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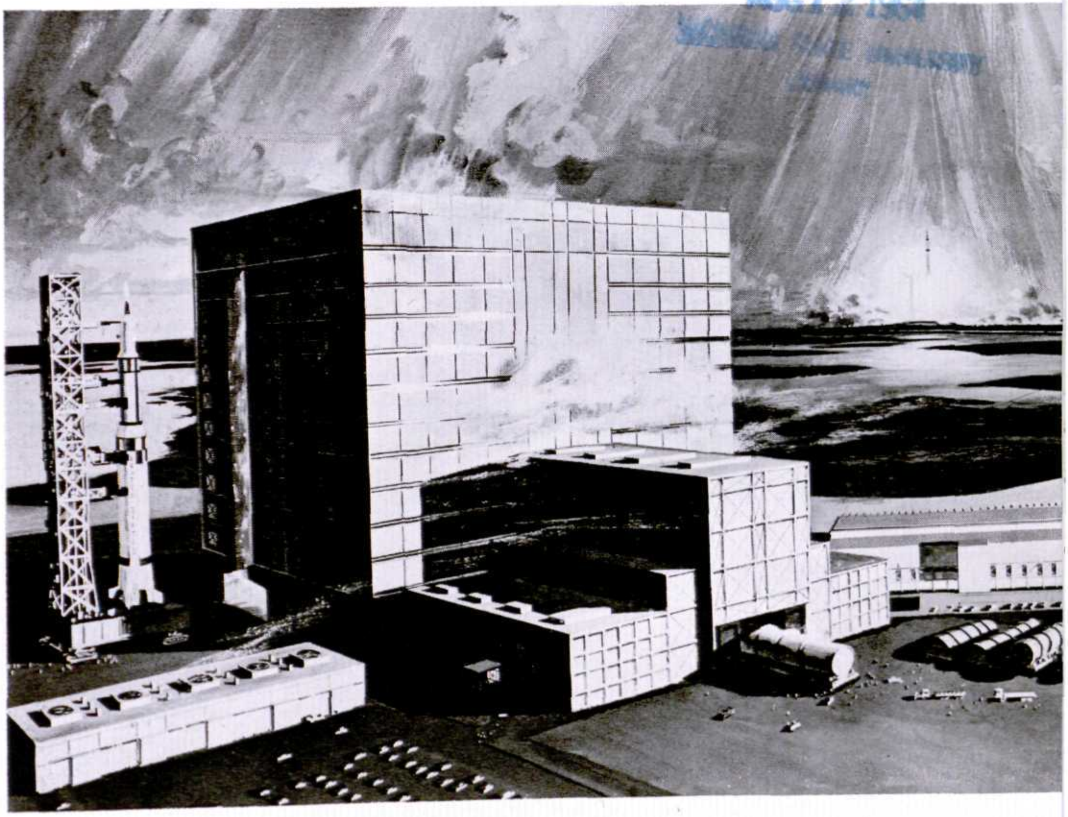
spartan

ENGINEER

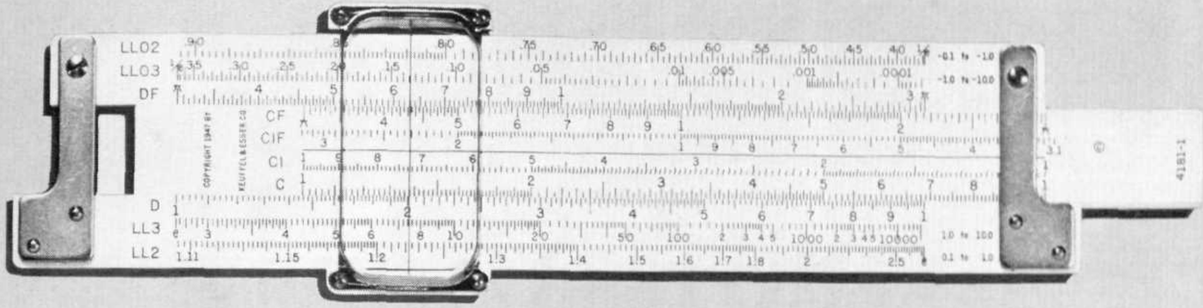
january 1963



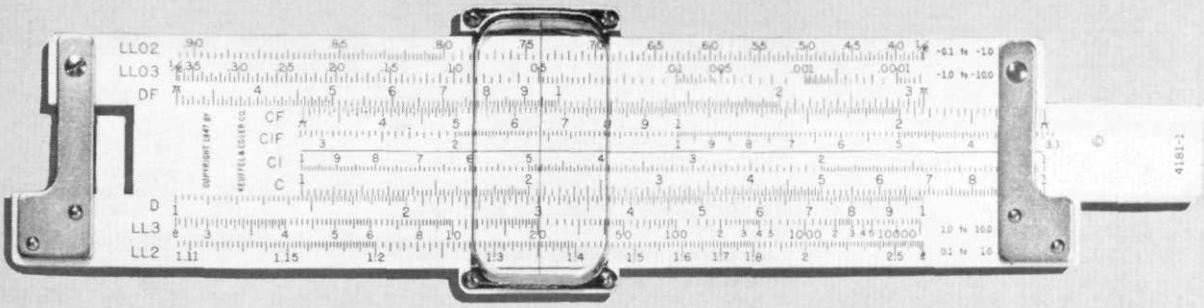
CAPE CANAVERAL TO THE MOON

What's down under the sea? Hostile submarines? New food sources? Biological wonders like the archaic coelacanth fish? ¶ In many ways, we know more about the surface of the moon than we do about the sea around us. The sea guards its secrets in darkness, with pressures that crush steel like an eggshell. Radio waves that put us in touch with the stars can penetrate less than 100 feet of its depth. ¶ Westinghouse scientists are helping to unravel the sea's mysteries by perfecting new precision instruments for measuring salinity, acoustics, currents, pressures, sea floor contours. ¶ Westinghouse was the first to develop centralized engine room control for oceanographic ships, a development that will help make hydrographic and oceanographic surveying faster and more accurate than ever before. ¶ New undersea propulsion methods under investigation at Westinghouse involve fuel cells, thermo-electric generators, thermionic converters, cryogenic propellants. Strange words, strange world. ¶ For more information concerning a challenging career at Westinghouse, an equal opportunity employer, see our representative when he visits your campus, or write L. H. Noggle, Westinghouse Educational Center, Pittsburgh 21, Pennsylvania. You can be sure . . . if it's

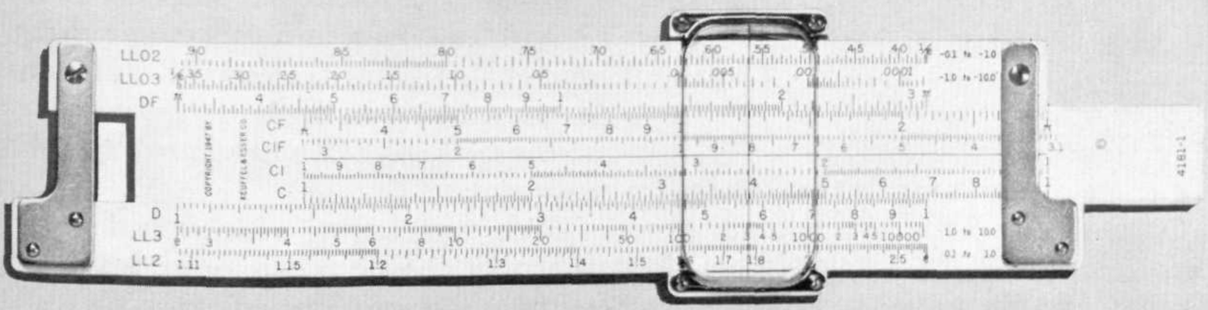
Westinghouse



MULTIPLY . . . your opportunities for advancement



DIVIDE . . . your time between classroom and job



ANSWER: AC's Career Acceleration Program

It takes only eight months in AC-Milwaukee's "Career Acceleration Program" to become an important member of one of the nation's top inertial guidance development and manufacturing operations. You will add to your technical background eight months of formalized classroom instruction in: **Ballistic and Cruise Missile Instruction and Laboratory, Engineering Analysis (Servo Mechanisms), Principles of Airborne Digital Computers, Basic Principles of Inertial Guidance, Probability and Statistics, and the Philosophy of Reliability**—plus rotating job assignments in Engineering, Manufacturing and Reliability Departments.

In 32 weeks you're working on guidance systems for Thor, Titan II and Apollo and a modified Bombing Navigational System for the B-52C&D.

You've multiplied your opportunities for advancement with up-to-date knowledge in this rapidly changing area.

MILWAUKEE—In addition to the "Career Acceleration Program" there is a Field Service Program: Two- to four-month classroom and laboratory On-the-Job Training Program which involves training on inertial guidance systems or bombing navigational systems. Domestic assignments follow completion of program.

BOSTON—Advanced Concepts Research and Development On-the-Job Training Program—AC's Boston Laboratory is engaged in development of navigational systems for manned aircraft, ballistic missiles and space vehicles.

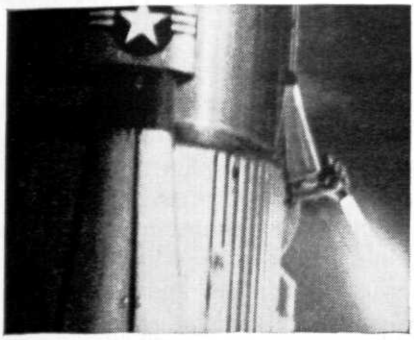
LOS ANGELES—Advanced Concepts Research and Development On-the-Job Training Program—AC's Los Angeles Laboratory is occupied with advanced guidance research for space vehicles and ballistic missiles, plus research in special purpose digital computers.

If you will soon have a BS, MS, or PhD in EE, ME, or Physics, contact your placement office or write Mr. G. F. Raasch, Director of Scientific & Professional Employment, Dept. 5753, AC Spark Plug Division, South Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS

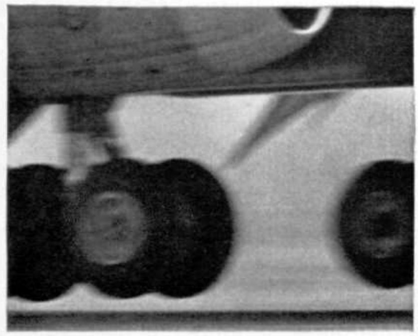
MILWAUKEE • LOS ANGELES • BOSTON • FLINT

An Equal Opportunity Employer

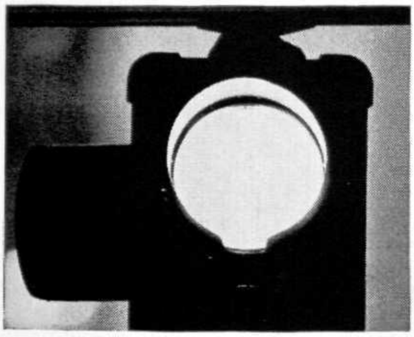


FROM THE LAUNCHING TO THE TARGET, EVERY MAJOR U. S. MISSILE DEPENDS UPON SYSTEMS, SUB-SYSTEMS OR COMPONENTS DESIGNED, DEVELOPED OR PRODUCED BY BENDIX TALENTS

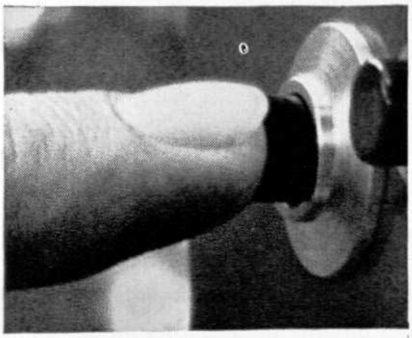
FOUR OF THE U. S. SPACE DETECTIVES THAT SPOT, SHADOW AND REPORT ON EVERY MAN-LAUNCHED OBJECT IN OUTER SPACE DEPEND ON EQUIPMENT OR TECHNICIANS, OR BOTH, SUPPLIED BY BENDIX



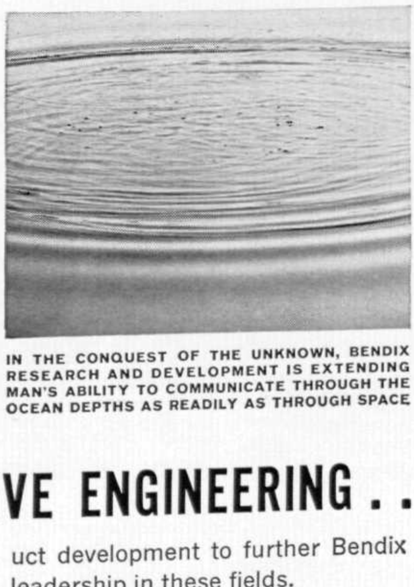
AT TAKE-OFF, IN THE AIR, ON LANDING . . . WHENEVER MAN FLIES, IT'S LIKELY BENDIX EQUIPMENT MAKES HIS TRIP SMOOTHER, SAFER. BENDIX HAS LOGGED MORE FLIGHT TIME THAN ANY NAME IN AVIATION



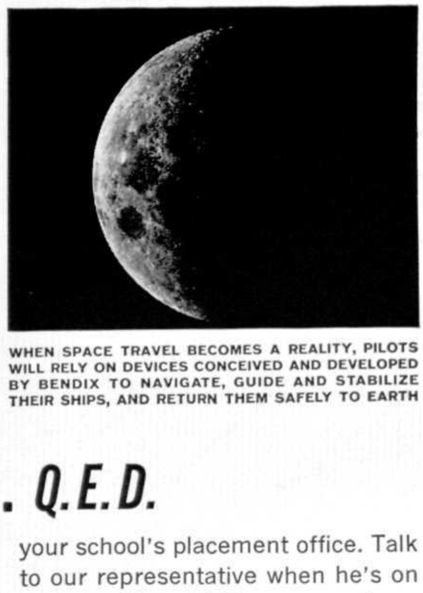
EVERY TIME YOU BRAKE YOUR CAR, CHANCES ARE YOU DEPEND UPON BENDIX. SINCE 1924 BENDIX HAS DESIGNED AND BUILT MORE BRAKES FOR MORE DIFFERENT VEHICLES THAN ANY OTHER PRODUCER



TODAY, AUTOMATED TAPE-CONTROLLED MANUFACTURING AS DEVELOPED BY BENDIX HELPS TURN BLUEPRINTS INTO FINISHED PRODUCTS, GETS PROTOTYPES INTO PRODUCTION FOUR TIMES FASTER



IN THE CONQUEST OF THE UNKNOWN, BENDIX RESEARCH AND DEVELOPMENT IS EXTENDING MAN'S ABILITY TO COMMUNICATE THROUGH THE OCEAN DEPTHS AS READILY AS THROUGH SPACE



WHEN SPACE TRAVEL BECOMES A REALITY, PILOTS WILL RELY ON DEVICES CONCEIVED AND DEVELOPED BY BENDIX TO NAVIGATE, GUIDE AND STABILIZE THEIR SHIPS, AND RETURN THEM SAFELY TO EARTH

CREATIVE ENGINEERING . . . *Q.E.D.*

The variety of challenges The Bendix Corporation offers the college graduate is practically unlimited. Bendix participates in almost every phase of the space, missile, aviation, electronics, automotive, oceanics and automation fields. We employ top-notch engineers, physicists, and mathematicians for advanced product development to further Bendix leadership in these fields.

Bendix operates 32 divisions and subsidiaries in the United States, and 12 subsidiaries and affiliates in Canada and overseas. Our 1950 sales volume was $210 million. Last year it was over $750 million.

Look over the materials we have in your school's placement office. Talk to our representative when he's on campus. If you'd like a copy of our booklet "Build Your Career to Suit Your Talents," write Dr. A. C. Canfield, Director of University and Scientific Relations, The Bendix Corporation, Fisher Building, Detroit 2, Mich. An equal opportunity employer.

WHERE IDEAS UNLOCK THE FUTURE

THE Bendix CORPORATION

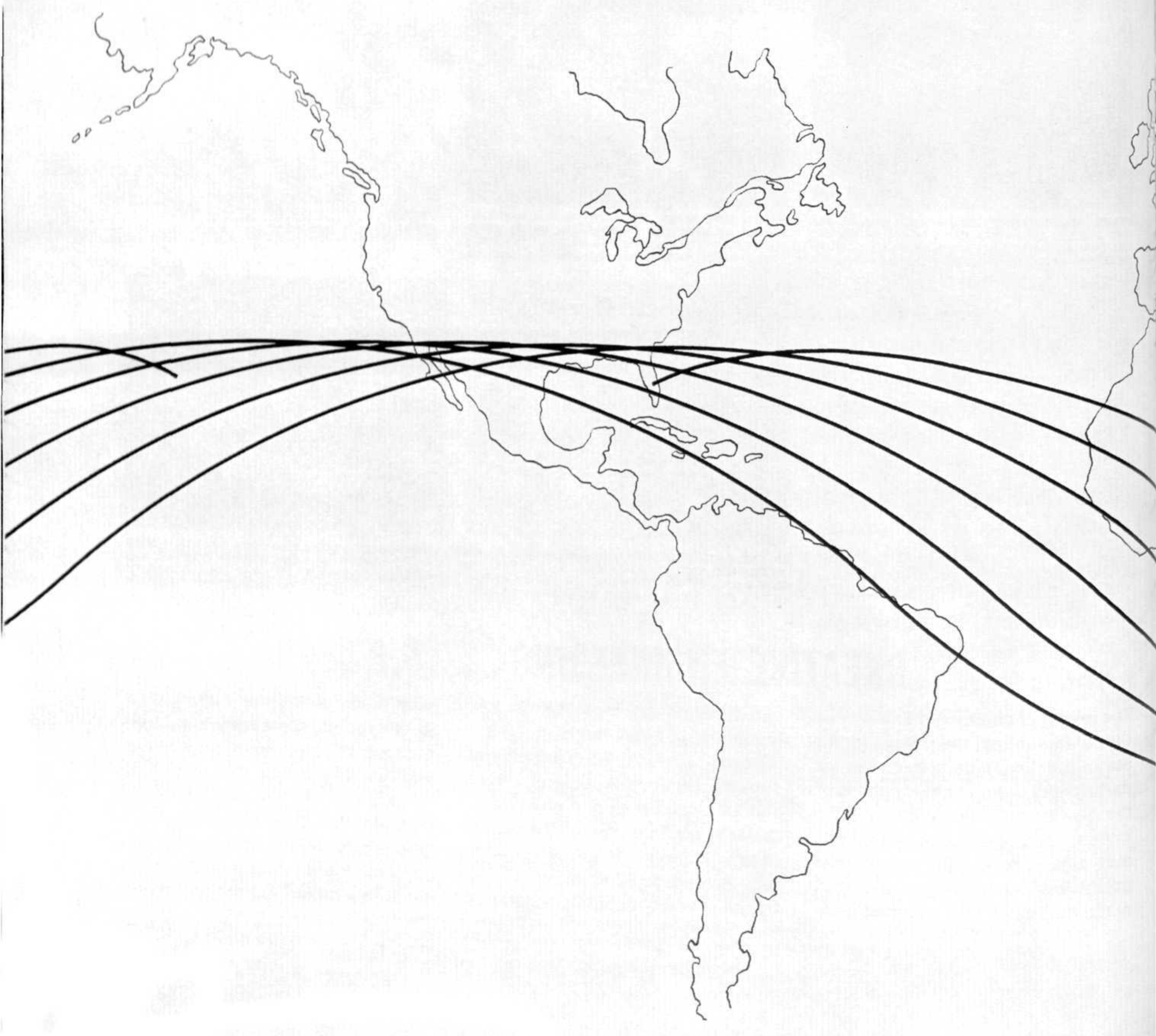
FISHER BUILDING, DETROIT 2, MICH.

