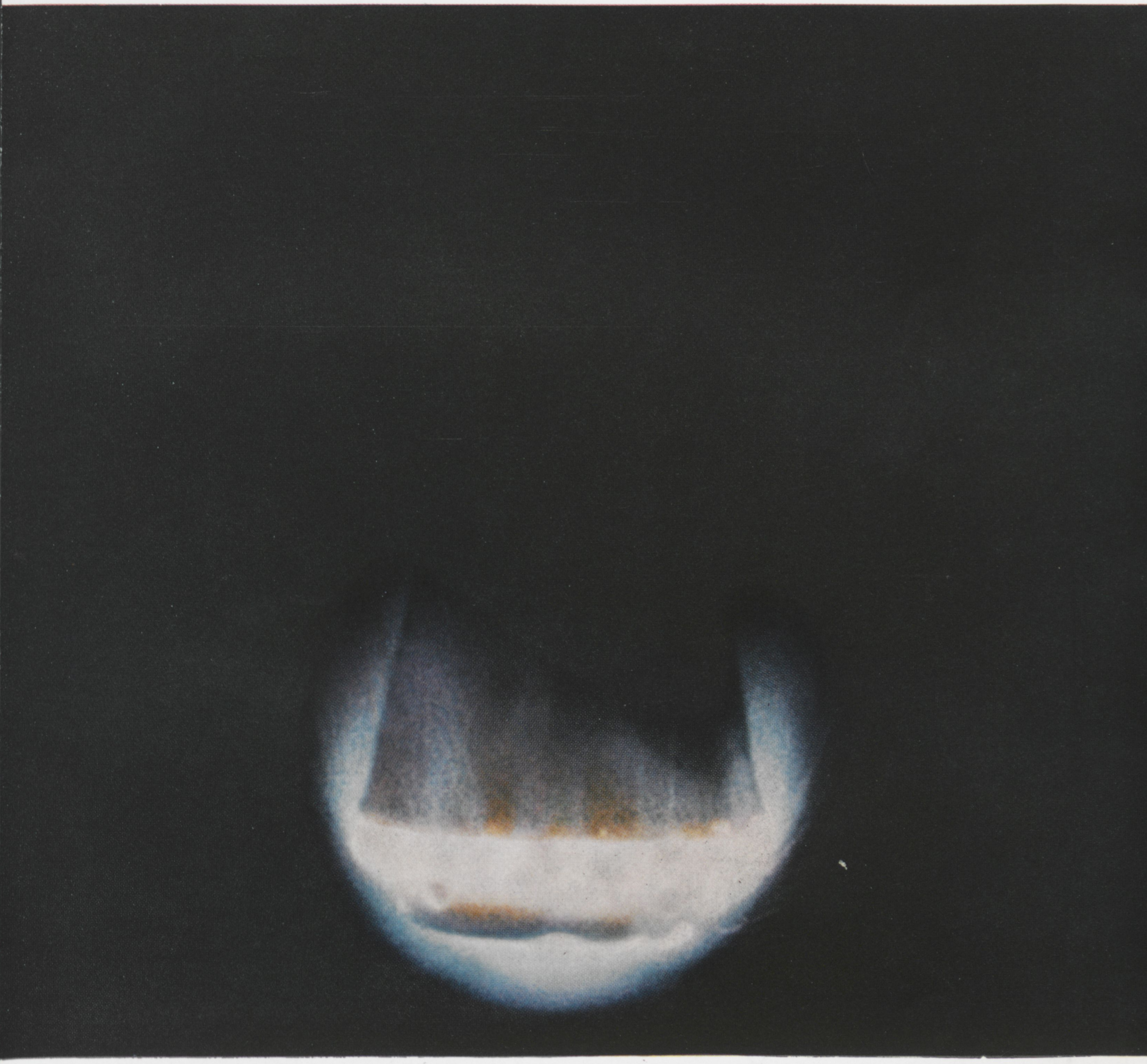
Fall 11-1963

Volume 75 - Issue 2 - November, 1963

Rose Technic Staff
Rose-Hulman Institute of Technology

Rose Technic

November 1963 50c



THE BREATHING OF BACTERIA
EGYPTIAN PYRAMIDS
WELL, WHADDAYA KNOW?
SATELLITE COMMUNICATIONS SYSTEMS

To Catch a Hummingbird

How the Gemini Spacecraft will find its target . . .

Suppose you had to capture alive one little hummingbird flying a known course high over the Amazon jungle. Difficult? Sure, but no more so than the job assigned to a new radar system Westinghouse is building for the NASA-Gemini space program.

The bird is an Agena rocket, orbiting the earth at 17,500 miles per hour. The hunter, in an intersecting orbit, is the Gemini two-man spacecraft being built by McDonnell Aircraft.

And so the hunt begins. The spacecraft radar finds the target and starts an electronic question-and-answer game. A computer keeps score, giving the astronauts continuous readings on angles and approach speeds until the vehicles are joined. The hummingbird is caught.

The Gemini experiments will be a prelude to the first moon trip. And Westinghouse is already working on advanced radar systems for lunar landings and deep space missions.

You can be sure . . . if it's Westinghouse.

For information on a career at Westinghouse, an equal opportunity employer, write to L. H. Noggle, Westinghouse Educational Dept., Pittsburgh 21, Pa.

Westinghouse

Member of Engineering
College Magazines Associated

IN THIS ISSUE

THE BREATHING OF BACTERIA

An excellent biological report on the respiratory affects of bacteria. This breathing is shown to be quite different from human respiration and refers to oxygen consumption in bacteria. The article goes into much detail discussing the methods of investigation of tracking oxygen traversing a certain pathway before being consumed by bacteria. The results of many experiments in this field are not only quite interesting, but very astonishing.

"WELL WHADDAYA KNOW?"

Mr. Biel gives us an example of critical reasoning as he reviews a popular topic in the philosophies of modern times. He asks the poignant question "How do we know that we really know anything?" In doing this he presents to us some common errors in the reasoning process as well as rather interesting definitions of truth and knowledge.

EGYPTIAN PYRAMIDS

Tom Davidson discusses the amazing feats of the early Egyptian engineers, who built the great pyramids without ever taking E. E. E.

SATELLITE COMMUNICATIONS SYSTEMS

This stimulating article delves into the many new developments that have recently taken place in the field of communications satellites. The author discusses the several types of satellites, the way in which they are used, advantages and disadvantages of each and future plans for their use.

Cover Note

This month's cover appears through the kind courtesy of REPUBLIC AVIATION CORPORATION.

Rose Technic

November 1963

VOLUME LXXV, NO. 2

AMERICA'S OLDEST ENGINEERING COLLEGE MAGAZINE IN CONTINUOUS MONTHLY PUBLICATION — 1891-1963

PRINTED BY MOORE-LANGEN PRINTING AND PUBLISHING CO.
140 North Sixth Street, Terre Haute, Ind.

Publisher's Representative
LITTELL-MURRAY-BARNHILL, INC.
369 Lexington Avenue,
N. Y. 17, N. Y.
and 737 N. Michigan Avenue,
Chicago 11, Illinois

Published monthly except June, July, August, and September by the Students of Rose Polytechnic Institute. Subscription $3.00 per year. Address all communications to the ROSE TECHNIC, Rose Polytechnic Institute, Terre Haute, Indiana.

Entered in the Post-office at Terre Haute as second-class matter, as a monthly during the school year, under the act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 13, 1918. This magazine does not necessarily agree with the opinions expressed by its contributors.

"Don't Just Stand There And Gripe"

It is certainly not uncommon these days to hear the complaints of students filling the halls of R.P.I. Although this constant griping is not a new thing on the Rose campus this semester, it seems that the level of noise arising from the dissatisfactions of students is at an unusually high level. What is the cause of all this unrest? Is the faculty really trying to wage war against the student body? Is it really the intent of those who handle the affairs of this institution to place increased restrictions and hardships upon us? Or are we simply blaming them for problems which are actually the result of our own limitations, and pointing the finger of guilt at them merely because their positions of responsibility make them the logical scapegoats?

Regardless of what the situation really is, one thing may be said without reservation. While the average Rose man does plenty of complaining, very few students make any effort to alleviate their problems through any logical and accepted means. For example, many complained loudly when the faculty decided not to dismiss classes on the Friday afternoon before Homecoming; but who made any effort to show the faculty why classes *should* have been dismissed? When certain Student Council officers took the initiative and circulated a petition to the faculty asking additional consideration of the matter, a common reaction was, "Sure I'll sign, but it won't mean a thing." Apparently it meant something to Dr. Logan and the members of the faculty who, despite definite inconvenience to themselves, met shortly after the presentation of the petition to reconsider the matter.

Just why is so much energy spent on the exercising of vocal chords and so little on doing anything about the situations that arise? A logical explanation is that very few students know what they can and should do to further their own interests. This seems like a poor excuse for complacency, however. Careful reading of a few select pages in the Student Handbook, and conversation with responsible student leaders and faculty members would give anyone interested enough to take the time a clear understanding of what his rights and responsibilities as a student of this school are. There are no doubt many who would be somewhat surprised to find out how student affairs should be handled, if they would just take the time and effort to do a little investigating.

Even at a school as small as Rose, not every student can take his personal problem to the President's office (although Dr. Logan would certainly do his best to help out). For this reason, there exists on this campus an organization known as the Student Council. The Council is the representative body of the students of R.P.I. It would be a step in the right direction if everyone realized this and acted accordingly. Whatever it may have been in the past, the Student Council is not a group of popularity contest winners; nor will it be in the future as long as the students realize the importance of sound, responsible student government. This year's Council is making a concentrated effort to improve the handling of student affairs. The next time you have a gripe, take it to your Council representative. You may still be barking, but you'll be barking up the right tree.

R.T.K.

The Dean's Corner

In 1928 the Abbé Ernest Dimnet wrote "The Art of Thinking" a book that was so well received it ran to over twenty printings. It outlines helps and obstacles to thought and it suggests to the reader ways to develop his own creativity. Perhaps its greatest contribution is the thesis that thinking can be consciously cultivated as an *art*.

Many students at Rose feel harried and "pushed" to complete passably the assignments given them. Time to reflect on the meaning and significance of their new knowledge is hard to find. Yet to *reflect* is the very act of thinking. The simplest definition of reflection is "thinking attentively of the same thing several times over."

Problem solving, in its more satisfying aspect, is not mere recall of memorized fragments. It is reflection—deliberate and conscious. A whole sequence of patterns or images is paraded before the mind's eyes to catch a congruence between some previously captured concept and the particular pattern evoked by the statement of the problem at hand. One by one the less probable alternatives are discarded. Finally a certain pattern or sequence of reasoned steps emerges and is recognized as more probable than its rivals. It is seized upon by the intellect which then stops in its search for further possibilities. With this interruption comes a definite resolve on a course of action—"the solution." Here is decision, the logical outcome of reflection.

As Dimnet says "The object of reflection is invariably the discovery of something satisfying to the mind which was *not* there at the beginning of the search. There is no fundamental difference between this discovery and scientific invention." Somebody once asked Newton "How did you discover the law of gravitation?" "By thinking about it all the time," was his answer.

Because of the elemental nature of connected sequences of images, it is not surprising that in the search for "machines that can think," intensive attention is being directed to pattern recognition by computer methods. Recently developed machines have remarkable powers of discrimination. Some can recognize the essential nature of, say, a pentagon in graphic form regardless of its orientation, position or scale. But how primitive this achievement seems when compared to the working of the disciplined human brain. Creative thinking by even the biggest computer seems still very remote.

Every student has limitless opportunities to improve his mastery of basic concepts in mathematics and physical sciences by consciously practicing the art of reflective thinking. For example, each one of us would gain a deeper and richer appreciation of the principles of conservation of energy and conservation of momentum from a serious effort to enumerate every item in the exact balance of energy changes occurring in a manned space vehicle through take off and rendezvous in space.

Conscious development of one's own art of thinking requires elimination of obstacles such as selfconsciousness, slavish conformity, or endless idle conversation. Conversely, thought is promoted by solitude, concentration, critical reading, and the creative act of writing down one's own thoughts with precision.

Time, no matter how precious, must be set aside for genuine reflection if we are to know the joy of comprehension—the deep satisfaction of an understanding of life and of the universe around us.

Herman A. Moench

Dr. Arthur is the Chairman of the Committee on Bioengineering and Applied Biology here at Rose. He graduated from Ripon College in 1949 with the degree of Bachelor of Arts in Mathematics, from Northwestern University in 1953 with the degree of Bachelor of Science in Civil Engineering, from Harvard University in 1956 with the degree of Master of Science in Sanitary Engineering, and from the State University of Iowa in 1963 with the Doctor of Philosophy degree in Sanitary Engineering. He is a Professional Engineer in the states of Indiana and Wisconsin.

Yes, bacteria do breathe. Perhaps they do not in the same sense that man breathes, but if one considers the use of oxygen by a single cell within the body, then bacteria do in truth, breathe. In other words, they consume oxygen and produce carbon dioxide by utilizing the processes of respiration and oxidation.

The rate at which oxygen is consumed by a cell has been the subject of investigation by bacteriologists, biochemists, chemical engineers, physiologists and environmental health engineers. Interest in this subject by this diversity of disciplines is probably due to the fact that oxygen consumption is an integral part of metabolism. Metabolic pathways, fermentation productivity and fermentor design criteria have all been investigated by measuring the rate of oxygen consumption.

The first attempt to measure oxygen consumption was made by Otto Warbug in the early 1900's. The original Warbug manometer worked in the following manner. A culture of bacteria was suspended in water and placed in a closed container to which a manometer was connected. In addition to bacteria the suspension would contain nutrients and also some dissolved oxygen. Since bacteria utilize oxygen in the dissolved form only a portion of the dissolved oxygen would be immediately consumed by the bacteria. The reduction of dissolved oxygen concentration would lead to transfer of additional oxygen from the gaseous state to the dissolved state. As oxygen was removed from the atmosphere above the culture, the pressure inside the closed container decreased.

