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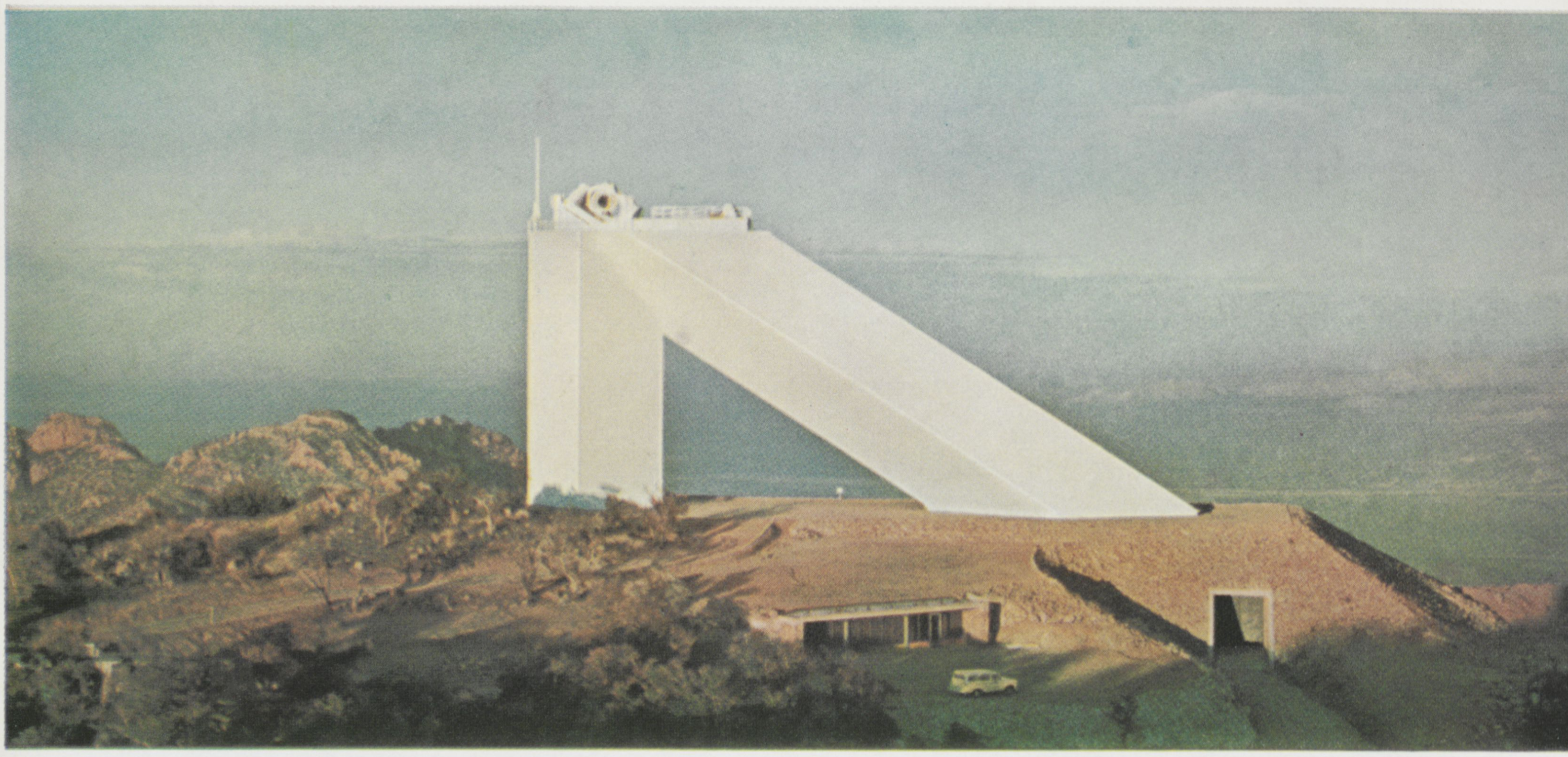
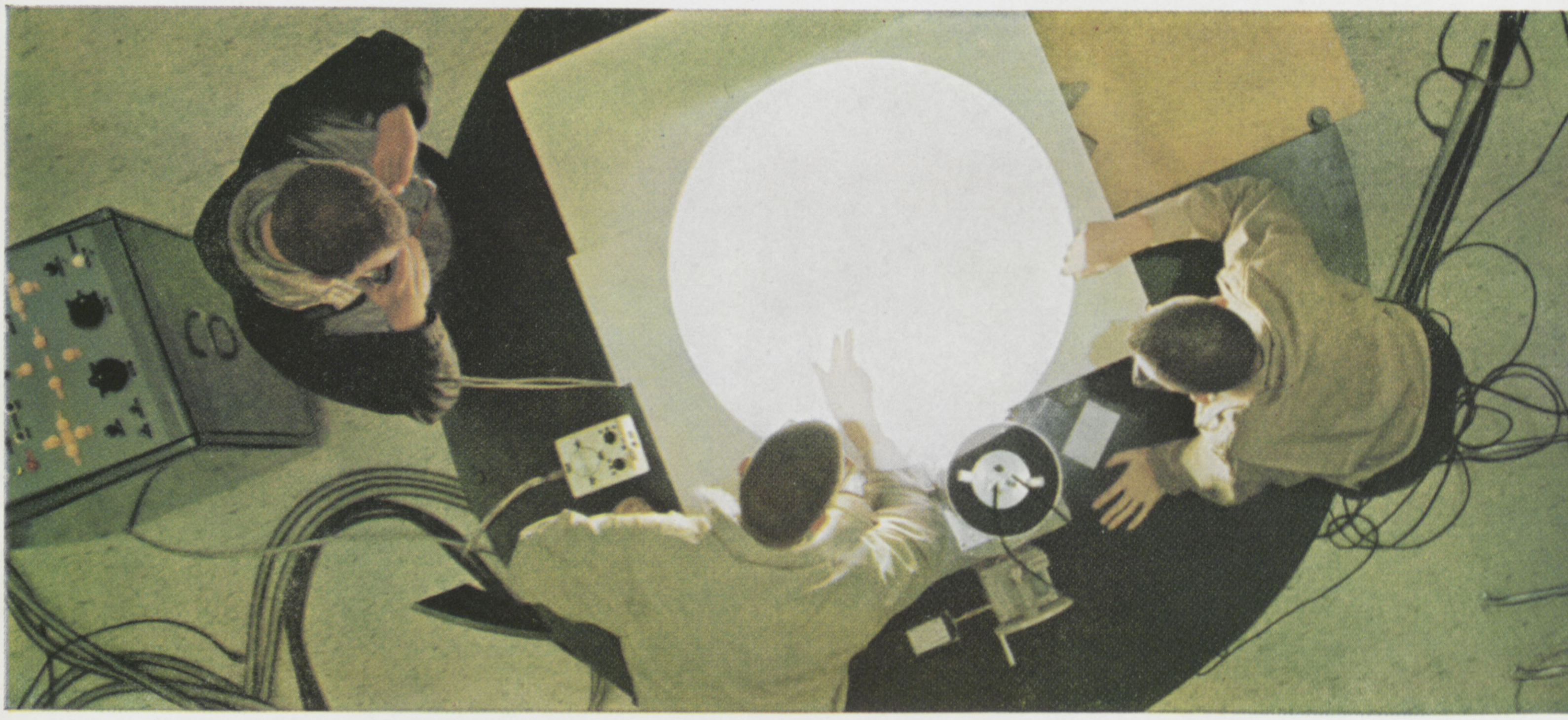
Rose Technic

February 1965

GENERAL SYSTEMS THEORY
ATOM CONNECTIVITY MATRIX
ORIGIN OF THE MODERN SCIENTIFIC METHOD



On top of Kitt Peak, the world's largest solar telescope



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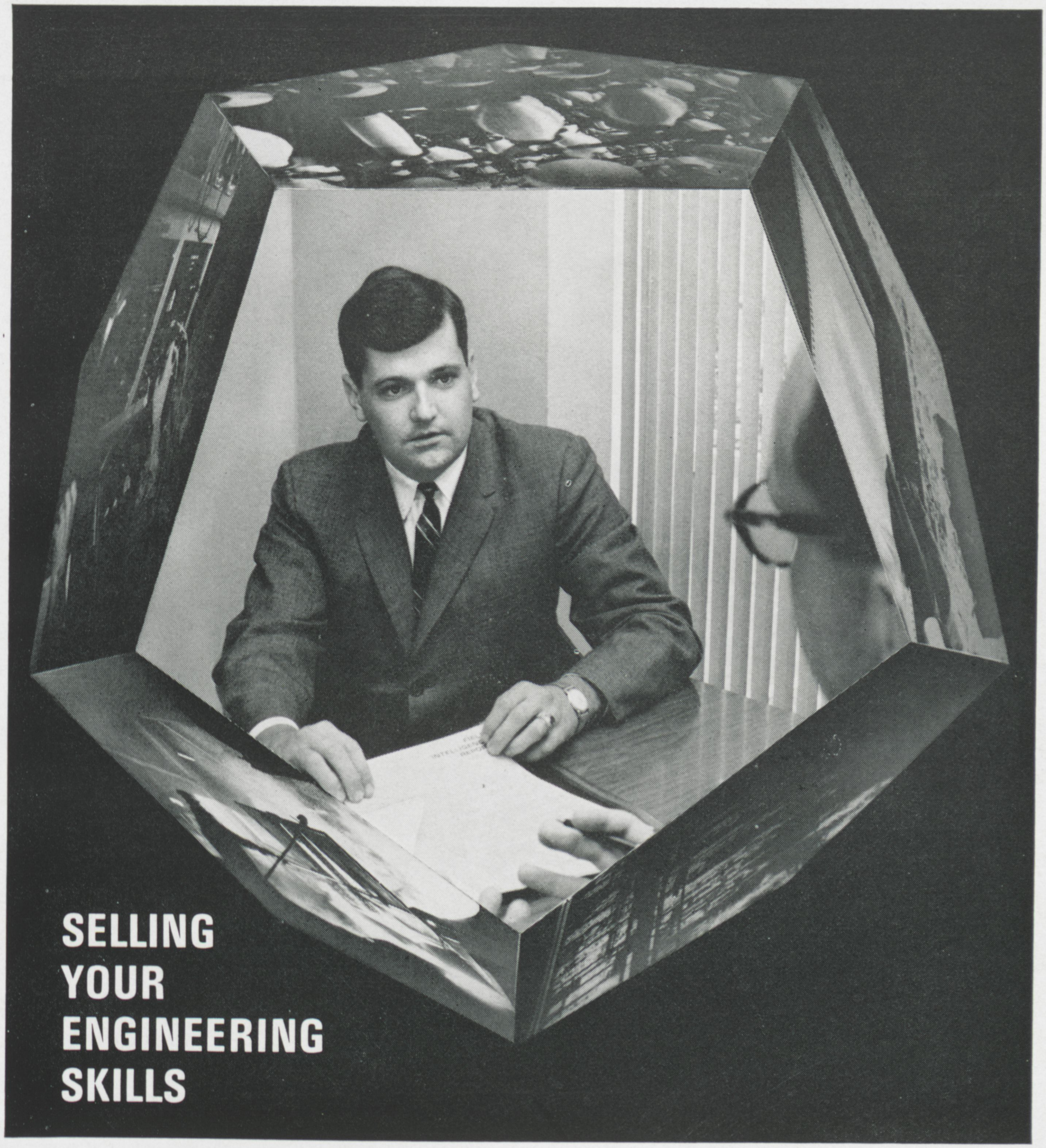

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IN THIS ISSUE

Elmer A. Guerri presents a discussion on the definitions, uses, results, and controversy of the General Systems Theory beginning on page 8.

For Ron Gesell's explanation of ACM (Atom Connectivity Matrix), a new symbolism allowing transformation of two dimensional pictorial molecular representations into mathematical expressions, see page 12.