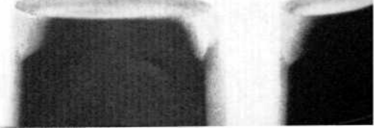
THERE ARE BENDIX DIVISIONS IN: CALIFORNIA, MISSOURI, IOWA, OHIO, INDIANA, MICHIGAN, PENNSYLVANIA, NEW YORK, NEW JERSEY, MARYLAND.

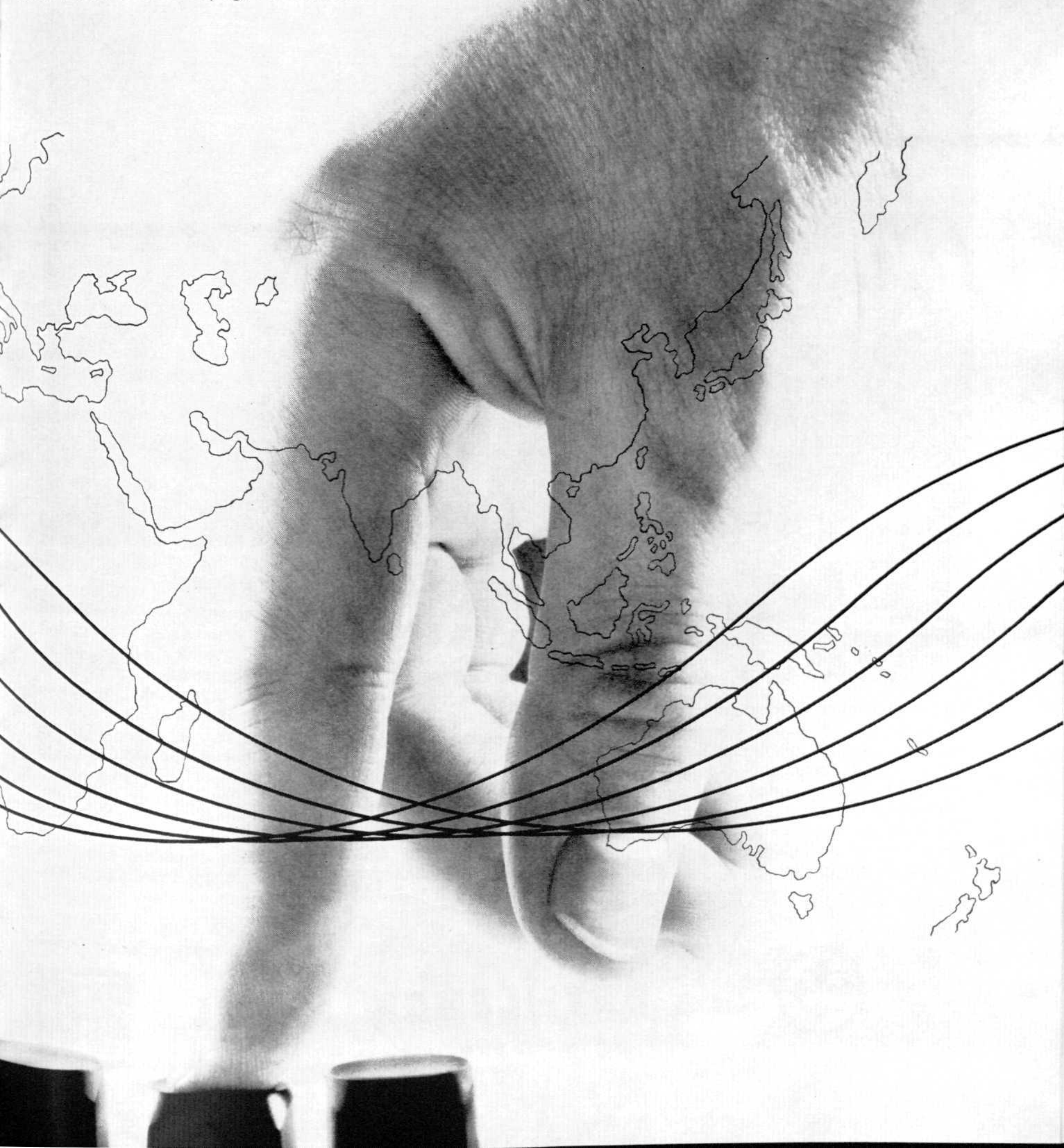
At IBM® you design systems that bring space down to earth

In research and development at IBM, engineers and scientists are exploring new methods, materials, and ideas—*a new world of data processing tools and techniques to extend the reach of man's mind.* In space, IBM miniaturized computers will guide satellites into orbit, gather information from the stars, store data, and relay it on command back to earth. The IBM developments that make possible these systems for broadening man's grasp of the universe—and the new technologies that result from the application of data processing systems—form a firm basis for further progress in the development of information systems.

IBM is at work on applications of data processing concepts to meet the urgent need for effective information-handling systems for gathering vast quantities of data, assembling collected data, storage, and making vital information instantly accessible. For example, large-scale computer systems have been developed for coordinating the coast-to-coast network of airline flight reservations. Other computer systems handle research calculations for nuclear and thermonuclear energy. For automatic bank check processing, systems read characters imprinted on checks with magnetic ink.



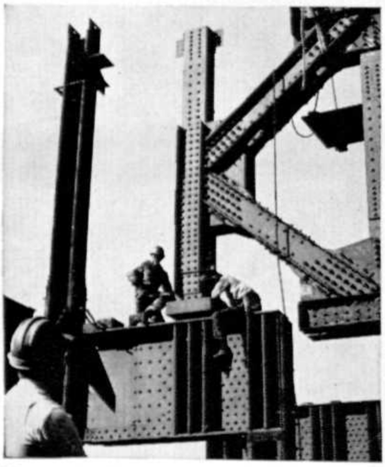




Opportunities are better than ever at Bethlehem Steel!

What kinds of engineers do you find with Bethlehem?

Here's the answer: Chemical Engineers . . . Civil Engineers . . . Electrical Engineers . . . Industrial Engineers . . . Mechanical Engineers . . . Metallurgical Engineers . . . Mining Engineers . . . Naval Architects and Marine Engineers, and more.



Every major engineering degree is represented within the management ranks here at Bethlehem Steel.

It makes sense. The mining and processing of minerals obviously suggest the need for Mining Engineers. Then come the chemical processes of coke-making, smelting, refining. Fuels are consumed, valuable by-products are made. Is it any wonder steelmaking calls for Chemical Engineers?

And how about the machinery, the mills, the furnaces, the instrumentation that make up a modern steel plant? Mechanical Engineers design them, and frequently supervise installation. Civil Engineers design and put up the buildings to house them, and the feed lines to keep them supplied.

Power? Steel is the biggest industrial consumer of electric power. You cannot conceive of a greater concentration of electrical equipment than in a modern steel mill. And many steel plants *generate* electric power, too. Electrical Engineers are busy fellows in the steel industry.

Steelmaking calls for volume production, complex and scientific, often highly automated. We manufacture numerous finished products, too, from nuts and bolts to nuclear-powered cruisers. The Industrial Engineer finds plenty to do here at Bethlehem.

What's more, the kind of engineering degree does not limit a Looper's assignments. The superintendent of a huge open-hearth department, or a giant rolling mill, might well be an M.E., a Ch.E., a Met.E., an I.E., or C.E.

Sales Engineers

Because of the nature of our products, a man with a technical background and a "sales personality" has a great opportunity in sales with Bethlehem Steel.

Research

Our research policy and our magnificent new research laboratories, in Bethlehem, Pa., offer unexcelled opportunities for research and development engineers and scientists. The exciting results of research promise bright prospects for all Bethlehem operations.

Shipbuilding

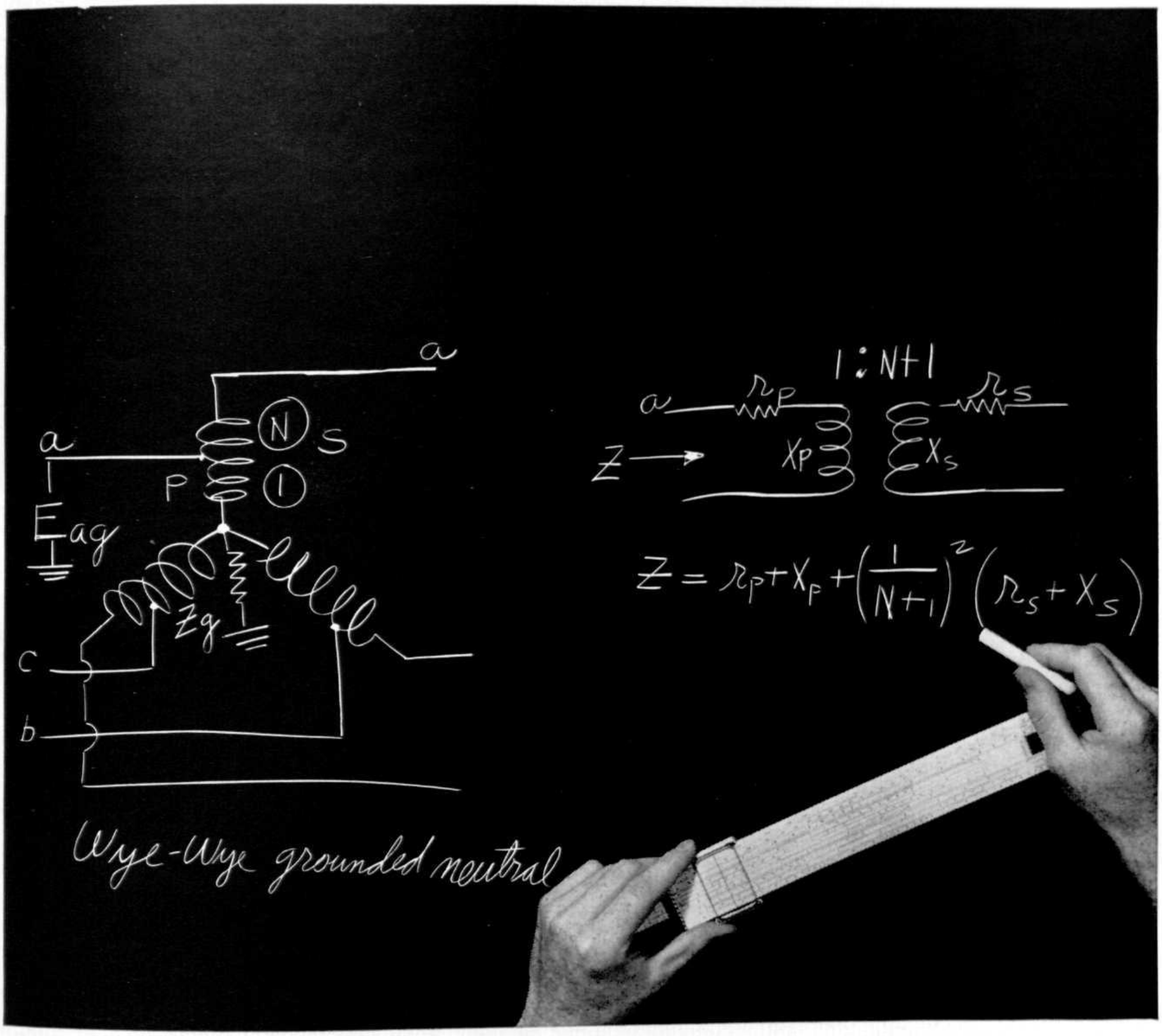
As the world's largest privately owned shipbuilding and ship repair organization, Bethlehem offers careers to Naval Architects and Marine Engineers, as well as to engineers in many other categories.

The Loop Course

This program was established some forty years ago, to select and train well-qualified college graduates for management careers in the Bethlehem organization. It was so named because of an observational circuit (or "loop") of a steel plant. After a five-weeks' basic training period, which is held once a year at company headquarters in Bethlehem, Pa., loopers receive their first assignments, which call for specialized training that may last for a few weeks or for as long as a year. Next comes on-the-job training, and the looper is on his way.

An equal opportunity employer

BETHLEHEM STEEL



"NOW LET'S PUT IT ALL TO WORK"

An engineer knows no greater satisfaction than putting his training, his ideas and energy to work. At Detroit Edison, engineering talent finds rewarding opportunities for expression and professional advancement in this great and growing industrial center of Southeastern Michigan.

You might be interested in training as a Detroit Edison Project Engineer, developing vital power-producing installations. Or you may prefer Research or Electrical Systems or Production Engineering—just three of many challenging fields open to you at Detroit Edison.

For full career information, write for our free booklet about professional opportunities for graduates in our company. Address is 2000 Second Ave., Detroit 26, Mich. Or talk with our representative when he arrives on your campus.

THE DETROIT EDISON COMPANY

An Investor-Owned Electric Light and Power Company

Spartan Engineer

VOLUME 16 NO. 2 JANUARY, 1963

Member, Engineering College Magazine Associated
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* *

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Dean's Letter

You have all certainly perused the curriculum leading to a degree in your chosen major. Perhaps only a few of you have given it real thought as freshmen or sophomores. In those years you are busy with mathematics, physics, chemistry, or are looking ahead at the junior or senior years when you will get into those "real" engineering courses; the curriculum is only delaying you. Certainly not too many of you have realized that a curriculum is only a Table of Contents, that as a planned program of engineering education it is not complete.

The real education lies in the subject matter of the courses themselves and in learning how to think logically from point to point. These are the contributions of the faculty to your education. There is another fraction of your education that is not even listed in this Table of Contents, and must be added by you as an individual. This portion of your education is obtained through participation in extra-curricular campus activities; the University provides an opportunity for this, but you must participate to gain the benefits—and benefits there are. Our curriculum does not include courses in "Parliamentary Law" or "How to Influence People and Others," nor do we find "Conduct on Committees," "Impromptu Politics," or "Selling the Boss," yet such courses are available every day on this campus in the many activities of the student organizations. Their meetings and promotional activities offer opportunity for laboratory experience in human relations, personal conduct, speaking, and organization—all on an informal, unrecorded basis. If you fail in your first attempt to "Sell the Boss," no record is made or grade recorded. This takes much of the pressure off this portion of the learning process, and makes it fun as well as practice in the art of human relations.

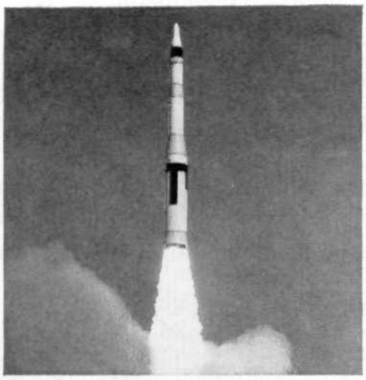
There are many all-campus opportunities for this activity—here in Engineering we have the various Student Branches of our professional engineering societies in our departments, the Engineering Exposition, or work on the staff of this magazine, the "Spartan Engineer." Later on after having met the entrance criteria, there are the activities of the various engineering honor societies.

We wish to especially commend the work to be found with this magazine. Ability to write and to understand journalistic procedures is much sought after in industrial circles, and is also an area without much competition. The Spartan Engineer provides such experience and opportunity.

In fact, this whole unpublished topic in our curricular Table of Contents will be found worthwhile—without an experience here, you will not really have been to college. In fact, an employment interviewer might subtly tell you so.