The amount of decrease was indicated on the manometer. The rate of oxygen consumption was determined by plotting time versus manometer reading. Although the equipment today is more elaborate, the principle of the Warbug manometer remains the same as in the original

THE BREATHING OF BACTERIA

by Dr. Robert M. Arthur
Associate Proffesor of Bioengineering
edited by Willfred Stratten

instrument. One precaution that must be observed is that the rate of transfer of oxygen from the gaseous to the dissolved state must at all times be higher than the rate of consumption of oxygen by the bacteria. This is usually accomplished by shaking the culture vessel.

Another method of measuring the rate of oxygen consumption is to place a suspension of bacteria in a vessel and then determine the change in the concentration of dissolved oxygen over a period of time. The concentration of dissolved oxygen can be determined using chemical techniques or voltametric techniques. The rate of oxygen consumption can be determined from a plot of the dissolved oxygen concentration versus time. This technique will not work when the rate of oxygen consumption is lower than the rate of oxygen transfer from the gaseous to the dissolved state.

All of the past investigation on oxygen consumption has utilized one of the techniques described above. These techniques depend either on the decrease of partial pressure of oxygen in the gaseous state or the decrease in dissolved oxygen. It is assumed that the bacteria are actually utilizing the oxygen at the same rate indicated by these oxygen consumption rate measurements. All that these methods actually measure, however, is the rate of disappearance of oxygen from either the dissolved or gaseous state. This indicates little about the actual, final and ultimate use of oxygen.

The ultimate use of oxygen by a living cell is as a hydrogen acceptor with the formation of water. This means that measuring the rate of oxygen utilization can only be done by measuring the rate of formation of water. To do this in an environment which already contains water requires the use of an oxygen tracer. Radioactive isotopes of oxygen have very short half-lives. Oxygen-15, the longest radioisotope, has a half-life of only 2 minutes. It was therefore necessary that a stable isotope of oxygen be utilized in this investigation. A stable isotope, Oxygen-18, (enriched to 98%) was obtained from the Weizmann Institute of Science, Rehovoth, Israel. Analysis for the stable isotope of oxygen can best be determined by means of a mass spectrometer which differentiates atoms on the basis of their mass. For this investigation mass spectrometer analysis was made by the Commercial Solvents Corporation, Terre Haute, Indiana.

Oxygen in a suspension of bacteria must pass through many barriers before it reaches its ultimate objective. It must pass from a gaseous state to a dissolved state, then through a liquid film surrounding the cell, and finally through the cell wall for conversion to water. Resistances which must be overcome by oxygen traversing this pathway include:

1. gas film
2. interface
3. liquid film
4. transfer through water
5. liquid film at cell wall
6. cell wall and cytoplasm
7. reaction resistance with cytochrome system
8. transfer of H_2O out of cell.

The cytochrome system is merely a carrier mechanism for hydrogen atoms and electrons.

Hydrogen atoms and electrons are transferred along this system from the mitochrondria of the cell to be combined with the dissolved oxygen of the suspension. In this manner oxygen is finally utilized to form water. The rate at which this water was formed was the subject of this investigation.

METHOD OF INVESTIGATION

A number of species of bacteria could have been used in this investigation. A strict aerobe, *Pseudomonas fluorescens,* was selected because it had fairly well defined initial oxidation products. The species of bacteria was supplied by the Northern Regional Research Lab of the U. S. Dept. of Agriculture, Peoria, Illinois. Considerable work has been done in the past by other investigators to determine the metabolic products of this organism. It has been shown that this organism, during aerobic fermentation of glucose, produces gluconic acid in quantity along with carbon dioxide and some pyruvic acid. The following chemical equation expresses this reaction:

$$C_6H_{12}O_6 + 1.20_2 \rightarrow 1.2C_6H_{10}O_7 + .08C_3H_4O_3 + 1.24H_2O + 0.24CO_2$$

From this equation it is evident that when one mole of glucose is consumed by the bacteria, 1.2 moles

(*Continued on page* 32)

We go from A (Auburn) to Y (Yale)

This recent Bethlehem Loop Course class includes 202 graduates of 78 colleges and universities. They are fresh from campuses in 32 states and the District of Columbia . . . from Maine to California, from Minnesota to Georgia.

If you are interested in a career in the management of a diversified and *growing* industrial corporation, and if, in all modesty, you consider yourself qualified to meet the challenge—consider the Bethlehem Steel Loop Course.

Most Loopers are Engineers

All the technical degrees indicated here are represented in this Loop class, and in virtually *every* Loop class. Of the 202 members, 154 are engineering graduates; twelve have non-engineering technical degrees; and 36 possess business administration, liberal arts, or other non-technical degrees.

Your career at Bethlehem Steel might be in steelmaking operations, research, sales, fabricated steel construction, mining, shipbuilding, or other activities depending on your specific interests. All require the talents of college trained men.

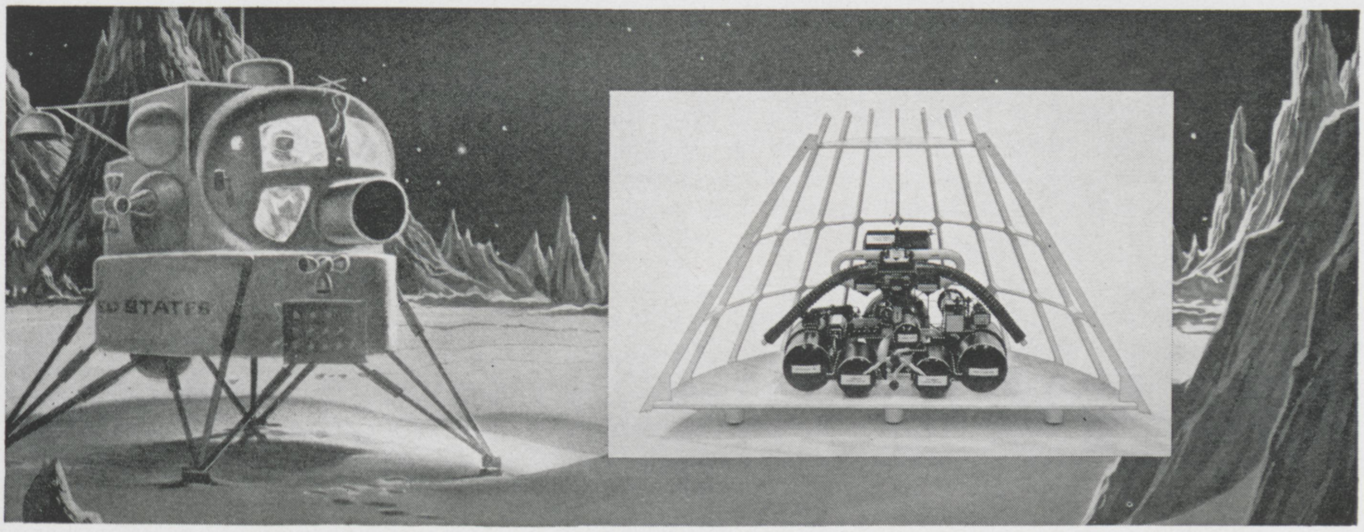
You can get a copy of our booklet, "Careers with Bethlehem Steel and the Loop Course," at your Placement Office, or by sending a postcard to our Personnel Division, Bethlehem, Pa.

An equal opportunity employer

BETHLEHEM STEEL

WHAT YOU COULD BE ENGINEERING AT

Hamilton Standard



Shown with an artist's conception of proposed Lunar Excursion Module, a mockup of a typical spacecraft Environmental Control System currently under development at Hamilton Standard.

One possible assignment: participate in the advanced development program to produce the environmental control system for the Lunar Excursion Module. Utilize your training in:

- **heat transfer**
- **thermodynamics**
- **control dynamics (flow, temperature, pressure)**
- **fluid dynamics**
- **atmospheric supply for human life**
- **contamination control for human life**

to develop a regenerable system to provide for life support on long-duration space flights.

Other ECS activities: optimization of atmospheric storage methods • development of pressure control concepts for two-gas atmosphere • testing of catalytic oxidizers as a method of eliminating atmospheric contaminants • reclamation systems for water and oxygen • fabrication and testing of heat exchangers, water boilers, etc., under manned spacecraft conditions.

OTHER MAJOR HAMILTON STANDARD PROGRAMS:

- ground support equipment
- advanced propeller systems
- electron beam machines
- air inlet controls
- electronic control systems
- physiological monitoring systems
- space life support systems

See your placement officer for a campus interview, or write:

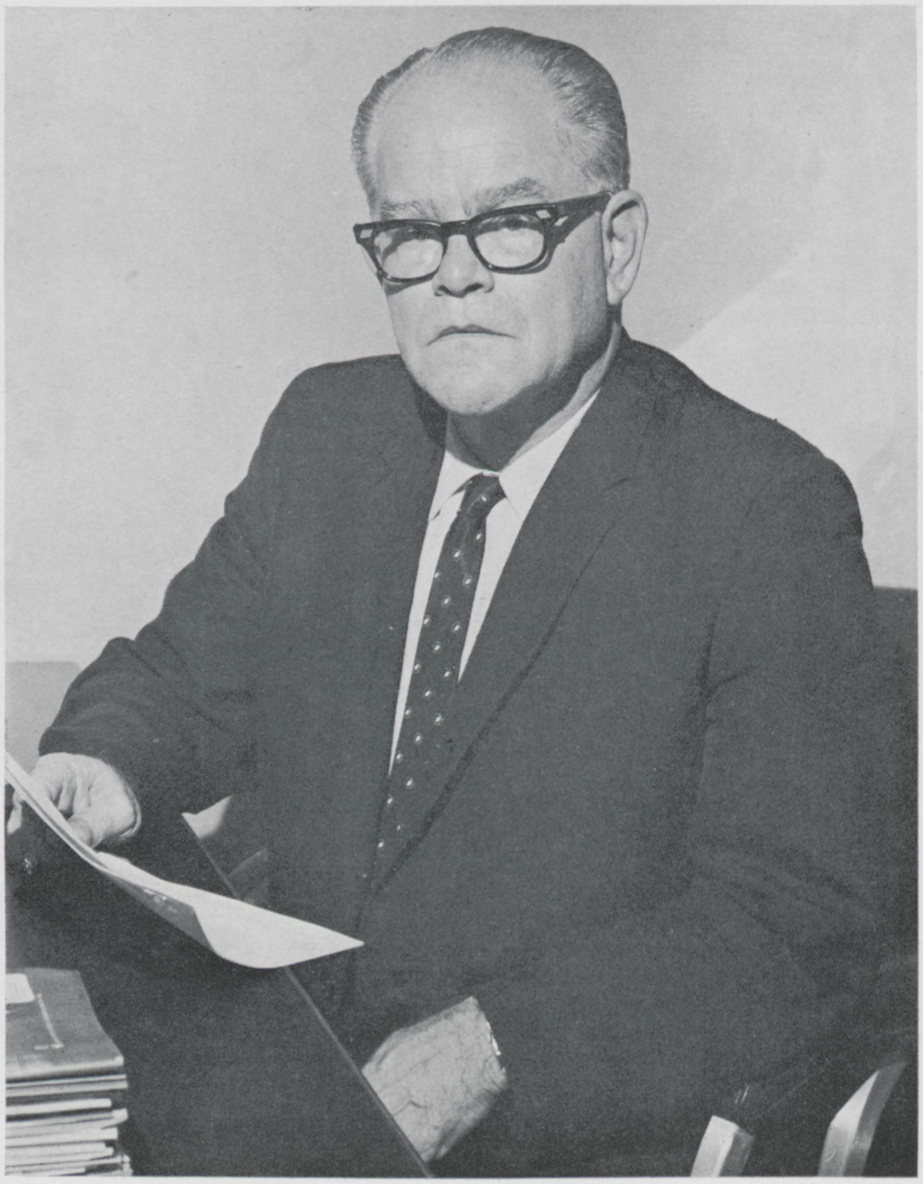
SUPERVISOR COLLEGE RELATIONS

Hamilton Standard DIVISION OF **United Aircraft**

WINDSOR LOCKS, CONNECTICUT

an equal opportunity employer

Mr. John G. Biel is Adjunct Professor of Humanities and Social Sciences in the areas of Economics, Business Law and Scientific History. After graduating from the Indiana University School of Law, Mr. Biel began his law practice in Terre Haute with Dix, Dix, and Biel. After several years with the firm he began his own practice and ventured into the area of economics and particularly investment. He is a noted historian and is very active in local historical circles. Mr. Biel began teaching at Rose a few years ago as a guest lecturer in Business Law. From that time he began the Economics curriculum of which he now conducts a class in Applied Economics. At present, Rose is one of very few colleges having a course in the History of Science and Technology. This course is being initiated this year by Mr. Biel and this article is taken from part of his research in the formulation of the course.



The search for knowledge is as ancient as the ages. When man first covered his nakedness with furs and started to live in groups and began to use tools for more utility in the satisfaction of his desires and wants, he had been striving to overcome the limits of his local environment and the realization of a need to know arose. He had discovered that knowledge was indispensable for his domination over the objects in his environment in order to make them subservient to him.

He gradually learned that fire could be produced by rubbing wood in a certain way — a generalization from individual experiences which resulted in the realization that rubbing wood in this way will always produce fire. He *discovered* that fact; therefore we conclude, the art of discovery appeared to be the art of correct generalization. He found that these considerations were irrelevant and could, therefore, be excluded from the generalization. He found, however, that there were relevant considerations which must be included in the generalization. The wood had to be dry; it could not be wet. He came to the conclusion that considerations which were relevant must be reckoned with in order for the generalization to be valid. Early man thus started on the beginning of knowledge by realizing that he must separate relevant factors from irrelevant factors in order

Well whaddaya know?