The beginning and continued development of scientific methods is brought to light by George W. Allen in "The Origin of the Modern Scientific Method." For a clear picture of the different methods and the men who formulated them, turn to page 14.

COVER NOTE

This month's cover is by Greg Samoluk, a Junior Math Major. It is entitled "Transportation."

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Rose Technic

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NO NEWS IS BAD NEWS

Student publications at Rose seem to undergo periods of success and periods of failure much like business cycles in economic situations. This is a condition brought about by the periodic turnover of staff members, necessarily a characteristic of all student organizations. The degree of success or failure depends on what policies each staff in office chooses to follow.

During last semester the school newspaper reached the bottom of a cycle, and to the surprise of many people came to an abrupt halt in publication. This left only the Technic and the Modulus as student publications. While these are both fine organizations, they are somewhat removed from the day to day life of the student body.

Many students were so concerned with this situation that they have organized, and I am happy to report that we are again going to receive the services of a school newspaper. This will be an entirely new publication with a new staff, a new constitution, new policies, and a number of new ideas. By the amount of work this new staff has done and by the amount of interest they show, I feel this new organization will return the newspaper to the top of its cycle and establish an all time high.

I, therefore, encourage you, the students and staff of Rose, to support this new newspaper if by no other way but by reading it. I feel these men who have returned this service to us deserve our thanks, and I wish them the best of luck and the greatest success.

B S

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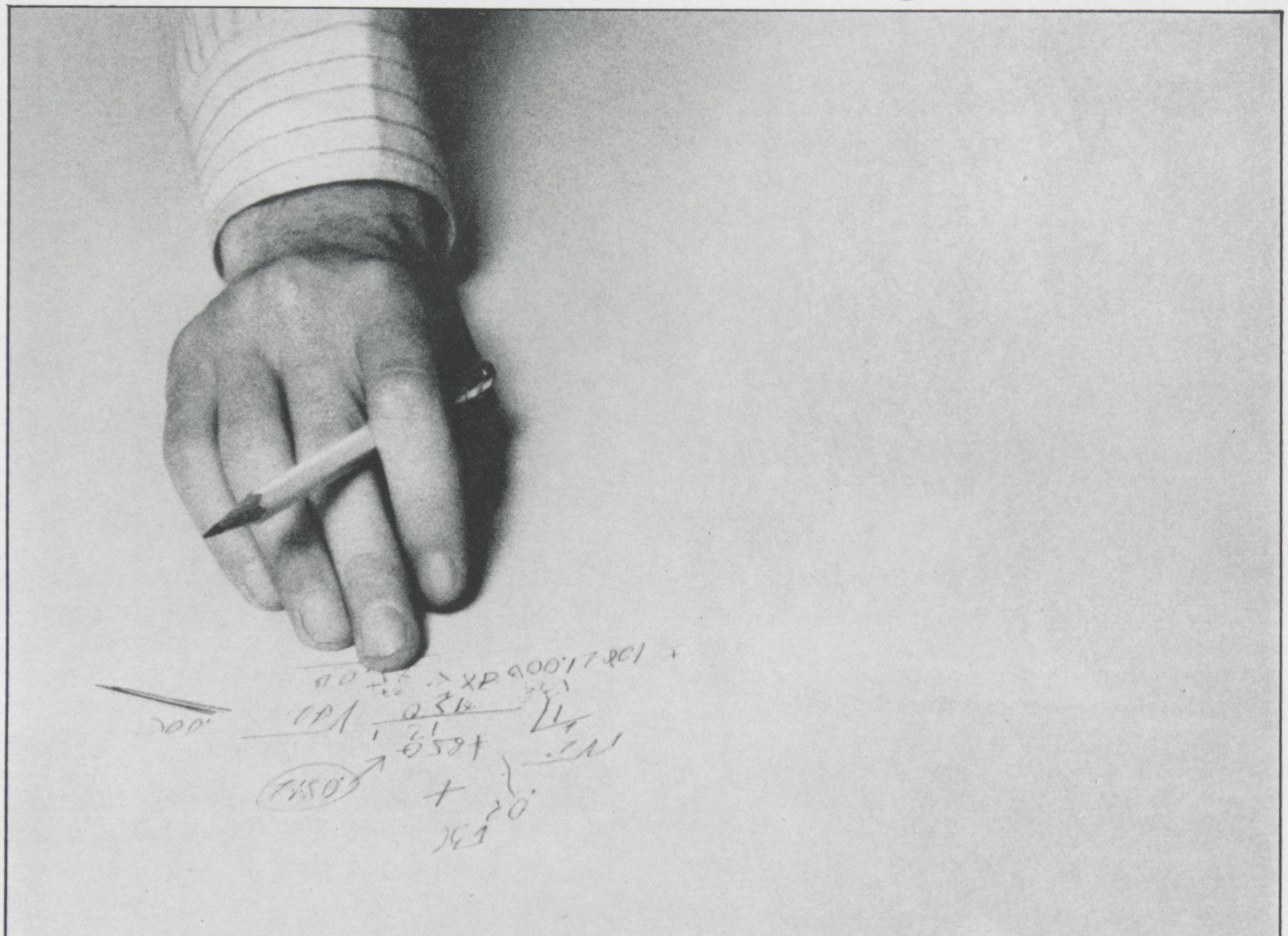

Lots of things. With a BS, MS or Ph.D. in chemical engineering, he may be working with plastics, polymers, inks, paper, metals, foods or pharmaceuticals.

In NCR's Finishes Control Laboratory, his assignment might deal with new process design for electro or electroless plating. Or with new etching techniques for printed-thru-hole circuit boards.

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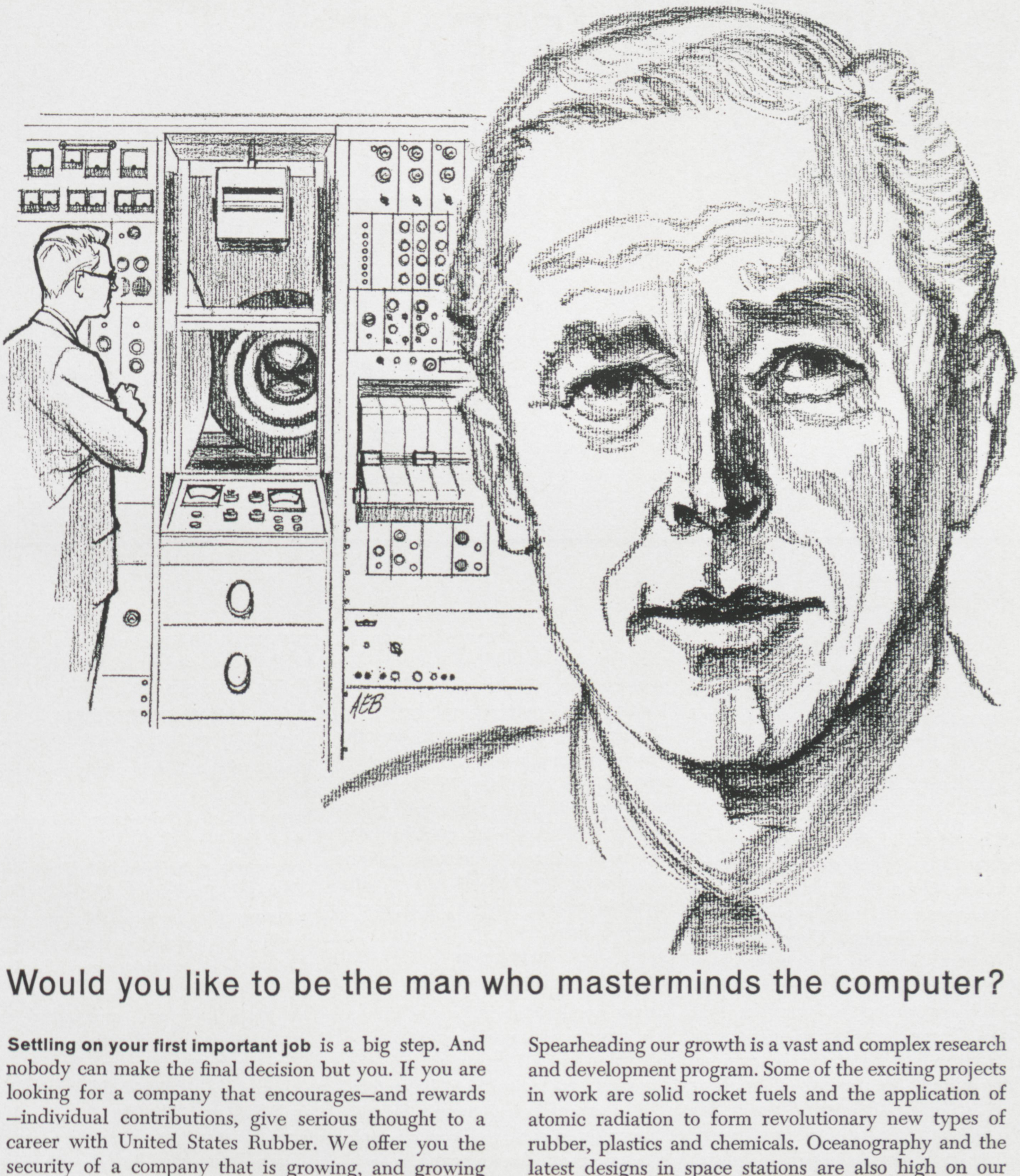

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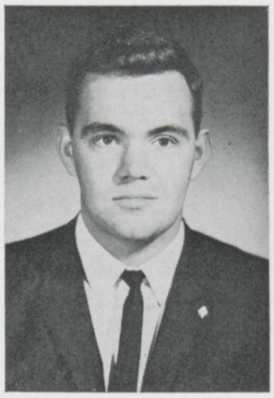
GENERAL SYSTEMS THEORY

by

ELMER A. GUERRI

Sr. Chem.



Elmer A. Guerri is a senior majoring in chemistry. He is married and commutes from Clinton, Indiana. Elmer is president of both the American Chemical Society Student Affiliate chapter and the S.A.M.E.

INTRODUCTION

The purpose of this article is to present a brief discussion of General Systems Theory. The definitions of General Systems Theory, the uses of General Systems Theory, and the results and controversy of General Systems Theory will be dealt with briefly.

The scope of the paper is not to present any new ideas or theories regarding General Systems Theory, but to merely discuss the above topic in General Systems Theory.

General Systems Theory contains relatively new methods for the study and investigation of complex systems. There have been many important advances made in various "disciplines" as a result of application of General Systems Theory.

Although General Systems Theory is relatively new (the first "General Systems" publication didn't appear until 1955), the overwhelming following it has gained among prominent scientists illustrates the high hopes which are being placed upon it for future use.

Any worker who calls upon General Systems Theory as one of his tools must develop a somewhat new scientific strategy. This strategy demands the acceptance of the organism or process being studied as a complex whole, as opposed to the more widely accepted scientific strategy of subdividing the complex system into simpler parts and "attacking each part separately."

This paper will not state that the "breaking into parts and analyzing" system has no place in "scientific strategy 1965.' This paper will merely try to illustrate the possibility of the application of General Sytems Theory to systems where the older strategy either fails or leaves much to be desired.

PURPOSE

General Systems Theory makes use of modern scientific techniques to develop warranted assertions applicable to all systems whether physical, biological, or behavioral. The purpose of General Systems Theory is to seek to discover analogies or more basic common principles in the various areas of scientific inquiry that will lead to fruitful integrating and interdisciplinary hypothesis.

One of the founders of General Systems Theory says: " . . . there exist models, principles, and laws that apply to generalized systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relations of 'forces' between them. It is legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general.

NEW DISCIPLINE

General Systems Theory can be looked at as the new discipline whose subject matter is the derivation and formulation of those principles which are valid for "systems in general."

According to Kenneth Boulding: "General Systems Theory is the skeleton of science in the sense that it aims to provide a framework or structure of systems on which to hang the flesh and blood of particular disciplines and particular subject matters in an orderly and coherent corpus of knowledge."