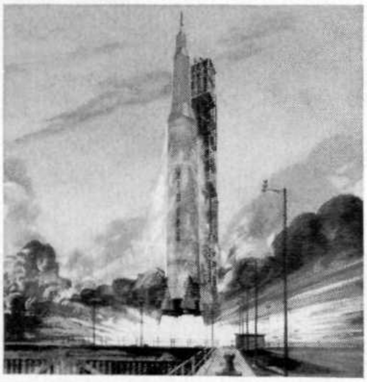
J. D. Ryder, Dean


System contractor: DYNA-SOAR


System integration: MINUTEMAN


Boeing 707 with Boeing-Vertol 107


New Boeing 727 short-range jetliner

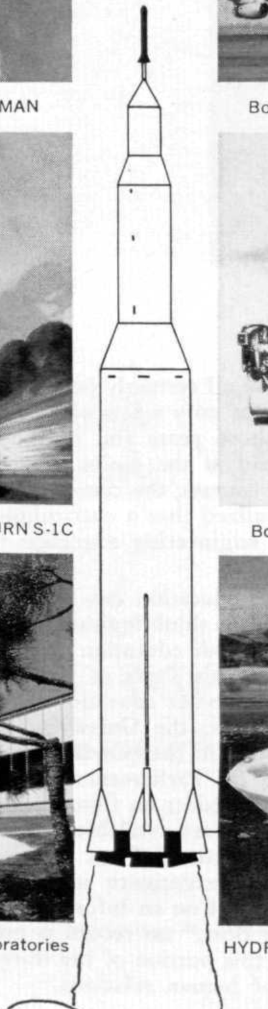

Space booster development: SATURN S-1C


Boeing turbines power helicopters


Boeing KC-135 jet tanker-transport


Boeing Scientific Research Laboratories


HYDROFOIL development, construction

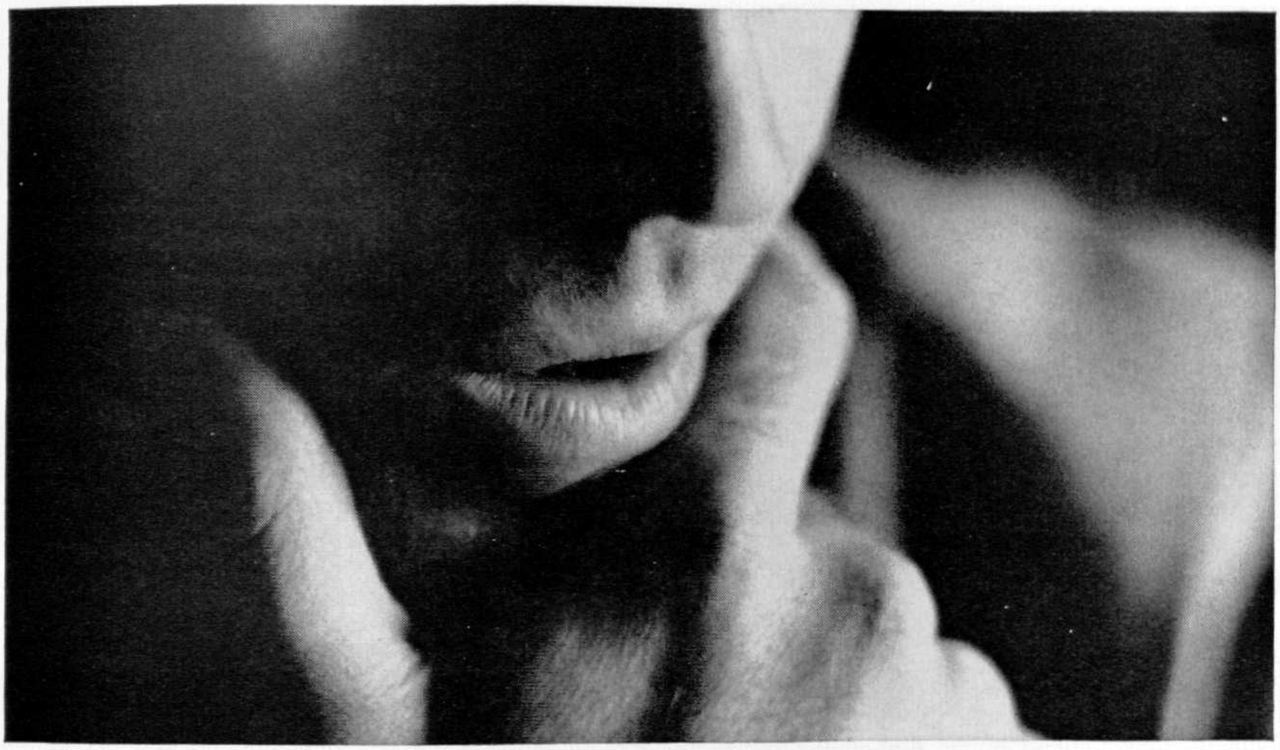


CAREER BULLETIN FROM BOEING

The wide variety and continuing growth of such Boeing programs as those illustrated on this page offer outstanding career openings to graduates in engineering, scientific and management disciplines. At Boeing you will enjoy the advantages of a professional climate that is conducive to deeply rewarding achievement and rapid advancement. Other Boeing advantages include up-to-the-minute facilities, a dynamic industry environment and company-paid graduate study programs (Masters and Ph.D.).

The Boeing representatives will visit your campus soon. They will be happy to provide additional information about expanding Boeing activities in a broad spectrum of fields. The Boeing Company is an equal opportunity employer.

BOEING



From Phend

Educators recognize that the demands of our nation for professionally trained men and women—for engineers, teachers, doctors, and scientists—show no signs of slackening. But they recognize, too, that professional education must go beyond specialized technical knowledge alone—that it must extend into the broad understanding, insight and perspective which have been historically associated with liberal education. The educators realize that the engineer and the scientist need to understand the world's social and political problems, as well as its economic and political problems, and that they must be aware of the cultural and humanistic values upon which our society rests.

There are other considerations, of course, in developing the imaginative, creative men and women our country must have. We need a greater emphasis on the fundamental arts and sciences at the secondary level. We need to give considerably more attention to identifying and educating individuals of unusual talent and potentialities. We need a greater realization that education must begin and continue in the home; we need to recruit more able people into all sectors of the educational profession.

It seems to me, however, that in order to be really effective in our preparation for the challenges of a rapidly changing world we may have to go one step further—or one fathom deeper—in our thinking about education. We may need to go beyond all the specifics of curriculum content and teaching methods to the spiritual and psychological needs of human beings. No man is just a thinking machine or a bundle of skills or a filing cabinet of ideas. What we need to remember is that in man's nature there is a spark that ignites his creative energies and makes him a useful, responsible and effective person. Perhaps there has been a tendency to take this too much for granted; perhaps we need a greater realization that it is the responsibility of education to develop this spark in as many young people as possible.

In this connection, we should consider what effect the forces and pressures of this changing technological age are having on the human personality. In recent years we have been hearing from many writers and commentators that our society is sick with the disease of conformity. We are told that our young people are simply a herd of twist fans; that group-mindedness in business and government is creating a nation of organization men and destroying the initiative and vigor of American business

(Continued on Page 57)

Calvin W. Emerson, Purdue BSME '60, MSME '62, inspects hollow air-cooled turbine blades after a test run of a first-stage prototype wheel in a turboprop engine power section. Emerson is one of numerous young engineers engaged in applied research on advanced gas turbine engines now under development by the Allison Division of General Motors. Blades of the type shown in the wheel have played a major role in boosting horsepower as much as 63% in development engines. These air-cooled blades operate in higher inlet gas temperatures with a lower blade surface temperature than uncooled blades, making possible improved fuel consumption as well as increased horsepower output.

● **ADVANCED TURBINE ENGINE DEVELOPMENT**—Allison, world leader in the design, development and production of turbo prop engines, is extending their capabilities to meet changing military needs.

Current programs greatly advancing the state of the art include developments for V/STOL applications and programs to maximize fuel economy and range through air cooled turbines and high temperature regenerative cycles.

And, in other fields, first and second stage rocket engine cases designed and produced by Allison for Minuteman have achieved a 100 per cent reliability record. Allison's steadily growing competence in the field is reflected in the forward strides made in titanium and glass filament-wound ICBM cases. Also, Allison has developed a highly efficient regenerative liquid metal cell that may point the way to a powerful, yet compact, electrical system for space-age applications.

Atomic Energy Commission's announcement of negotiations with Allison as prime contractor for development of MCR (Military Compact Reactor) also creates long-range opportunities in the nuclear field. Perhaps there's a place for you in the creative environment at Allison. Talk to our representative when he visits your campus. Let him tell you first-hand what it's like at Allison where "*Energy Conversion Is our Business.*"

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Allison

THE ENERGY CONVERSION DIVISION OF GENERAL MOTORS, INDIANAPOLIS, INDIANA

Dr. Harold G. Elrod

FACULTY REVUE

by Paul D. Adams

"Our schools endeavor to turn out versatile mechanical engineers, capable of further development in many different fields," said Dr. Harold G. Elrod, a newly appointed member of the MSU Mechanical Engineering faculty.

"As a mechanical engineer," he said, "I have often had occasion to use basic mechanical engineering principles to solve problems in new fields such as space and nuclear science. Each new field has, of course, certain special characteristics and theories of its own but a large proportion of its problems can be solved by the systematic use of established disciplines already in our curriculum."

Dr. Elrod received a Bachelor of Science degree in 1942 from MIT. He received an MA in Engineering Science in 1947 and a Ph.D. in Engineering Science in 1949 from Harvard University.

He has taught graduate and undergraduate courses in fluid dynamics, heat transfer, and thermodynamics, and has also directed doctoral programs in these areas.

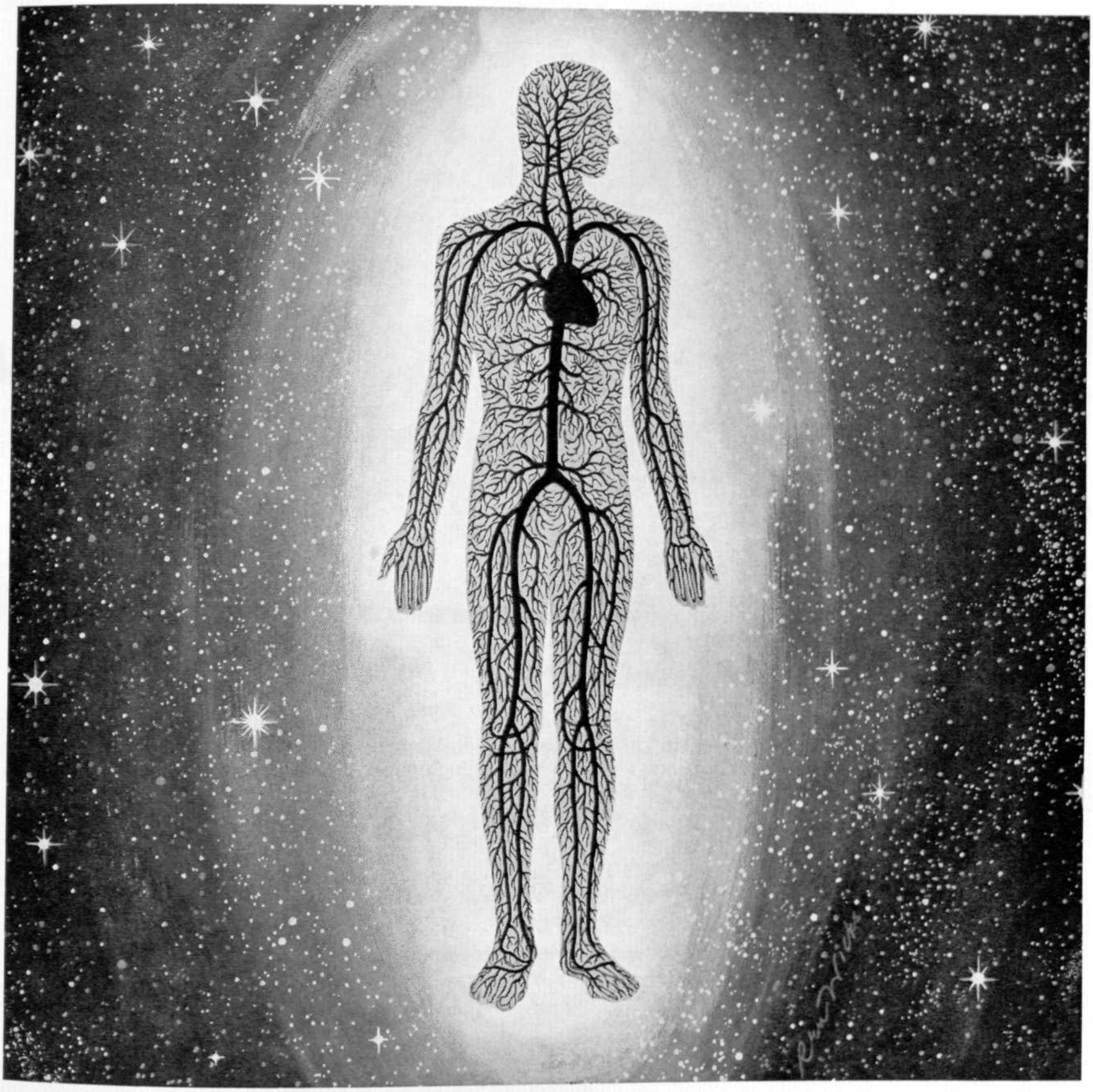
Dr. Elrod's research has been on numerical and lumped-parameter methods for the solution of transient heat conduction equations, including surface convection effects; studies of subsonic and supersonic shear flow; drag in turbulent flow; theories of gas lubrication.

He was professor of Engineering Science in the Mechanical Engineering Department at Columbia University from 1955 until he left to come to MSU in the fall of 1962. During the three years from 1952 to 1955 he was Assistant Professor of Mechanical Engineering at the Case Institute of Technology, Cleveland, Ohio, and from 1942 to 1945 was an instructor in the Department of Marine Engineering at the U. S. Naval Academy.

Dr. Elrod has spent considerable time in consulting activities with firms such as the Franklin Institute, Nuclear Development Corporation, Avco Research and Advanced Development Division, General Electric Company, American Machine and Foundry Corporation, Mechanical Technology Inc. and Thompson Products Inc. The work covered such topics as liquid-metal heat transfer, lubrication, supersonic wake phenomena associated with re-entering ICBM vehicles, solar energy collectors for space vehicles, heat conduction and radiation in ablating materials, boundary-layer theory and supersonic compressors.

As research engineer at the Babcock and Wilcox Company, Alliance, Ohio, Dr. Elrod worked on the theory of ejectors, electro-magnetic flow meters and flow distribution studies in boiler tube passages. He was technical supervisor for an experimental liquid-metal project under sub-contract with NEPA Division of Fairchild Engine and Airplane Corporation.

As technical advisor with the Nuclear Development Corporation, White Plains, New York, Dr. Elrod worked on problems associated with nuclear-powered aircraft and with transpiration coolants. He also conducted safety studies for the nuclear reactor in Monroe, Michigan. "The problems in a nuclear power plant," he said, "are complicated by the precision required in its fabrication and the handling of fuel and waste products."



Life sciences study effects of long range space travel

The life sciences group at The Garrett Corporation is concerned with the reaction of living organisms to their environment, and the development of environmental systems to support such organisms.

Intensive investigation is now being conducted at Garrett in all major areas of the life sciences—microbiology, neurophysiology, psychology, biochemistry, biophysics and related areas—to study the relationships of man to his environment in extended space travel. These studies vary in scope from determining the effects of near vacuum conditions on laboratory subjects over long periods of time, to definitively evaluating the effects of re-entry acceleration on human beings.

Garrett also designs, develops and manufactures environmental control systems for this country's major manned spaceflight programs, including Project Mercury, Gemini and Apollo.

For information about other interesting projects and the many career opportunities with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles. Garrett is an equal opportunity employer.

GARRETT

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ENGINEERINWIVES

by Sharon Smith

Meet thirty young women who will graduate from MSU during the next three years with an unusual degree.

The degree? A P.H.T.—Putting Hubby Through—of course.

These women are the Engineer's Wives, members of a social club open to all wives of engineering majors on campus. The club meets on the third Wednesday of every month. Meetings are announced in the State News.

The club was founded to acquaint engineer's wives with their husband's field.

"Purpose:" it is written in the club constitution, "To acquaint the wives with the field of engineering and prepare them for the social and community obligations they will face.

"Lectures, movies, and discussions keynote our monthly meetings," Joyce Reynolds, wife of Ronald, E.E., '63, and president of the club, said.

In April, Mrs. Reynolds said, the wives are going to Liebermann's in Lansing. Mrs. Don Price will show the women how to add a little "Spice to Your Tables." Featured will be table settings, centerpieces, and color schemes for different occasions.

Activities in the past included: a tour of the Engineering building; instructions from Stanley J. Idzerda, director of the Honors College, on being a wife; a get-acquainted mixer yearly; a panel discussion by wives of area engineers on what to expect as the wife of an engineer.

But the biggest event is a graduation ceremony in the Kiva in the spring. Dean John D. Ryder hands P.H.T. diplomas to the wives whose "hubbies have been pushed about as far as they kin go."

The officers of the Engineer's Wives are:

Mrs. Reynolds, president;

Jo Stephens, wife of Conrad, E.E., '63, vice-president and program chairman;

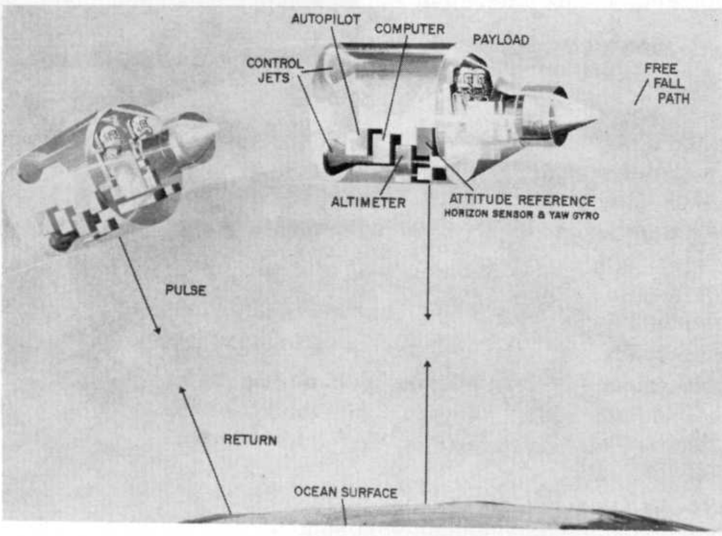
Nancy Presley, wife of Scott, M.E., '63, recording and correspondence secretary;

Wilma Young, wife of Phillip, Ag. E., '65, treasurer;

Jo Ann McDowell, wife of Judson, E.E., '63, Engineering Council representative.

Faculty advisors are Mrs. John D. Ryder, wife of the Dean of the College of Engineering, and Mrs. James Cutts, wife of the chairman of the department of civil and sanitary engineering.

GENIE IN A BOTTLE



Gemini, America's second major bid in space will be orbited within the next two years. Designed to carry two men and to fly higher and longer than previous shots, Gemini represents the connecting link between the Sub-orbital-Orbital craft and the true space vehicle. In orbit for a period of days rather than hours, Gemini poses new problems in engineering design. A major difficulty was that of supplying electrical power for the craft's many instruments and electronic systems. The requirements for long term power, light unit weight, and small size presented parameters which no conventional power sources were capable of meeting. In an effort to satisfy these requirements, design engineers have turned to a new source of power. Light, small and efficient, it constitutes a true "Genie in a Bottle."

by John Callahan

Ever heard of a genie in a bottle? All you had to do was have the right bottle and you could do all sorts of things . . .

Today we have a genie in a Gemini. Gemini, a two man spaceship soon to be launched into orbit, carries no batteries, generators, or solar cells; instead it has a bottle, two in fact, with a Genie for good measure.

The "Genie" is a fuel cell, the newest device to gain status in the family of power generating devices, and if you have the right bottles, you can do all sorts of things.