By John G. Biel
Prof. of Economics

to make a true generalization. Early man discovered all this from experience. That is what philosophers now call empiricism — a proposition affirming that the sole source of knowledge is experience; that either no knowledge at all or no knowledge with existential reference is possible independently of experience.

It has often been said that generalization is the origin of science — consider the *if-then always* statements, i.e., "if a metal is sufficiently heated, then it always melts." When we speak of the ancient sciences we are merely saying that the ancients had succeeded in establishing quite a few generalizations of a rather comprehensive nature. They knew laws of geometry, which hold for all parts of space without exceptions; they knew laws of astronomy, which govern time and they knew a number of physical and chemical laws, such as the laws of the lever and the laws relating heat to melting.

What is it we do then, when we attempt to explain anything? We attempt to generalize — we attempt to incorporate the fact that we are trying to explain into a general law. So, explanation becomes generalization. When we say that Newton's law of attraction explains the falling of bodies, we mean that the movements of bodies toward the earth is incorporated into a general law according to which all bodies move toward each other.

We sometimes cannot "see" a fact — it is unobserved. Still, we explain that unobserved fact by the way it fits into or results in or from some observed fact which fits into a general law — that is, one which we have already generalized. We explain a dog barking by assuming someone is approaching; we explain marine fossils on a mountain top by assuming that land was — sometime or other — under the ocean. So then, general laws can be used for uncovering new facts and explanation becomes an instrument for supplementing the world of direct experience with inferred objects and occurrences.

PSEUDO-EXPLANATION

Our insatiable desire to know urges us always toward ever greater generality. The multitude of observed facts — and they are many — still cannot satisfy our desire to know; "the quest for knowledge transcended observation and demanded generality." It is an unfortunate truism that human beings are inclined to give answers even when they do not have the means to find correct answers. A truly scientific explanation presupposes ample observation and critical thought — and the higher the generality aspired to, the greater must be the mass of observational material, and the more critical the thought. The history of science shows us that at the point where scientific explanation failed because the knowledge of the time was insufficient to provide the right generalization, imagination took over and supplied a kind of explanation which appealed to — and satisfied— that urge for generality. It was an appeasement by pseudo explanation. Analogies with human experiences were confused with generalizations and taken to be explanations.

COSMOLOGY

An excellent example of this "pseudo-explanation" is the ancients' explanation of the origin of the world — cosmology. The mythologies of all peoples include versions of the origins of the universe. Could the origin of civilization be accounted for and located in time, history would have an authentic beginning. But, in fact, all the varying starting points assumed by historiography are makeshifts. Unless it accepts a supernatural act of creation as the absolute limit of its regress, historical research is prevented by its very method from acquiescing in any *primum movens* (first motion). It is in this respect, however, in no worse position than scientific cosmology. But even if such creative inception of civilization were to be admitted, it could only be conceived as the transcendent enactment of the fundamental principles, and would, therefore, raise all the historical problems attending the con-

cept of revelation. The best known version of the origin of the universe, of course, is the story given in the Bible — a product of Hebrew imaginative spirit — and is dated about the ninth century B.C. Whatever reference or allusion there is to the creation of the world in the New Testament reflects the Old Testament teaching. This story explains the world as the creation of God. In the Old Testament story of creation, there is no explicit statement that creation was *ex nihilo* (out of nothing). Still, the Fathers from the earliest times insisted upon creation *ex nihilo*. The proof-text upon which they base their view is II Maccabees vii, 28. But that proof-text does not say that God created heaven and earth "out of nothing;" it says that God created them "out of things nonexistent." Step by step proceeded, then, by anthropomorphic analogies; as humans made homes and tools and gardens, God made the world. So, one of the most general and fundamental questions, that of the genesis of the physical world, is answered by an analogy with experience of daily environment and routine living.

The Babylonian genesis appeared in the earlier half of the second millennium B.C. It presented the earliest stage of the universe as a watery chaos. The chaos consisted of three elements: one, representing the sweet waters; another, representing the sea, and still another, representing the cloud banks and mist. These three types of waters mixed and mingled in a large undefined mass. There appeared two gods, born of the sea and the sweet waters, representing the silt which had formed in the waters. These gods gave birth to another who became the sky, and to another who became the earth. In speculating about the origin of the world, the Mesopotamians thus took, as their point of departure, things they knew and could observe in the geology of their own country. Their earth, Mesopotamia, is formed by silt deposited where fresh water meets the salt water; the sky, seemingly formed of solid matter like the earth, must have been deposited in the same manner and must have been raised later to its lofty position. The philosophers who gave us these fanciful pictures of the origin of the world took analogy to be explanation.

The point at which a science outgrows the mythological conception of the world, adequate for a merely descriptive inventory of reality, and enters the stage of genuine scientific achievement, is marked by the transition to thinking in terms of a system of relations, which is called an order of elements.

Histories of philosophy, — and of natural science — begin with the earliest Ionian system initiated by Thales of Miletus (640-546 B.C.). The one point which strikes most readers here is the rationalism which distinguishes it from mythical cosmogonies. The Ionians pushed back to the very beginning of things the operation of thought processes which are familiar and ordinary to us today. They made the formation of the world no longer a supernatural event — but a natural one. They left the gods out and began with "things as they exist." Later, they could put the gods back if they desired but, meanwhile, Ionian philosophers assumed that the universe was a lawful order intelligible in terms of natural causes. As an example of this thinking, a Hippocratic writer explained: "It seems to me that the disease (epilepsy) is no more divine than any other. It has a natural cause, just as other diseases have. Men think it divine merely because they do not understand it. But if they called everything 'divine' which they do not understand, why, there would be no end of 'divine' things." It was in this vein that the philosophical foundations of further search for knowledge and truth were laid.

FALSE GENERALIZATIONS

There are two types of false generalizations which must be considered. They are classified as innocuous and pernicious forms of error. The first which is often found among empirically minded philosophers is not serious and lends itself rather easily to correction and improvement in the light of further experience. The second, which consists in analogies and pseudo explanations, leads to empty verbalisms and dangerous dogmatism. Thales, who about 600 B.C. acquired fame by putting forth the theory that water is the substance of all things, made a false generalization. The fact that water is contained in many things was falsely extrapolated to the assumption that water is contained in every object. His theory, however, is sensible in so far as it makes one physical substance block for all others; it is at least a generalization, though a false one, and not an analogy. Take on the other hand, the statement that "Reason is substance, as well as infinite power, its own infinite material underlying all the natural and spiritual life." Calling "reason" a substance may produce some vague images in the listeners; but in further application such word combinations mislead one to jump to conclusions which logic cannot warrant. Pernicious errors through false analogies have been the "philosopher's disease" at all times in history. The fallacy committed in this analogy is an example of a kind of mistake called the substantialization of abstracta. An abstract noun, like "reason," is treated as though it refers to some thing — like entity.

It was to solve such problems — and from such ground — that philosophy sprang.

WHAT IS KNOWLEDGE?

Epistemology is that branch of philosophy which investigates the origin, structure, methods and validity of knowledge. We can, most universally, agree that whatever knowledge may be, it is, certainly, more than opinion and, certainly, may be less than truth. It is generally considered to be the relation between object and subject. In this statement there are two terms which must be defined and fully understood.

(*Continued on page* 26)

THE BELL TELEPHONE COMPANIES SALUTE: WARREN ROSKE

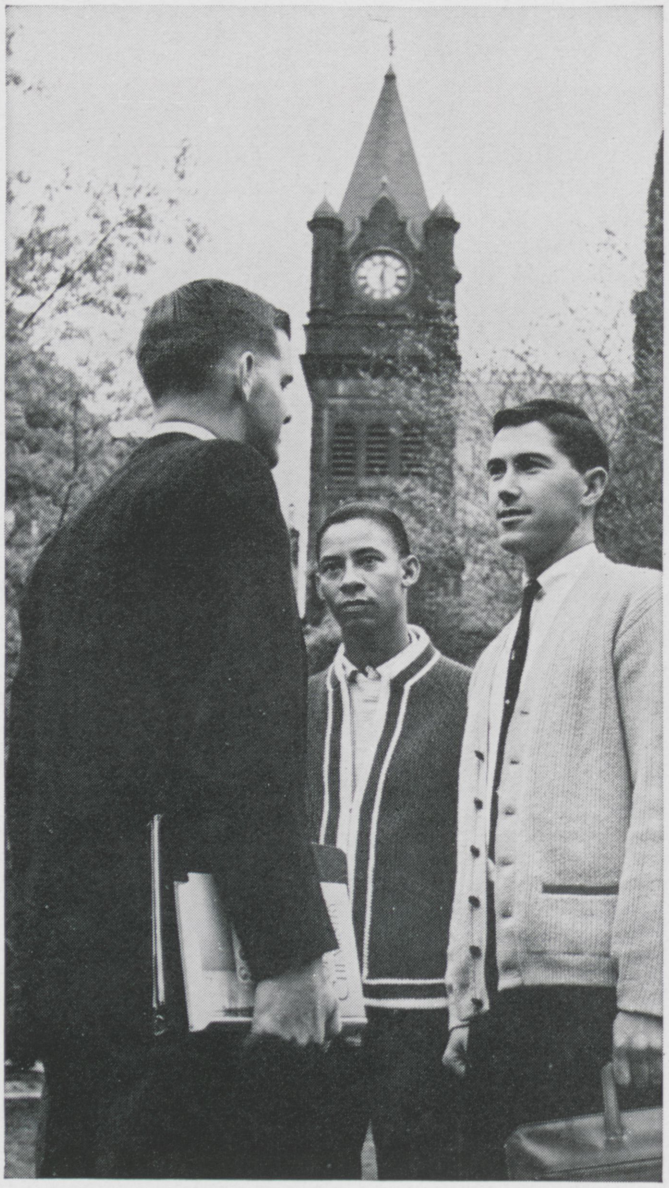
Whether a simple voice circuit for a small trunk line, or a complex high-speed data circuit for the Strategic Air Command, Northwestern Bell Engineer Warren Roske gets the nod. Warren (B.S.I.E., 1959), and the three engineers who work under him, design telephone facilities for private line customers.

On earlier assignments, Warren engineered communication lines through the famed Dakota Black Hills, helped in the Mechanized Teletypewriter cutover in Sioux Falls, S. D., and contributed a unique application of statistics to a Plant Engineering study.

But Warren's greatest success has come in the Transmission field where, after only seven months, he was promoted to his supervisory engineering position.

Like many young engineers, Warren is impatient to make things happen for his company and himself. There are few places where such restlessness is more welcomed or rewarded than in the fast-growing telephone business.

BELL TELEPHONE COMPANIES



Pardon me if I sound as if the executive position I've landed deals with the whole future of the world.

It does.

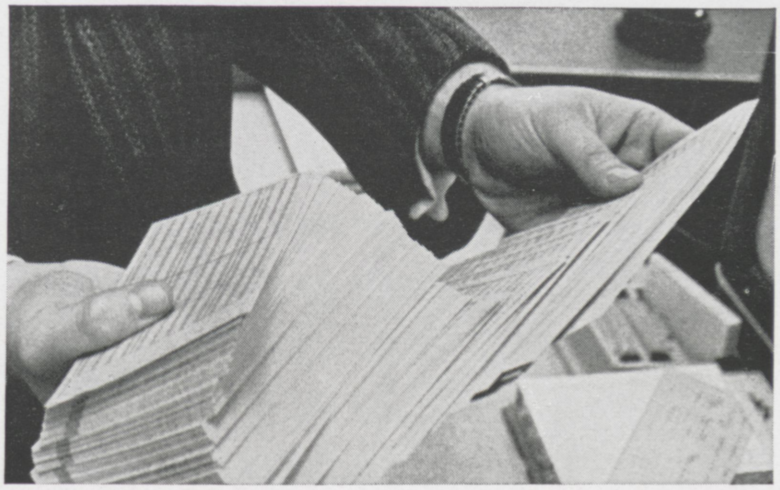
Certainly, there's no organization today conducting more vital business than the business of the United States Air Force. And very few organizations that give a college graduate greater opportunities for responsibility and growth.

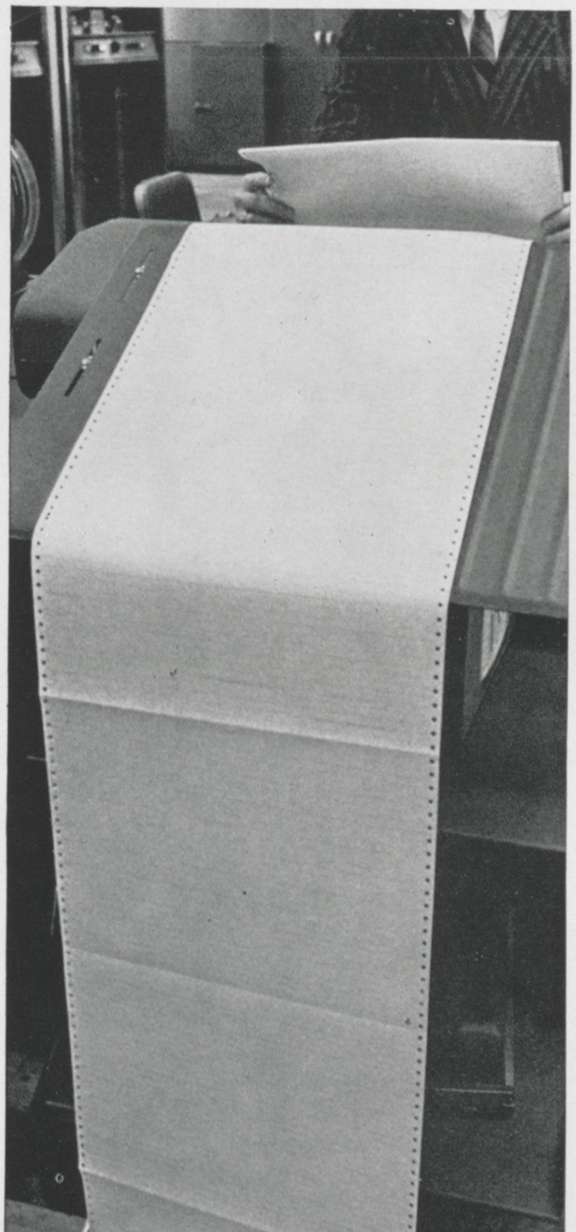
As an Air Force officer, you'll be a leader on the Aerospace Team—with good pay, a 30-day paid vacation each year, educational opportunities.