James G. Miller holds that General Systems Theory: " . . . finds formal identities between various physical systems, the cell, the organ, the individual, the small group or species, and the society (which) offer promise not only of coordinating the theories of . . . scholars but also of confirming their conclusions empirically, employing the dimensions and units of the natural sciences."

H. M. and A. B. Blalock say that system analysis is: " . . . taken to be a general mode of analysis used in all sciences. Systems are seen from three perspectives: (1) that involving the relationship between system and environment, (2) that involving interaction between several systems, and (3) that involving one type of system composed of other types of systems."

General Systems inquirers are concerned with all systems of any kind, not only with machine and man-machine systems. The inquirers attach great importance to furthering interdisciplinary studies and the unification of science. The techniques used to reach these goals center on finding analogies, "structural isomorphies,' "formal identities," and laws of wider and wider application in different systems.

Science has long been interested in living organisms, but for many years it has tried to find within the organism what is simple. The complexity of "the whole" has been overlooked in favor of the simple parts.

The process of looking for "simplicity" and overlooking "complexity" can be seen in the study of digestive process, the study of cerebralaction, physics, and biology.

"The triumphs of modern science have been along the lines of discovering and explaining the units out of which complex structures are made. This has been a triumph of analysis, not synthesis." Only as an afterthought has there been, in most instances, any studies made of the combined actions of the "simple units." The rule of "analyze into parts, and study them one at a time" was so widely followed that there was some danger of it degenerating into dogma.

ANALYSIS

Sir Ronald Fisher was one of the first to face squarely up to the fact that not all systems allow this analysis into single parts. He studied information about how the complex system of soil and plants would react to fertilizers by giving crops.

One method of analysis is to analyze plant and soil into a host of little chemical and physical substances, get to know each sub-system individually, then predict how the combined whole would react or respond. Fisher decided this would be too slow and that the information he wanted could be obtained by treating soil and plant as a complex whole. He then proceeded to conduct experiments where he could not alter the variables one at a time.

Fisher initiated a new scientific strategy. He accepted the complexity of the system as a non-ignorable property and showed how worthwhile information vould be obtained from it. It is important that he showed that this could be done only if the worker accepted the need for a new scientific strategy.

Hence we are looking at a system of studying an organism or process by accepting its complexity and studying it as a whole, as opposed to such sciences as chemistry and physics where a system to be studied is broken apart and studied piecemeal.

STUDY

The big question that now arises is: "What methods are there for the study of such systems, i.e., what general methods can General Systems Theory follow?

There are two plans of attack for study. The first one was well developed by Bertalanffy. It takes the world as we find it, examines the various systems that occur in it, and then draws up statements about the regularities that have been observed to hold. This is essentially an empirical method.

The econd method is to start at the other end. Instead of studying first one system than another, it goes to the other extreme, considers the set of "all conceivable systems" and then reduces the set to a more reasonable size.

Although the second method seems to be somewhat speculative, it has already been used with great reward in many instances, such as in crystallography. Crystallography studies on one hand to those crystals that actually occur in Nature, and it also studies all forms that are conceptually possible in its mathematical branch. It has been found that the set of all conceivable crystals must obey certain laws, and meathematical crystallography can make confident predictions about what will be found in certain cases. Mathematical crystallography thus forms a background or framework more comprehensive than the empirical material, on which the emperical material—the real crystals—can find their natural places and be apparently related to one another.

CONSIDERATION

The method of considering more than the actual has also been used to advantage in physics ,mathematics, and other sciences. For instance, in physics we speak of the massless spring, the fricionless pulley, and particles with mass but no volume. As shown above with the example of crystallography, consideration of a system whose parts are non-existent can be very useful and very conclusive at times.

The method devised by Bertalanffy, however, seems a little more feasible to us. Ludwig von Bertalanffy (1901-........) is one of the major contemporary biologists. His scientific interests range widely from physiology to biophysics and from methodology of natural science to historic-methodological researchs. He is a leader in the Society for the Advancement of General System Theory, which he founded.

A General System Theory did not occur to Bertalanffy all at once. In his earliest works bordering on General Systems Theory, he presents the idea of a continuity between natural-scientific (biological) and philosophical (methodological) research. Bertalanffy's methodological principles were developed in his theory of open systems and in his General System Theory.

By a system Bertalanffy understands a *complex* of elements in interaction. Starting from this definition, he essentially identifies systems with organized collections of objects. He speaks of "open" and "closed" systems. To the extent that closed systems do not possess the specific traits of organized complexes studied in modern biology, biophysics, chemistry, physiology, etc., Bertalanffy leaves them out of consideration,

(*Continued on page* 22)

since he is concerned exclusively with organized systems which he identifies with "open" or "teleological" ones.

A system is called "closed" if no substance flows into it or out of it (an exchange of energy, however, is permitted). A system is called open if not only energy, but also matter flows in and out. Equilibrium is a state of a closed system, independent of time, in which all macroscopic variables remain constant and all macroscopic processes cease.

Bertalanffy offers a definite mathematical model to describe the "behavior" of open systems, based on thermodynamics of irreversible processes.

Bertalanffy gives the general equation applicable to open systems in the form:

$$\frac{dQ_i}{dt} = T_i + P_j$$

$(i = 1, 2, 3, 4, \ldots, n.)$

where dQ_i is a definite characteristic of the ith element of the system (e.g., concentration or energy density), t is time, T is a function describing the velocity of transport of element as a given point in space, and P is a function describing the appearance of elements at a given location inside the system.

This general equation applies with proper modification and interpretation in any branch of science in which the investigation of open systems is the problem.

DEFINITIONS

According to Bertalanffy, a General System Theory must first of all give a logical definition of the notions "system" and "organization" and must classify the fundamental types of system. Second, it must make in certain cases a quantitative analysis of separate types of systems.

Bertalanffy emphaizes that a General System Theory is not an investigation of hazy and superficial analogies between physical, biological, and social systems. Analogies as such have little value, since differences can always be found among phenomena as well as similarities. He declares that the kind of isomorphism with which General System Theory is concerned is a consequence of the fact that in some respects correponding abstractions and conceptual models can be applied to different phenomena.

Within the bounds of General System Theory, Bertalanffy proposes the following classification of systems: (1) systems based on dynamic interaction of parts, (2) systems based on feedback loops, and (3) systems where stable states are reached by way of trial and error.

Now that we have considered a few definitions of General Systems Theory and have studied some of the characteristics common to all General Systems Theories, it is possible to turn to some applications of General Systems Theory and later to some controversial points regarding General Systems.

APPLICATIONS

Many advances have been made as a result of the direct application of General Systems Theory. The examples cited in this section are by no means an exhaustive list, but are meant to merely illustrate the variety of disciplines which have made use of General Systems Theory.

One of the most profitable applications of General Systems Theory was in the study of meteorology and psychology. John W. Thompson was a professional meteorologist in World War II. In the course of forecasting the weather he noticed certain analogies between meteorology and psychology which he thought would be worth studying at a more appropriate time. Two ideas occurred to Mr. Thompson: (1) It appeared that the meteoroligist's conception of an "adiabatic" process could be used to expose the limitations of current learning theory, and (2) that the introduction to meteorology during World War I of the notion of frontal discontinuities by V. J. Bjerknes suggested the desirability of a comparable revolution in terms of discontinuity in psychology and the social sciences, in which such concepts as homeostasi were overworked.

DISCONTINUITY

It appeared possible to develop a general theory of discontinuity embracing psychology, sociology, and capable of extension to politics and economics. Mr. Thompson did develop a theory which allowed for both continuity and discontinuity in human behavior and in equilibrium theory in the study of the past behavior of man. He illustrated that the large scale study of human behavior very closely resembled the study of weather as both involved the study of individual units grouped together into interacting systems.

In the field of botany a remarkable study in Systems Theory can be seen in the slime mold study of Ralph Gerard. Under conditions of adequate water and food supply a colony of this plant is made up of quite independent individuals, each with its own inputs, outputs, equilibratory mechanisms and ability to reproduce. Under more stressful conditions, when the environment is less favorable, however, these individuals flow together to form what is essentially a single multicellular organism with specialization of function or distribution of labor. Some become central cells, others peripheral cells which always flow toward the center, wherever it may be; some cells reproduce and others cannot a remarkable model of how humans band together under stress from a common enemy, as did the Londoners, for example, during fire raids in World War II. Mr. Gerard found that the slime molds and humans often react and function according to certain general principles common to both species.

MODEL

George J. Friedman used General Systems Theory to develop a model for the evolutionary process which will establish a series of models for learning behavior in a manner similar to that by which the process of natural selection establishes a series of individuals on an evolutionary scale. This is only one application to

(Continued on page 22)

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Dr. Tang was graduated from Chinese National Central University in 1944. He received his M.S.M.E. from the University of Wisconsin four years later, and in 1952, received his Ph.D.C.E. from the University of Florida.

Joining Allison in 1959, he is currently responsible for research in fluid dynamics and heat transfer devices for auxiliary power generation for space, under sea and terrestrial power plants. In the course of this work, he also carries out studies in boiling and condensing liquid metals, radiant heat transfer and phase separation in aerosols.

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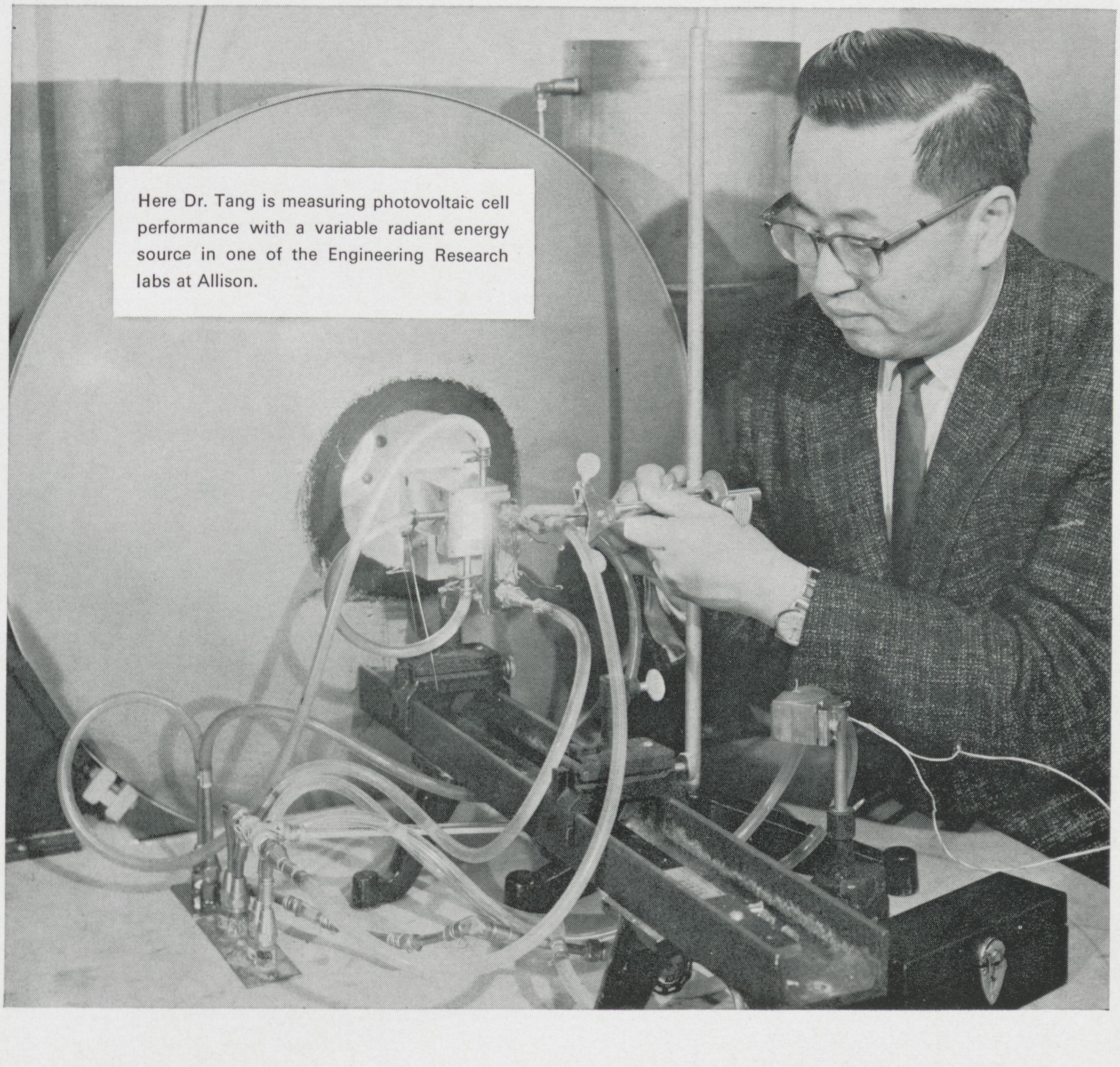


Here Dr. Tang is measuring photovoltaic cell performance with a variable radiant energy source in one of the Engineering Research labs at Allison.