What is a fuel cell? Somewhat like a battery, it is a device designed to convert a fuel directly to electrical energy. However, unlike a battery, the fuel is continually replaced. Such a device has tremendous advantages over other systems. It is small, light, highly efficient, and shows promise of being quite inexpensive. It can theoretically approach 100 percent efficiency (there's a thought to put engineers in orbit). Present day units already approach 85 percent efficiency. That is more than twice the efficiency of the closest, non-nuclear source.

One of the basic systems of operation and also one of the most highly developed is the hydrogen-oxygen cell. The cell consists of two hollow electrodes immersed in an electrolyte of potassium hydroxide. Hydrogen and oxygen, the fuels, are pumped into the electrodes which are made of porous carbon. The hydrogen molecules enter the negative electrode and come into contact with a catalyst in the porous carbon. The hydrogen dissociates into separate atoms which migrate along the porous openings to a reaction zone. There they are joined by OH^- (hydroxyl) ions which have migrated through the electrolyte from the positive electrode. The OH^- ions unite with the H atoms to form water. This reaction is accompanied by a release of electrons which flow, due to the positive attraction, through the external load to the positive electrode, thus producing usable power. Meanwhile oxygen, pumped into the positive electrode has passed into the pores in the carbon and combines with water from the electrolyte and the incoming electrons from the negative electrode to produce "perhydroxyl" O_2H and hydroxyl ions OH^-. These ions then pass through the electrolyte to the negative electrode, completing the cycle.

Well, that's all rather smooth, but any engineer knows full well that *nothing* ever works out *that* neatly. The fuel cell is no exception. Remember all that perhydroxyl we were so happily producing up above? It all comes home to roost. Right on the positive electrode, where it blocks the OH^- ions from leaving and stops the reaction. That's not so good! This is, however, prevented by placing a catalyst in the electrode which tends to decompose the perhydroxyl. Proper catalysts for such use are hard to find and there are many other types of fuel cells which are not feasible simply because there are no catalysts available to stop this kind of "polarization." So much for the perhydroxyl, but what about all that water being produced by the combining of H atoms and OH^- ions? That's "good old" H_2O and if left in the system it will produce "good old" diluted electrolyte. The water, therefore, must be removed from the system, usually by evaporation or condensation. However, the engineers at G.E., developers of the Gemini fuel cell, tried another approach. They substituted a solid electrolyte for the liquid one and the water produced simply drips out. They also came up with a use for it. You see, H_2O, among its other attributes is good for drinking and astronauts get thirsty.

The fuel cell holds great promise for the future. As in the Gemini fuel cell system, they are light, small, (in this case having no moving parts) and potentially inexpensive. With the development of cheaper fuels and catalysts, the fuel cell may soon be finding its way into cars, homes, and businesses. As our picture shows, fuel cells will soon have circled the globe. Want some electric power? Here's the recipe: Take a bottle of hydrogen, a bottle of oxygen, mix in the proper container . . . You have a Genie in a Bottle.

DIGITAL DICTION

"MT": The Machine Translation . . .

This paper presents no original research but is intended solely as an introduction to the historical and methodological development of the science of machine language translation. Several of the many unsolved problems are discussed. Included is a summary of the centers of MT research, the qualifications of an MT researcher, academic preparation pertinent to machine translation research, leaders in the field, and organizations and foundations currently subsidizing MT programs. A bibliography with evaluations of all entries is presented as an aid to the interested reader.

It is hoped that this paper will stimulate the curiosity of the reader and generate knowledgeable support for the initiation of an MT research program at MSU within the near future. It should be noted that only the interest and qualified personnel are lacking; the computing machinery is available.

by David R. Foster

Communications Graduate Student

According to the chapter of Genesis of the Old Testament, God confounded the tongue of man to thwart his defiant attempt to erect an earthly tower that would extend to the Heavens. Since that time, the multiplicity of tongues has served to isolate human cultures and impede interaction among the civilizations of man. We would probably be safe to assume that because of the rudimentary means of transportation and communication in biblical times, the myth of a single universal language prior to Babel was generally accepted as true.

Only as civilization spread and varying cultures met did the reality of the diversity of the modes of verbal expression become apparent. Owing to the highly developed transportation and communication systems of today, we have become aware of the existence of 2,976 languages, grouped into about a thousand language families, used by contemporary men.[1]

As the world continues to shrink smaller and smaller, the need for greater inter-cultural sensitivity and understanding becomes more urgent. International harmony depends upon the elimination of misconceptions and misinterpretations regarding other nations. Since nationalistic sentiments and allegiances will undoubtedly persevere eternally, we cannot ever expect the universal acceptance of an international language. Consequently, the art of translation among languages will continue to be the basis of intercultural communications.

We are assured that the supply of human translators is becoming increasingly inadequate as the avalanche of published material continues to grow. This is especially true in the field of scientific translations (particularly of Russian texts at the present time) where lengthy delays and the low volume of translations poses a very real threat to our national security. The rapidly expanding research facilities of the government, universities, and industry are producing more information than can be adequately collected, organized, indexed, and dispersed to research personnel.

The efficiency and rate of progress of our scientific investigation is highly dependent upon improved methods of information supply. Consequently, in only the last few years there has emerged a young, vigorous, and terribly crucial new inter-disciplinary branch of science concerned with the application of digital computers to the tasks of information retrieval, abstracting, indexing, and translation of languages.

This paper is intended to provide an introduction to one phase of this new science; namely, the machine translation of languages, commonly referred to as MT.

The historical origins of this new field date back to a 1946 discussion between British computer specialist A. D. Booth and Warren Weaver in which the former suggested that the newly-developed electronic computers might be utilized in automatic language translation systems. Subsequent limited experiments on simple word-for-word translations indicated that such a system might be feasible.

It has only been within the last five years that research activity in this field has been very extensive. However, today machine translation is one of the fastest growing phases of the computer revolution.

Although fantastic schemes have been proposed for the automatic transcription of speech sounds into a graphic record (as the "phonetograph" of Dreyfus Graf of Geneva), present MT research is concerned only with written language input. Until very recently researchers have been satisfied with punched tape and card or electric typewriter input devices. However, modern computers are capable of such high speeds of operation that these slow input means are preventing the realization of maximum efficiency and speed in text translation. Consequently, much work has been devoted to automatic character recognition devices. The automatic check sorting and tabulating machines used widely by banks today are products of this research.

The two general methods employed in automatic character recognition devices are the comparison of a character with several standard patterns or the identification of the number and the geometrical position of intersections of the elements of the character. Methods for normalizing input characters to account for variations in position, density, scale, orientation, and viewing perspective have been investigated.[2] Especially promising are the new optical scanners such as the Farrington Optical Scanner, which reportedly can scan whole pages at a rate of 240 characters per second and instantaneously translate what it reads into punched paper tape code.[3]

When the problems of graphical transcription (of diagrams) and the actual incorporation of the optical scanners into the translation system are solved, input speeds will be more compatible with the computer speeds available. On-line or off-line printers are utilized in the output stages.

The lexical problems of MT were the first attacked and continue to be quite challenging. However, recent strides in computer memory capacities have largely solved the storage and access time problems. Thus, earlier concern with the total number of words that could be stored has yielded to considerations of the best means of classifying and cross-indexing the words of the two languages to allow rapid access.

Proposed methods have been based upon alphabetical, conceptual, numerical, logical, and other aspects of the word. Division of the vocabulary into special dictionaries covering certain subject matter fields (microglossaries) have been investigated. It was found that six thousand words are sufficient for understanding ninety-five per cent of English mathematical texts.[4]

Especially troublesome in lexical MT work are the problems of multiple meaning, homographs, the rapid evolution of scientific and technical vocabularies, discontinuous constructions, slang and local speech, idioms, and of course style and word choice. Special computer sub-routines are being developed to identify and code such constructions. Previous to the development of high capacity memories, many schemes were devised to select the most essential words for storage in limited entry dictionaries.

These investigations yielded results that are still helpful in classifying the vocabulary for maximum speed in word look-up and in selecting words for storage in expanded dictionaries.

Words are coded electronically on magnetic tape, ferrite cores, magnetic drums and discs; as holes in cards and tape; as dark and light spots on film; and so forth. The grammatical role of the input word in the sentence is determined by certain computer sub-routines, and numerical codes representing the part of speech, position in the sentence, etc. are affixed to the machine code representing the input word. Through a transformation proc-

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Digital Diction

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ess (binary subtractions and various sub-routines) the machine then finds the target language equivalent of the input word and codes this in its memory along with the grammatical codes.

In early research, when an input word would have several output equivalents (polysemy), all these alternative choices were printed out; but the trend at present is to refine this output by usage of "semantic keys" (which instruct the machine to print out only the word common to the subject field at hand) and by other means. Once all this information concerning the input word in language A is coded, the machine takes this code and consults the language B section of the dictionary to locate the equivalent word which it prints out.

Finally, it should be mentioned that the general procedure followed in deciding what words to put into the dictionary storage is simply to collect all the words from a number of articles in the particular field and then enter those words of a certain frequency of occurrence. An operational Russian-English scientific dictionary of 170,000 words has been developed by Reifler in this manner.[5]

We should add that the semantic problem is far from solved. Determination of the signals that can be detected in the input sentence and which indicate a certain word meaning must be further investigated and coded. Ever present will be the fact that the human translator can often resolve polysemantic problems by drawing upon his background and knowledge of the subject matter, but it is doubtful that computers will ever be able to be supplied with a general cultural background as well as a thorough scientific education. Thus, the machine will never be able to precisely determine whether the French "champignon" should be translated as a "fungus," "mushroom," or "toadstool" in English. But we should note that the machine will be as clever as the non-specialist human translator in most scientific translations, and we can not expect super-human performance by a machine. Greater use of the methods of comparative and statistical semantics will perhaps clarify some of the translation mysteries surrounding idioms and polysemantic words.

One different approach to solving polysemantic problems is the thesaurus method being pursued by the Cambridge Language Research group. They have modified and coded Rogert's thesaurus in such a way that the searching machine locates the language B equivalent for a polysemantic language A word by finding that word in language B which is common to all the thesaurus headings under which all the words in the immediate context of this input word can be found.

A similar approach has been suggested by Ross Quillian of MIT. He proposes that a multi-dimensional system employing a certain number of scales on which specific values could be assigned might be adequate for specifying completely the semantic content of any word. Once all words had been carefully codified by assigning the proper values to the various dimensions, these groups of numerical values (representing the semantic content of various words) could be utilized in a machine translation algorithm.[6] The semantic problem will probably never be completely solved, but much progress is being made along this line.

Before highly readable translations by machine can be realized, more progress in the field of transformational grammars must be made. Insertions, deletions, full or partial substitutions, and rearrangements of words are structural transformations that must be accounted for in the machine program. The demands upon the machine are far less in the realm of morphology and syntax than in that of lexicography. However, Yngve found that his early word-for-word translations in which the original German morphology and syntax were preserved and only the stems translated was of little use to one unfamiliar with German grammar. He maintains that refinements of word-for-word translation methods can solve about 80% of the translation problems but that the remaining twenty per cent makes the difference between an acceptable and an unacceptable product.[7]

Researchers thus began development of programs capable of stripping down the word endings of the input word and synthesizing the correct endings for affixation to the output words. Stems and endings are stored in separate memories. Descriptions of the number and types of flectional endings of the languages under investigation and the interrelations between these endings are being undertaken to aid in the coding and categorization of forms.

In highly inflected languages (as Russian), morphology provides the answer to the majority of grammatical problems; whereas in poorly inflected languages (as English) the grammatical features reside largely in the syntax. Thus, Yngve's work on the generation of logical and grammatically correct English sentences by computer techniques may perhaps provide the solution of the synthesis stage of a language X to English translation machine capable of producing highly readable output.[8]

A comprehensive inventory of structures in languages is essential to the resolution of the syntactic problem. Somehow, the machine must automatically identify each structure of the source language, reduce it to a codeable formula, convert this to a target language formula, and then generate the structures of the output language accordingly.

Delavenay describes a twenty-seven step sub-routine used in Panov's program to analyze the case of the English noun or pronoun.[9] A bi-lingual "dictionary" of structural formulae and the machine sub-routines necessary for identifying and using these formulae in analyzing the input language and synthesizing the output language would be a valuable tool for the MT researcher.

Much discussion has concerned the topic of bi-lingual versus multi-lingual translation systems. In the bi-lingual system it is necessary to determine only the similarities and differences between two languages and to establish transformational grammars applicable only to those two languages. The greater structural similarity, the less complex would be the bi-lingual translation program. Researchers in the U.S. adopted this view until only recently.

The other alternative would be the translation through some natural or artificial interlanguage. This approach would involve a specific analysis program from each language into the interlanguage and then only one synthesis program from the interlanguage into the desired output language. This interlanguage would have to be able

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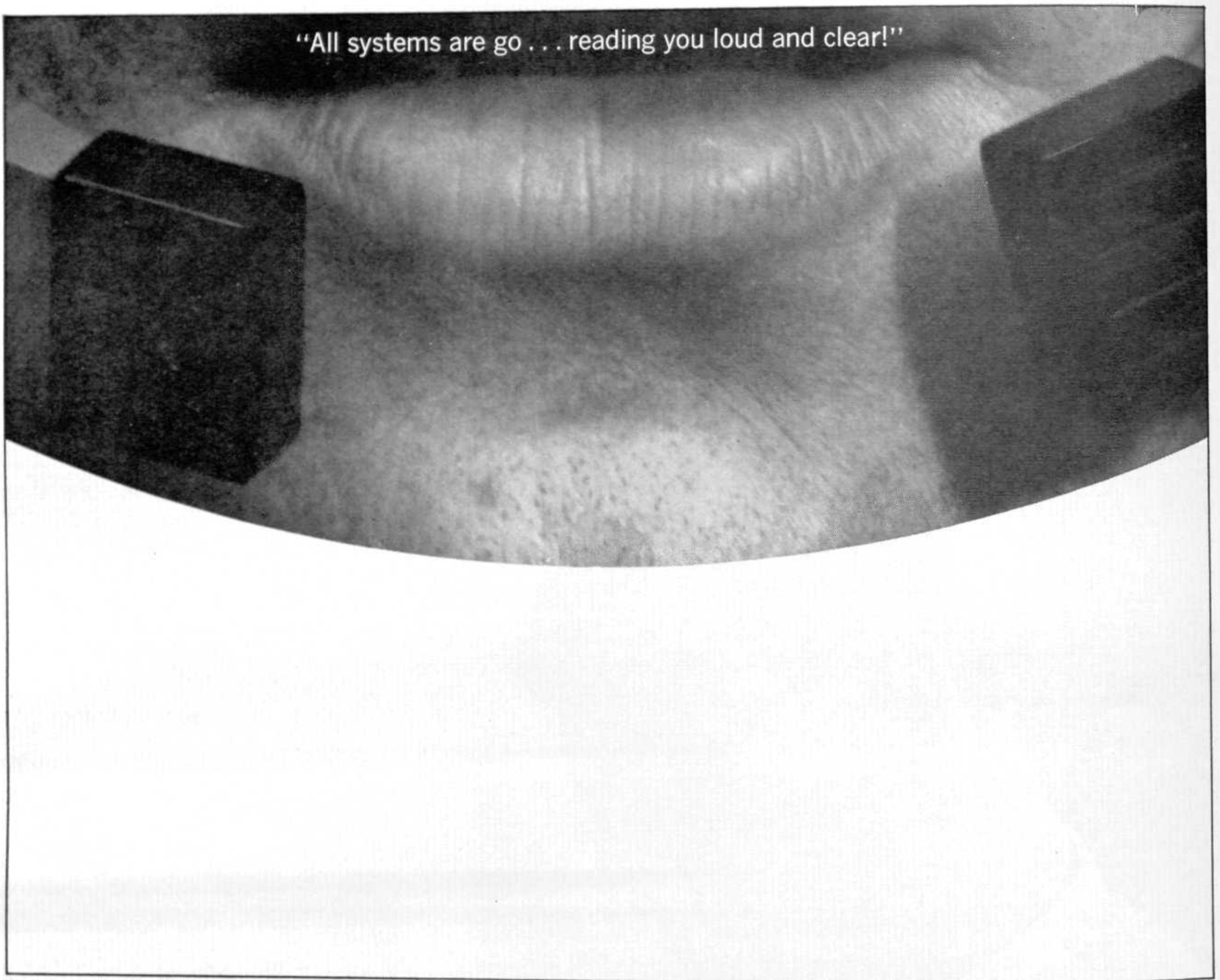
THE BELL TELEPHONE COMPANIES SALUTE: HAL D'ORAZIO



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A Career In Engineering Education

by Leighton Collins

Professor of Theoretical and Applied Mechanics, University of Illinois

The shortage of well qualified, career engineering teachers is a crucial aspect of the over-all engineering and scientific manpower problem in the United States. This is a statement made by the Committee on Development of Engineering Faculties of the American Society for Engineering Education (ASEE) in its report "Engineering Enrollment and Faculty Requirements, 1957-67," and published in 1958. Events since then indicate that this critical situation is still the number one problem in engineering education. It is true that in the fall of 1961 enrollment in the colleges of engineering having one or more curricula accredited by the Engineers' Council for Professional Development decreased for the fourth successive year. Likewise, the number of B.S. degrees awarded by these schools decreased for the second consecutive year. Percentage wise, the decreases are 14 and 5.8, respectively. But even more alarming is the fact that the percentage of degree-credit enrollment constituting engineering has decreased from 8.4 in 1957 to 6.1 in 1961. The 6.1% is significantly below the thirteen-year average of 7.4%.

These figures may seem to indicate that the need for engineering teachers should diminish, but that is not the case. The figures have been cited to indicate that the potential supply of teachers is diminishing in the face of ever increasing long-term needs. Since 1870 there has been a five-fold increase in our labor force whereas the number of engineering and scientific workers increased more than eighty-five times.[1] There is no reason to expect that this trend will not continue, and consequently the demand for engineers, scientists, and technicians will continue to remain greater than for other types of workers.

The ASEE study already referred to indicated that in 1956-57 there were about 9,078 engineering teachers in the United States and that the faculty levels estimated to be necessary by 1966-67 would require new appointments to engineering faculties, including replacements, increasing the total faculty in *public supported* institutions by 125 per cent and in *private institutions* by 79 per cent. These data indicate that the shortage of engineering teachers has been measured and that a deficiency will continue to be a national problem for years to come. In round numbers, the study indicates that at least one thousand additional engineering teachers will be required each year!