How can you get started? For many, the best way is through Air Force ROTC. But if you missed out on AFROTC, or if there's no unit on your campus, you can still apply for Air Force Officer Training School. This three-month course leads to a commission as a second lieutenant in the United States Air Force.

For more information about Air Force OTS, see your local Air Force representative.

U. S. Air Force





WHO DOES THE THINKING FOR THINKING MACHINES?

Even though we didn't invent it, we at American Oil use the computer so extensively in Linear Programming that we often think of it as "our baby." And as such it must be spoon-fed known data by experts in order to come up with the answers to a myriad of refinery operation problems.

One of the experts at American Oil who helps the thinking machine think is Leonard Tenner, 24, a graduate Chemical Engineer from M.I.T. His current assignment: prepare a mathematical model covering the manufacture of gasoline, home fuel and jet fuel from crude oil.

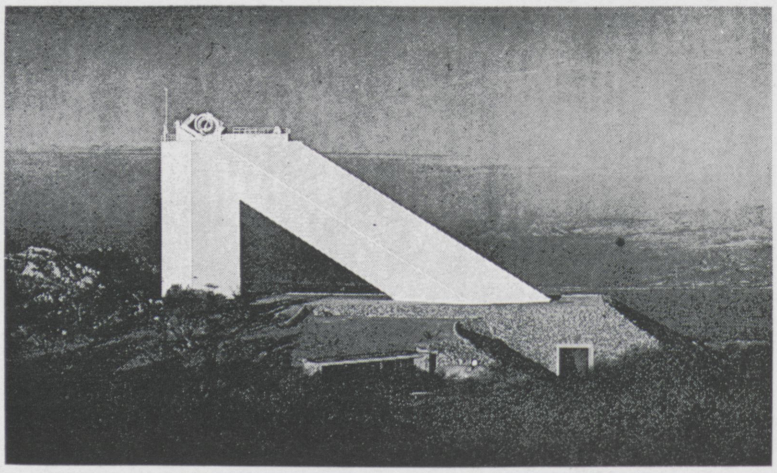
The fact that many gifted and earnest young men like Len Tenner are finding challenging careers at American Oil could have special meaning for you. American Oil offers a wide range of new research opportunities for: Chemists—analytical, electrochemical, physical, and organic; Engineers—chemical, mechanical, and metallurgical; Masters in Business Administration with an engineering (preferably chemical) or science background; Mathematicians; Physicists.

For complete information about interesting careers in the Research and Development Department, write: J. H. Strange, American Oil Company, P. O. Box 431, Whiting, Indiana.

IN ADDITION TO FAR-REACHING PROGRAMS INVOLVING FUELS, LUBRICANTS AND PETROCHEMICALS, AMERICAN OIL AND ITS AFFILIATE, AMOCO CHEMICALS, ARE ENGAGED IN SUCH DIVERSIFIED RESEARCH AND DEVELOPMENT PROJECTS AS: Organic ions under electron impact / Radiation-induced reactions / Physiochemical nature of catalysts / Fuel cells / Novel separations by gas chromatography / Application of computers to complex technical problems / Synthesis and potential applications for aromatic acids / Combustion phenomena / Design and economics: new uses for present products, new products, new processes / Corrosion mechanisms / Development of new types of surface coatings.

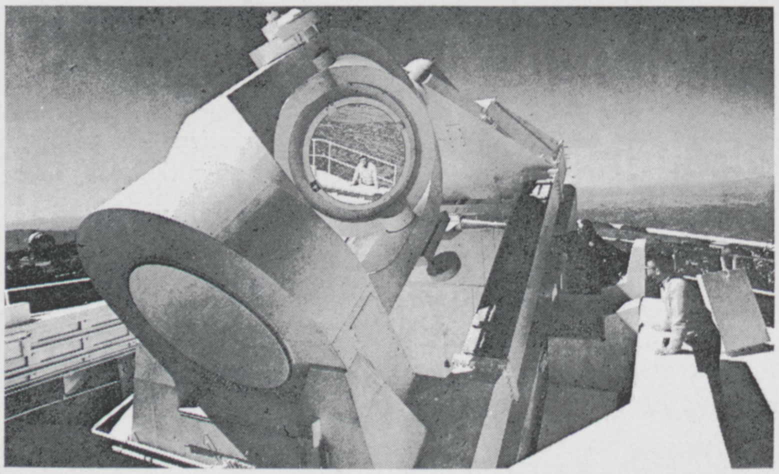
STANDARD

STANDARD OIL DIVISION
AMERICAN OIL COMPANY



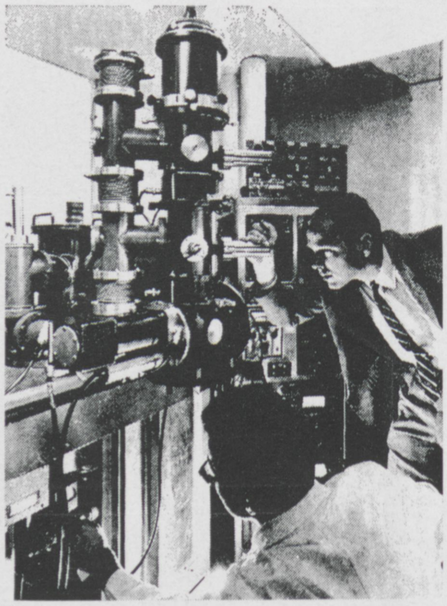
LARGEST SOLAR TELESCOPE

Looking like an inverted checkmark on the mountaintop at Kitt Peak, Ariz., the world's largest solar telescope has a design almost as dramatic as the work that is being done there. Only a third of the telescope's 500-foot-long shaft is above ground. The heliostat, or mobile mirror at the top of the shaft, follows the sun all day, reflecting sunlight down the 500-foot shaft to a 60-inch image-forming mirror, then 300 feet up the shaft to a third mirror, then to an underground observation room where astronomers can study the sun's composition using spectrographs. Mounts for all three mirrors were built by Westinghouse at Sunnyvale, Calif. The solar telescope is part of the National Science Foundation-financed Kitt Peak Observatory.



80-INCH TELESCOPE MIRROR

The solar telescope at Kitt Peak National Observatory near Tucson usually tracks the sun all day, but here its heliostat reflects the image of George F. Gayer, (right) engineer manager at the Westinghouse Sunnyvale, Calif., divisions. Westinghouse designed and built mechanical mounts for the 80-inch top mirror and for the two smaller mirrors of the world's largest solar telescope. The telescope is capable of photographing areas as small as 500 square miles on the sun 93 million miles away. After being reflected a total of 800 feet through the series of three mirrors, the sun's image is photographed or studied by astronomers in an underground observation room.



WESTINGHOUSE "EYE" SCANS SUBMICROSCOPIC WORLD OF ELECTRONICS

A new scanning electron microscope has been developed by Westinghouse having such depth of focus and resolution, that the pictures it gives are better than can be achieved with the best optical microscope.

Like a conventional electron microscope, the scanning variety "sees" with a beam of electrons. However, instead of taking a single snapshot of an area, the instrument scans the surface by repeatedly sweeping the electron beam across it, building up a picture as it goes.

The scanning electron microscope needs only about 15 millionths of a square inch of area to yield its extremely detailed pictures. Prime use of the Westinghouse instrument has been to study the surface structure (topology) of molecular electronic devices and other microelectronic structures and surfaces.

Edited by
Jerry Armes
Jr. E.E.

Optical Research and Development

This is the second installment of the revised feature formerly found in the **ROSE TECHNIC**. The feature presents current research and development briefs from industry, with the emphasis placed on different areas of specialization throughout the year.

Roswell E. Cutler (left), U. of Illinois '40, chief project engineer for regenerative engines, discusses the T78 program with Gordon E. Holbrook, M.I.T. '39, chief engineer for product design and development at Allison.

OPPORTUNITY IS AT ALLISON IN TURBINE ENGINE ADVANCEMENT

Allison—long-famous leader in the development and production of aircraft engines—is pacing state of the art advancement in the turboprop area.

A regenerative turboprop engine—embodying concepts further advanced than in any known turboprop in the world today—is being developed for the U. S. Navy by Allison . . . The Energy Conversion Division of General Motors.

Featuring a regenerative cycle which transfers heat from exhaust gas to compressor discharge air, Allison's T78 will extend long-range and on station capabilities of anti-submarine warfare through greatly improved fuel economy . . . thus projecting the usefulness of turboprop engines well into the future.

Too, hollow, air-cooled turbine blades—under development at Allison for the last 5 years—will permit higher inlet temperatures for a major improvement in engine performance. Greater reliability and simpler maintenance will be achieved with a unique, unitized propeller-reduction gear box.

Perhaps there's a place for you in our long-range engineering program here in the creative environment at Allison. Talk to our representative when he visits your campus. Let him tell you what it's like at Allison where Energy Conversion Is Our Business.

An equal opportunity employer

Allison

THE ENERGY CONVERSION DIVISION OF GENERAL MOTORS, INDIANAPOLIS, INDIANA

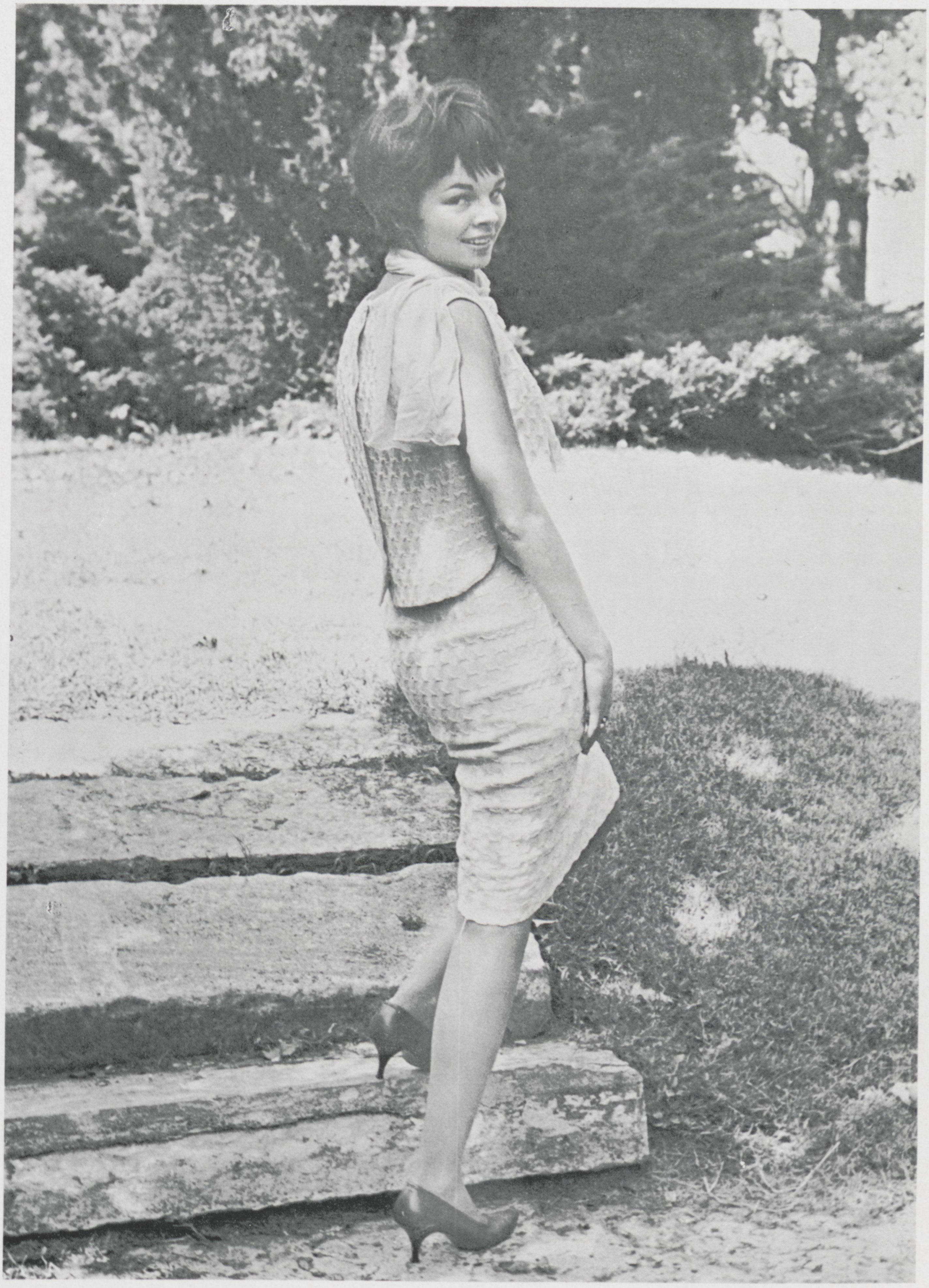
GM GENERAL MOTORS


THERE WILL BE AN EAGLE
PRATT & WHITNEY AIRCRAFT
DEPENDABLE ENGINES

This month's Miss Technic is Miss Gerry Bratt, a freshman at Indiana State. Gerry, an Elementary Ed. major, was born and reared here in Terre Haute. In fact she was reared to a very interesting 35-23-36 degree. She is a young lady of 18 and stands 5′5″ while weighing 115. Among her other interests (I imagine she has others, don't you fellas) she likes swimming and is a Dolphin pledge at State.