THE ATOM CONNECTIVITY MATRIX

by RON GESELL, Sr. Math.

The atom connectivity matrix or ACM, is a new unambiguous symbolism which allows ready transformation of the usual two dimensional pictorial molecular representation into a unique mathematical expression readily useful for hand or computer manipulation. To use the ACM, one only needs to follow two simple rules.

Rule 1: Sketch the molecule with all the atoms and interatomic connectivities (bonds, bands, orders, ionic character, etc.) desired to be used in the ACM. Atoms and connectivities should be indicated in the sketch. Any model from a stick formula to more complicated structures may be used.

Rule 2: Construct a matrix array, the ACM, wherein the a_{ii} elements (the diagonal) represent the constituent atoms and the off diagonal elements represent the connectivity between the i'th and j'th atoms. The order of writing the diagonal elements is unimportant.

The characteristic polynomial, ACMCP, is obtained by evaluating the determinant of the ACM. Thus, ACMCP = det. ACM. The ACMCP is invariant with respect to direction of viewing the molecule and order of numbering the atoms, and has a unique one-to-one correspondence with its pictorial model.

The ACM and its ACMCP are

1. HYDROGEN CHLORIDE : H–CL

$$ACM = \begin{bmatrix} H & 1 \\ 1 & CL \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} H & 1 \\ 1 & CL \end{vmatrix} = HCL - 1$$

2. HYDROGEN CYANIDE : H–C≡N

$$ACM = \begin{bmatrix} H & 1 & 0 \\ 1 & C & 3 \\ 0 & 3 & N \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} H & 1 & 0 \\ 1 & C & 3 \\ 0 & 3 & N \end{vmatrix} = HCN - 9H - N$$

3. CARBON DIOXIDE : Ø = C = Ø

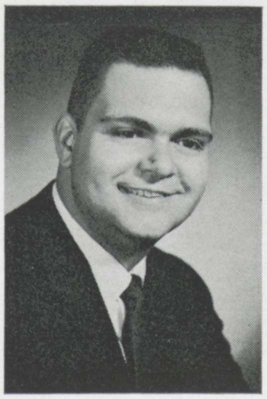
$$ACM = \begin{bmatrix} \text{Ø} & 2 & 0 \\ 2 & C & 2 \\ 0 & 2 & \text{Ø} \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} C & 2 & 2 \\ 2 & \text{Ø} & 0 \\ 2 & 0 & \text{Ø} \end{vmatrix} = C\text{Ø}^2 - 8\text{Ø}$$

4. METHYLACETYLENE : C≡C–C

$$ACM = \begin{bmatrix} C & 3 & 0 \\ 3 & C & 1 \\ 0 & 1 & C \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} C & 3 & 0 \\ 3 & C & 1 \\ 0 & 1 & C \end{vmatrix} = C^3 - 10C$$



Ron Gesell, better known as Guzzy, is a Senior Math Major. Decatur, Illinois, is his home town. Guzzy is a member of Alpha Tau Omega fraternity and is a cheerleader at the varsity games at Rose.

versatile in that any order of approximation may be selected, depending upon the molecular details to be represented. Demonstrations of the different orders are shown in Examples 1-5.

The zero order approximation: Only the basic linked backbone atoms are listed with hydrogen being omitted in organic molecules and fluorine in fluorocarbons or repeating groups in ionic structure. The connectivities between pairs of atoms are assigned integral bond order value of 0, 1, 2, and 3 for no, single, double, and triple bonds respectively.

Example 6. 2—methylcyclopropene: This gives rise to the same results as example 5. This is because one is the reflection of the other, and both have the same molecular formulas by conventional methods.

One might then ask if any four-carbon structure gives the same results. The answer is no, as example 7 will show. This is because of the bond structures which by conventional formulas would all be the same, but by using the ACM, a formula can be found which differentiates between the different chemical structures.

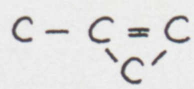
By letting R stand for a radical, some organic equations can be reduced to simple zero order structures. This is shown in Example 8 below.

The first order approximation is the same as the zero order, only all the atoms are included. See Example 9 below.

Then the higher orders may in

(*Continued on page* 28)

5. 1-METHYLCYCLOPROPENE:

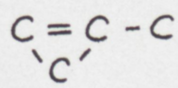


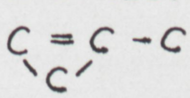
$$ACM = \begin{bmatrix} C & 1 & 0 & 0 \\ 1 & C & 2 & 1 \\ 0 & 2 & C & 1 \\ 0 & 1 & 1 & C \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} C & 1 & 0 & 0 \\ 1 & C & 2 & 1 \\ 0 & 2 & C & 1 \\ 0 & 1 & 1 & C \end{vmatrix} = \begin{vmatrix} C & 2 & 1 & 1 \\ 2 & C & 1 & 0 \\ 1 & 1 & C & 0 \\ 1 & 0 & 0 & C \end{vmatrix}$$

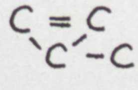
$$= C^4 - 7C^2 + 4C + 1$$

6. 2-METHYCYCLOPROPENE:





7. 3-METHYLCYCLOPROPENE:



$$ACM = \begin{bmatrix} C & 1 & 0 & 0 \\ 1 & C & 1 & 1 \\ 0 & 1 & C & 2 \\ 0 & 1 & 2 & C \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} C & 1 & 0 & 0 \\ 1 & C & 1 & 1 \\ 0 & 1 & C & 2 \\ 0 & 1 & 2 & C \end{vmatrix} = C^4 - 7C^2 + 4C + 4$$

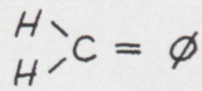
8. ALKYBROMIDE:

R- BR

$$ACM = \begin{bmatrix} R & 1 \\ 1 & BR \end{bmatrix}$$

$$ACMCP = RBR - 1$$

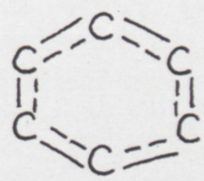
9. FORMALDEHYDE:



$$ACM = \begin{bmatrix} H & O & 1 & 0 \\ O & H & 1 & O \\ 1 & 1 & C & 2 \\ 0 & 0 & 2 & \emptyset \end{bmatrix}$$

$$ACMCP = H^2C\emptyset - 4H^2 - 2H\emptyset$$

10. BENZENE:



ACMCP =

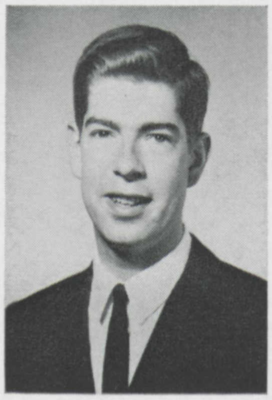
$$\begin{vmatrix} C & 3/2 & 0 & 0 & 0 & 3/2 \\ 3/2 & C & 3/2 & 0 & 0 & 0 \\ 0 & 3/2 & C & 3/2 & 0 & 0 \\ 0 & 0 & 3/2 & C & 3/2 & 0 \\ 0 & 0 & 0 & 3/2 & C & 3/2 \\ 3/2 & 0 & 0 & 0 & 3/2 & C \end{vmatrix}$$

$$= C^6 - \frac{27}{2}C^4 + 81C^2 - \frac{729}{64}$$

The Origin of the Modern Scientific Method

by

GEORGE ALLEN
Soph. Ch. E.



George Allen is a native Hoosier, from Indianapolis. He is a sophomore in Chemical Engineering. George is also a member of the Debate Team.

Since the beginning of human history, one of man's basic characteristics has been curiosity. In order to satisfy this quest for knowledge and to attempt to better understand themselves and their environment, human beings developed and are continuing to develop the scientific method. Throughout the centuries of its use this process has naturally changed and evolved right along with the type of scientist using it.

In its basic form the scientific method is the process of man applying his trained and organized common sense to answer his questions. Therefore, any study of the scientific method through history is simply looking at the different methods people have used to interpret the nature of things in the most logical manner.

The birthday of the scientific method, as we know it today, occured late in the Sixteenth Century. It was from these new ideas, methods, and principles that our modern techniques for obtaining scientific knowledge have evolved.

Of course a scientific method had been used before the Sixteenth Century. The first human to take an active interest in science and scientific methods were men of the early civilizations in Persia, Egypt, Greece, and Rome. The two major scientific philosophers of ancient times were Archimedes and Aristotle. These men gained scientific knowledge using a method known as syllogism. Syllogism is a process of taking two premises and deriving a logical conclusion from them. A typical syllogism would be: All metals are good conductors of heat, and all good conductors of electricity are metals; therefore, all good conductors of electricity are good conductors of heat. Obviously some syllogisms are valid; others are not. Aristotle, by observing natural phenomena around him, was able by syllogism to create the first real set of scientific ideas. Since he was unable to suggest any unfallible method of obtaining the necessary premises, his syllogistically derived ideas were not always accurate or correct. This syllogism was, however, the first step along the road to a valid scientific method.

After the fall of the Roman Empire the world entered the Dark Ages, a period in which little or no scientific progress was made. In fact much of the ancient scientific effort was lost or forgotten. Scientific progress during the Renaissance was confined to the rediscovery of lost information with most schools and men of science re-establishing and reaffirming classical science as the accepted fact with any change or revision of it being suppressed.

With the beginning of the Intellectual Revolution in Western Europe came the skeleton of the scientific method as we know it today. The champion of this new method was Sir Francis Bacon, an English scientist. Bacon realized that syllogistic reasoning was very unsuitable for discovering and interpreting the laws of nature. Recognizing that some of Aristotle's theories were not absolutely correct, he proposed a new method of scientific research to replace syllogism and to answer some of the questions left by Aristotle. His method is known as induction, provided a process whereby scientists could cautiously rise from known observed facts by expanding these facts into wider and wider generalizations. Upon expanding the observation, every effort was made to disprove or find exception to the generalization. If the generalization were disproved, it was replaced or modified to fit the new facts.

An important part of Bacon's new method was experimentation. Before this time scientists had been mainly concerned with observing and interpreting naturally occurring phenomena. Bacon's induction depended upon unnatural or induced phenomena aimed specifically at proving or disproving an hypothesis. Haphazard experimenting is no good. Experiments should be organized and directed.

In general induction consists of four distinct, ordered steps: 1) Observation, 2) Hypothesis, 3) Experiment, and 4) Induction. Obviously if any of the four steps are incorrect beyond the necessary degree of accuracy, all the other steps are meaningless, and the final conclusion invalid.

Bacon had the right idea, but he carried it a little too far. He felt that his method was an infallible one which would automatically give the scientist the right answer. There were, however, two fallcious suppositions involved with the method. Bacon felt that there were only a finite number of observations and experiments possible, and thus man would be able to complete his scientific investigation in a finite amount of time. It is now known that scientific knowledge by its very nature is capable of infinite extension meaning that neither induction nor any other method will ever enable men to know everything. Secondly Bacon assumed that every observation would be absolutely corect. Again it is now known that all answers obtained, no matter how convincing they may seem at the time, are always subject to change in the light of fresh evidence.

