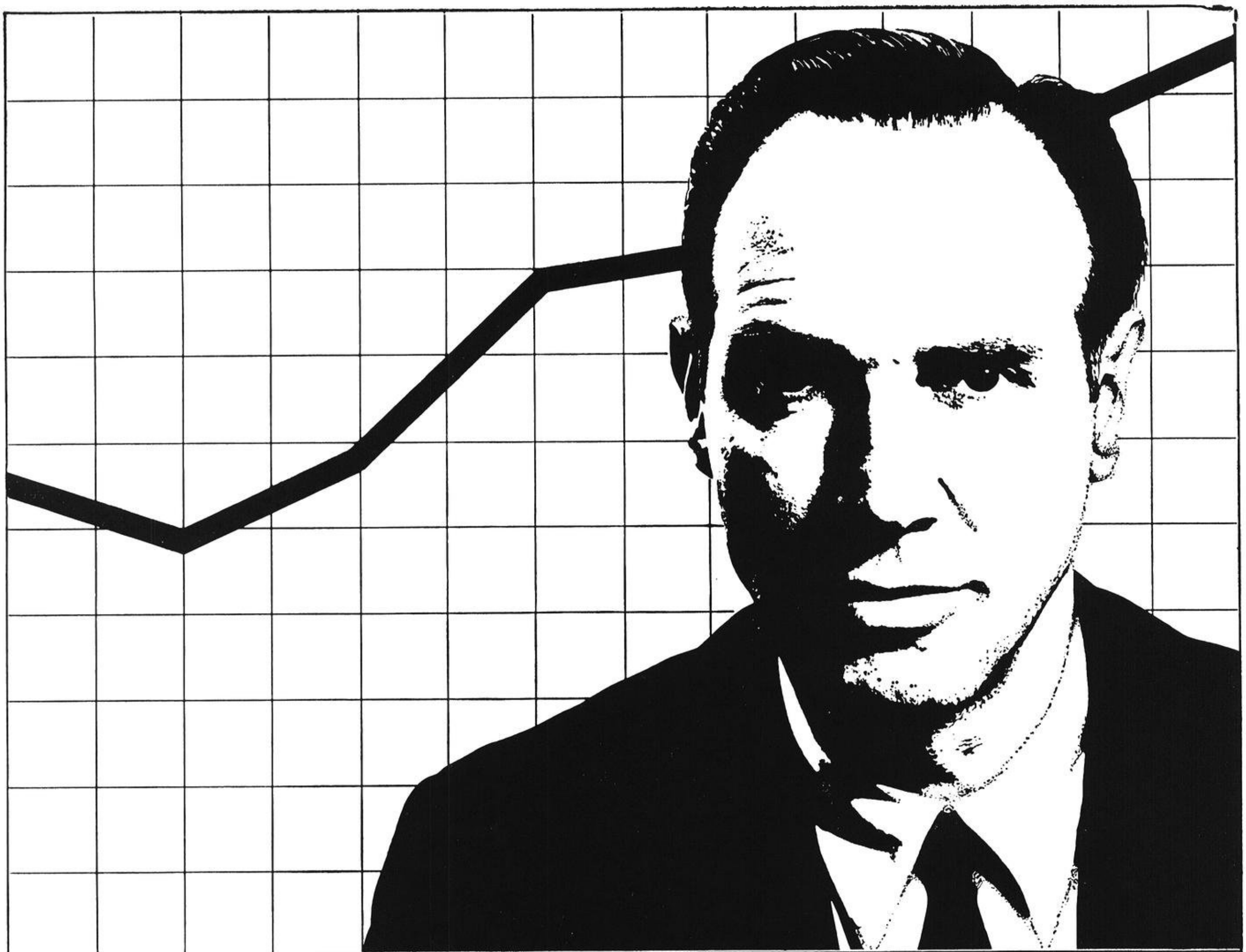
the physics lab



the new steam lab



the wood shop



IMPROVEMENT:

1954: Gross Sales = $259,133,000
1964: Gross Sales = $665,773,000
1974: Gross Sales = ?