(Photography by Andy Breece)

miss technic for november



Egyptian Pyramids

Mr. Davidson is a Senior in Civil Engineering. He came to Rose after his graduation from Carl Sandburg High School in Orland Park, Illinois in 1959. Tom is well versed in construction work and the various types of material connected with this field. He is a married student and has a son Tom Jr. Even though he is kept busy being both a full-time student and father, he has been quite active the past four years on the Technic staff.

Tom Davidson
Senior, C.E.

Feats of great engineering and scientific achievement are performed almost daily: rockets probing space, lasers burning their way into measurement and communications, and atomic powered engines producing energy. These are but a few of the devices which, in the future, will trigger greater advances. Fifty years ago, lasers, rockets, atomic power, were unheard of, unimagined. At that time the wonders of chemistry and electric power were the sensations of the world. People found it hard to envision a more advanced society; what more could be invented? Airplanes, although crude, were a reality; the Model T was available to 95% of the people; the first modern war machine was flexing its muscles. Needless to say, other things have been invented, since the comparison of conditions then and now bear only slight resemblances. Before the 18th century, changes were made, but at a much slower rate, and before that at an even slower rate. Yet at each period in history people of that time swelled with pride at their accomplishments and wondered why the people of an earlier period had not thought of the same idea and performed the same feat. The answer is in the manner in which knowledge is gathered—with past experience as a foundation. It can be compared to a snowballing effect, the body of knowledge growing and gaining speed with time. Unfortunately, some history and knowledge gained by experience is spun off in the rush of time, just as the arts of making stained glass and cement were lost and had to be rediscovered. Another example of lost knowledge is the construction methods used to build the pyramids of ancient Egypt.

Although they stand today, much of their story lies untold in the sands of Egypt, never to be told and left only to hypothesis. These pyramids are an outstanding monument to early craftsmen and engineers, not only because of sheer mass, but also for their accuracy of construction. They were a fitting tribute to the kings for whom they were built.

If we had been in Egypt any time between 27-22 hundred B.C., we would have witnessed the construction of one of the famous pyramids. At the site, the engineer-architect would have been looking over plans, checking dimensions, and supervising construction. His instruments for measurement were crude, probably still water for leveling, a huge square for making right angles, and a graduated rod for distance. The mechanical aids for construction were limited to the inclined plane, rollers, and the lever. The only power available was man power. Perhaps the most famous of

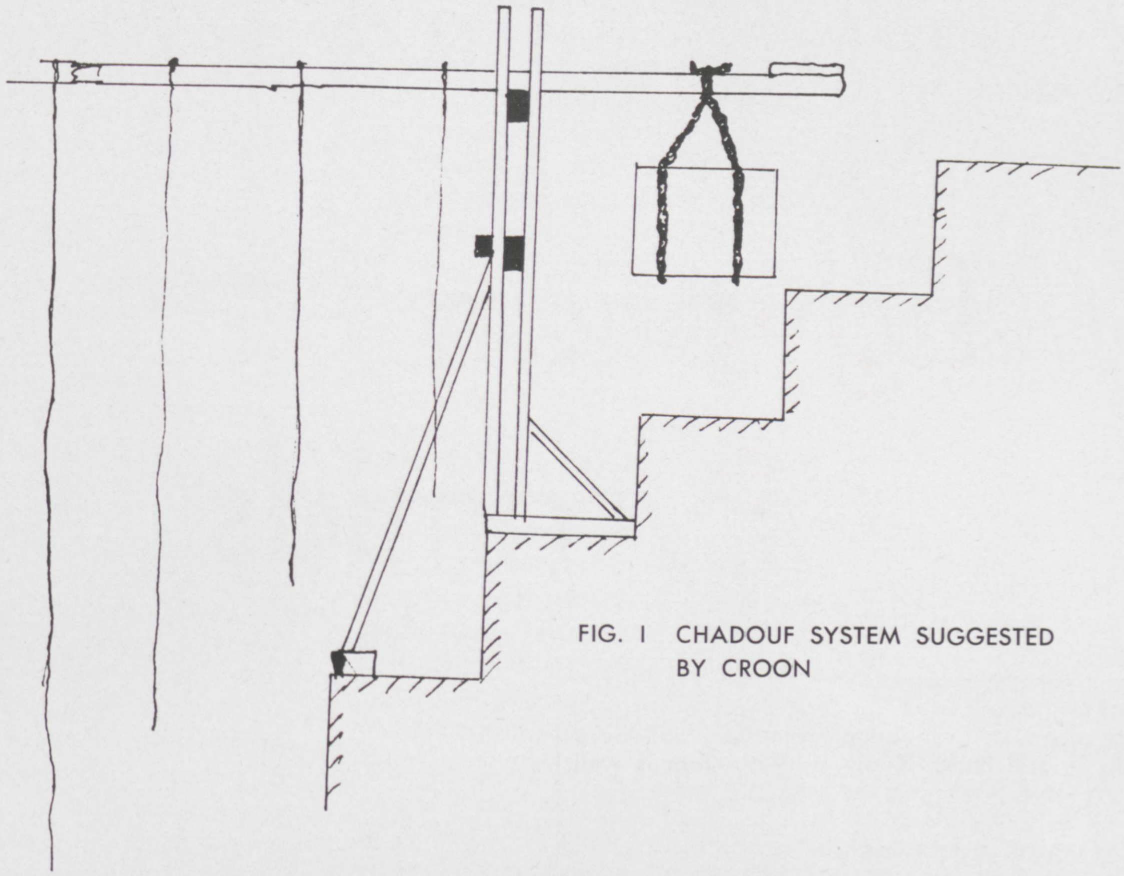


FIG. I CHADOUF SYSTEM SUGGESTED BY CROON

the pyramids, because of its size, was the great pyramid at Giza, built in the 27th century B.C. The height of this pyramid, when first built, was 481 feet; the base dimensions were 755 feet. These two dimensions show the magnitude and complexity; the problems which faced the builders. Actually, each of the $2\frac{1}{2}$ million blocks which made up the Great Pyramid was a problem in itself, because the average weight of each was over $1\frac{1}{2}$ tons. This would seem to be only a minor problem; however, it was greatly magnified by the fact that most of the blocks had to be quarried opposite Giza on the other side of the Nile River. Once the blocks were shaped, they were probably put into flat bottom boats by a gang of men which could have ranged in size from 20 to 100 men, depending upon the size of the block.

Once the blocks were dragged to the site of the pyramid, they were pulled into position to form the base course of the foundation which was on bed rock. The foundation was not flat and posed additional problems, such as maintaining the successive layers of blocks in a horizontal plane, and keeping the structure square. Two of the angles of the Great Pyramid of Giza are within three or four minutes of being perfect right angles, and on two sides there is only a variation of one inch from the average base length. Keep in mind that this is over 4500 years ago and that the instruments of the Egyptians consisted only of rods for laying off distance, wood squares for making right angles, and a still water sighting device for leveling.

After the base layer was laid, the next problem was lifting the blocks to the height of the first layer, and after that layer was completed the problem multiplied. There are several hypothesis of how Egyptians raised the blocks into position. One is the sand mound theory, which assumes that each layer was surrounded with an inclined plane of sand so that the stones could be dragged up the plane to complete the next layer. Then that layer was surrounded with sand until the new layer was finished. This process was continued until the pyramid was finished and surrounded by a mountain of sand. The angle of repose for sand is approximately 27°. Therefore, the height of the pyramid being about 500 feet, the sand would extend at least 750 feet from the base. An alternate theory to the sand-mound theory is the ramp concept which seems to have ample support from existing evidence. According to this theory, a sloping roadway was built either straight up or turned about the pyramid.

The roadway, sloping up at an angle of 20°, was probably surfaced with sun baked bricks to give a uniform surface for the block to be slid over. It has been estimated that a well drilled gang of men might raise the larger blocks 20 feet a day using the ramp. Another theory for raising the blocks was that of using cranes made of short timbers to move the blocks from one layer to the next. By this theory, it has been suggested that each tier had its own

(*Continued on page* 36)

HOW DO WE KNOW?

(*Continued from page* 14)

"Object" as used here, is that toward which consciousness is directed; the "object" of mind is anything perceived, imagined,, conceived or thought about. "Subject" as used here, is the individual "knower" considered either as a pure ego, a transcendental ego or an act of awareness. "Ego," of course, is "self" and "pure ego" is the "self" conceived as a non-empirical principle, ordinarily inaccessible to direct introspection but inferred from introspective evidence. There are two theories of "pure ego." The first is the "soul theory" which regards the "pure ego" as a permanent spiritual substance underlying the fleeting succession of conscious experience; and the second is the transcendental theory of Immanuel Kant (1724-1804) which considers the "self" an inscrutable subject presupposed by the unity of empirical self-consciousness. "Awareness" as used in this statement about the individual "knower" is consciousness considered in its aspect of *act,* i.e., an *act* of attentive awareness as the sensing of a color patch or the feeling of pain as distinguished from the *content* attended to, the sensed color patch, the felt pain. There is another conception of "self" which should be noted. This is the "bundle theory" and conceives of "self" as a mere aggregate of mental states. This is so-called as an allusion to David Hume's (1711-1776) famous description of the "self" as "a bundle or collection of different perceptions which succeed each other with an inconceivable rapidity and are in a perpetual flux and movement."

Epistemological monism is the theory that non-inferential knowledge (such as perception, memory, etc.), the object of knowledge (the thing perceived or remembered), is numerically identical with the data of knowledge — that is, the sense data, memory images, etc. This monism may be either epistemologically realistic when it asserts that the data exist independently of the konwing mind, or epistemological monism which identifies the content and object of knowledge by assimilating the object to the content. The idealism of George Berkely (1685-1753), by its rejection of a physical object independent of ideas directly present to the mind, is an example of epistemological monism.

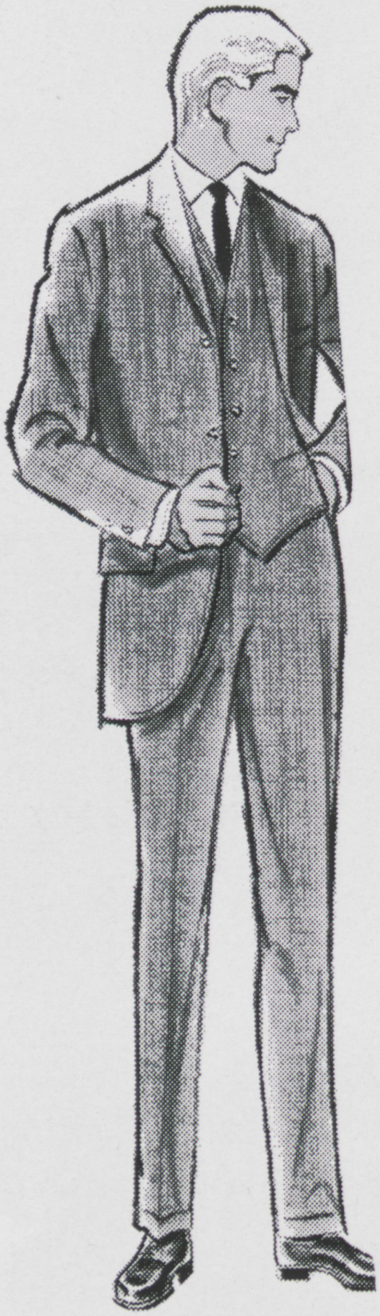
Although there has always been a distinct branch of philosophy concerned with the origin of knowledge there has always been the traditional problem of how knowledge originates. By what faculty or faculties of mind is knowledge attainable? The arguments over this question gave rise to the principal cleavage in modern epistemology between rationalism and empiricism — though both do occur in any thinker. The rationalists — Rene Descartes (1596-1650); Benedict Spinoza (1632-1677) and Gottfried Wilhelm Leibniz (1646-1716) — rely primarily, though not exclusively, on reason as the source of genuine knowledge and the empiricists — John Locke (1632-1714); George Berkeley (1685-1753) and David Hume (1711-1776) — rely mainly on experience. The limits of knowledge have always been in dispute. An epistemologist, who rejects an extreme or agnostic scepticism, may very properly seek to determine the limits of knowledge and to assert that genuine knowledge is possible within certain prescribed limits but yet, beyond those limits it is impossible. There are innumerable ways of delimiting the *knowable* from the *unknowable.* A typical instance of the sceptical delimitation of knowledge is that distinction which is made by Immanuel Kant (1724-1804) between the phenomenal and the noumenal world — his distinction between any presentation, cognition or experience whose form and order depend upon the synthetic forms of the sensibility and categories of the understanding; in contrast to "noumenon" and "thing in itself" which lie outside the conditions of possible experience and remains, therefore, theoretically unknowable.

WHAT IS TRUTH?