Bacon's induction, however, was used throughout the Intellectual Revolution, and during this period it was constantly extended and bettered by contributions from various scientists. The first real user of induction was the "father of modern science," Galileo. The first example experimentation specifically to test a theory was Galileo's famous test of Aristotle's story of the velocities of falling bodies. Late in the Sixteenth Century Galileo supposedly dropped two bodies of different weight from the Leaning Tower of Pisa. The two bodies hit the ground simultaneously, thereby disproving Aristotle's theory. He performed many small scale, simple experiments and suggested many other "thought experiments" to be tried later by others.

Galileo made four important contributions to the scientific method. First he showed that before causes of a phenomenon could be established, it was necessary to determine what the phenomenon actually was and how it was related to other phenomena. Secondly he insisted upon the complete objectively of the observer during experimentation. For example he differentiated between properties of a body (mass, size, position) and properties which bodies have that produce an effect upon the observer (smell, taste, color). This difference, he noted, must be kept in mind during an objective scientific investigation. His third contribution to the scientific method was his manner of interpreting observations and experiments. The main feature of his interpretation was the important place he gave to space and time. Fourth, he showed that experiments could be carried out through readily available means and that important theoretical conclusions could be drawn from relatively simple experiments.

Other following scientists modified and improved the new method of scientific investigation. Newton, the greatest scientist of the age, introduced mathematics strictly as an instrument of investigation. While he did not exclude experimentation from his method, he had greater success with his mathematical investigation. Clerk Maxwell was also very successful in his mathematical interpretation of observed phenomena.

In contrast to these two, the physicist Farady showed that the method of inductive investigation could be caried out very successfully without the use of mathematics, elaborate apparatus, or endless experiements if only the scientist would make full use of acute observation, imagination, and his power of simplification.

Another contributor to the scientific method was made by the chemist Henry Cavendish. Thanks to extremely careful and cautious work, he was able to prove that the one-one hundred and twentieth part of the air which was not nitrogen or oxygen, was not an experimental error but was actually another constituent gas of the air, argon. Thus the importance of accuracy in the inductive process was established.

Newlands and Mendeleeff, in discovering that properties of elements varied periodically with thir atomic numbers, established classification as an important part of the modern scientific method.

In addition to the men who actually used and changed the scientific method in their work, there were others who, through their discoveries and inventions, gave to the scientific method many new tools. In spite of Faraday's amazing "mathematics-less" successes, Bacon's induction would have produced new startling results without the resurrections of the ancient and the invention of new mathematical science. Mathematical advances of the age such as Newton's and Leibniz's calculus, Napier's logarithms, Descarte's coordinate system, Fourier's series, and Lagrange's differential equations are largely responsible for the development of the scientific method to its present usefullness.

A method which is so dependent upon observations and measurements was naturally enhanced by the invention of better and better measuring and observing devices. The invention of the telescope, microscope, barometer, thermometer, balance, and electrical equipment by such famous scientists as Galileo, Torricelli, Hygens, Newton, Michel, and Volta made the use of the scientific method easier, more efficient, and more effective.

(*Continued on page* 29)

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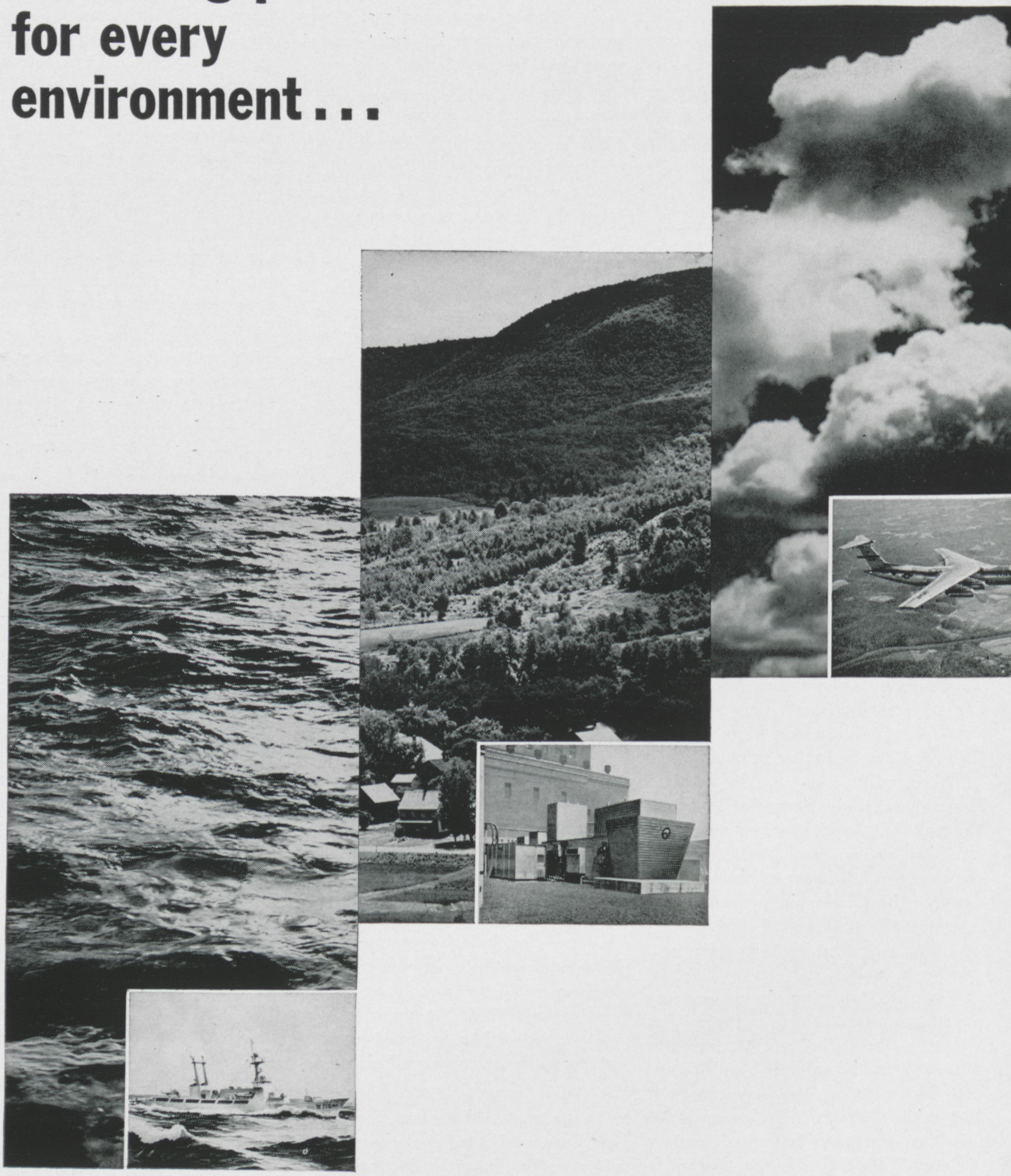

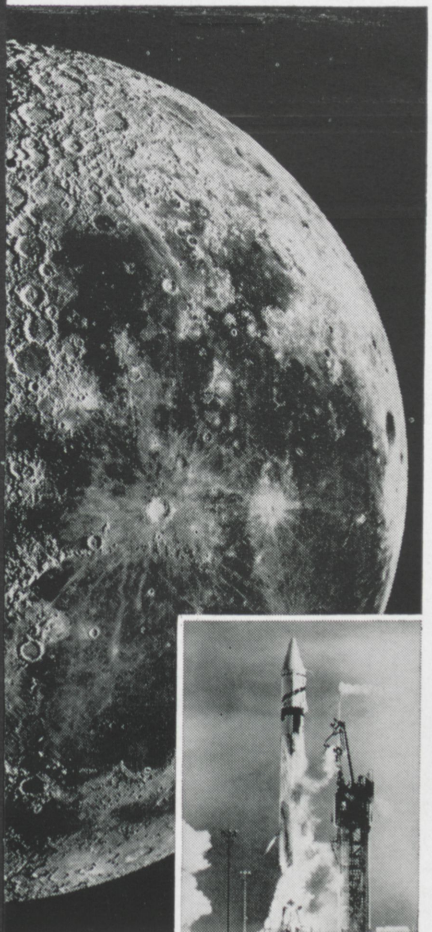

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library notes

by harry gilbert

librarian

THE STRATEGY OF DECEPTION, edited by Jeane J. Kirkpatrick. Farrar, Straus and Co., 1963.

This is a collection of essays on the Communist strategy of deception gathered from various sources by the late S. M. Levitas, who was for over thirty years editor of the New Leader. Shortly before his death Mr. Levitas placed the essays he had collected in the hands of Mrs. Jeane Kirkpatrick, asking her to supplement and edit them and to provide an introduction. The result is a book of outstanding importance, covering the wide-ranging efforts of Communists all over the world to hide their doings by various deceptions. It is a book the free world can well afford to study with utmost care, for it pin-points the major devices used by communism to build an image of itself that has itself been a lie.

Using the case method, the various contributors, all experts in their field, describe the ideological basis of Communist action and the Communist revolutionaries. Then, example by example, this book deals with communism at work in the soft and vulnerable areas: the take-over of mainland China by Mao; the Communist penetrations elsewhere in Asia, particularly in India and Burma, as well as in Latin America and Africa. It tells how Czechoslovakia was subverted without a shot being fired and the danger which the strong Communist parties in France and Italy represent for these democracies; then there is an excellent study of how communism has sought and too often succeeded in penetrating the trade union movement here and abroad. Finally, it tells of the confrontation between the United States and the Soviet Union in the United Nations and how the Soviet misuses the Charter to promote its own objectives. Thus, it exposes the vast deception that has been practiced since Lenin's day to hide the collapse of Marx's grandiose predictions.

The high scholarship of the book, as well as its readability and intrinsic interest, make it a particularly valuable text for college study. For what the book conveys about communism is exactly what the young mind most needs to know as it approaches its civic and political responsibilities. Equipped by the knowledge given by this book, free-world mind can be in a far better readiness than they have been to know their enemy.

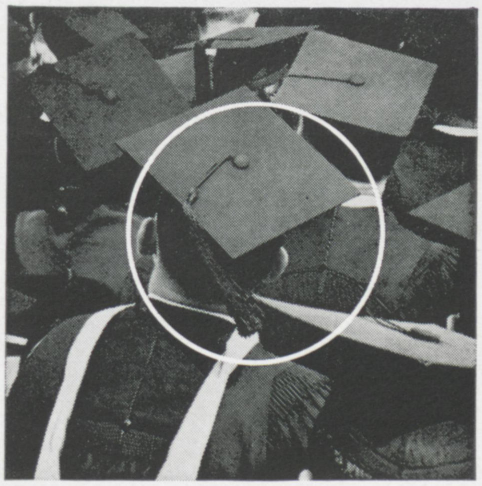
WORLDS APART, by Owen Barfield. Faber and Faber Ltd., 1963.

In this too specialized age streams of thought and ideas are more and more imprisoned in watertight compartments. No man will talk his 'shop' to another who stands outside it. When it comes to first principles, such as the nature of man himself and his universe, minds are world apart and never meet.

Troubled by this breakdown in communications, the narrator in this new book by Owen Barfield borrows a tape recorder and a cottage and persuades seven thinkers to share them with him for a short weekend: a physicist, a biologist, a psychiatrist, a professor of theology, a linguist philsopher, a young rocket-research worker, and a seventh guest who does not fit too readily into any one of the contemporary pigeon-holes and claims to shed fresh light on them all.

This is not a 'Philosophical Dialogue' in the ordinary sense, where the contrasted points of view are suavely and decorously expounded out of the mouths of two or three characterless lay-figures. Not all the participants are even interested in philosophy, and at least one of them remains convinced that there is no such thing. Personalities as well as ideas are heard to clash and the temperature sometimes rises rather dangerously. By the time the party breaks up the heat has been successfully dissipated and the reader is left to decide for himself whether the light remains.

