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Rose Technic Staff
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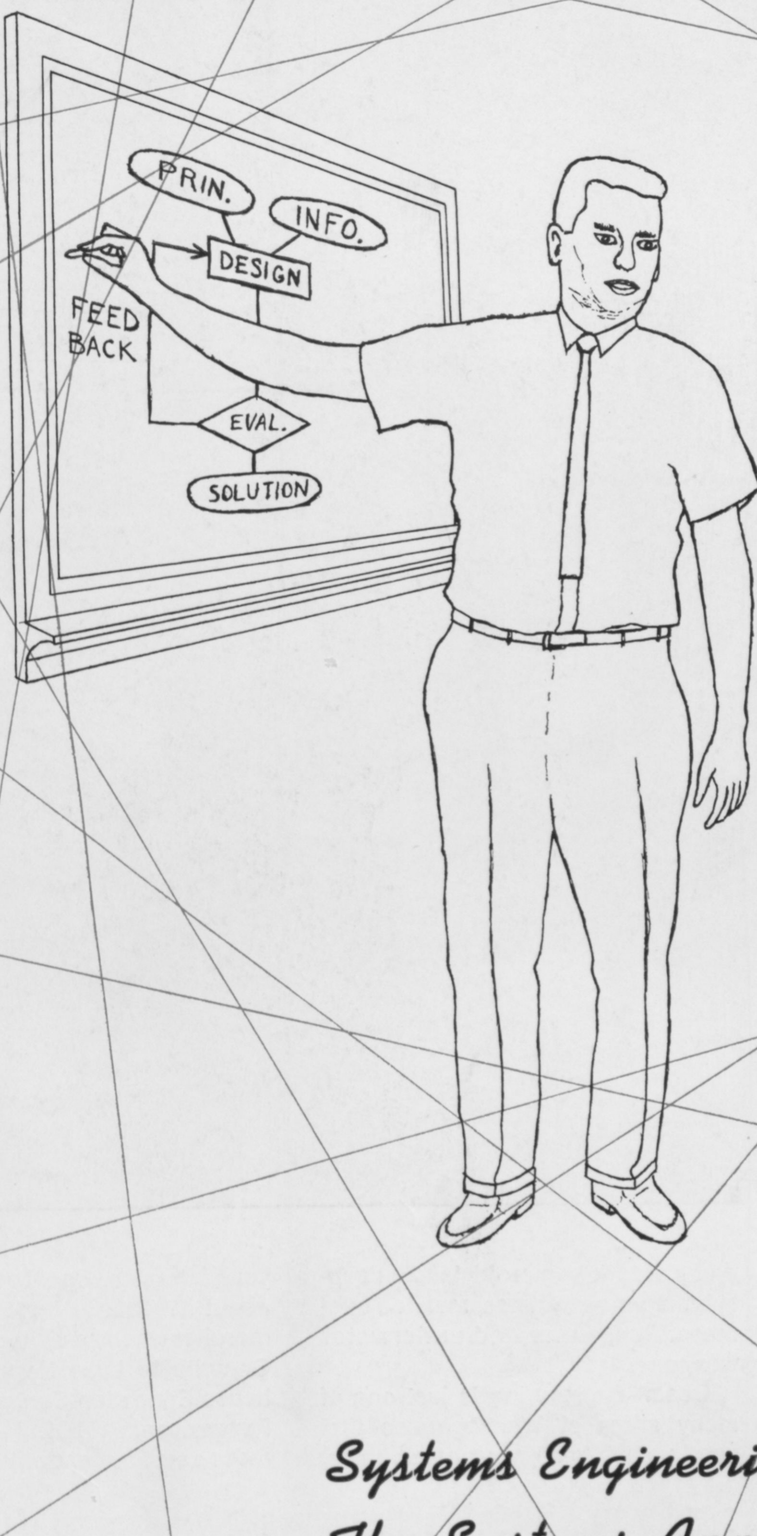
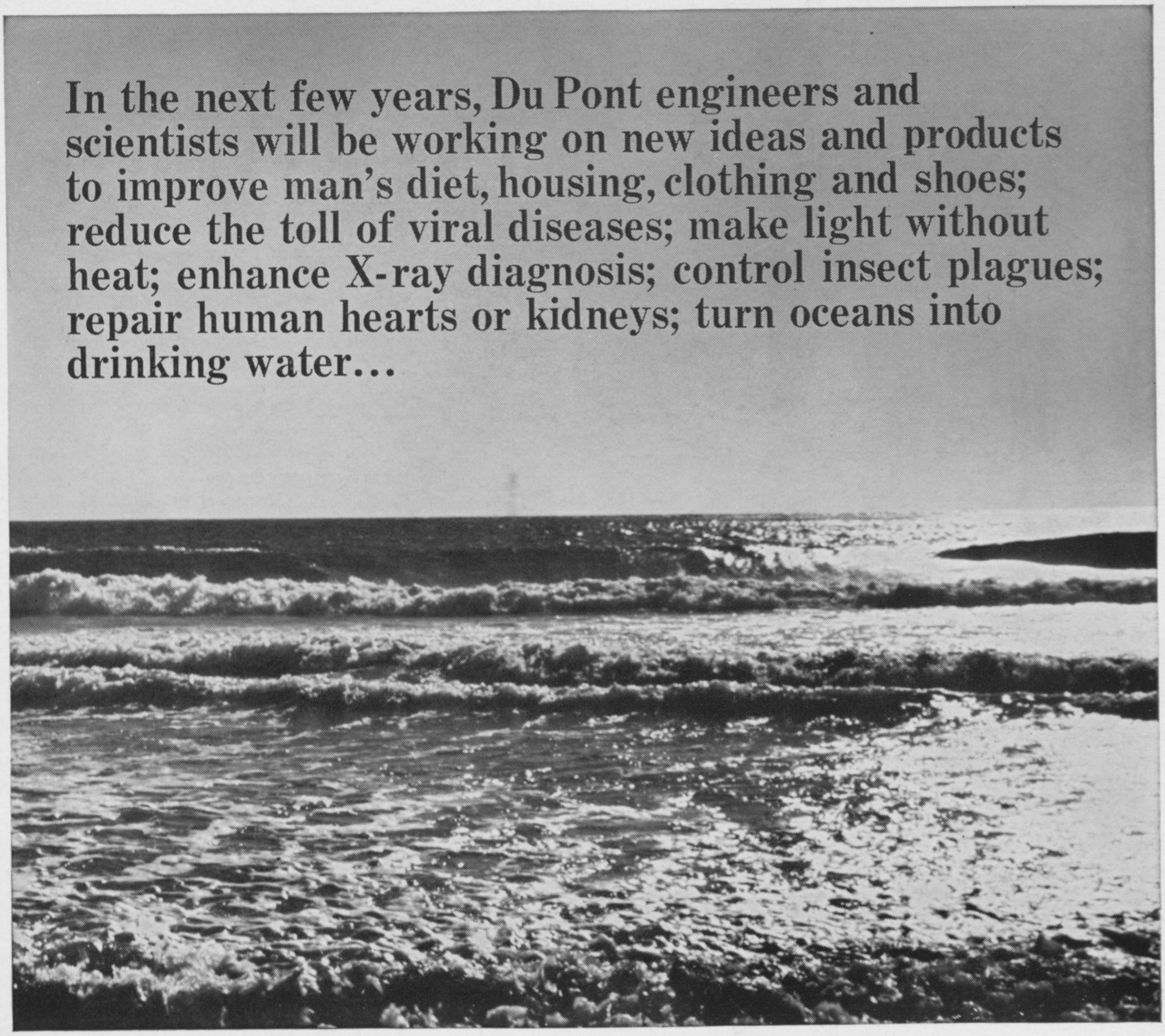