We don't know the answer, but it will involve more IMPROVEMENT.

NCR always has been guided by the improvement concept: methods, quality, materials, people. That's why we hold professional seminars, provide advanced education, evaluate a man at regular intervals. We know that people must be ready for the next step up.

We know also that an employee's expectations from his work must be known and met.

What about you? Do you see a climate for self-improvement in your present job? If you are an engineer's engineer, can you see the sometimes mythical "technical ladder"? If you are management oriented, is there room for you?

If you are a professional person with a minimum of a BS degree in Electronics, Mechanics, Chemical Engineering, Chemistry and research, development or manufacturing engineering background, write to us. See if we can meet your expectations.

By the way; we are interested in what you have done, but we are more interested in what you want to do! IMPROVE? Sure! You will have to, to stay up with NCR. Write to:

T. F. WADE
EXECUTIVE AND PROFESSIONAL PLACEMENT
THE NATIONAL CASH REGISTER COMPANY
MAIN & K STREETS, DAYTON, OHIO 45409

An Equal Opportunity Employer

NCR

THE NATIONAL CASH REGISTER COMPANY ® DAYTON, OHIO 45409

ALUMNI NEWS

Robert A. Himmelmann of 422 N. Catherine Avenue, La Grange Park, has been elected a vice president of The Peoples Gas Light and Coke Company.

Himmelmann became associated with Peoples Gas in 1949 as a service engineer in the Industrial Sales Department. In 1960 he was named assistant manager of the department, and in February of this year he was elected assistant vice president.

Dr. John W. Andersen of Northfield, Minnesota will become director of research at Wheeling Steel Corporation. He will take over his new assignment on June 1st.

Just prior to joining Wheeling Steel, Andersen was director of research and development for HITCO of Gardena, California, manufacturer of ablative materials, composites and fibers. Before that, he was vice president and director of engineering for G. T. Schjeldahl Company of Northfield, Minnesota, manufacturer of aerospace hardware, laminate materials, and packaging materials.

From 1949 to 1962, Andersen was with Monsanto Company at Dayton, Ohio and St. Louis, Missouri, in capacities ranging from research chemical engineer through technologist. While at Mansanto, he was engaged in process research and development from laboratory to full scale plant design and construction.

nd the holder of several patents for chemical processes.

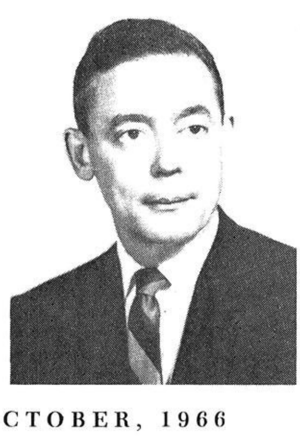
He is the author of a number of technical papers and the holder of several patents for chemical processes.

During World War II, he served with the United States Navy as an engineering officer on a heavy cruiser.

P. Dan Gilbert has joined The Trane Company's St. Paul–Minneapolis, Minn., sales office as a sales engineer, Bob Owens, manager of that office, has announced.

Trane is a manufacturer of air conditioning, heating, ventilating and heat transfer equipment for commercial, residential and industrial applications.

Gilbert is a 1965 graduate of the University of Wisconsin with a bachelor of science degree in civil engineering. Prior to receiving his field assignment, he completed the Trane specialized graduate engineer training program. The program consists of instruction on Trane products and their specialized heat transfer theory and practice.



Karl T. Hartwig has been elected vice president of planning, engineering and development of Commonwealth Oil Refining Company, Inc.