Owen Barfield has a high reputation as a penetrating if sometimes unconventional thinker and with Worlds Apart he once again presents an unusual challenge to his readers.



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John attended one of Western Electric's three Graduate Engineering Training Centers and graduated with honors. Now, through the Company-paid Tuition Refund Plan, John is working toward his Master's in Industrial Management at Brooklyn Polytechnic Institute. He is currently a planning engineer developing test equipment for the Bell System's revolutionary electronic telephone switching system.

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Miss Technic for February

Miss Marty Pflug

Miss Technic for February is Miss Marty Pflug, a junior at Indiana State University. There, she is majoring in elementary education. Marty comes to ISU from the town of Huntingburg, Indiana.

Marty is an active member of Alpha Omicron Pi sorority. She is also a member of the Sycamore Players, and she has been a Sparkette for three years. In her free time, Marty enjoys dancing and twirling. In the summer, her free time activities also include swimming and water skiing. Marty has been a life-guard for the past few summers.

Blue-grey eyes and brown hair complement her radiant smile. She is 5'7" tall, weighs 120 lbs., and sports an attractive 37-23-35 figure.

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SYSTEMS

(Continued from page 9)

grow out of the realization that many similarities exist between living and non-living systems. Giant electronic "brains" imitate the computational and logical activity of the human mind. The study of these areas of similarity could lead to the development of more advanced and sophisticated computer-control systems and perhaps could even give insight into nervous system disorders and more efficient methods of teaching humans.

Karl W. Deutsch made an interesting application of General Systems Theory in the field of communication. He thought of any metropolis as a huge engine of communication, a device to enlarge the range and reduce the cost of individual and social choices. He compares this metropolis to a switchboard. In the familiar telephone switchboard, the choices consist of many different lines. Plugging in the wires to connect any two lines is an act of commitment, since it implies foregoing the making of other connections. The concentration of available outlets on the switchboard permits a wider range of alternative choices than would prevail under any more dispersed arrangement. It also imposes less stringent condition of compatibility.

POTENTIAL

The limit of potentially useful size of a switchboard are fixed by the capacity of the type of switching and control equipment available. The facilities of the metropolis for transport and communication are the equivalent of the switchboard. The units of commitment are not necessarily telephone calls but more often face-to-face meetings and transactions. For any participant to enter into any one transaction usually will exclude other transactions. Every transaction thus implies a commitment. The facilities available for making choices and commitments will then limit the useful size of a metropolis. The various attempts of

(*Continued on page* 24)

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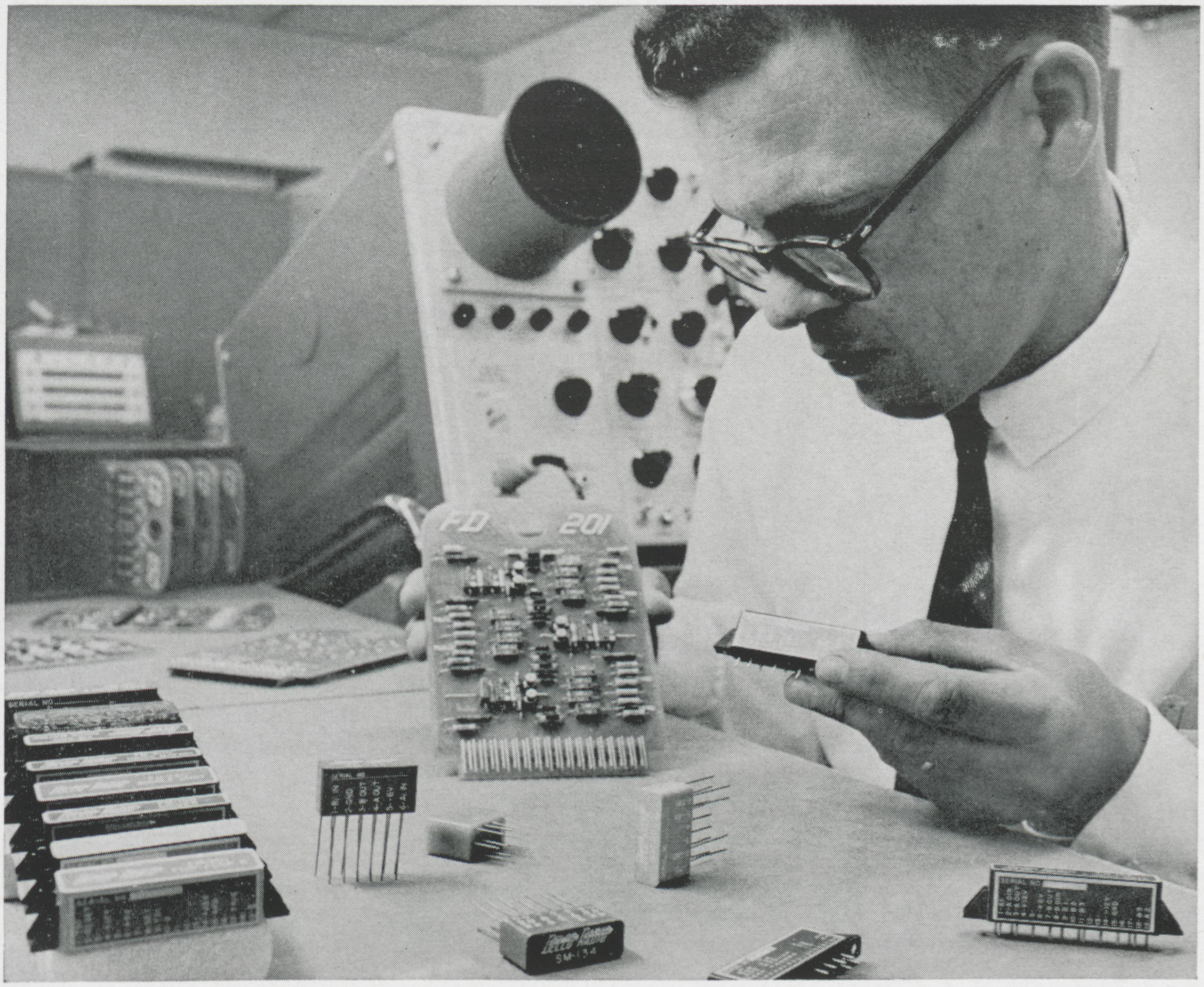

FROM CAMPUS TO CAREER WITH DELCO RADIO

Dewey Nelson came to Delco Radio Division of General Motors in 1958 with a BSEE from Iowa State University. Today, as a project engineer at Delco, Dewey helps design the building blocks for digital control systems—such as the logic cards and modules pictured above. He also assists in designing complete digital systems using these parts.

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SYSTEMS

(*Continued from page* 22)

research along these lines have yielded many conclusions which will be helpful in the future for dealing with such problems as urban decentralization, the need for beauty and clarity in our cities, and perhaps with the need for more responsive government, capable of integrating a wider range of metropolitan and suburban services, if the expanded metropolis is to become a genuine home for its people.

PROBLEMS

Peter H. Greene used General Systems Theory to investigate and search for some problems which he thinks will be central ones in the effort to design, develop, and produce machines that can in some sense be said to perceive, think, make reasonable inferences, or learn to perform acts of skill. He summarizes his argument after sighting many problems by saying, "We have seen that present day computers deal primarily with external relations among concepts which are given in a form that does not represent their 'inner structure'. In order for a machine to discover new patterns and to make inductive generalizations, it appears that the following notions must be taken into account. The primary challenge to be met is that of forming impressions into logical elements. The individual element must contain the schemata for its connections with other elements. The consequence for computer design is that one must not seek to build a machine that perceives and conceptualizes and then inserts into its components independently achieved schemata of spatial and causal relations. On the contrary, in order to perceive at all it must perceive according to schemata, and the spatial and causal schemata must be an inherent part of the percepts and concepts themselves. A computer will probably have to arrive at reasonable inferences by selection from a larger set of inferences which are not at all reasonable."

The examples sighted above are only a very, very small sampling of the applications of General Systems Theory. Other systems and diciplines which make use of General Systems Theory are Growth in time Systems, Relative Growth Systems, Competition and Related Phenomena, Systems Engineering, Personality Theory, Theoretical History, and many others.

The limitations of General Systems Theory are quite obvious, as will be shown in the final section of this paper; "but the principles appear to be essentially sound as shown by their application in different fields."

CONTROVERSY

Although General Systems Theory has found many applications and has yielded many useful results, there are many people who hold that there is absolutely no benefit to be gained from such a theory. The critics often maintain that the analogies discovered apparently have very little, if any, significance.

For instance R. C. Buck, in discussion of Miller's analogy between slime molds and human behavior says: "Well, so what? What are we to conclude from all this? That Londoners are a form of slime mold? That myxamoebae are a sort of city dweller? Or, perhaps. that during the battle of London some citizens, due to their new and more specializd activities, became sterile, while others devoted themselves exclusively to reproductive activities? One finds it difficult to believe that these are the conclusions he is expected to draw, but if not these, what others? And, if no conclusions, why all the fuss, why bother with the analogy at all?"

Critics, and in some case sympathizers, find it difficult to discover precisely what general systems theorists want to achieve. For instance, R. C. Buck says: ". . , the general usefulness of analogies, especially as suggesting plausible hypotheses for subsequent testing, is explained in most beginning logic books. But surely, one feels, General Systems Theory is doing, or at least trying to do something more, but just exactly *what* more it is extraordinarily difficult to discover. And the basic reason for the difficulty is that, after drawing our attention to some positive analogy, these theorists in general simply fail to say anything about what the analogy is supposed to prove or suggest, while nevertheless managing to convey the impression that something pretty momentous has been proved or suggested."

Von Bertalanffy recently has answered Buck: " . . . Buck has simply missed the issue of a general theory of systems. Its aim is not more or less hazy analogies; it is to establish principles applicable to entities not covered in conventional science."

AIMS

The interdisciplinary theme occurs repeatedly. Another quotation from von Bertalanffy is representative: ". . . the aims of General Systems Theory can be indicated as follows: (a) There is a general tendancy towards integration in the various sciences, natural and social. (b) Such integration seems to be centered in a general theory of systems. (c) Such theory may be an important means for aiming at exact theory in the non-physical fields of science. (d) Developing unifying principles running 'vertically' through the universe of the individual sciences, this theory brings us nearer to the goal of the unity of science. (e) This can lead to a much-needed integration in scientific education."

Many criticize the General Systems workers for neglecting the dissimilarities of the systems they study and emphasizing only the similarities. It should be noted, however, that at present General Systems writers are sensitive to this criticism and insist that the systems they deal with are analogous in only some respects, not all.

The controversey and criticism of General Systems Theory is mainly built around the controversial points sighted above. General Systems workers answer most controversey by saying that the real answers can come only from actual testing of the usefulnesses of the analogies discovered. General Systems inquirers who accept the need for testing often have not had the time to do the actual testing themselves.

One reason the testing needs to be emphasized is the stated intention of General Systems theorists. If the aim is to derive "universal principles applying to systems in general," the job of verification is obviously an enormous one.

MERITS

The relative newness of this area of inquiry makes assessment of its merits diffiicult in some respects. It may very well turn out that some of the analogies discovered will be highly fruitful for science in the sense that verifiable hypotheses will be arrived at that overlap present disciplinary boundaries.

"General Systems Theory was developed to meet a need felt by a large number of behavioral science inquirers, The theory attempts to give a coherent picture of diverse fields and to provide some unity in explanation. It should be remembered, however, that many past efforts to construct integrating systems have proved scientifically sterile. This is not to deny a need for the systematic interrelation of the hypotheses of the various sciences, a need General Sytems theorists try to meet. But so much of the work done under the label of General Systems research consists in outlining future hope and possible programs of research that even those who sympathize with its aims may be skeptical about the worth of much of the work done so far."