Where are all these new engineering teachers to come from? At present the best source is the graduate student in engineering, increasingly the Ph.D. But when one studies that supply he finds that for the years 1953 through 1957 the number of Ph.D.s granted in engineering remained at a plateau of about 600. By 1961 the number had increased to 942, a truly remarkable growth, but still a total wholly inadequate to meet the needs.

The competition for engineers with doctorate degrees is keen, and growing keener all the time. Industry, the federal government, and the armed services all compete with the colleges of engineering for their services. As a result, only about 35 per cent of those receiving the doctorate go into teaching. This means about 330—when 1,000 are needed!

You rightfully can ask why the number of Ph.D.s is used as the yardstick to measure the need for engineering teachers. The reason is that ever since the close of World War II engineering curricula have been placing greater emphasis on the basic sciences —mathematics, physics, and chemistry —and on the engineering sciences—mechanics of solids, mechanics of fluids, transfer and rate processes, thermodynamics, electrical sciences, and nature and properties of materials. The changes are still so rapid that some say a revolution is going on. In any case, though, to teach the more sophisticated course content of the 1960's requires a faculty which has studied sophisticated material. For the young man this means having earned a doctorate degree. Saying this does not depreciate the value of industrial experience to the college teacher, it merely establishes the direction of the first step in preparing for a teaching career.

The high salaries offered by industry at the time of receiving the B.S. degree make it difficult for the engineering student to decide to take graduate work; and even after he has advanced degrees the competition of the dollar is great. Teachers' salaries no-

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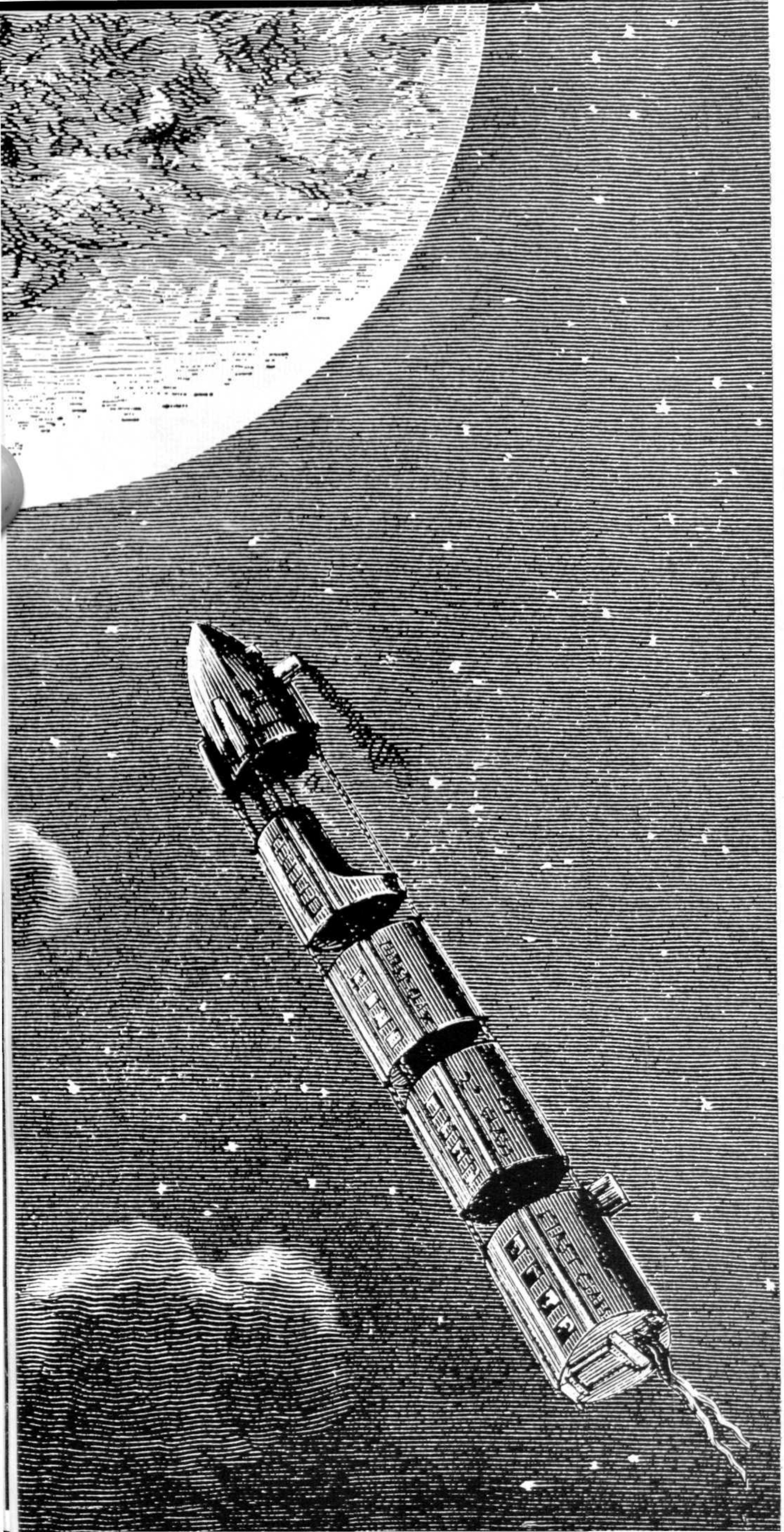

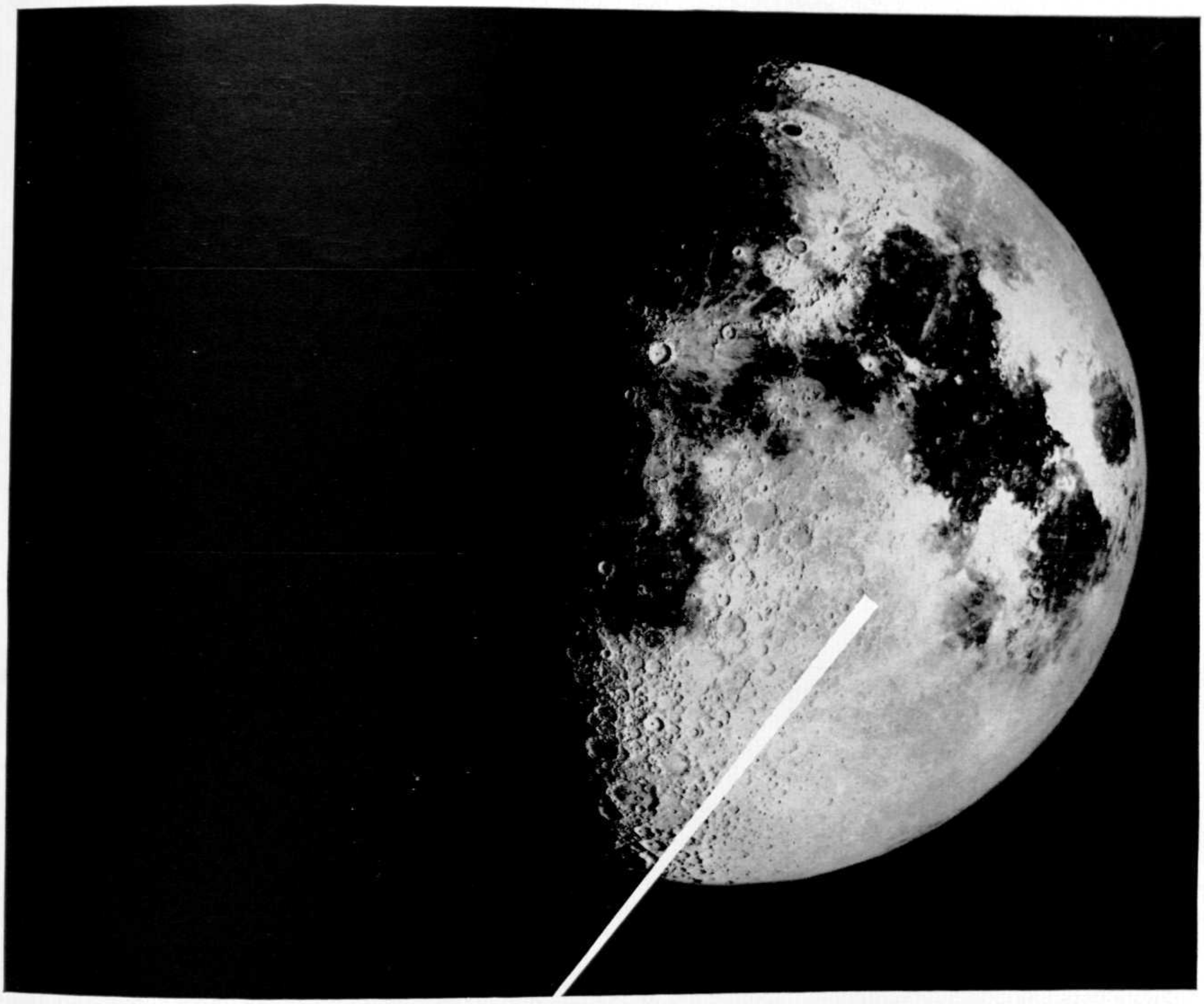

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RAYTHEON

AUTOMATED PRODUCTION OF DEPOSITED CARBON RESISTORS

Western Electric Company

Western Electric Company's new automated production line at the North Carolina Works is the first of its kind—a completely computer controlled process for making deposited carbon resistors. As far as we know, it's the first completely automated process to manufacture any discrete electronic component.

The line consists of eleven stations —all tied into control by a general purpose computer. Feedback of process data from three key points along the line permits rapid closed-loop operation. The process begins with the deposition of carbon on a tiny ceramic core. Then the cores goes successively through inspection, termination, capping, spiralling to value second inspection, molding of a protective case, marking, leak inspection, final inspection and packing—with the resistor untouched enroute by human hands.

Western Electric decided to develop the automated line when an early survey indicated a considerable increase in total resistor usage, with a definite trend toward the deposited carbon type, and a severe need for greater reliability in resistors—particularly for military usage.

How Western's development engineers met this challenge is best understood by following a resistor through the line step by step. First, however, it is necessary to know something about the real brains of the line—the computer control equipment.

CONTROL EQUIPMENT

The heart of the control equipment is a digital computer with a 4096 word magnetic drum memory. The engineers redesigned it extensively, adding the input and output circuits required for it to control the programming, setup and feedback control of individual machines. Basically, the computer performs in three areas:

1. It programs production control. A month's requirements can be fed into it at random. It completely schedules and programs the work . . . arranging it according to the four resistor power sizes and an almost infinite number of possible resistance values.

2. Using the methods of statistical quality control, it analyzes control data plotted at three critical points in the automated process and applies statistical tests to determine if a trend is developing.

3. It formulates the information to detect any drift away from the accepted manufacturing tolerances. No control action takes place while this analysis indicates normal statistical distribution around a desired nominal. But when a trend away from this condition develops, the computer uses stored data to calculate new setup information for the appropriate station.

In addition to feedback control functions, the computer provides initial setup of wattage size at eight machines and resistance value at six machines.

Time sharing of the input equipment and of portions of the output equipment helps to conserve apparatus in the computer system. The computer output is stored in transistorized registers—such setups at wattage size, gas flow and core speed requiring binary registers for each machine. Those machines requiring decimal setup—the helixing machine, the marking machine and the two inspection storage bridges—share a single binary coded decimal register.

The input unit is an analog-to-digital convertor. Although it is time shared between the individual input stations, the 140,000 bit-per-second speed at which it sweeps data into the computer precludes any delay in the computer operation.

COATING

The large batch coating method commonly used in industry proved unsuitable for the automated deposition of carbon film. Effective feedback control required a continuous unit-by-unit, feed-through process.

The tiny ceramic core is the nucleus of the resistor. It begins its long odyssey through the line at the coating machine where a control device regulates its speed through the three separate chambers of a horizontal furnace. A horizontal, three-roller support system rotates it enroute to assure uniformity of coating. It is safe from oxygen contamination, too. Inert nitrogen gas, continually flushed through the

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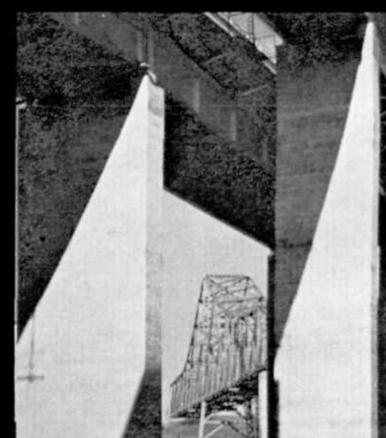

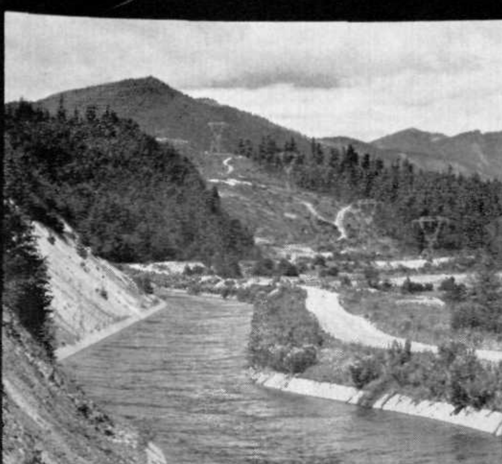

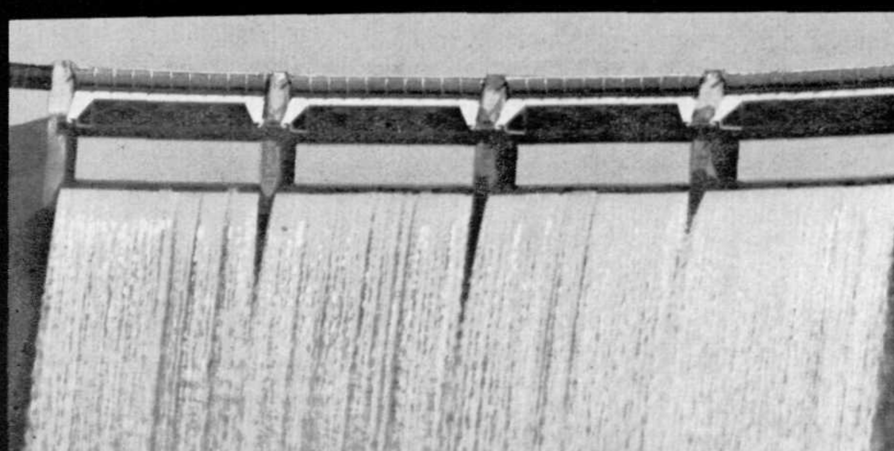

MISS ENGINEER

What's Her Name?

See Page 54

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Each NASA research center offers its own comprehensive plan to help advance your knowledge and speed the time when you can contribute at the peak of your capacity. The plans differ from center to center, but this summary is generally valid throughout the NASA complex:

NASA Installations Maintain University Ties

NASA centers have established close relationships with nearby universities. As a professional staff member, you may pursue graduate study either in the evening at NASA's expense or during regular working hours on full salary. And, if necessary to fulfill university requirements for a graduate degree, you may become a resident student, also on full salary.

NASA encourages advanced study in astronautics, physics, electronics, chemistry, metallurgy, mathematics, astronomy, and geophysics, as well as aeronautical, mechanical, electronic, electrical, nuclear, ceramic, and civil engineering, engineering mechanics, and engineering physics.

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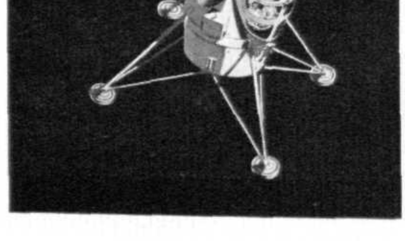

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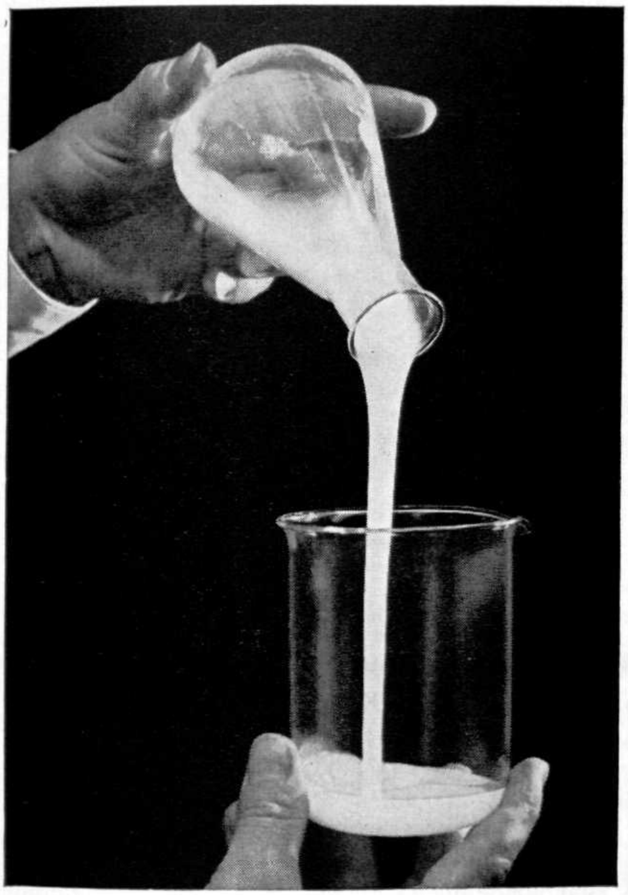

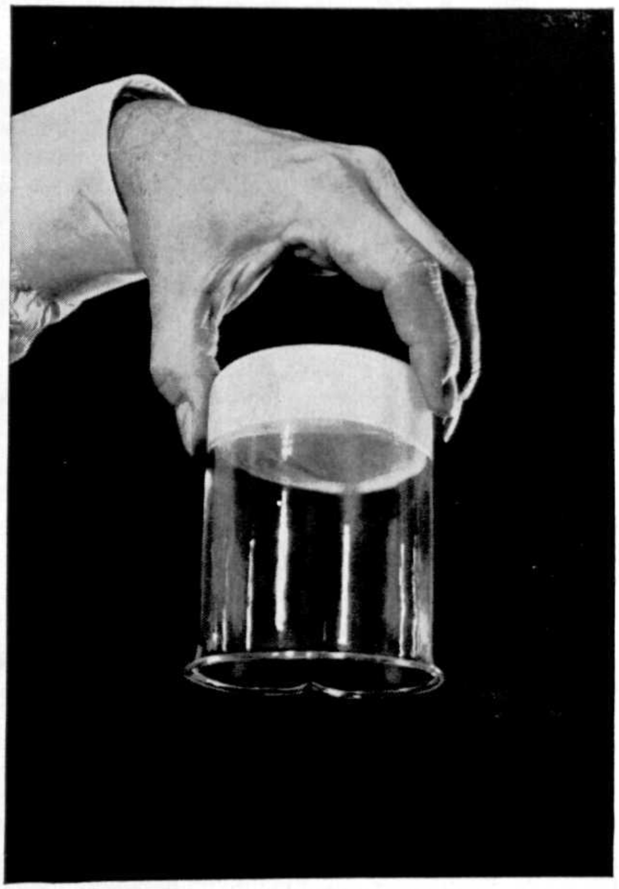

MSU NEWS NOTES

Edited by SHARYN SMITH

ENGINEERING ENROLLMENT UP

Engineering enrollment increased 15 per cent over last year, Dean John D. Ryder reported.