Mr. Hartwig joined Corco in 1962. He was executive assistant to the president, and for the past several years has been responsible for supervising both the planning and design of Corco-owned and joint-venture petrochemical plants. Prior to his association with Corco, he was manager of project engineering for Universal Oil Products Company joining that firm in 1939. Mr. Hartwig holds a B.S. degree in chemical engineering from the University of Wisconsin.

COMING NEXT ISSUE

★ **WISCONSIN'S OAO by Abby Trueblood**

April 1966 saw the University of Wisconsin looking anxiously towards Florida's Cape Kennedy for the launch of the first Orbiting Astronomical Observatory (OAO), which contained a Wisconsin instrument package. The subsequent failure of the satellite did not end the University's participation in the NASA program, and plans remain to carry out the full OAO program.

The University of Wisconsin's participation in the federally supported NASA program is indicative of the increasing number of colleges and universities across the nation taking part in similar space oriented programs.

The following article is about this first Orbiting Astronomical Observatory, and explains why scientists hope that there will be a more successful launch of this kind of satellite soon.

★ **SPACE NUCLEAR PROPULSION by Jay Bradford**

★ **VTOL AIRCRAFT by Douglas Paneitz**

★ **WISCONSIN'S ALBUM—FOOTBALL IN 1896**

★ **WISCONSIN'S FINEST—THE LATEST IN GO-GO WITH UMMMMMM . . . YEAH!**

★ **FROM THE DEAN'S DESK—PROFESSOR LEIDEL SPEAKS TO FRESHMEN**

★ **AND LOTS MORE!**

BUY THE WISCONSIN ENGINEER

. . . an engineering tradition

INDEX OF ADVERTISERS

FILEABLES FOR '66

"Did you get that fellow's license number?"

"No, he was going too fast."

"That girl with him was some chicken."

"Yeh, I'll say she was!"

* * *

First Engineer: "Going around with women a lot keeps you young."

Second Engineer: "How come?"

First Engineer: "I started going around with women when I was a freshman two years ago, and I'm still a freshman."

* * *

A fool and his money are invited places.

* * *

"How did your brother die?"

"He fell through some scaffolding."

"What was he doing up there?"

"Being hanged."

* * *

Tim: "What was the cause of the collision at the corner today?"

Jim: "Two motorists after the same pedestrian."

* * *

A mule and a midget car met one day on the highway and stood for some time looking at each other.

Finally the mule said, "I'm a horse. May I ask what you are?"

"I am an automobile," said the midget car.

Whereupon both laughed heartily.

* * *

Doctor: "Why do you have BF9287 tattooed on your back?"

Patient: "That's not tattooed. That's where my wife ran into me when I was opening the garage doors."

* * *

A certain man was traveling overnight on a train. As he was preparing to retire for the evening, he noticed that the berth beneath his was occupied by a young lady who was trying vainly to attract his attention. The man, somewhat annoyed, ignored her, got into his own berth, and was just about asleep when a voice was heard from below, "I'm so cold. Can I borrow an extra blanket or something to keep warm." The man thought a minute and then responded, "Why don't we pretend we are married tonight?" With a slight giggle she replied, "That sounds like fun." "Good," the man quipped. "Go get your own damn blanket!"

* * *

Moe and Joe were fishing in Florida waters for the first time. Suddenly Joe felt a jerk on his line. "Moe," he said, "I got me a haddock!"

"Vel," said Moe, "vy don't you take an aspirin?"

* * *

The old-timer, looking bent, weary and dejected, hobbled painfully up to the bar.

"What's the trouble?" asked a bystander. "You look bad."

"It's yoorz," moaned the old-timer. "I've got a bad case of yoorz."

"What's yoorz?" asked the bystander.

"A double Scotch, thanks."

* * *

A tourist seeking an ideal southern town stopped in Jackson and asked an old timer if the place was healthy.

"Healthy?" the old man roared.

"Why this is the gol' darn healthiest place you ever did see. Shucks, nobody ever dies in these parts."

"That's strange," remarked the tourist. "On my way into town I passed a funeral procession."