Truth is the culmination of the search for knoweldge. Today, it is usual to distinguish between the *nature* of truth and the *tests* for truth. There are three principal theories of the nature of truth. The first is the *correspondence* theory by which truth is conceived as a relation between an "idea" or a proposition and its object. Thus the statement "It is raining here now" is true if, in fact, it is raining here now; otherwise it is false. The second is the *coherence* theory which adopts as the criterion of truth the logical consistency of propositions with a wider system of propositions so that a proposition is true insofar as it is a necessary constituent of a systematically whole and this whole must be such that every element in it necessitates — indeed entails — every other element. Thus, its attaches to propositions as we know them only to a degree so that a proposition has " a degree of truth" proportionate to the completeness of the systematic coherence of the system of entities to which it belongs. The third is the *pragmatic* theory by which a proposition is accepted as true if it works or satisfies. Under this theory, some writers insist that truth characterizes only those propositions (ideas) whose satisfactory working has verified them; others believing that only verifiability through such consequences is necessary.

All this inquiry and investigation of knowledge leads directly into that branch of philosophy known as metaphysics which has been stated to be "the science of being as such." Simplified, it is nothing more than an attempt to think things out clearly to their ultimate significance or, as William James (1842-1910) has said, "to find their substantial essence in the scheme of reality" and thereby to unify all truth and reach that "highest of all generalizations" which, after all, constitutes the aim and purpose of philosophy.

(*Continued on page* 28)



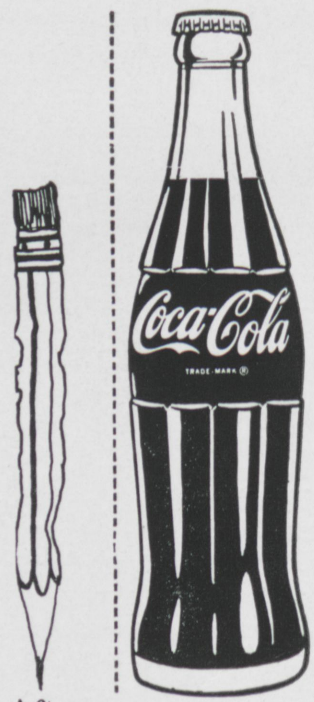
HOW DO WE KNOW THAT WE REALLY KNOW ANYTHING?

Now, after we understand all this, how do we really know that we know anything? Is absolute certainty of knowledge impossible? Will Durant has said that "no one ever convinced anybody by logic; and even logicians use logic only as a source of income." Arthur Schopenhauer (1788-1860) calls man the "metaphysical animal." If all this is true then, there still remains the question of how we know that we know anything. If, as has been said, "only knowledge is power and freedom" how can we know we have that power and freedom?

Few persons are able to describe coherently and consistently how anyone knows anything. We, of course, say that we know the date of our birth — but that is pure hearsay. We were there, certainly, but we have no memory of the fact; we have no awareness of that event remaining in any faculty we have to call upon. We do reach the conclusion that we were born by immediate deduction, or we have that knowledge because we reached it by reasoning but not by direct experience — still, our knowledge of the date is pure hearsay. A thing is said to be known *directly* when our cognition terminates in, and refers immediately to, the thing itself. On the other hand, a thing is known *reflexly* when our cognition terminates in, and refers immediately to, the image or concept of the thing previously known. Thus, we know a man directly upon seeing him but we know him reflexly when we see his portrait because then, we know him through the cognition of the image.

We are often extremely confident that we know something. But to what extent is that confidence that we know something a sufficient guarantee that we know anything? A great many people who are supremely confident they know what they are talking about, patently, do not. The Central Hospital for the Insane is full of them — and there are a great many of such persons running around loose. With all this, "knowing behavior" changes with the development of civilization and thought. "Knowing" reflects the views of the people at the time. What we understand, today, to have been the basic and fundamental beliefs of primitive people is at great variance with our beliefs. We do not have to go so far back to find examples to prove this point. Our ancestors knew that certain people were witches — knew it well enough to hang and burn them — yet we know, today, that despite our ancestors' complete and satisfying confidence in their beliefs, they did not know what they thought they knew.

The American Institute for Economic Research, at Great Barrington, Massachusetts, has, just this year, instituted a new graduate course in Modern Scientific Method, the objective of which is to attempt to determine the answer to the



question, "How do you know that you know anything?" Philosophers have been studying this question for many thousands of years — and have not come up with a satisfactory answer as yet. The Institute suggests a new hypothesis about knowing as human behavior: "Knowing may be described as awareness of similarities and differences in relations among things and events. Like all scientific hypotheses, this notion is not a conclusion or warranted assertion but a summary description of where (they) have decided to focus (their) attention for further research. Thus a baby may be said to know its mother when, after experience in noting similarities and differences, the infant differentiates and notes similarities sufficiently to identify its mother. The stages of this process are more prolonged than most of us are able to remember. An infant requires days, apparently, to differentiate between light and darkness, more days slowly to differentiate among the innumerable things from which light rays impinge his retina, and many more days in which gradually to increase awareness of similarities and differences among objects (including perhaps sound waves) in its environment before mother is known more definitely than a source of comforting warmth and necessary food."

The range from such simple knowing to the far more complex knowing evidences by the graduate student who successfully passes the general examination for his Ph.D. is great indeed. Nevertheless, the Institute suggests that knowing behavior throughout this great range can be described by the hypothesis adopted. They intend to investigate human knowing behaviors as they find them in the 20th Century and as they are found recorded for earlier periods. The sole purpose of this research will be to explore the usefulness of the hypothesis offered in order to ascertain whether or not and to what extent, if any, it may be useful in describing the knowing behaviors of men.

It is impossible, in advance of inquiry, to even pretend what the outcome will be. The adopted hypothesis may prove to be worthless, or it may be modified as the research progresses so that it can serve the needs as they appear, or it may prove to be useful in the sense that, until something better is developed, it will serve as a recorded description of part of man's knowing behavior.

Philosophy has often been criticised as not being a science; that it is inseparable from speculation; that the philosopher cannot use methods which establish knowledge, be it knowledge of facts or of logical relations; that he must speak a language which is not accessible to verification. Philosophy certainly, has had its "growing"' period; it has by now proceeded from speculation to science. The research now being inaugurated by the American Institute for Economic Research will inquire into the matter more adequately than has ever been done in the past and with the best of scientific methods available. The results will be awaited with great interest.

The Student Council

This is the second article of a series concerning the major student organizations on the Rose campus. The purpose of the series is to inform our readers of the background, activities, purpose and scope, and future plans for the elements of extra-curricular life at Rose. Hopefully, alumni will read about changes and developments in organizations they helped found or perpetuate. Also they may see new ideas and developments in the extra-curricular activities. Our high school readers may be interested in seeing what Rose has to offer to augment the academic program. Also, his series will inform the campus reader of the opportunities that are available to him by association with the Rose family of student organizations. This month we present the Student Council, the student government body at Rose.

Written by
John Stineman
Senior Class Representative

In the year 1899 the students of Rose Polytechnic Institute inaugurated what was called a "students' council." Its purpose was to be an intermediary between the student body and the faculty, and to allot student funds to the various organizations. The council was made up of the president of each class and the leading officer of each recognized organization at the Institute. Because only a minority of the council was actually elected by the student body, there was often great dissension between the students and their council, but membership on the student council was determined in this manner until 1958.

At the end of the 1957 school year there was again a great objection by the students concerning the methods by which they were represented. The student council president who took office in the next school year took it upon himself and his council to work out this major problem. Because of this, a new student council was formulated in the spring of 1958. A new constitution was written with a great extension of the duties and purposes of the council. Its membership was strictly by student election in the same method as we know it now. Three representatives are elected from each class. The other members are the presidents of each class and the financial secretary who is elected by the faculty. This type council is more representative than before, but it is often the opinion of the student body that their representatives are not fulfilling their elected duties as they should.

Although it is still early in this school year, the present council has shown that it does not want to be so over-ruled and soft-spoken as many councils before it. The Council is also seeking strength as well as respect and admiration from the student body, administration, and faculty. It is willing to tackle problems that were either passed over or left to the faculty in past years. Its first job this year was the long needed reapportionment of student funds. Next on the agenda it has offered to study the campus parking problem as a project of student interest. The problem has been resolved and awaits approval of the administration.

The main goal for this year is to make the council more representative of the student. This may mean an evident change in the form of government to the type used in electing our nation's congress, namely proportional representation. It could possibly include an all-campus election of a council president and vice-president, and separate unit elections for representatives by percentage of class population.

Dr. Logan, President of Rose, has been instrumental in helping with the needs of the Student Council and recognizing some of its shortcomings. He has generously contributed his services in planning self-government by the students of Rose without need of constant supervision and rebuttal from the faculty.

The Student Council wishes to serve well in its role as a mediator between the student body, organizations, and the faculty. Only through a formal organization such as this can the students make known their ideas and proposals. To carry on, it needs responsible men who are willing to devote both time and effort. In this way the Council can easily gain the prestige it seeks and deserves as an outstanding student governing body.

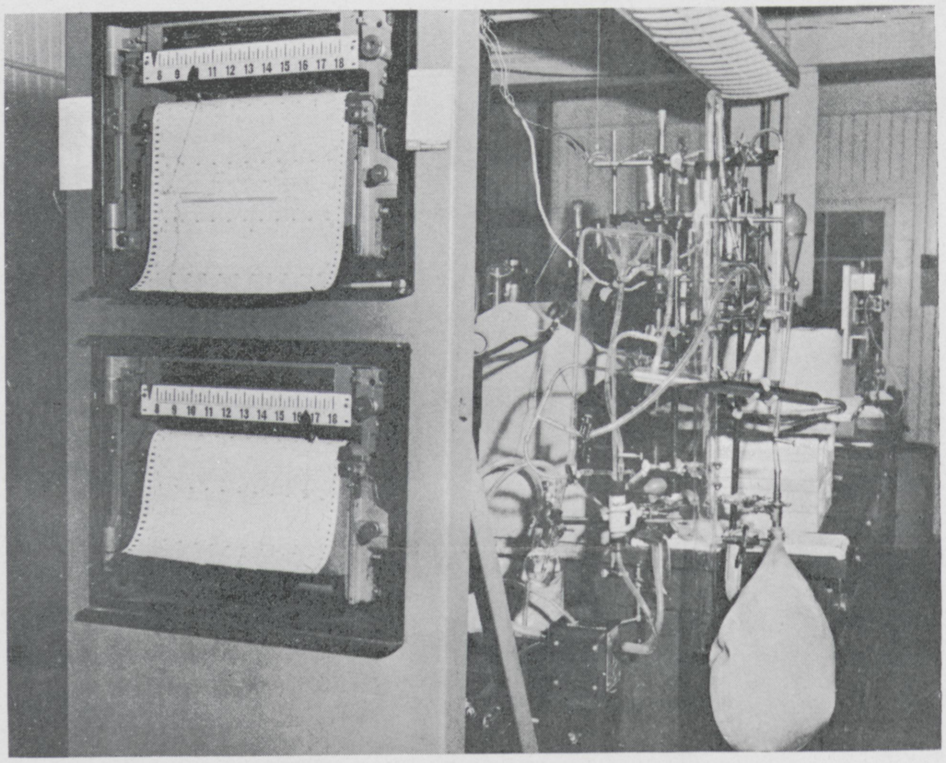
As important as the men who serve on it, the Council needs the ideas and support of the students it represents. With this support and the devotion of the council members, Rose can more readily adjust to its future increasing size and gain prestige in the eyes of its students, faculty and alumni.

BREATHING OF BACTERIA

(*Continued from page 9*)

of oxygen must also be consumed, and 1.24 moles of water is created. These same values must also hold for the rates of glucose and oxygen consumption and water production. Preliminary work in this investigation was devoted to studying glucose consumption rates and their relationship to oxygen consumption rates.

This was accomplished by measuring the depletion of glucose in the culture medium and by observing the oxygen consumption manometrically in a recording respirometer (shown in figure 1). These tests were all made using Oxygen-16. The final test during this investigation utilized Oxygen-18 and in this manner the rate of formation of water was determined.



All of the cultures utilized in the investigation were grown in the following manner. Twenty-four hour starter cultures were made on slants of tryptose agar. Three hundred milliliter Erlenmeyer flasks containing 100 milliliters of a nutrient media and fitted with porous stone diffusers were autoclaved for 15 minutes at 15 pounds per square inch. When cooled these flasks were inoculated from the slants. After 24 hours of aeration the contents of the flasks were asceptically transferred to 5 liter fermentors containing 2 liters of medium. The entire fermentor containing nutrients was previously autoclaved for 15 minutes at 15 pounds per square inch. After 12 hours the contents of the fermentor were removed, centrifuged at 2000 XG and washed three times. The washed cells were then resuspended in one liter of distilled water to a desired concentration of dry solids measured turbidimetrically. The suspension was then placed in the aeration chamber of the automatically recording respirometer. Glucose was then added and the run was started. The oxygen consumption rate was recorded automatically on the brown recorder of the recording respirometer. Samples of the culture were collected periodically and glucose concentration determined.

During the runs with Oxygen-18, samples of the culture were periodically collected, centrifuged and the supernatant liquid introduced into an electrolysis apparatus for separation into hydrogen and oxygen. The oxygen samples were then analyzed for Oxygen-18 using a mass spectrometer.

RESULTS AND CONCLUSIONS

The results of the glucose consumption and oxygen consumption tests indicate that the ratio between these two is equal to 1.17. This compares quite favorably with the ratio 1.20 as indicated in the chemical equation given above.

The results of the Oxygen-18 tests indicate that the ratio between the rate of oxygen consumption and the rate of production of water are 1.38, 1.64 and 1.18. In accordance with a chemical equation, the ratio should be 0.97.

The results of this investigation indicate the following:

1. The fermentation equation given above is correct in the relationship between oxygen consumption and glucose consumption.
2. The fermentation equation given above is incorrect in the ratio of oxygen consumed to water produced or the fermentation equation cited above is correct but there is a slower rate of water production than oxygen consumption, that is, there is some storage of the oxygen before it is actually utilized and converted to water.