General Systems Theory followers do not say that the piecemeal analysis method of scientific inquiry has no use today. In fact, Anatol Rapoport says: "There is no denying that this approach is effective in specific areas of investigation."

"To the extent that General Systems theorists have made sanguine prognoses of 'unifying science', they may have been guilty of utopian dreaming. But to the extent that concrete steps of conceptual unification have been proposed, they have made a number of significant contributions."

O'Day's

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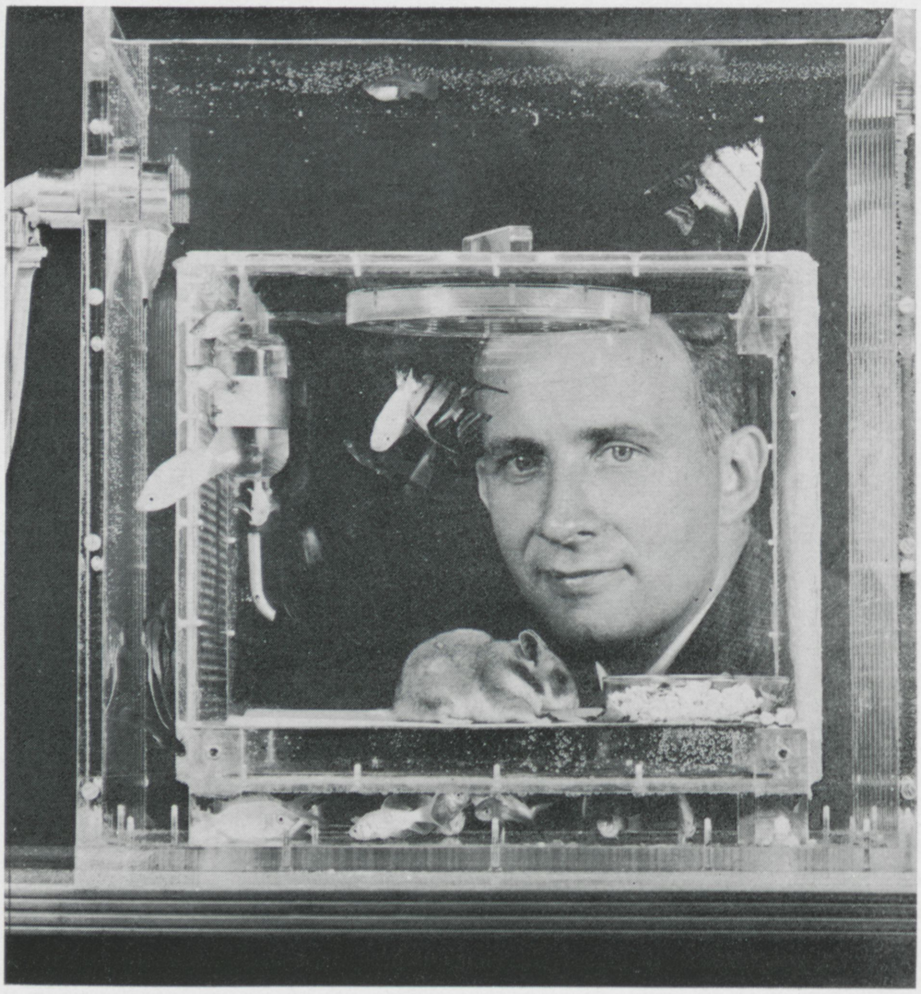


This "aqua-hamster," penned in a submerged plastic tank, is kept alive by an artificial "gill" — a special synthetic membrane stretched across the top, bottom, and two sides of its underwater home. The "gill" extracts air from the surrounding water, while resisting the passage of the liquid. Carbon dioxide exhaled by the hamster passes out through the membrane, dissolves in the water, and is carried away. Without the "gill," the animal would suffocate. The membrane — an extremely thin film of silicone rubber that is also free from holes — was invented by Dr. Walter L. Robb (rear), a scientist at the General Electric Research Laboratory. Tubes at left are used to circulate water through the outer fish tank. Since sea water is essentially saturated with air to a depth of many hundreds of feet, an artificial "gill" made from the new membrane could furnish air for the crew of a submarine or the inhabitants of an underwater experimental station.

A new type of silicone film has been produced that is thinner and more permeable than any silicone membrane that has yet been developed. The membrane is completely free of holes, yet is 1000 times as permeable as most commercial plastic films used in wrapping foods.

Since World War II research in the field of selective membranes has been on the increase. They are called selective membranes because they allow different types of gases and liquids to pass at different rates. One of the most useful thus far has been synthesized from a silicone rubber developed during World War II.

For example, in a space capsule, a vent covered with such a membrane would allow unwanted water vapor and carbon dioxide to escape easily into the vacuum of space, while at the same time oxygen could be kept in because of the first two gases' faster rates of diffusion. In fact, since water vapor passes through at about 50 times as fast as oxygen, the membranes could be used as dehumidifiers in our homes.

Oxygen, on the other hand, passes through such a membrane over twice as fast as nitrogen, which makes up 80% of the air we breathe. As a result, if ordinary air is brought into contact with one side of a membrane, while the other side of the membrane is maintained at a lower pressure, the gas passing through the membrane will be rich in oxygen. If the low-pressure side of the membrane is maintained at 1/15 of atmospheric pressure, for example, the air passing through will contain approximately 35% oxygen, instead of the usual 21%. The 35% figure is close to that found in hospital oxygen tents and infant incubators.

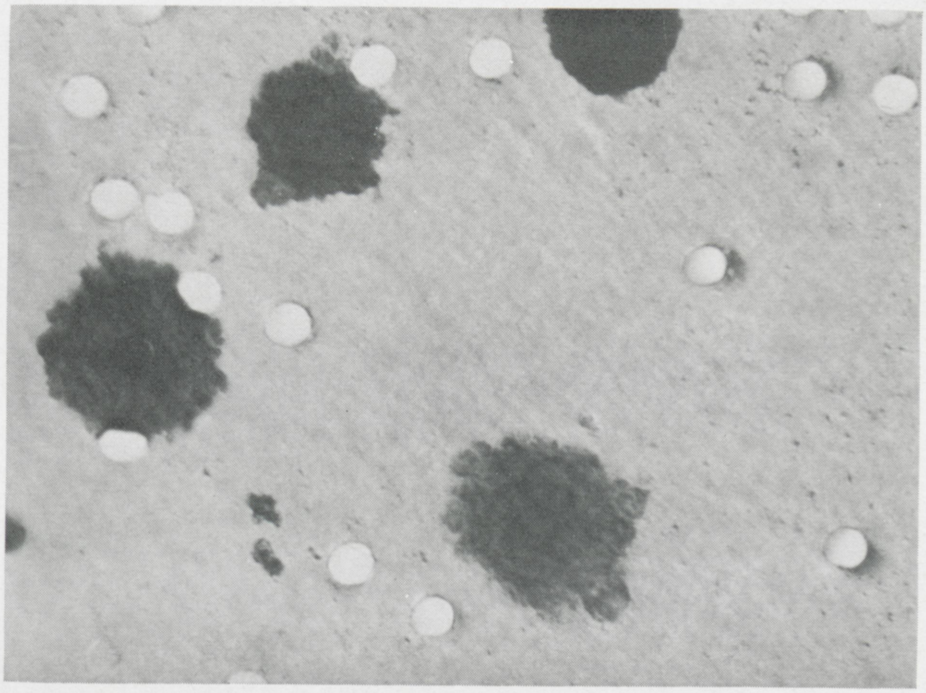
A man consumes about three quarters of a cubic foot of oxygen per hour. To meet his requirements solely by means of a selective membrane system could require as little as 2½ square yards of membrane, plus a compressor or pump to remove the enriched air from the low pressure side of the membrane. The membrane is over 100 times as permeable as the membrane material of which the lungs are composed.

For patients needing oxygen-rich air in hospitals or at home, a small air-enriching device with a compressor to provide a difference in pressure and a membrane to separate the gases could replace pure oxygen bought by the tank, cutting costs sharply. In military field hospitals, use of this system would eliminate the need for replaring oxygen cylinders weighing a total of some two to three tons every 10 days. Simplification of the supply problem would be especially important in view of the fact that field hospitals must be capable of being moved and resupplied by air.

Another medical application of the membrane is in artificial heart-lung machines, necessary during open-heart operations. In this case, the blood would be brought in direct contact with the membrane, while air was circulated on the other side.

In industry, enriched air is used in a variety of processes, where the membrane system could reduce costs. Helium could also be "filtered out" of air or natural gas. In such cases, other types of polymers would be used, rather than silicone rubber, since various polymers differ in the rate at which they allow different gases to pass through.

Underwater applications would depend upon the fact that sea water is essentially saturated with air to a depth of many hundreds of feet. A membrane with sea water flowing past on one side and with pressure below one atmosphere on the other side would extract air, while resisting the passage of water under tremendous pressure. Carbon dioxide and other noxious gases will also pass through the membrane in the reverse direction, into the water Hence the membrane performs the same function as a gill in a fish. A small quantity of water would pass through, which would be an added bonus, since the salt would be removed from it as it passed through the membrane. The crew of a submarine or the inhabitants of an underwater experimental station would therefore be supplied not only with air but also with fresh water for drinking. As in the case of other membrane applications, the simplicity of the system should reduce costs and improve reliability.



Cancer cells (large dark blobs) are shown on a new plastic filter developed at the General Electric Research Laboratory. Unlike conventional filters, the new research tool consists of cylindrical holes (small white circles) with uniform diameters. Such holes do not clog easily. As a result, delicate particles — such as cancer cells — can be non-destructively filtered by gravitational action, rather than by an applied pressure. Because the filter is transparent and chemically resistant, cells can be stained and studied right on its surface, reducing the danger of accidental damage to the cells. (Magnification: 1600X.)

Dr. Guy Suits, General Electric vice president and director of research, describing the new membranes at a meeting in New York, referred to them as "a significant step forward in man's efforts to control and adapt to his environment. Since man is an air-breathing animal, he faces some difficulties in functioning under the water, in the vacuum of space, and even — in some cases — on the usually hospitable surface of the earth."

"NUCLEPORE"

Another new type of film, though totally unlike the first, may also find widespread use in medical applications. This type of film, called "nuclepore" by its developers, is a thin plastic filter, perforated by superfine holes.

Researchers found that "fission tracks" in solid materials could be etched out to form uniform sized tubes when dipped in a suitable reagent.

In a thin plastic film, less than one thousandth of an inch thick, bombardbment by fission fragments creates irregular holes a few atoms in diameter. Chemical etching converts the ragged holes into tubes of uniform size and roundness. Tube diameters ranging from one micron or less up to about ten microns have been achieved. The number of holes can be increased simply by longer irradiation.

Tests of the new filter have been conducted by the Memorial Sloan-Kettering Cancer Center in New York City. Cancer cells were successfully filtered from blood samples from more than 100 cancer patients. Experiments with the filter are continuing at the Center.

Because the new filter, which General Electric has named "Nuclepore," has cylindrical holes of uniform diameter, the holes do not clog easily. Delicate particles, such as cells, can be non-destructively filtered by gravity, rather than by applied pressure. Since the filter is transparent and chemically resistant, cells can be stained for study right on its surface, thus reducing the danger of accidental damage to the cells.

ATOM MATRIX

(*Continued from page* 13)

clude fractional bond orders (see Example 10 below), directed or vectorial connectivities, etc. These are not as common as the simpler orders.

In delocalized benzene the bond order C — C is 3/2; using the ring structure we get the results shown in Example 10.

For localized free radicals an added symbol is required for the electron, as these are ionized. Let E be this symbol in Example 11.

For linked rings where no direct bonding occurs, but integrity of each ring is required, the ACM takes the following form:

Let A and B be the two rings (the example is for two, but is applicable for "n" which implies molecular complexes or an "n-mer" polymer). The results are shown in Example 12.