"Oh that," the old timer grunted. "That was only the undertaker. The darn fool starved to death."

* * *

The man was applying for relief, and the girl at the desk was filling out the questionnaire.

"Do you owe any back house rent?" she inquired.

"Ma'm," he replied with dignity, "we've got modern plumbing!"

* * *

Chief Engineer: Your reports should be written in such a manner that even the most ignorant may understand them.

Assistant Chief: Well, sir, what part is it you don't understand.

* * *

An old maid is a gal who knows all the answers but is never asked the question.

* * *

A man finally bought a parrot at an auction after some spirited bidding. "I suppose the bird talks," he said to the auctioneer.

"Talk?" was the reply. "He's been bidding against you for the past half hour."

* * *

A gravedigger, absorbed in his thoughts, dug a grave so deep he couldn't get out. Came nightfall and the evening chill, and his predicament became more and more uncomfortable.

He shouted for help and at last attracted the attention of a drunk.

"Get me out of here," he shouted. "I'm cold."

The drunk looked into the grave and finally distinguished the form of the uncomfortable gravedigger.

"No wonder you're cold," he said. "You haven't any dirt on you."

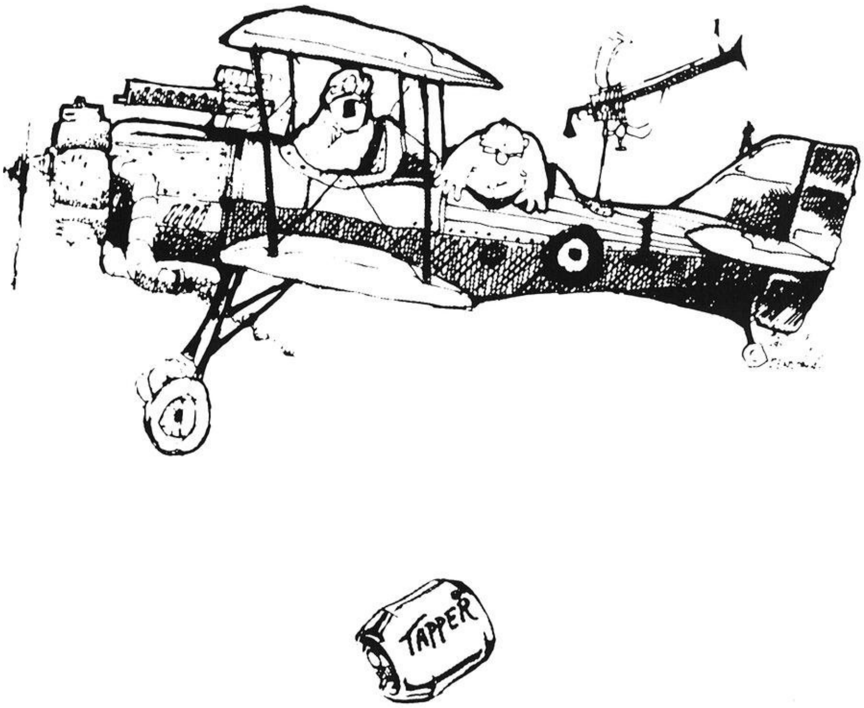
The new doctor was the only one available in the mining town when Engineer Kelly's wife was taken ill. Called to the Kelly home, he went upstairs to the sick room but came down in a few minutes to inquire, "Have you a corkscrew handy?" Given the tool, he disappeared up the stairs for the second time.

Several minutes later the doctor was back. "Got a screw driver?" he asked the anxious Kelly. Instrument in hand, he went upstairs again.

Almost immediately he was downstairs again. "A chisel and mallet, quickly," he demanded. The distraught engineer could stand it no longer. "For the love of Heaven, doctor," he begged, "what's the matter with my wife?"

"Don't know yet," was the reply. "Can't get my medicine bag open."

* * *



"You dropped the WHAT?"