This work has made two small contributions to the vast store of knowledge about biological systems. The fact that it was possible to observe an increase in the production of water during respiration is an important observation. Additional work utilizing Oxygen-18 would lead to a better understanding of respiration kinetics. Secondly, a quantitative trace of the production of water would be important in future metabolic studies of aerobic fermentation products. It is now possible to check on the production rates of all of the metabolic products.

This investigation was financed in part by a grant from the National Science Foundation.

Satellite Communications Systems

On October the fourth in fifty-seven
Sputnik was launched up toward heaven,
In the US the people were in shock,
The question fell upon Congress like a rock,
How the heck can anyone sleep
When all the night it goes beep, beep, beep?
Anonymous

by Stanley Hensen
Jr. E.E.

As mentioned above, the first man-made earth satellite was successfully launched about six years ago. During these six years many advances have been made in space technology and today definite plans are being made for a world-wide satellite communication network.

At the present time there are three different groups working on two separate satellite networks. NASA (National Aeronautics and Space Administration) and the Communications Satellite Corporation are working on a commercial system and the military is developing a separate system to meet the growing communications requirements for the defense of the country.

The three groups working on the communication satellite problem have different requirements and goals. The military requires a system that will provide rapid reliable communications at all times, even during a nuclear war. The Communication Satellite Corporation must have a system that is economical and provides high quality service to please the customers. NASA is working with the Communication Satellite Corporation by providing research, launch and tracking facilities and is conducting experiments with various types of satellites. In addition to helping the Communication Satellite Corporation, NASA is exploring many other parts of the communication satellite problem. By conducting research in these related fields, NASA is helping to maintain this country's position as the world's leader in communication satellite technology.

There is almost an infinite number of types of satellites which could be used to meet the requirements of these two systems. However, at this time the following three types are favored: the passive type such as Telstar and Relay and the active synchronous altitude type such as Syncom. The passive type of satellite is a large reflector which bounces signals back to earth. This type does not retransmit the signal. The active type of satellite uses complex transponders, antennas and power supplies to retransmit the signals from the ground stations. Low and medium altitude orbits are below the 22,300 mile altitude of the synchronous or 24 hour orbit. All three types of satellites have their advantages and disadvantages which must be contended with in designing a communication satellite system.

ECHO—THE PASSIVE REFLECTOR

Echo I was the first passive communications satellite launched and it proved highly successful. It was a 100 foot diameter balloon made of Mylar, covered with aluminum, which was put into a 1000 mile orbit in August of 1960. Many communication experiments were successfully carried out using telephone, facsimile and television signals. These tests proved the feasibility of using a passive satellite for communications and also shed some light on the problem of extending the life of the satellite. Echo I is still in orbit but it has suffered from atmospheric density changes and solar radiation pressures which have caused its reflectivity to drop about 3db. Even with this 3db loss of reflectivity, a television signal was sent from Massachusetts to California via the satellite. In an effort to overcome Echo I's structural limitations, Echo II was designed. It is a larger balloon with a 135 foot diameter and a stiffer skin. Except for the first model bursting in orbit, Echo II has also been successful.

NASA has limited its passive satellite efforts past Echo II to the problems of increasing the size of the reflector without increasing the weight and developing structures which would provide some signal gain. One promising solution to the first problem is to use a sphere made of wire mesh. However, this creates the problem of inflating a balloon that is full of holes.

The second approach of using a reflector with some gain also has its difficulties. To get gain from a reflector, it must be made directive which requires that the satellite maintain a constant attitude with respect to the earth. An active positioning system for a passive satellite would be unthinkable but fortunately a passive gravity-gradient stabilization system has been developed and was recently proved successful by use in a Nancy satellite. Gravity-gradient stabilization requires a satellite with one axis long compared to the others. This long axis will tend to align itself along the gravity-gradient. If other forces are reduced and a damping mechan-

(*Continued on page* 34)

SATELLITE

(*Continued from page* 33)

ism is added, gravity-gradient stabilization can be used effectively to hold a satellite in a constant attitude. The refinement of this technique will probably lead to the launching of a directive passive satellite.

Passive satellites have several advantages to their credit. They can have very long lifetimes, are practically jam-proof, are not frequency sensitive, can transmit all types of signals, are simple and low cost, and are ideal for multiple access by using different frequencies. Multiple access is the use of the satellite by several stations at the same time.

Some of the disadvantages of the passive type of satellite are the elaborate ground stations with complicated tracking antennas that are required and the relatively low orbits which require several satellites and creates the problem of jumping from one to another with possible breaks in communications while waiting for the next satellite to come within range.

TELSTAR & RELAY— THE ACTIVE REPEATERS

The Telstar satellite is probably the best known of all satellites, except for Sputnik I, because of its intercontinental television broadcasts. In addition to the television broadcasts, Telstar also provided much useful information about satellite performance in the space environment. One item of importance for a commercial system learned from the Telstar program is that tracking by the ground station is not as difficult as was feared and that tracking procedures for the future systems can be simplified. Also, much was learned about radiation damage to transistors in the satellite. The transistors in Telstar II took about four and a half times as long to reach the same level of degradation as those in Telstar I. The Telstar program has proven the feasibility of using low altitude satellites for a communications system.

The relay satellite which followed Telstar has been in operation for over seven months and has proven that a low altitude active satellite can provide high quality communications in a consistent and predictable manner. Relay has ironed out most of the problems faced in designing a first generation commercial system except launch reliability and longer operating lifetimes. The lack of solutions to these two problems is the main factor holding a commercial communications satellite system on the ground.

A communications system of active low altitude satellites has its advantages and disadvantages. Among the advantages are relatively easy launches into non-critical orbits, only a small loss of total communication facilities if a satellite is lost, and the satellites are of medium complexity and expense. On the disadvantage side are the complex and expensive ground stations, the tracking problems, occasional short losses of communications and the need of many satellites.

SYNCOM— THE SYNCHRONOUS REPEATER

Although the first communication satellite system will probably be made up of several low altitude active satellites similar to Relay, it is generally conceded that a system of active satellites in synchronous orbit would make a better system.

The first successfully operating satellite launched into synchronous orbit was Syncom II which was launched on July 26, 1963. Although it is in a synchronous orbit, Syncom II is not in a stationary position. It moves in a figure eight shaped pattern over the Atlantic between South America and Africa due to the plane of its orbit being inclined with respect to the equator. To place the satellite into the 22,300 mile high synchronous orbit, two steps were used. First, the satellite was fired into an elliptical orbit of 140 miles to about 23,000 miles. Then an apogee-injection motor in the satellite was fired to achieve a circular synchronous orbit.

Syncom was designed to handle all types of signals except television but recently a television signal

without sound was successfully relayed through the satellite's wide-band transponder. Most communications tests utilize voice, teletype or facsimile signals and are conducted between the Army ground station at Lakehurst, New Jersey, and Kingsport, a Navy satellite communications ship in the harbor at Lagos, Nigeria.

A larger version of the Syncom satellite is being built which will have greater communications capacity. With its lifetime extended to a few years a satellite similar to the Advanced Syncom could be used for a world-wide satellite communication system.

The advantages of a system of three synchronous satellites include simplest ground stations, minimal tracking problems, fewest satellites, no normal losses of communications and greatest flexibility in multistation use. The disadvantages include very complex satellites, critical orbit placement, transmission echo and almost complete loss of service with the loss of one satellite.

All three types of satellites — passive, active low altitude and active synchronous altitude—are being considered for use by the military and the Communication Satellite Corporation. The military has decided to start with a system of 24 to 30 medium altitude active satellites in random polar orbits. The second generation military system will probably be an active synchronous system and the third generation is planned to be a passive system. The military considers the passive system to be best suited to its requirements of growth, survivability, flexibility, reliability, and security.

Unlike the military, the Communication Satellite Corporation does not have to contend with the possibility of hostilities and is not worried about survivability and related problems. Also, unlike the military, the Communications Satellite Corporation does have the problem of making a profit. High quality service must be provided at a reasonable cost to the consumer.

The Communication Satellite Corporation's first system is as yet undetermined but it is expected to be either a system of a few active synchronous orbit satellites similar to Syncom or a system of about 25 or 30 random orbit active satellites similar to Relay. Before either system can be used the operating lifetime of the satellites and the launch reliability must be increased. Mr. Siegfried H. Reiger, Manager of Systems Analysis for Communication Satellite Corporation, has estimated that either system could begin to pay for itself by 1970 if a launch reliability of 50% and an operating lifetime of at least 3 years for medium altitude satellites or 2 years for synchronous satellites can be obtained.

Whichever system is used, it is obvious that an international satellite communication network is just around the proverbial corner waiting for modern technology to bring it into existence. Just what modern technology will find around this corner is about as definite as division by zero but who knows, you may be the one who gets the first peek.

Egyptian Pyramids

(Continued from page 25)

crane to speed up the raising of the cumbersome blocks. Croon, a German engineer, believes that this system was the same principal as the chadouf system which was, and still is, used in Egypt to draw water. The chadouf, if built strongly enough, could have provided the leverage needed to raise the blocks as shown in Fig. 1.

Some people believe that the construction of the pyramids was a phenomenon of levitation. Kingsland, author of *The Great Pyramids in Fact and Fiction,* wrote, "When the King built the pyramids, the large stones were brought from a great distance. They were placed on pieces of papyrus bearing certain symbols. They then rose into the air and covered a distance equivalent to the flight of an arrow. In this way they finally reached the site where the pyramids were built." This hypothesis has several loopholes, to say the least.

Another obstacle which confronted the Egyptian engineer was that of placing each layer so that it formed an angle of 51°52′ with the preceding layer so that the constant slope of the sides could be maintained. When the "stepped" portion of the pyramid had been completed, the outer casing of the pyramids, which consisted of white limestone, cut so as to incline inwards and give the structure its smooth plane surface, was applied.

The inclined stones were generally heavier than the other blocks, weighing up to 12 tons, and were cut with great precision so that the joints would be as close as possible. The joints were bonded together with a mortar of gypsum and sand. The quality of work is extraordinary, with the best work forming almost imperceptible joints as narrow as 1/50 inch, thus the sides of the pyramids formed planes from top to bottom. In the course of time, the shiny white facing of limestone has been removed and used in other buildings in the Nile Basin, thereby leaving the naked "stepped" pyramids which stand today, in various stages of ruin, ranging from slight truncated tops to a pile of assorted rocks.

Some people say that the Egyptians contributed little to further technology and engineering principles. Others regard their accomplishments in building the pyramids as great physical feats. There is little credit given to the Egyptian engineer. Today, using modern machinery, all of the pyramids could be built by an equal number of men as then in about three years. But consider the task it represented 4,500 years ago, with the tools then available, and not the modern machinery which took thousands of years to be conceived, designed, and improved. On a relative basis the Egyptian engineering feat would be on a plane with today's accomplishments, such as our space program. In summing up, it is apparent that the contributions of the Egyptian engineer are as basic as each rock of the pyramids, just as each experience or piece of knowledge is basic to the body of learning.

library notes

by Carson Bennett
Librarian

"Books are true levellers. They give to all, who will faithfully use them, the society, the spiritual presence of the best and the greatest of our race."

W. E. Channing,
Self Culture, 1838.

After thirteen and one half years of directing the "fortunes and misfortunes" of the Rose Library, I have accepted the position of Director of the Library in Heidelberg College, Tiffin, Ohio.

Somehow, I feel I have reared the Rose Library from infancy. The day I arrived, March 1, 1950, the books were on the floor in the present reading room. The new library was just being completed. In 1958 we again grew by adding the upper stack level.

Dozens of new periodicals, thousands of books, a record player and some 500 records, and other improvements have been made during my reign!

Mrs. Bennett and I wish to extend our sincerest best wishes to the Faculty and to each and every Rose student for continued success and happiness over the years.

From an inscription over the Library at Alexandria, Egypt comes this quote referring to the library— "A hospital for the mind." The library at Theges says "Medicine for the soul." Here, in some short reviews of our new books we hope we offer you some medicine!

AMERICAN HERITAGE HISTORY OF FLIGHT. American Heritage Publishing Company, 1962.

The ocean of the air has been conquered, bottom to top. Once he got going, man took only half a century to flutter off the earth and up to the portals of space. This delightful book begins with the myths of flight which seem to have haunted mankind from the very beginning. Supplementing the 70,000 word narrative and 450 pictures are portfolios of excerpts from the writings and reminiscences of the men who made the history of flight. The pictures represent one of the world's largest collections of art on the subject of flight which has ever been brought together in one place, or printed in good color.

AVI-YONAH, MICHAEL and KRAELING, EMIL G. OUR LIVING BIBLE. McGraw, Hill, 1962.

The Bible, with its enduring message for men of every age, is the most important collection of writings in the whole of world literature. In view of the all but incredible archeological discoveries in recent years, vast new dimensions in our understanding of Biblical lands, the people of the Bible, and the Bible itself have opened to us.

Our Living Bible was conceived as a work that would tell the story of the Book of Books in the light of these ancient treasures unearthed in modern times. Such visual records, drawings, ritual objects, and monuments, described as they are in this volume, provide valuable aids to a full appreciation of the Bible. Some 400 full color illustrations used here give the book an unrivaled visual impact as it recounts the story of the world of the Hebrew people of the early Christians.

BARACH, ARNOLD B.
1975: AND THE CHANGES TO COME. Harper, 1962.

Here is a panorama, by turns startling and sobering, of extraordinary changes to come between now and 1975. It is based on social developments that can be accurately predicted and on technical innovations that are already a certainty.

As W. M. Piplinger observes in his foreword to the book, "This book is history in reverse . . . "

BEAL, MERRILL D. "I WILL FIGHT NO MORE" — CHIEF JOSEPH AND THE NEZ PERCE WAR. University of Washington, 1963.