It is noted that the first term of the ACMCP is identical to the usual simple molecular formula, except that the subscripts have now become superscripts. Hence, cataloging is compatable with the conventional formula indices.

11. ETHYL RADICAL : C − C

$$ACM = \begin{bmatrix} C & 1 & 0 \\ 1 & C & 1 \\ 0 & 1 & E \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} C & 1 & 0 \\ 1 & C & 1 \\ 0 & 1 & E \end{vmatrix} = C^2E-C-E$$

12. DIMER : (A)(B)

$$ACM = \begin{bmatrix} (ACM)_A & 0 \\ 0 & (ACM)_B \end{bmatrix}$$

$$ACMCP = \begin{vmatrix} (ACMCP)_A & 0 \\ 0 & (ACMCP)_A \end{vmatrix}$$

For computers, either the ACM or the ACMCP may be used. If one is using a computer, it is a very advantageous means of solving the ACMCP, especially for more complex molecules and the high order approximations. For memory storage the ACMCP has many advantages over the ACM, because the ACMCP is useful in classification purposes. For encoding, the ACM is preferable.

Hence it is seen how matrix notation can be used to reduce pictorial molecular representations to unique mathmatical expressions, which are computer oriented.

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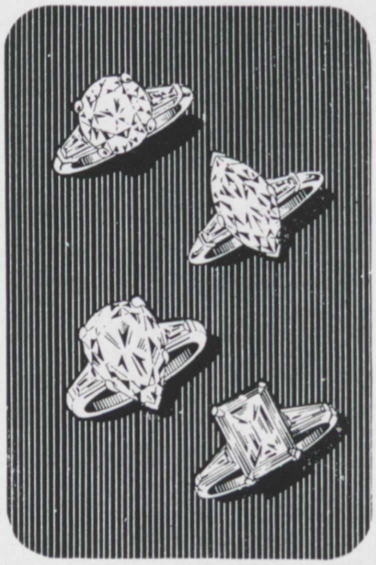

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Interview Schedule For March

Date	Company
2	U. S. Dept. Commerce
2	The Trane Company
3	Deere & Company
3 & 4	General Motors
4	General Telephone (Indiana)
4	Caterpillar Tractor
5	U.S. Pub. Health Service
5	Firestone Tire & Rubber
8	Ind. State Highway
9	Surface Combustion
9	The Kendall Co.
9	Reilly Tar & Chemical
9	Spencer Chemical Div. Gulf Oil Corp.
10	Public Service of Indiana
11	American Air Filter
11	Perfect Circle Corp.
12	I. B. M.
16	Marathon Oil Co.
18	City of Detroit
23	Wash. St. Highway
24	The Boeing Co.
25	Indiana Bell Telephone
25	Western Electric Co.
25	A.T. & T. Long Lines

SCIENTIFIC METHODS

(*Continued from page* 15)

New techniques also gave the method more constructive power. Faraday's discovery of magnetic induction, Boyle's method of qualitative analysis, and Lavoisier's method of quantitative analysis are examples of improvement in technique and procedure.

What were some of the causes of the scientific revolution which brought forth the modern scientific method during this period of history? Some say it was simply because of the presence of so many great intellectuals and scientists. However, the ancient civilizations also had had great thinkers but developed no experimental scientific method.

The increased desire for technological improvement was an important factor. While the feudal system was ruled by tradition and custom, the new capitalists were always looking for new methods and techniques to enhance their enterprises. This desire for technological advancement was bound to have its effect upon pure science.

The relaxing attitude of religion toward scientific investigation helped to make conditions more conducive to the development of new ideas. Naturally this was a gradual relaxation with the first scientists (Galileo, for example) meeting some persecution and ridicule from the church. However, the entire liberal movement of the times soon overcame any reluctance or influence which organized religion had on the scientific revolution.

There can be no doubt about the importance of the development of the scientific method during this period. It has become one of the most important contributions to mankind as even today in our own scientific revolution, this same basic method is the backbone of all modern research. Sir Francis Bacon and all the other contributors would surely be very proud of the part that their method has played in the progress of humanity. For as old General Electric so emphatically stated, "Progress is our most important product."

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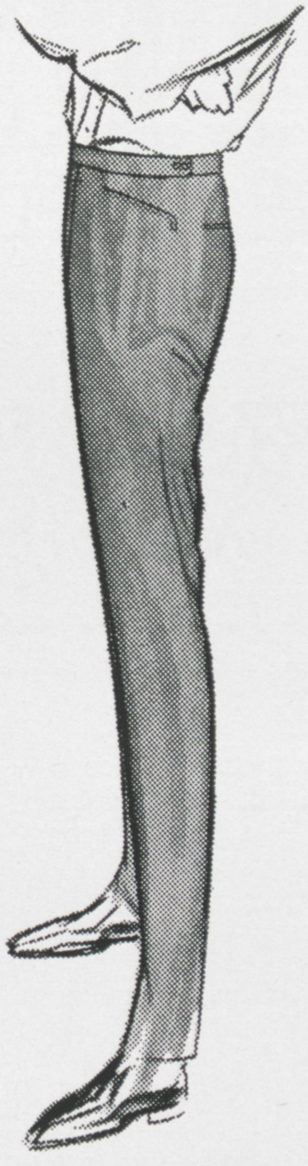

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* * *

An astronaut set his rocket down on a strange planet. The moment he stepped off the rocket, a number of little furry animals came running to him. "Take me to your leader," the astronaut requested. A little furry took him by the hand and led him to a large glass building. Sitting majestically on a throne was a large furry with a long pointed needle on his head. "Why do you have the needle on your head?" asked the puzzled astronaut. "Why, I'm the furry with the syringe on top!" was the reply.

* * *

A driver tucked this note under the windshield wiper of his automobile: "I've circled this block for 20 minutes. I'm late for an appointment and if I don't park here I'll lose my job. Forgive us our trespasses."

When he came back he found a parking ticket and this note: "I've circled this block for 20 years and if I don't do this I'll lose my job. Lead us not into temptation."

* * *

The moon was yellow, the lane was bright, as she turned to me in the night: And every gesture and every glance, gave hint that she craved romance. I stammered, stuttered, and time went by—the moon was yellow and so was I.

* * *

A cadet staggered into the Latin Quarter one night and in a loud voice yelled, "When I drink, everybody drinks!" He summoned everyone to the bar—the musicians, hat-check girls, waiters, and guests. Everybody took a drink. When he finished his whiskey, he yelled agin, "When I take another drink, everybody takes another drink."

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like, man . . . .
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Once more everyone gathered around the bar. They even called in the taxi drivers, doormen, and a cop from the corner. When he finished that one, the cadet took a dollar out of his pocket and slapped it on the bar. "When I pay," he screamed, "everybody pays."

* * *

"Thish match won't light."

"Washa matter with it?"

"I dunno—it lit all right a minute ago."

* * *

Someone asked this C.E. why he always closed his eyes when he took a drink.

"Well, fella," he said, "the sight of good liquor makes my mouth water and I wouldn't want to dilute my drink."

* * *

An engineering and an arts professor were talking at a faculty tea. "I had a peculiar one today," said the arts professor. "I asked who wrote "The Merchant of Venice" and one of the fellows replied, 'It wasn't me, sir.'"

"Ha, ha," laughed the engineering professor. "And I suppose the rascal had done it all the time."

* * *

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

"Why no!" reassured her soggy spouse.

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

* * *

E.E.: "Why don't you wear ear muffs?"

C.E.: "I haven't worn them since the accident."

E.E.: "What accident?"

C.E.: "Someone asked me if I wanted a drink and I didn't hear him."

* * *

Rose Student 1: "Is there any lunch in the refrigerator?"

Rose Student 2: "Not a drop."

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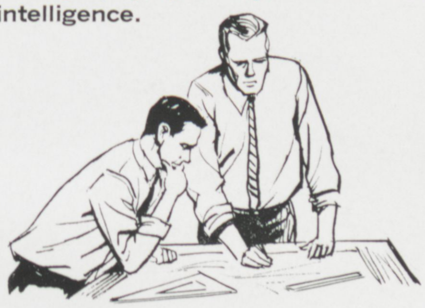

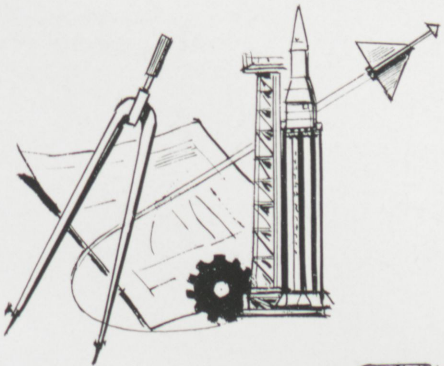

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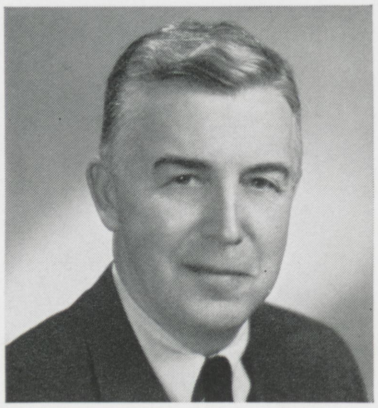
Should You Work for a Big Company?

An interview with General Electric's S. W. Corbin, Vice President and General Manager, Industrial Sales Division.



S. W. CORBIN

■ Wells Corbin heads what is probably the world's largest industrial sales organization, employing more than 8000 persons and selling hundreds of thousands of diverse products. He joined General Electric in 1930 as a student engineer after graduation from Union College with a BSEE. After moving through several assignments in industrial engineering and sales management, he assumed his present position in 1960. He was elected a General Electric vice president in 1963.

Q. **Mr. Corbin, why should I work for a big company? Are there some special advantages?**

A. Just for a minute, consider what the scope of product mix often found in a big company means to you. A broad range of products and services gives you a variety of starting places now. It widens tremendously your opportunity for growth. Engineers and scientists at General Electric research, design, manufacture and sell thousands of products from microminiature electronic components and computer-controlled steel-mill systems for industry; to the world's largest turbine-generators for utilities; to radios, TV sets and appliances for consumers; to satellites and other complex systems for aerospace and defense.

Q. **How about attaining positions of responsibility?**

A. How much responsibility do you want? If you'd like to contribute to the design of tomorrow's atomic reactors—or work on the installation of complex industrial systems—or take part in supervising the manufacture of exotic machine-tool controls—or design new hardware or software for G-E computers—or direct a million dollars in annual sales through distributors—you can do it, in a big company like General Electric, if you show you have the ability. There's no limit to responsibility . . . except your own talent and desire.

Q. **Can big companies offer advantages in training and career development programs?**

A. Yes. We employ large numbers of people each year so we can often set up specialized training programs that are hard to duplicate elsewhere. Our Technical Marketing Program, for example, has specialized assignments both for initial training and career development that vary depending on whether you want a future in sales, application engineering or installation and service engineering. In the Manufacturing Program, assignments are given in manufacturing engineering, factory supervision, quality control, materials management or plant engineering. Other specialized programs exist, like the Product Engineering Program for you prospective creative design engineers, and the highly selective Research Training Program.

Q. **Doesn't that mean there will be more competition for the top jobs?**

A. You'll always find competition for a good job, no matter where you go! But in a company like G.E. where there are 150 product operations, with broad research and sales organizations to back them up, you'll have less chance for your ambition to be stalemated. Why? Simply because there are more top jobs to compete for.

Q. **How can a big company help me fight technological obsolescence?**

A. Wherever you are in General Electric, you'll be helping create a rapid pace of product development to serve highly competitive markets. As a member of the G-E team, you'll be on the leading edge of the wave of advancement—by adapting new research findings to product designs, by keeping your customers informed of new product developments that can improve or even revolutionize their operations, and by developing new machines, processes and methods to manufacture these new products. And there will be classwork too. There's too much to be done to let you get out of date!

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-12, Schenectady, N. Y. 12305

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