Ryder indicated that Michigan State has bucked the national trend which has seen reduced enrollments of engineering students at a rate of seven per cent.

He attributed the rise in MSU's enrollment to a high school selling program.

"We've been able to get over to the high school students the idea that MSU has changed its emphasis from applied to theoretical engineering. And we've laid stress on the fact that MSU's engineering curriculum leans to mathematics and fits into the rocket, missile and space fields."

Other factors which contributed to increased enrollments here, according to Ryder, include:

1. MSU's winning mathematics team which beat out such high powered schools as MIT and Cal Tech last year in the Putman competition.

2. The MSU honors college which allows students who have achieved top grade averages to proceed in their chosen field at their own rate of progress.

3. The emphasis on a broad engineering background rather than a specialized one.

NUCLEAR REACTOR AT LAGUNA OKAYED

Plans for a nuclear reactor at Laguna Beach, Mich., meet safety requirements, two prominent physicists announced recently.

Harvey Brooks, deputy chairman of the President's Science Advisory Committee joined Hans A. Bethe, a Cornell physicist who helped develop the world's first atomic bomb, in giving the endorsement.

They testified before a safety and licensing board of the Atomic Energy Commission in behalf of the Power Reactor Development Co. which sought to operate the Fermi reactor at Laguna Beach at a trial power of one megawatt.

If all goes well with the test, the company is expected to seek authority for operations at 200 megawatts.

PHYSICISTS FILM "NOTHING"

Michigan State University physicists have conquered the problem of filming a substance that has no heat, no friction, no color and doesn't even exist above minus 452 degrees Fahrenheit.

Liquid helium, the coldest known liquid, has properties so remarkably different from anything else that the physicists made a movie to demonstrate them to science classes across the country.

There's another point to the film.

The demonstrations are among the few in modern physics which can be seen directly: most others yield only readings on dials or scopes. They are being put on film because the equipment and techniques used with liquid helium are not adaptable to the classroom.

The physicists, Prof. Alfred Leitner and his assistant, Richard F. Au, are working under a grant from the National Science Foundation. The movie is being filmed and distributed by the MSU Audiovisual Center.

In one of the demonstrations, the "super leak," liquid helium suddenly flows through the bottom of a cup as if the cup has turned into a sieve.

The "catch" is that liquid helium has two phases, Helium I and Helium II.

When helium, normally a gas, is cooled below minus 452 degrees Fahrenheit, it changes to liquid Helium I. Cooled another four degrees, it becomes Helium II and acquires a whole new set of characteristics that earn it the name "superfluid." Most of this Helium II has no heat or friction.

In the "super leak" demonstration, Helium I is placed in a beaker with an unglazed ceramic bottom. The Helium I is cooled until it becomes superfluid. The superfluid flows through the bottom of the beaker by way of microscopic pores, each less than 1/25,000 inch in diameter.

In another demonstration, the superfluid is put into a test tube. A thin (only a few molecules thick) film creeps slowly up the inside of the tube, flows down the outside and drips off a point at the bottom of the tube. Because liquid helium is colorless, the flow is invisible; but the dripping can be seen.

The MSU film also shows the unique heat properties of liquid Helium II.

As liquid helium changes phases, its ability to conduct heat multiplies by the fantastic factor of one million. The superfluid conducts heat in waves, a unique property called second sound.

As it demonstrates the superfluid properties of liquid Helium II, the film also demonstrates principles of thermodynamics.

Dr. Leitner, who joined the MSU staff in 1951, is a specialist in major introductory lecture courses and in demonstrations in physics. He has published numerous articles, both in English and in German, on the mathematical aspects of physical problems.

— MSU

BRAIN AND COMPUTER COUSINS

As you read this sentence, what is happening to your brain?

What physical and chemical changes are taking place that enable you to grasp meaning from what you perceive?

Dr. Leory G. Augenstein, chairman of the Department of Biophysics at Michigan State University, is doing research based on a theory that men receive, store and use information in much the same way computers do.

The main difference, he believes, is that brain molecules replace transistors and other electronic gear.

These molecules, by changing their conformation in a sort of "flip-flop" fashion, enable humans to think in a series of rapid-fire, yes-no decisions, according to the MSU scientist's theory.

He estimates that they ordinarily make 20 to 25 such decisions (bits) per second but are capable of as many as 30.

"The theory is crude and it may be wrong," Dr. Augenstein comments, "but I think it offers a reasonable basis for conducting experiments that will lead to more exact knowledge."

A better understanding of the molecular basis for the thought processes, he believes, could revolutionize education and the treatment of mental illness.

It might even make it possible to bypass the senses and place knowledge directly in the brain, he contends.

Another staff member is working in a related area. Dr. Barnett Rosenberg, associate professor of biophysics is currently involved in research on the physical basis of vision.

Together, Dr. Augenstein and Dr. Rosenberg have received grants for their research from the Atomic Energy Commission and the National Institutes of Health adding up to about $250,000 per year.

"Dr. Rosenberg," explains Dr. Augenstein, "is interested in the physical mechanisms underlying the vision process, and I am interested in what happens to the information after it is received."

Several years ago, Dr. Augenstein was a member of a group at the University of Illinois doing research to help the Department of Defense make better use of men and computers in tracking aircraft flights.

In one experiment, the group found that subjects could identify and play musical notes at the rate of four or five per second when the notes were selected at random from a 32-note keyboard.

The researchers reasoned that the subjects mentally divided the 32 notes into groups of 16 each and classified the note to be identified as a member of one of them.

Narrowing the selection down to eight, then to four, then two and finally to one note by this halving process would require a total of five decisions. Since the subjects identified four or five per second, it appeared that they might have been performing at the rate of 20 to 25 bits per second.

While this might seem slow, Dr. Augenstein points out that at the rate of 25 bits per second, it would be theoretically possible to identify one of 33 million musical notes per second through this yes-no or binary process.

On the other hand, some computers, which operate on a binary process, handle up to a million bits per second.

Since his work with the Illinois group, Dr. Augenstein has been doing research on the shapes of biological molecules. Now he hopes to combine his knowledge of molecular structure with what he knows about perception and thinking.

Dr. Rosenberg has been primarily interested in investigating a new physical theory of how the receptors in the eye convert light into nerve signals.

In accounting for the observations they have made to date, MSU scientists theorize that:

The eye relays information to the brain in burst. Each burst lasts about 33 milliseconds (33/1,000ths of a second), relaying a large amount of information about the outside environment to the brain. Between successive bursts there is an interval of about 250 milliseconds. During this interval, the information is stored where it is temporarily available for processing by the brain's molecular "computer."

This accounts for an individual's ability to recall many things about something he views for only a small fraction of a second.

Dr. Augenstein wants to test the idea that large molecules in the brain process the temporarily stored information by changing the conformation —probably by "flipping" or "flopping" from one or two basic shapes.

To further the general research on the molecular basis for nerve and brain functions, Dr. Augenstein hopes to add the following senior biophysics staff members.

—A combination crystallographer and quantum chemist who can study mechanisms whereby information can be read out of the memory without destroying the memory.

—A planarian (flatworm) specialist who can study training and learning in lower animals.

—An electrophysiologist to study the relationship between electrical activity in the brain and behavior.

—A tissue culture specialist to study the synthesis of large molecules and the behavior of single cells.

— MSU

Digital Diction

(Continued from Page 22)

to account for every element of every language known and would thus be highly complex. Dr. Panov (Academy of Sciences, U.S.S.R.) has stuck resolutely by this approach from the beginning and has guided the Russian program along these lines rather successfully.

Until about 1959 the U.S. workers agreed that to translate from N languages into an interlanguage and then utilize an English synthesis program unnecessarily requires a greater number and more complex programs than to translate N languages directly into English. They also felt that the bilingual program research would help to develop an ideal MT interlanguage that could later be used in a more generalized translation program. However, in 1959 a program was begun at the Linguistic Research Center of the University of Texas under Dr. W. P. Lehmann which is designed to develop a multi-lingual system using a logical machine interlanguage.[10]

A generalized mathematical model (a series of increasingly complex algorithms) of the translation process is being formulated and programmed for the (CDC 1604, IBM 709) computer. A generalized linguistic format is used to allow inputting any desired language. The Texas program, however, still has a considerable distance to go before completion. In any case, research in both the bi-lingual and the multi-lingual directions continues to produce valuable material.

In all phases of MT research, the aim is of course to find invariant quantities (or universals) that relate the input quantities and can be stored in the computer. Until recently, MT methodology was essentially empirical and programs capable of producing readable translations were given top priority. Developing a theoretical basis for MT and improving grammatical schemes are beginning to receive increased support. Thus, the emphasis is now shifting from the production of quantity (the aim being one million translated words per day per machine) to that of quality. Finally, let us remember that the necessity of post-editing should not condemn the machine method, as there is no human translation facility today that does not employ some system of reviewing and polishing up the initial translations before delivery to the customer.

OUTLOOK

The future is promising for MT. Concentration will continue to be on the scientific languages which have fewer semantic variations than the literary forms. We can expect a greatly intensified effort directed at categorizing the intricacies of sentence structure with machine programming in mind—a new liguistic methodology will develop. The classical view that good translation is possible only when one acquires a "feeling" for the language must yield to a precise, concrete methodology of language translation.

Machine translation is a proven fact and machine translations are being used today on a large scale; only further refinements remain. Improved style and semantic sophistication will receive greater emphasis. The machines necessary for highly-refined translations exist today; linguistic advances and more elaborate programming methods must be found to complement the electronic machinery.

Although much remains to be done, the essential foundations of MT have been established. Profitably, the empirical point of view is yielding to more solid theoretic insights and the ideal translating machine will hopefully soon emerge.

CONFERENCES AND FINANCIAL SUPPORT

Co-ordination among the research centers is an important phase of any scientific research program. Conferences besides those already mentioned include the Russian meetings that have been held in Moscow since 1957 by the Soviet MT researchers, the 1960 Conference on Information Retrieval and Machine Translation held at Western Reserve University, the Twelfth Symposium on Applied Mathematics (devoted entirely to the structure of language and its mathematical aspects,[11] the 1961 International Conference on Machine Translation of Languages and Applied Language Analysts, and the yearly conferences at MIT. An Office of Documentation was established in the National Academy of Sciences of the U.S. and in 1958 the National Science Foundation provided (Public Law 85-864, section 901) for the establishment of a Science Information Service to ". . . arrange for the provision of indexing, abstracting translating, and other services leading to a more effective dissemination of scientific information . . ."[12] and to develop new systems capable of facilitating scientific information availability. The National Bureau of Standards was designated to execute the program. Also, the Linguistic Society of America and the American Philosophical Society are showing increased interest in MT. In June of 1962 a professional society called the Association for Machine Translation and Computational Linguists was formed with V. H. Yngve as its first president.

Organizations sponsoring MT research in the U.S. include the U.S. Army (Signal Corps), the U.S. Air Force (Office of Scientific Research, Air Research and Development Command, and the Rome Air Development Center), the U.S. Navy (Office of Naval Research), the National Science Foundation, the Rockefeller Foundation, the Carnegie Foundation, the American Mathematical Society, IBM, the Rand Development Corporation of Santa Monica, Systems Development Corporation, RCA, General Electric, Eastman Kodak, Documentation Inc., the Institute for Defense Analyses, and numerous universities and industrial concerns. The Nuffield Foundation in England and the Academy of Sciences in the U.S.S.R. have aided work abroad. Kent provides an extensive review of the literature as of 1960 (including investigator and institution, source and target languages, subject fields, lexical studies, grammatical, and syntactical studies, and the machine and the machine techniques used.[13]

THE MT RESEARCHER

What traits and abilities should the MT researcher possess?

Lindsay recommends a thorough grounding in logic and modern algebra with supporting work in descriptive linguistics, transformational grammars, mathematical linguistics, psycholinguistics, and semantics.[14]

(Continued on Page 46)

Digital Diction

(Continued from Page 44)

Yngve recommends as broad and basic an education as possible in science, mathematics, linguistics, engineering, and the general communication sciences.[15]

Excellent programs in which the prospective MT researcher would be interested include the MIT program under V. H. Yngve, the Harvard project under A. G. Oettinger, the Communication Sciences program at the University of Michigan under G. E. Peterson, and the new Information Processing program at the University of Texas under R. K. Lindsay. In England, the Cambridge program under Margaret Masterman Braithwaite and the London program under A. D. Booth are both quite active. The field has attracted talent from diverse disciplines.

It is revealing to note the areas from which some of the prominent researchers come: Yngve, Germanic languages; Oettinger, applied mathematics and physics; Panov, mathematics; Bar-Hillel, logic; Reifler, Chinese languages; Booth, computer engineering; and so forth.

These men have supplemented their backgrounds with further specialized training essential to MT work. This highly interdisciplinary approach is essential for we must "keep in mind that the problem of producing good translations will not be solved by tricks or computing speed, but will require answers to some of the most complex philosophical problems we know."[16]

CONCLUDING REMARKS

Yngve and others point out that the real value of MT research might be more in its contribution to the fundamental understanding of linguistic phenomena and information processing in general than in the machine translations produced. Perhaps deeper insights into the nature of human creativity and expression will result from such work.

The value of MT research in literary analysis was proved when Father Roberto Busa reconstituted missing words in the *Dead Sea Scrolls* manuscripts using machine methods.[17]

Studies of vocabulary and of language evolution and classification, analysis of meaning, the release of creative human talent from the drudgery of routine translation, reduction in the translation time lag and resulting increases in the efficiency of scientific research, increased reliability once the MT programs are perfected, vastly increased translation speeds (potentially 20,000 to 200,000 words per hour versus 300 words per hour maximum of the human translator), and the increased cross-fertilization of scientific disciplines are all significant by-products of MT research. Delavenay asserts that translating machines will soon become indispensable items in the intellectual equipment of nations and will greatly facilitate the exchange of knowledge and the spread of enlightenment throughout the world.

Having perfected the written language translating machine, scientists will concentrate on developing voice inputs and outputs (Bell Labs is working on such devices now). It is reasonable to assume that the translating machines some day will become integral elements in the global satellite communication system being developed today. At that time we will truly be sitting on our neighbor's doorstep; and hopefully such intermingling of minds, cultures, and ideologies will facilitate the realization of greater international sensitivity, mutual understanding, co-operation, and greater world harmony.

And for those who view the future of MT with excessive skepticism, let us remind them of the philosophy of Dr. Robert Goddard, the "Father of the Modern Rocket," who believed that "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow"[18].

FOOTNOTES

Note: a simplified notation is used here. Thus 4: 25, p. 96 means that footnote 4 refers to article 25 in the Bibliography (following) and page 96 of that article.

1. 26 (in the speech)
2. 10 (refers to article as a whole)
3. 9, p. 16
4. 8, p. 91
5. 23, p. 32
6. 22, p. 17-29 (refers to article as a whole)
7. 28, p. 71
8. 28 (refers to article as a whole)
9. 8, p. 76
10. 17 (refers to the project, described in these reports)
11. 12 (this is the report of the proceedings)
12. 13, p. 7
13. 13, p. 140-224
14. 15, p. 1
15. 29
16. 15, p. 1
17. 8, p. 13
18. 27, p. 4 (quote taken from here)

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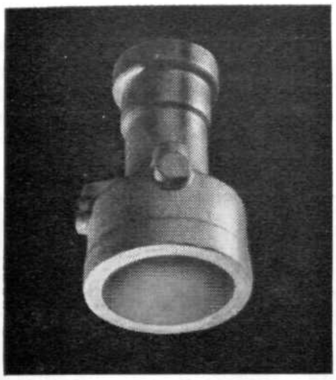

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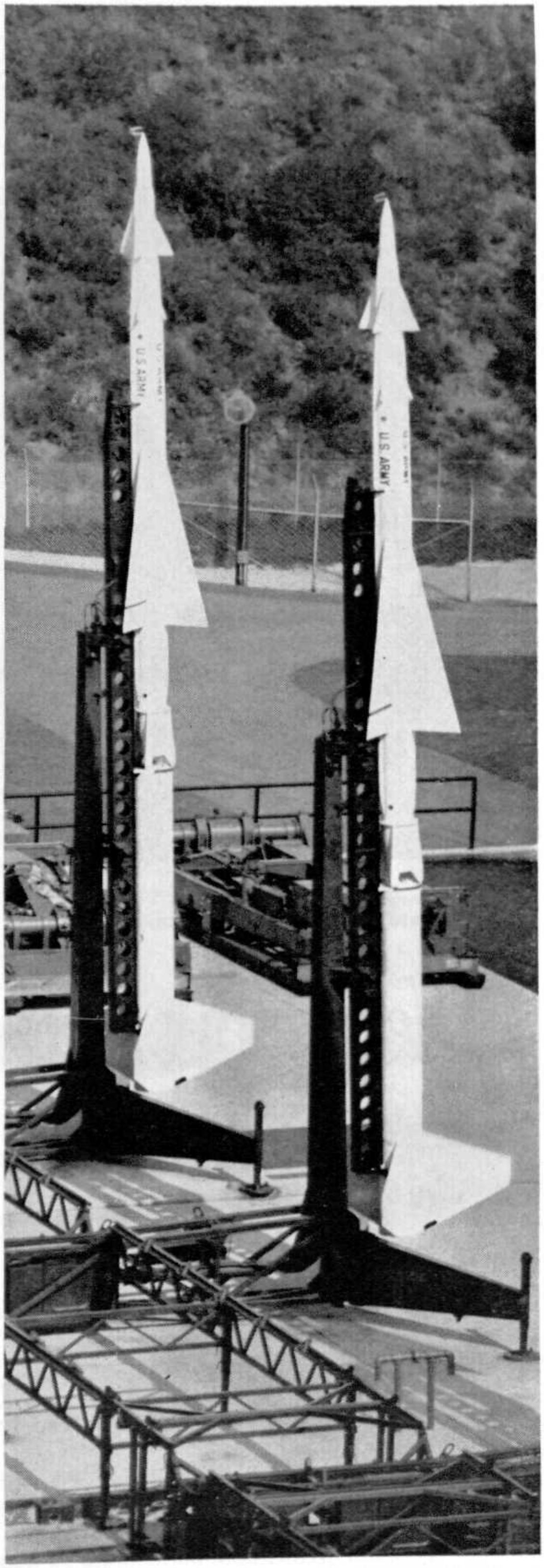

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EXPEDITION TO MARS

Like Columbus's venture to the New World, America's first expedition to Mars might be a convoy rather than a single ship.