Unpublished letters and diaries by eyewitnesses, interviews with descendants, and intimate knowl-

(*Continued on page* 38)

LIBRARY NOTES

(*Continued from page* 37)

edge of the country enrich this narrative of the heroic Nez Perce Indian War waged in 1877 against relocation.

. . . A world surfeited with deceptive success stories can ill afford to forget a people and their leader who attained their true moral stature as they were facing their doom.

BIDDLE, FRANCIS. IN BRIEF AUTHORITY. Doubleday, 1962.

This is the second volume of Francis Biddle's memoirs. The period this book deals with, is from the years with Roosevelt to the Nurnberg Trial. Of course Mr. Biddle served as Attorney General of the U. S. during World War II. He served in many public offices prior to the appointment. After he resigned from the position of Attorney General, President Truman made him the American member of the International Military Tribunal which, for a year, tried the major German War Criminals at Nurnberg. A third volume will soon be published dealing with the trial — the horrors committed under Hitler's direction.

DAY, DONALD WILL ROGERS: A BIOGRAPHY. David McKay, 1962.

To go to the lighter side of life, this book is full of wit, anecdote and personality . . . Will Rogers was one of our most beloved countrymen. When he was killed in an airplane crash in 1935, a wave of sadness passed over the country similar to the national mourning following the death of Abraham Lincoln.

Will was born on the frontier, from mixed blood lines dominated by Cherokee. He had little education and early became a working cowboy. From the beginning, bit by bit, slowly as an oak grows, he branched out until at the time of his death he was the best known, best loved, most widely listened to man in the country.

JANSON, H. W. HISTORY OF ART. Abrams, 1963.

This volume is more than "just another history of art." It is fresh, lively, creative interpretation of the major visual arts — painting, sculpture, architecture — since the caveman. This book is a pleasure to read, it has accuracy, wit, and brilliance that has earned for its author the highest honors from his fellow art historians. The book really makes the story of art an adventure, an engrossing and continuing search for forms and techniques to satisfy man's ceaseless drive for effective expression in images and buildings. The pictures are outstanding — many colorplates with gold and red and the generous format of this book give it a sumptuousness without rival among the histories of art. It is a volume to read, to pore over and to enjoy!

LANDSBERG, HANS and others. RESOURCES IN AMERICA'S FUTURE: PATTERNS OF REQUIREMENTS AND AVAILABILITIES, 1960-2000. Resources for the Future, Inc., 1963.

One of the great questions before any nation concerns the adequacy of natural resources to provide the kind of living its people want . . . This book will give you an insight into the needs of our future.

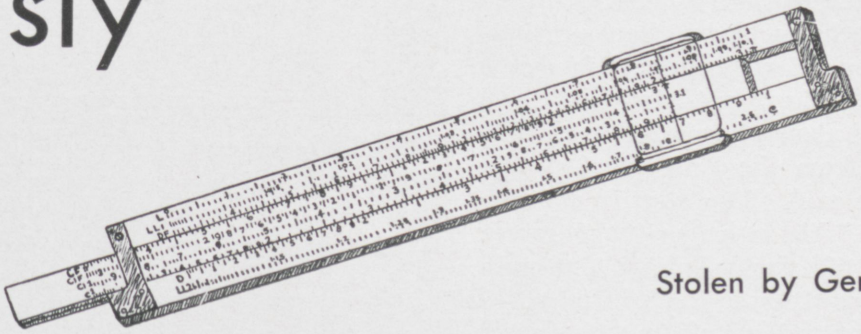
RAE, JOHN B. AMERICAN AUTOMOBILE MANUFACTURERS: THE FIRST FORTY YEARS. Chilton Co., 1959.

Typically American, because it embodies inventive genius, technological know-how, and organizing ability — here is the story of America's most representative industry — the AUTOMOBILE.

SCHUMAN, FREDERICK L. RUSSIA SINCE 1917: FOUR DECADES OF SOVIET POLITICS. Knopf, 1962.

Russia since 1917 is a brilliant and thoroughly documented reinterpretation of Soviet Russia's domestic and foreign affairs — the triumphs and tragedies, the accomplishments and failures of the Soviet regime to be found in one volume. It pays special attention to the changing relationship, bred of fear and suspicion, between East and West.

sly droolings



Stolen by Gerrand Mellinger, Sr. E.E.

A parrot was sitting in the salon of a luxurious steamer watching a magician do tricks. The magician was having considerable trouble though because after every trick the parrot would say, "Nothin' to it. Nothin' to it. Anybody could do that." Well, this went on for a while, and then the magician announced that he was going to do a trick that had never been done before. Just as he pulled up his sleeves and started to make a few fancy motions, the ship's boilers blew up, blowing the ship to pieces. A few minutes later as the parrot came to, floating about the ocean on a piece of driftwood, he spied the magician floating about in a life raft. He flew over to the raft and looking quite amazed, said to the magician, "No kiddin buddy, what didya do with that ship?"

* * *

The best way to drive a baby buggy is to tickle his feet.

* * *

The professor who comes in 15 minutes late is rare; in fact he is in a class by himself.

* * *

During a recent California drought everything was so dry that the trees were going to the dogs.

* * *

The awkward age: when girls are too old to count on their fingers and too young to count on their legs.

FAMOUS LAST WORDS:

"Hell they don't flunk graduating seniors!"

* * *

Rush Chairman: "Our fraternity maintains four homes for the feeble minded."

Rushee: "I thought you had more chapters than that."

* * *

"I just don't care (sob) . . . It wasn't nice of you (sob) . . . Now you can just take your arms away . . . I don't care what you say (sniff) . . . No, you're not gonna get this beer too."

* * *

Coed: The nimblest man on campus is the one who can shift gears in a Volkswagon without getting his face slapped.

* * *

It was the sleepy time of the afternoon. The prof. droned on and on; formulae, constants, and figures. An engineer, sitting in the second row, was unable to restrain himself and gave a tremendous yawn. Unfortunately, as he stretched out his arms, he caught his neighbor squarely under the chin, knocking him to the floor. Horrified, he bent over the prostrate form just in time to hear a murmur, "Hit me again, Sam, I can still hear him!"

* * *

Definition of a bird that got caught in the lawnmower—Shredded tweet!

* * *

"What was that explosion on Si's farm?"

"He fed a chick some 'Lay or bust' feed, and it turned out to be a rooster."

* * *

Brightly painted sign on a cross-country truck: "This truck stops for all crossroads, railroad crossings, blondes, brunettes, and will back up 20 feet for a redhead."

* * *

Bus Driver: "All right back there?"

Feminine Voice: "No, wait till I get my clothes on."

Then the bus driver led the stampede to the rear to watch a girl get on with a basket of laundry.

* * *

Two wealthy industrialists fell into an argument about whether the Russians were really our friends or not. The one who admitted that they were said, "Why, I'll bet I could ride a Russian ship to Russia, tour the country, and nothing at all would happen to me."

The other man called his bet and the sum was set at one million dollars. Two weeks later as the Russian ship left New York harbor, the ship's captain called the American from his cabin. "We haff cable for you from New York, friend," he snarled. "Read it."

The American, puzzled at the captain's belligerant manner, looked at the cable. It read: "If you can't get Nikita, try for Mikoyan."

(Continued on page 40)

JOKES

(Continued from page 39)

Three football players at different schools had flunked their classes and were dropped from the team. They got together and talked about their misfortune. The man from the University of San Diego said, "The calculus was too much." The man from Cal-Western said, "It was trig that got me." The guy from ISC said, "Did youse guys ever hear of long division?"

* * *

The freshman's father paid his son a surprise visit. Arriving at 1 a.m. he banged on the fraternity house door. A voice from the second floor yelled, "What d'ya want?"

The father answered, "Does Joe Jones live here?"

The voice answered, "Yeah, bring him in."

* * *

Wife: (to drunken husband at door): "Drunk again."

Husband: "Me, too."

* * *

The teacher was explaining to the grammar school students the merits of owning a yearbook and having one's picture in it.

"Just think," she said. "Thirty years from now you can look in this annual and say, "There's Willie Jones; he's a judge now. And there's Sally White; she's a nurse. And there's . . . .

"And there's teacher," came a voice from the back of the room. "She's dead."

* * *

Professor (pointing to a cigarette on the floor): Jones, is that yours.

Jones: (pleasantly) No, sir. You saw it first.

* * *

Daffynitions

Shotgun wedding: A case of wife or death.

Professor: A textbook wired for sound.

Confession magazine: A place where people write their wrongs.

Camel: A warped horse.

National Ad Index

Local Ad Index

This kind of chemical engineering is not as easy as it looks

An outmoded stereotype should not scare a good Ch.E. off from a highly satisfactory career in marketing. We are proud to say that the job calls for more than a collection of shaggy dog stories plus a convincing manner of taking two more strokes than the customer on that dogleg 14th hole.

Often a marketing career in our non-photographic operations starts out much like the traditional concept of chemical engineering, except that you work on the *customers'* production problems instead of our own. Then you get to meet a few live customers who come to see what you are up to. Maybe you are sent to a trade convention where you meet more than a few customers. To your amazement, they seem to regard you as a fountainhead of valuable technical information in a given area. To your further amazement you realize it's true—they do badly need to know exactly what you are being paid to tell them and show them. (Willy Loman never had it so good.) By and by, you may do a tour of duty in one of our field sales offices, or even get into the advertising end. As another course, you may settle down into liaison with manufacturers of equipment that needs to be fed with our plastics, fibers, solvents, chemical intermediates, or fine chemicals.

We define the chemical marketer as a chemical engineer who forges the most rational links between what we can most efficiently turn out and what other companies can most efficiently use. He is a hero of the chemical industry today.

As for the chemical engineer of different personality bent who, early in his career, prefers to put down roots in one of the three communities where we manufacture—Rochester, N. Y., Kingsport, Tenn., Longview, Tex.—we need him too. And of course, diversified as we are, we also need engineers of other than chemical persuasion, to say nothing of scholarly chemists and physicists to lay down good, solid foundations for all that engineering and creative salesmanship.

EASTMAN KODAK COMPANY

Business and Technical Personnel Department, Rochester 4, N. Y.

Kodak

An equal-opportunity employer

COULD YOU OUT-THINK A COMPETITOR?

Consider a Career in Technical Marketing

An Interview with G.E.'s J. S. Smith, Vice President, Marketing and Public Relations

Mr. Smith is a member of General Electric's Executive Office and is in charge of Marketing and Public Relations Services. Activities reporting to Mr. Smith include marketing consultation, sales and distribution, marketing research, marketing personnel development, and public relations as well as General Electric's participation in the forthcoming New York World's Fair. In his career with the Company, he has had a wide variety of assignments in finance, relations, and marketing, and was General Manager of the Company's Outdoor Lighting Department prior to his present appointment in 1961.

For more information on a career in Technical Marketing, write General Electric Company, Section 699-08, Schenectady, New York 12305.

Q. Mr. Smith, I know engineering plays a role in the design and manufacture of General Electric products, but what place is there for an engineer in marketing?

A. For certain exceptionally talented individuals, a career in technical marketing offers extraordinary opportunity. You learn fast what the real needs of customers are, under actual industrial conditions. You are brought face-to-face with the economic realities of business. You participate in some of the most exciting strategic work in the world: planning how to out-engineer and out-sell competitors for a major installation.

Q. Sounds exciting. But I've worked hard for my technical degree. I'm worried that if I go into marketing, I won't use it.

A. Don't worry—you'll use all the engineering you've learned, and you'll go on learning for the rest of your life. In fact, you'll have to. You see, the basic purpose of business is to sense changing customer needs, and then marshal resources to meet them profitably. That means that you must learn to know each customer's operations and needs almost as well as he understands them himself. And with competitors trying their best to outdo you, believe me—every bit of knowledge and skill you've got will be called into play.

Q. Is that why you said you wanted "exceptionally talented people"?

A. Technical marketing is not everybody's dish of tea. It takes great personal drive and energy, and a talent for managing the work of others in concert with your own. It takes flexibility . . . imagination . . . ingenuity . . . quick reflexes . . . leadership qualities. If you're nervous with people or upset by quick-changing situations, I don't think technical marketing's for you. But if you are excited by competition, like to help others solve technical problems, and enjoy seeing your technical work put to the test of real operation—then you may be one of the ambitious men we're looking for.

Q. Now what, actually, does a man do in technical marketing?

A. Let me describe a typical situation in General Electric. A field sales engineer is in regular contact with his customers. Let's say one of them makes an inquiry, or the sales engineer senses that the time is right for a proposition. With his field application engineer, he determines the basic equipment needed. Then he contacts the marketing sales specialist in the G-E department that manufactures that equipment. The sales specialist, working closely with his department's product engineers, specifies an exact design—realistic in function and cost. Then the sales engineer and his supporting team try to make the sale, changing and improving the proposition as they get cues from the competitive situation. If the sale is made—a very satisfying moment—then the installation and service engineers install the equipment and are responsible for its operation and repair. With the exception of the product design engineers, all these people are in technical marketing. Exciting work, all of it.

Q. In college we learn engineering theory. How do we get the sales and business knowledge you mentioned?

A. At General Electric, a solid, well tested program of educational courses will quickly advance both your engineering knowledge and your sales capacities. But perhaps even more important, you'll be assigned to work with some of the crack sales engineers and application and installation men in the world, and that's no exaggeration. A man grows fast when he's on the sales firing line. As a FORTUNE writer once put it, the industrial sales engineer needs "that prime combination of technical savvy, tactical agility, and unruffled persuasiveness." Have you got what it takes?

699-08

Progress Is Our Most Important Product

GENERAL ELECTRIC