He lived on the border between Russia and Poland and he worried about it for years. "I'm a man without a country," he said. "I don't know where I live." So eventually, he got a state surveyor to swing around his way and make a careful survey. "You live," decided the surveyor, "in Poland."

The Pole hurled his hat in the air with a cheer "Thank God!" he cried. "No more of those terrible Russian winters!"

"Luke ain't been much help since he found that"

A clergyman at a dinner had listened to a talkative young man who had much to say on Darwin and his "Origin of the Species."

"I can't see," he argued, "what difference it would make to me if my grandfather was an ape."

"No," commented the clergyman, "I can't see that it would. But it must have made a great difference to your grandmother."

* * *

Before elections, some political speakers sound a little hoarse. Others sound like part of a horse.

* * *

Then there is the nurse who is so conceited that when she takes her patient's pulse, she subtracts ten beats for her personality.

* * *

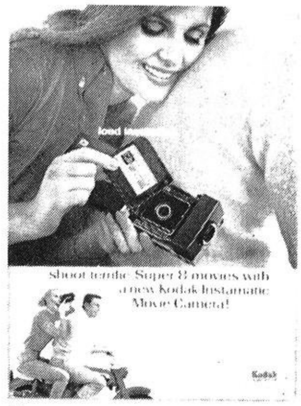
Having taken a few too many drinks at a hotel dance, a pretty young thing ran out of doors, fainted, and fell over a trash barrel. A shovel runner saw her, picked her up and carried her to his room. The next morning he wired his partner out of the state: "CLOSE OFFICE, SELL EVERYTHING. COME TO TEXAS. THEY THROW AWAY BETTER STUFF HERE THAN YOU CAN BUY IN OTHER STATES."

How dull if everybody who joined us had the same aims, color, and interests!

The guy who wrote what you are reading joined the company as an optical physicist. Now he's an advertising man. His assistant, an English and French major from Catawba College in Salisbury, N.C., who first joined our French affiliate, Kodak-Pathé, in Paris, has just written a manual in English that introduces beginners to a system of separations chemistry for which we market equipment and supplies. Her husband works in our Photographic Technology Division engineering color motion-picture processing systems. (Four other departments tried to lure him away, but he decided he preferred the exciting new development work in his area.) The chairman of our board also came originally as a physicist, the president as a mathematician, one of our two executive vice presidents as a chemical engineer, the other as a Ph.D. chemist. On the other hand, our vice president of marketing majored in economics at the local university.

The point: out of self-interest, pure and frank, we have to help every college graduate who joins us find where he is happiest and can therefore earn raises fastest. What makes this a little easier here for both parties is our tremendous scope.

Having long been part of many, many more industries than the one with which the general public identifies us, we operate in technologies that range from optics to cattle nutrition, from knitting to laser-cavity design. Perhaps more significant to the person choosing an affiliation for the long haul, we have room and need for every shade of personal bent. In most people personal bent is still to be discovered at the time of college graduation.



The general public knows us for snapshots and home movies. We like it that way. Actually, 72% of our sales comes from elsewhere.

One makeup is tuned for avid pursuit of better understanding of the physical world, whatever the purpose. He can enjoy himself here. Another will enjoy himself here far more in tough competition to create demand for the ultimate fruits of the first fellow's studies. One technical talent finishes what the other technical talent starts. To man the long line between them, we have urgent need for just about every other honest technical talent, male or female, all creeds, all colors. That's how broad we are.

Chat with our representative on campus or drop a note about yourself to Director,* Business and Technical Personnel Department, EASTMAN KODAK COMPANY, Rochester, N.Y. 14650.

*The engineer who previously occupied that position has been promoted to associate director of the Photo Technology Division. One of his former assistants then moved up to the job.

Kodak

An equal-opportunity employer with major plants in Rochester, N.Y., Kingsport, Tenn., Longview, Tex., and Columbia, S.C.