Freeman D'Vincent, who is in charge of design of manned space systems at General Dynamics/Astronautics, is making plans for two crew ships and two service ships to make the initial flight, hopefully in the early 1970s.

The crew vehicles would carry four to eight men and the instrument-controlled service vehicles would carry small spacecraft and scientific instruments for landing on and studying Mars.

"Among other advantages, this convoy arrangement would provide greater security for crew members," D'Vincent explained in a Mechanical Engineering seminar at M.S.U.

"If something went wrong with one of the crew ships," he pointed out, "the entire section housing the crew could be removed and substituted for the corresponding section on one of the service ships."

Small craft for making repairs and shuttling men between ships would be taken along, he noted.

In addition to reaching Mars, the larger ships would also make a complete orbit of the sun, the MSU lecturer said.

The ships would leave the orbit the earth makes around the sun and intercept Mars in its orbit 110 days later. After about 50 days in the vicinity of Mars, they would continue around the sun, intercepting earth in its orbit 230 days later. A little more than a year would have gone by and the earth would be slightly past the point it was at the time of departure.

D'Vincent said the four vehicles would be assembled at space stations orbiting the earth. Each ship would be about 350 feet long and weigh roughly 2 million pounds.

He said he would like to have the ships put into orbit in two sections each. This would require boosters capable of 30 million pounds of thrust, much larger than any now under active development.

After assembly the ships would be shot into space by chemical boosters capable of 500,000 to 750,000 pounds thrust. Then, the crew ships would tumble "head over heels" toward Mars.

The tumbling motion would create a gravitational field, giving the men a sense of "up and down" and eliminating problems that might be caused by living without gravity for a prolonged period. The service ships would not tumble.

Crew members would be protected from radiation by a shield of liquid hydrogen about 10 feet thick.

The space ships would also be equipped with nuclear reactor engines which would achieve propulsion by heating and expelling hydrogen.

These engines would be used to correct the course, if necessary, to orbit the ship around Mars, and to supply power for the return flight.

After going into orbit around Mars, instruments would be landed to send back information about the atmosphere, temperature and other factors. If the surface is not too inhospitable, members of the crew could land with small craft carried by the service vehicles.

"It would be a crime to go so far and not to land if it were at all possible," D'Vincent commented.

The General Dynamics designer pointed out many problems of interplanetary travel. Among them, he said, are building a suitable reactor and developing a life cycle process which would eliminate the need to carry along a year's supply of food for eight men.

Time is also short, he noted. In order to launch an expedition by 1972, he said, the ships should be assembled and ready for testing by 1970.

AMERICAN SPEEDOMETERS GRADED IN KILOMETERS

American car speedometers ought to be graded in kilometers as well as miles as a start in changing over to the metric system in the United States.

Dr. Chauncey D. Leake, a distinguished scientist reports that such rhymes as "Jack and Jill" owe their origin to lack of sound standards for measures, advocated the change.

"The English-speaking peoples," he said in a lecture at Michigan State University, "are causing themselves unnecessary inconvenience, as their horizons expand and their trade becomes more sophisticated, in clinging to the ancient system of measurements."

Science is an example of the benefits that come from having universal agreement on standards, noted the professor of pharmacology from the University of California Medical School at San Francisco.

"Scientists everywhere use the metric system," he explained. "What a scientist measures in one country can be verified by a scientist in another country. This is what makes the system so powerful."

He noted that standards vary from the United States to Canada and England. The British gallon is bigger than the American gallon and the British inch is slightly shorter than the American inch. The difference in the inch, he added, causes difficulties where small, precise measurements are important, such as in tooling up for Space Age technology.

Starting with the Egyptians in about 4,000 B.C., said the former president of the American Association for the Advancement of Science, men have been using their bodies as standards for measurement.

Thus the Biblical "cubit" was the distance from finger tips to elbow and the English yard was the length of the arm or roughly three feet.

Although measurements were frequently standardized on the proportions of royalty, there were many

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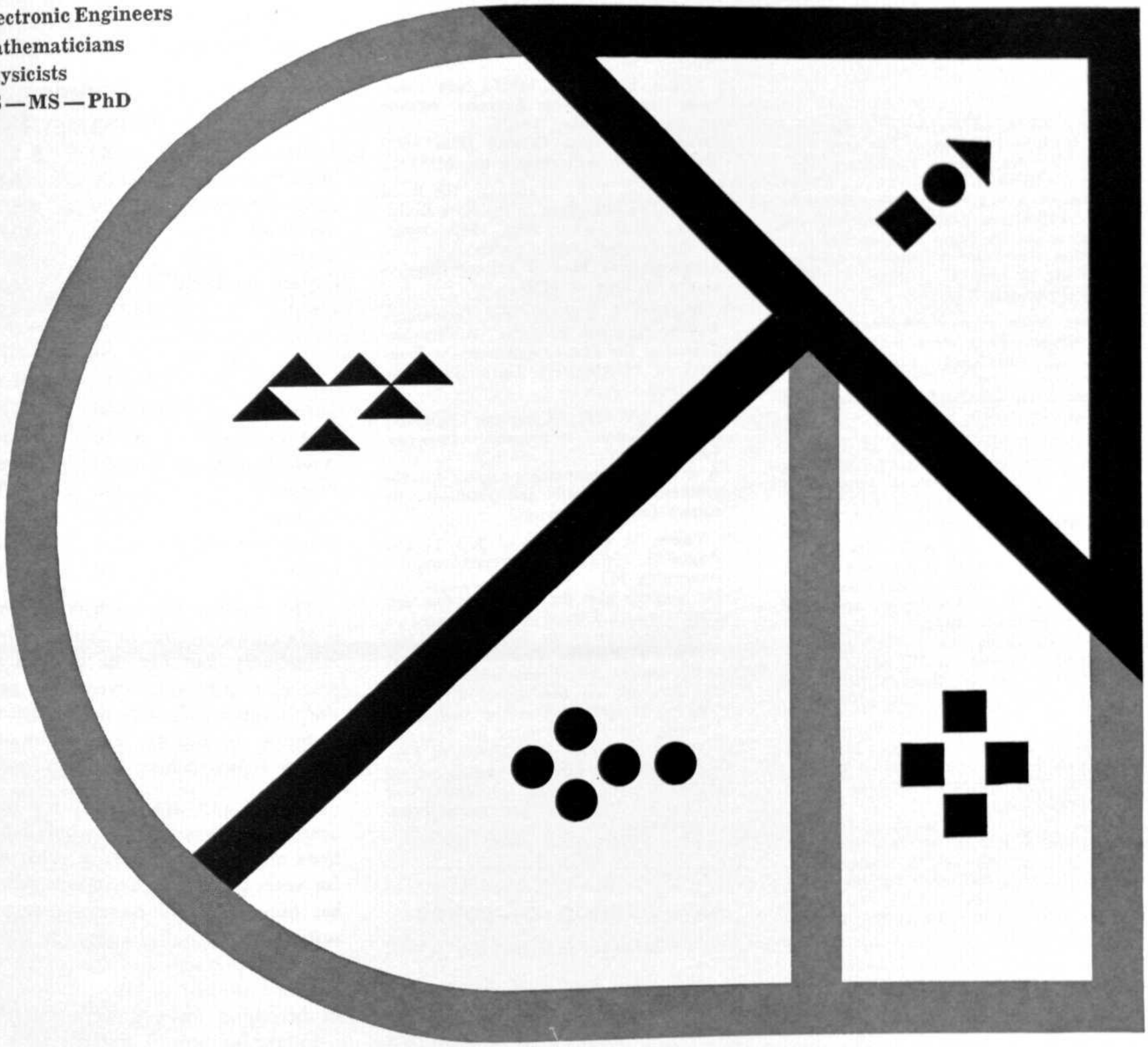
Electronic Engineers
Mathematicians
Physicists
BS — MS — PhD



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Engineering Education

(Continued from Page 29)

toriously have been low, but for engineering teachers there has been rapid improvement during the past few years, as indicated by the reports of the Engineers Joint Council and the American Society for Engineering Education published in 1956, 1958, and 1960. Between 1956 and 1958, the basic teaching salaries of engineering educators increased thirteen and one half per cent; between 1958 and 1960, the increase was 13.4 per cent. The current study is expected to show still another increase. More significant, however, is the total professional income of engineering teachers, for most engineering teachers supplement their salary by income from summer work in industry, teaching summer school, year-round consulting work, etc. The average professional income of engineering teachers in the United States in 1956 was $8,862, this increased to $9,598, in 1958 and to $11,013 in 1960, or a total of almost 25 per cent in four years. Data, by rank, from the EJC-ASEE report for 1960 are tabulated below.

Median and Mean Salaries and Income, by Rank, 1960

Salaries

Rank	Median	Mean
Instructor	$ 5,380	$ 5,392
Asst. Professor	6,800	6,869
Assoc. Professor	8,200	8,299
Professor	10,500	10,836
Lecturer	6,100	6,755
Department Head	11,700	11,891
Dean	13,500	14,210

Income

Rank	Median	Mean
Instructor	$ 6,500	$ 6,633
Asst. Professor	8,500	8,828
Assoc. Professor	10,250	10,815
Professor	13,200	14,373
Lecturer	7,500	8,531
Department Head	13,700	14,643
Dean	15,420	16,312

The median for teachers' earnings is always below the median for those in industry, but for the top ten per cent it is only after twenty-five years since receiving the B.S. degree that the earnings in industry are significantly greater than teachers' earnings.

In summary, the market for engineering teachers is good, and indications are that it will remain that way for years to come. The income picture has improved, and there is reason to suspect that it will continue to do so. The real problem lies in getting the qualified student to take the first step in becoming an engineering teacher —to take on-campus graduate work on receiving the B.S. degree instead of accepting an immediately lucrative offer in industry. Once the student is taking graduate work, he can and probably will, become interested in teaching by virtue of part-time employment, encouragement, cajoling, or perhaps even by a swift kick in the pants. Then, once the satisfaction of teaching is experienced, the probability of selecting engineering teaching as a career becomes real. It should be clearly understood, though, that taking graduate work does not close the door to industry; the opportunities for employment in industry for the holders of M.S. and Ph.D. degrees are great, for industry, too, has a growing need for more and more engineers with an education going beyond the B.S. degree.

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1. *Trends in the Employment and Training of Scientists and Engineers.* National Science Foundation, Washington: May 1956.

Automated Carbon

(Continued from Page 36)

deposition area of each chamber, forms a pressure seal against end-baffles. In the heating areas of each chamber, a temperature of over 2000 degrees F. decomposes methane gas to form crystalline carbon on the core. The core is then cooled to room temperature and sent to an inspection station.

Three parameters govern the resistance coating value: the speed of the core through the coating zone, the pyrolysis temperature and the flow of methane gas. The computer controls these parameters through a feedback loop around the furnace. It computes the control information from statistical quality control data stored on the memory drum. Solenoid actuated degital flow valves provide the computer with the precise binary unit response needed to control the gas flow in the coating zone.

FIRST INSPECTION

The first inspection station forms a feedback loop from the coating furnace through the computer. Here, the coated core goes between four probes using the Kelvin bridge principle. Analog voltage proportional to resistance is digitized and fed to the computer memory drums where it is stored and sampled on an SQC basis against that of the programmed requirements also stored on the drum. The results from this inspection form the basis for feedback control of the furnace. A graph at this station records the test for visual monitoring.

This station also inserts magnetic slugs as instructed by the computer to separate individual lots of resistors when changes of resistance value or of resistor size are called for.

Terminating

The carbon coated core next goes to a terminating machine which sputters a gold contact over each end. Rotary indexing vacuum chambers are the work horses of this machine. A few of the 36 stations are used to load and unload parts. The others are used for pump-down and back-filling of argon gas and for the sputtering, as the vacuum chambers advance on their circular track.

The core first goes to a pick-up station to be fitted with a mask, which holds and protects the center of the core. (Since there are four different sizes of resistors, the computer programs proper mask sizes.) The mask is loaded on a vacuum station and covered with a bell jar, which is pumped to a vacuum and then backfilled with argon gas at low pressure. Then the ends of the core protruding from the mask are sputtered with particles from a gold cathode. The sputtering lasts for almost a minute, depositing a layer of gold approximately ten millionths of an inch thick. The gold deposits uniformly because two rollers, actuated by an external magnet, rotate the core inside the mask for maximum exposure.

CAPPING

Our ceramic core is now a resistor. Attach a wire lead to each end and wire it into a circuit, and it will resist the flow of electricity. The capping machine attaches these leads.

The wire leads are first attached to tiny hexagonal caps of gold-plated brass. This is done by an automatic percussion welding machine outside the line. The cap-lead assemblies are then inserted into the capping machine which feeds them into capping chucks. The resistor core, coming from the terminating machine, is loaded onto a turret which holds it in position while the capping chucks simultaneously press the cap-lead assemblies over both ends. (The machine operates on a demand basis so that the arrival of a carbon-coated core automatically triggers a capping operation.) The capping force is sufficient to weld the gold plating of the cap to the gold on the ends of the core. It also creates a highly reliable, low-noise contact.

The capping machine uses two different capping assembly heads and three different sizes of caps to take care of the four resistor wattage sizes. The computer controls both the switching of the assembly heads and the changing of the cap sizes.

HELIXING

This is where our resistor obtains a precise value.

The helixing machine cuts a spiralled groove along the carbon film of the core to obtain the desired resistance. A computer-controlled bridge monitors the cutting, which is done by rotating the properly chucked resistor against a diamond-impregnated wheel. The bridge's control servos balance when the desired resistance is reached,

(Continued on Page 58)

Facilities for Flight to Moon Now Underway at Cape Canaveral

New moon flight facilities for Cape Canaveral, shown in artist's rendering on our cover, are now being designed by a combine of four New York City architectural and engineering firms known as Urbahn-Roberts-Seelye-Moran—with Max O. Urbahn as the managing partner.

The 360-foot tall space vehicles, destined to take American astronauts to the moon, will be erected, mated and checked out in the immense assembly building and then transported three miles to the launch pad.

Measuring approximately 524 feet high, 674 feet wide, and 513 feet long, the huge structure will enclose the greatest volume of any known building, 130,000,000 cubic feet. Its 45-story doors will set another new record.

The vehicle will be checked out from the Launch Control Center (right), a separate four-story structure which will also house the control facilities for the launching operations.

The project is under the supervision of the Jacksonville District of the U.S. Army Corps of Engineers, which is handling the development of the facilities for the National Aeronautics and Space Administration.

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AN ENGINEER'S RESPONSIBILITY TO SOCIETY

G. E. Reistle, Jr.
President of Humble Oil and Refining

A call to professional engineers to "develop a more profound social consciousness" and take a more active interest in public affairs was sounded by C. E. Reistle, Jr., president of Humble Oil & Refining Company.

He spoke before the winter meeting of the National Society of Professional Engineers in San Antonio.

"I believe that engineers as a group," said Mr. Reistle, "have no more than a hazy awareness that their engineering skills provide them with singular opportunities and clothe them with unusual responsibilities toward society."

He cited instances where engineering skills could be used to great advantage, but have been largely abdicated to others.

Engineers, he said, appear to have failed to work effectively with politically oriented groups so as to integrate their technical work into the solution of problems that are basically questions of public policy.

"If engineering skills are to make their fullest contribution to human welfare," he said, "engineers must raise their sights from their slide rules and consider the relation their work has to the broad stream of human activity. There must be a blending of technologically and socially directed activities."

The Humble president cited four areas where "engineers and engineering societies have unique responsibilities, capabilities, and opportunities to serve."

They are:

(1) Those activities of business and government wherein the engineering application of science creates public problems that would not otherwise exist. An example: the severe occupational hazards which accompanied early industrialization and were aggravated by entrepreneurial indifference.

(2) Those problems involving the public welfare wherein the engineering application of science can contribute materially to the solution. He mentioned urban renewal and city planning as being in this category.

(3) The relation of engineers to government—the assurance that full value is received for public money allocated to implement the projects and objectives designated by proper authority.

(4) The obligation of engineers to be sure that colleges and universities graduate an adequate number of technically qualified engineers who are cognizant of their obligation to society.

There are many engineers who have rendered outstanding public service, Mr. Reistle said, but he asked why engineers "have not been in the forefront of constructive thought or effective leadership more often in regard to the broader sphere of human activity." He noted that only five members of Congress, two senators and three representatives, or less than one per cent, have an engineering background.

As to why engineers do not take a more active interest in public affairs, Mr. Reistle felt there are three contributing factors:

(1) Neither training nor experience has led engineers to consider that they have any peculiar responsibility for the problems of society.

(2) When engineering activities impinge on the public welfare, problems may develop complications in other areas such as politics, economics, law, labor relations, and the psychology of human wants. These problems are no longer subject to the application of strict logic and development of unique solutions. Many engineers lack interest in resolving human differences.

(3) The environment in which engineers work. Unless they have transferred to executive jobs, they are usually in staff positions where they seldom have the ultimate power of decision and are not the motivating force governing the decisions.

Those who employ engineers, said Mr. Reistle, must share the blame for any failure to direct engineering effort into channels "that will lessen the evils and enhance the benefits of technological change."

MSU News Notes

(Continued from Page 50)

abuses. Traders bought on the basis of long measurers and sold on the basis of short measures, Dr. Leake related.

In England during the seventeenth century, the MSU lecturer continued, a "jack" (jackpot) was two handfuls and a "jill" (gill) was two jacks or a half a cup.

Charles I made the standard for the jack smaller in order to obtain more money from food taxes. The people in resentment made up such rhymes as "Jack and Jill" (the crown is still a unit of British money) and the one about the crooked man who ran a crooked mile.

The need for better standards led Napoleon to establish the metric system soon after the French revolution, Dr. Leake observed.

Although the newly formed United States had gone from the English to a decimal currency system, Dr. Leake notes, no serious attempt was made to adopt the metric system.

Dr. Leake also points out that during the 19th century standards varied enough from country to country to make it profitable for a trader to know which way to buy long and sell short.

"It might be ungracious," he adds, "to suggest that British traders have generally opposed any uniform worldwide standardization measures because it would tend to reduce their profits in skillful trading.

"Nevertheless it is to be remembered that the British were among the most successful traders of all people during the 19th century."

MSU GROWTH IN SCIENCE

Growth of science at Michigan State University was apparent in Friday's (Jan. 25) meeting of the MSU Board of Trustees.

In separate actions the Trustees:

—Let contracts for construction of a $6,000,000 chemistry building.

—Accepted a $2,000,000 grant from the National Institutes of Health to support construction of biochemistry and veterinary medicine buildings.

—Accepted a grant of $96,523 from the NIH for research in the new biophysics department.

—Accepted about 40 other research grants totaling nearly $500,000 and covering many subjects from cholesterol to computers.

The chemistry building is being built with state funds. The legislature appropriated $750,000 last year and has authorized the remaining $5,250,000. When completed in 1964, it will be among the most modern, best-equipped chemistry research and teaching buildings in the nation.

Plans for the biochemistry building are nearly complete and may be sent out for bids next month. The building also has the support of a $1,213,000 grant accepted in November from the NSF. It will cost $5.2 million.

The veterinary medicine building will cost $3.5 million. Plans are not complete but University officials hope to let a contract for it by late spring.

The biophysics grant will be used under the direction of the department chairman, Dr. Leroy G. Augenstein, for research on the molecular basis for thought processes. Biophysics was introduced as a formal program at MSU in October 1961 and became a department in October 1962. Dr. Augenstein and Dr. Barnett Rosenberg, associate professor of biophysics, also hold other grants from the NIH and the Atomic Energy Commission. Their total grants now add up to about $250,000 per year.

Among the other grants were $70,000 from the NSF for research by Drs. Norman E. Good and Seikichi Izawa of botany. They will investigate some of the intricate chemistry involved in the initial stage of photosynthesis, the process by which plants convert sunlight into chemical energy.

While most of the financial support came from government sources, there were also several grants from industry.

These included $26,867 from International Business Machines Corp. (IBM) for work on a computer program for analysis of electrical networks. Dr. Richard J. Reid of electrical engineering is in charge of the project.

MSU ENGINEERING FACULTY

Michigan State University's capabilities in space engineering were substantially strengthened by four recent additions to the mechanical engineering faculty.

"The new members of our staff," reported Dr. Charles R. St. Clair, Jr., mechanical engineering chairman, "have been right in the thick of space research."

The men are experts in such areas as fluid dynamics, heat transfer, thermodynamics and applied mathematics.

"While these subjects are vital to space research, they also have a wide range of applications," Dr. St. Clair pointed out. "They can be applied to a car engine as well as to a space vehicle.

"Space research, however, has rapidly extended our knowledge in these fields. The fundamentals still apply but now we have fantastically higher speeds and greater temperatures. The material we present to our students has to be extended accordingly."

Dr. St. Clair also noted that the new arrivals will be doing important research at MSU. The new members of the mechanical engineering faculty are:

—Dr. Harold G. Elrod, professor, an expert on fluid dynamics and heat transfer. Previously he was a professor of engineering science at Columbia University. He has also been a consultant for several companies engaged in space research. (See pg. 14)

—Dr. Matthew A. Medick, professor, and former senior staff scientist for Avco Corp. His specialties are continuum mechanics, vibrations, and visco-elasticity with an emphasis on the application of mathematics.

—James V. Beck, instructor, also a former senior staff scientist at Avco. He is noted for his work on analytical solutions to heat transfer problems. He will continue doctoral degree studies at MSU.

—Dr. Shankar Lal, a visiting professor from India where he was professor and head of mechanical engineering at Thapar Institute of Engineering and Technology. He has also been a visiting professor at Auburn University. His fields are thermodynamics, gas dynamics and heat transfer.

Dr. St. Clair, himself, is also a space specialist. He was associate manager of the physics research department at Avco. His work has been on heat transfer. He was involved in nose cone research for the Minuteman and Titan missiles.

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Meet the Author

An earlier version of this paper was written during the summer of 1962 as partial fulfillment of the requirements for GCA 499, a readings course directed by Dr. Malcom MacLean, Acting Director of the Communication Research Center. In the early days of the fall quarter, I began to contact several professors in various departments who I thought might have some interests in the *area of information processing,* specifically in my interest area of mechanical translation. Dr. Wrigley of the Bureau of Political and Social Research was especially interested in seeing an exploratory group formed to investigate such questions and he encouraged me to take the initiative to organize such a group.

Consequently, I revised the paper on mechanical translation and Dr. MacLean had about 40 copies of it mimeographed. Personal contacts and phone calls during the next few weeks provided me with a nucleus of interested persons to whom I mailed the paper and the letter and questionnaire. This original group numbered 18. Returned questionnaires indicated a great deal more enthusiasm than I had expected would result. Also, the mailing list grew to about 35. The second letter will be sent soon and shortly thereafter the first meeting will be scheduled. The format of this first exploratory meeting will be largely spontaneous. Two or three short presentations (perhaps papers) will be included to stimulate discussion. The purpose is to define the breadth of interests of the participants, develop an organizational structure for the group, define our goals and purposes, and formulate some initial research objectives.

I am hopeful that the organization will come to serve as a guiding body for the collection and dissemination of research proposals and results of papers pertinent to our interests written by MSU (and other) personnel. I visualize a general administrative structure (chairman, secretary), task groups organized according to special interests (mechanical translation, machine literary analysis, machine linguistic analysis, computer simulation techniques, information synthesis by machine, artificial intelligence, etc.), and a goals committee to define our purpose and potential as a group and to investigate the possibility of securing grants from various foundations to support our research projects.

I am hopeful that one of the members of the group will assume the responsibility of organizing an interdisciplinary graduate seminar relative to our interests. Finally, a series of monthly meetings should be scheduled. I am sure that a program committee for the group will be able to secure leaders in these fields as speakers at our meetings. Our research reports and discussion will occupy the remaining program format.

The above describes my purposes. I should mention that at our first meeting I intend to relinquish the secretarial duties of the group to the duly elected or appointed person. I am inadequately prepared to be a part of the permanent organizational structure of such a scholarly group.

I wish only to get the group organized and functioning in an area that I consider vital.

My present research interests involve me in the flow-charting and programming of a computer routine to automatize the phonemic and morphemic analysis of a corpus of words derived from several languages. I am employed by the Department of Communication as a graduate research assistant. My duties include 20 hours per week of data processing and computer programming for the department. My academic studies are centered in the field of linguistics, communication theory, and the psychology of language. I plan to obtain a doctorate in computational linguistics from Harvard, MIT, U. of Texas, or U. of California.

From Phend

(Continued from Page 12)

enterprise; that team action is stifling scientific invention; that what we need is more people schooled in the tenets of rugged individualism.

It is my belief that those who are drawing this dismal picture of modern life are guilty of oversimplification. They are trying to make black and white distinctions where, in fact, there are none to be made. They overlook the many conditions of our day that make teamwork and common effort necessary.

Big and complex operations in business, research, government and international affairs require the effective combination and utilization of many skills and abilities. In a world of constantly expanding knowledge, no man can be an island unto himself—unless it is an extremely small and perhaps insignificant island. We can expect that the vast enterprises and growing challenges of the future will demand, more than ever, a pooling of talents, a meeting of minds and a concert of opinion.

Certainly the contemporary world needs men who know how to make creative contacts with other men, who know how to motivate and lead others, who know how to coordinate and cooperate, even in committees! But isn't it possible that what we need most is individuals who can remain stable in an exceedingly unstable world, who have the spiritual rudders to maintain their course in the rough seas of the turbulent twentieth century? Isn't it possible we need individuals who have moral conviction, lofty ideals and personal pride and confidence—men and women who have individual integrity and who always retain that integrity in dealing with others?

With the above in mind, the engineer and the scientist of tomorrow will be able to evaluate change in terms of progress, and this will help prepare them to accept new discoveries without discarding the valid experiences of the past.

SIDETRACKED

Two men were sitting in a bar. "Albert," asked one, "After you drink a lot, does your tongue burn?"

"I don't know, Sam," replied the other. "I've never been drunk enough to light it."

A liberal arts graduate on his first job was handed a broom to sweep the floors for his first duty.

Grad: But, I'm a college graduate.

Employer: Oh, in that case I'll show you how.

Automated Carbon

(Continued from Page 54)

disengaging the bridge lathe. During cutting, the bridge also senses any nonlinearity indicative of chipping or thin spots in the coating; such cores are automatically rejected. The control circuits also reject any resistor that reaches value before 75% of its length is used, or fails to reach value in its full available length.

The helixing, or spiralling, is done "dry" and continues until final resistor value is reached—an achievement which eliminates the hand-rubbing final adjustment method previously used. The helix lathe bridge is slightly biased to compensate for machine inertia and for resistance change caused by the heat generated in grinding. This data is programmed and stored in the computer memory drum. The computer also ties into a servo that controls the speed and pitch used for proper spiralling. The three-second spiralling speed, a fraction of that commonly used elsewhere, was accomplished by carefully balancing the rotating mechanism and using a magnetic counter-weight to hold the movable chuck assemblies against the diamond cutting wheel.

SECOND INSPECTION

The feedback control and self-correction of the helix lathe bridge is based on a statistical quality control analysis of values inspected at the second inspection station. A wheatstone bridge, set to the desired nominal resistance value of each resistor lot by the computer, precisely measures the resistance of our resistor. Off-balance voltage is digitized and fed back to the computer, which then computes the desired correction and corrects the helixing machine setting. Defective resistors are automatically rejected. Visual monitoring of values is also provided at this station.

ENCAPSULATING

The resistor next feeds into an encapsulating machine. Here, a precured epoxy shell is fitted over the core, and two partially cured epoxy pellets are inserted over each lead. Held between resilient rubber chucks, the resistor moves through an oven for approximately 15 minutes in a curing temperature of over 300 degrees F. (The resilient chucks prevent escaping trapped air from causing leaks in the finished resistor.) The shell, fully cured, does not melt, and rests on the gold caps of the resistor, retaining an air space along the resistor body to prevent organic contamination of the carbon film. The partially cured pellets on the leads do soften, forming an effective seal with the shell. The resistors then pass through cooling water jets which terminate the cure of the epoxy pellets.

Detection circuits within the machine reject any resistors with missing shells or missing pellets.

LEAK DETECTION

Moving along a conveyor from the oven, the resistor is picked up by the holding clip of a leak inspection turret. The holding clip immerses it in a hot water bath containing a wetting agent to prevent surface bubbles from clinging to the resistor body. The heat expands the air inside the capsule, and a series of ten photoelectric cells watch for air bubbles which would indicate a leak.

A special memory device rejects improperly sealed resistors as they leave the tank. The heart of this device is a mechanical memory tab associated with each resistor holding clip. The tab retains the identity of any individual resistor rejected at any one of the leak detectors. The machine can detect leaks as small as 2×10^{-6} cc per second.

MARKING

A computer-controlled marking machine now stamps on the wattage, resistance value, production lot number and date on the encapsulated resistor.

The machine used a modified offset printing technique. Conventional offset printing requires a small type head which reciprocates during the inking cycle of the blanket roll. In this machine, however, the necessity for response to computer control dictated the use of a rather bulky typehead. Therefore, it was decided to mount the blanket roll and inking rolls on a planetary gear arrangement. This permits the type head to remain stationary, and permits the addition of servo drives to make automatic type changing feasible.

Servo drives controlled by the computer can set any one of forty-five different code numbers with over a million and a half permutations of code and resistance value combinations. The automatic controls also provide blanket roll cleaning between code changes and during idle periods which might otherwise cause the ink impressions to dry on the blanket roll.

THIRD INSPECTION STATION

The final inspection station—a feedback control point—resets the preceding inspection station to compensate for shifts in resistance value caused by the heat of encapsulation.

PACKING

Next, our resistor moves onto a packing platform where it is pushed into a bank between two loading jaws. When the banks fills, an anvil pushes the prepositioned resistors into a styrofoam block. The block goes down a hopper into a loaded magazine.

This machine is also controlled by the computer, which actuates servos to control the platten and anvil stroke settings for each of the four resistor sizes.

And now, our completed resistor, which began its odyssey as a tiny ceramic core, is ready to begin the most important phase of its life cycle—reliable service in an electronic circuit.

CONVEYORS

Between the first four stations of the automated line, the resistor core is transported by being blown through a plastic tube with gentle air pressure. From the capping machine through the succeeding operations, the resistor moves from machine to machine by a conveyor control system. This system used individual stainless steel pallets which move along continuously-running conveyor belts.

The pallets transport individual resistors to the machine operating position and receive the resistor after the completion of operation. The conveyors, part of each individual machine, provide an indexing pallet transport mechanism. A rubber-tipped push rod retains the resistor on its tip by means of a vacuum system connected through the rod's hollow core. A suitable cam actuating mechanism for the push rod is synchronized with the machine operation, loading the resistor into the machine.

Space is allowed between each machine for accumulation of a five minute "bank stock," and each machine

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MSU News Notes

(Continued from Page 56)

Except for Dr. Lal, the new appointees have been directly connected with current American space programs. All are recognized authorities in their fields and have published many papers in technical journals.

Other noted space researchers on the mechanical engineering faculty are Dr. Maria Z. v. Krzywoblocki and Dr. Amritlal M. Dhanak.

Dr. Krzywoblocki, a mathematician as well as an engineer, has prepared five volumes of mathematics for calculating trajectories for a flight to Mars. The work was done for the National Aeronautics and Space Association.

Dr. Dhanak is a specialist in heat transfer and boundary layer analysis.

NATIONAL SCIENCE FOUNDATION GRANT FOR BIOCHEMISTRY

A National Science Foundation grant of $1,213,000 to support construction and furnishing of a new biochemistry building was accepted by the Michigan State University Board of Trustees, meeting at MSU-Oakland.

The planned five-story building will cost about $5.2 million. It will be built east of the Biology Research Center on the East Lansing campus.

The University anticipates that additional funds will be forthcoming from another federal agency and a private foundation.

The NSF grant specifies that $110,000 of the total will be spent for scientific equipment.

While the new building will be important to MSU's plans to develop a two-year preclinical medical program, this was not the only consideration for the NSF, noted Dr. R. Gaurth Hansen, chairman of the Department of Biochemistry.

"The basis of the grant," he said, "is the scientific competence of the staff in biochemical research and the caliber of the graduate teaching program.

"We are honored by this recognition of our work."

The proposal made by the University to the NSF, he pointed out, stressed the research and graduate teaching presently being carried out by the department in the College of Agriculture and the College of Natural Science.

The two colleges have been jointly administering the department since its establishment on April 1, 1961. Previously, research and teaching in biochemistry was centered in the chemistry and agricultural chemistry departments.

At present, biochemistry has offices and laboratories in four of the University's older buildings—Food Science, Kedzie, Agriculture and Horticulture.

These facilities, said Dr. Hansen, have the department cramped for space now and make it difficult to expand in keeping with the growing importance of biochemistry.

Dr. Hansen noted that biochemistry, which is concerned with the chemical activity that supports life, dates back to about 1900 but has had its greatest growth in the past 30 years.

Many advances in biology, public health, nutrition and agriculture have resulted from biochemical research. A number of Nobel prizes have been awarded for biochemical and closely related research.

Dr. Nathan E. Tolbert, professor of biochemistry, has been chairman of the biochemistry building committee. Final working plans are nearly complete. The architect is Harley, Ellington, Cowin and Stirton, Inc., Detroit.

FALLOUT SHELTER FOR CYCLOTRON BUILDING

A special type of fallout shelter 100 feet deep and three feet in diameter is being drilled at Michigan State University.

This "fallout shelter," a part of MSU's cyclotron building now under construction, is designed to shield sensitive experiments from cosmic rays and other normal background radiation.

The steel-lined well will be used when it is necessary to make highly accurate measurements of extremely small amounts of radiation being emitted from certain substances under study, Dr. Henry G. Blosser, codesigner of the cyclotron, said.

By screening out most normal background radiation, the MSU physics professor explained, scientists can be assured that whatever radiation they detect is coming predominantly from the source under study.

Dr. Blosser pointed out that cosmic rays are constantly penetrating the atmosphere and striking the earth from several angles at the rate of about 1 per cent centimeter per second.

When fine measurements are called for, Dr. Blosser said, the source can be lowered into the well with appropriate measuring and recording instruments.

It may be necessary, he added, to fill the well with water and lower experimental rigs in waterproof capsules.

The MSU cyclotron, which is to be in the 50 million electron volt class, is scheduled for completion in 1964.

Automated Carbon

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feeds from this storage space on a demand basis. Inventory control is maintained, since each machine shuts off when the storage space fills on the succeeding machine.

CAP-LEAD WELDER

An automatic machine outside the line percussion-welds a solder-coated lead to the gold-flashed brass cap used in the capping operation. The weld is made at the joint of the cap and the lead by an extremely short (less than 300 microsecond) arc of high intensity. This machine's output rate is approximately 3,600 parts per hour. It has changeable tooling to accommodate three different cap sizes and two wire sizes. Fail-safe features shut off the machine or reject the part in the event that no cap is fed, a lead is not attached, or a poor weld occurs.

SIDETRACKED

Old blondes never fade. They just dye away.

* * *

Jimmie's mother greeted him on his return home from his first day at school.

"Well," she asked, after a big hug and kiss, "what did my little man learn in school today?"

Jimmie smiled proudly and said, "How to whisper without moving my lips."

THE ADVERTISER'S INDEX


Kodak beyond the snapshot...