Systems Engineering

The Systems Approach

E. H. C. H. & D. at Low Temperatures



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AMERICA'S OLDEST ENGINEERING COLLEGE MAGAZINE I
CONTINUOUS MONTHLY PUBLICATION — 1891-1967

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IN THIS ISSUE

On page 12 Tony Tietz provides an edited preview of the System Engineering Seminar at Homecoming.

The Systems Approach's explanations and quotes gathered by Dr. Rogers begins on page 14. He summarizes the use of the systems approach.

The interrelationship of heat capacities and specific heats to other properties in a chemical system is a very important and interesting topic of discussion to engineering students. For a comprehensive report by John Elzufon, turn to page 16.

COVER NOTE

An artist conception of one view to Systems Engineering is this month's cover.

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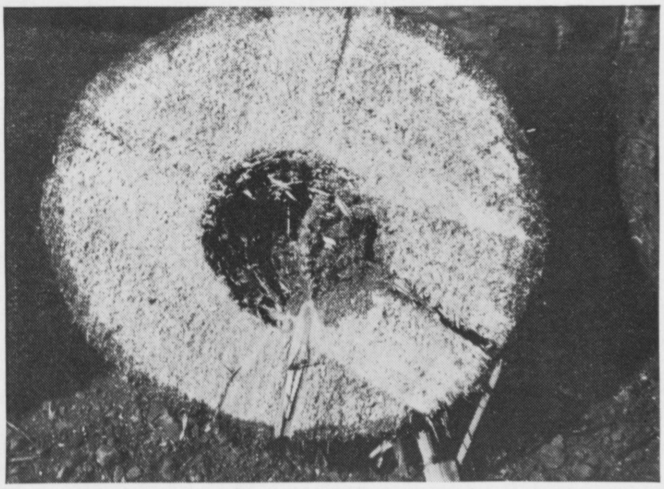
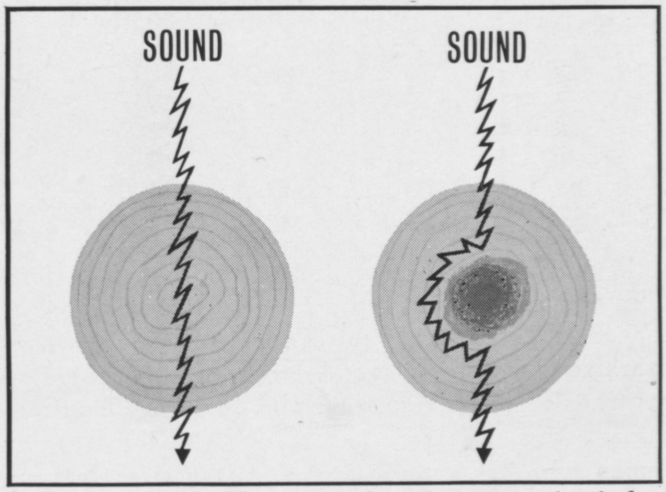
Got an idea?

Detroit Edison's interested.



1. Edison engineer, Dick Popeck, wanted to find a more effective method of determining the amount of pole decay.



2. Dick's idea: Measure the time required for sound to travel through a pole. Sound takes longer to traverse a decayed pole.

3. Transistorized circuitry was designed. And a Sonic Pole Tester was built and tested.

4. Ed Hines, Director of Research, (left) discusses patent coverage with inventor Dick Popeck.

New ideas grow at Detroit Edison. The picture story here shows the progress of one, from its conception through its development, to finalization.

The development of the sonic pole testing device* has benefited the company and the young inventor both economically and professionally. The device helps Detroit Edison serve the electric industry's customers better and more economically.

Uses for the sonic pole tester range from the examination of wooden railroad bridges to the determination of the soundness of standing timber.

Detroit Edison's forward looking management . . . its engineering and research facilities . . . along with its liberal patent policy . . . make it an ideal place for the young man with ideas.

If you are interested in putting your ideas and energies to work—write to George Sold, The Detroit Edison Company, 2000 Second Avenue, Detroit, Michigan 48226, or better yet, visit him when he interviews on the campus.

*U.S. Patent Applied for

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GUEST EDITORIAL

R(t)- A Brief View of Rose As A Function of Time

Dr. Bailey is a professor of mathematics and acting chairman of the department at Rose Poly. He received his B.S. in Electrical and Chemical Engineering from Rose; his M.S. in Electrical Engineering from Illinois, and his M.S. in Math and Ph.D. from Purdue.

By DR. HERBERT BAILEY

In the mid forties I was a student at Rose and in the mid sixties I am a teacher at Rose. As a vehicle for comparing student life then and now, let us transform an average current freshman (Joe, class of '71) to a freshman who has entered Rose in 1943.

Many things are very similar. The war is called the second World War. The main building looks about the same and there seems to be no change in the large oak tree. Most of the traditions are the same but Joe notes a difference here. The freshmen are often fighting with the sophomores rather than kneeling down to them.

His schedule is different. For example, he has English instead of Humanities and he wonders when he will learn about mankind. The blind dates at the Wood's are about the same and he will learn about womankind.

He expects his math courses to be rather dull since they are teaching Algebra and Trig (which he has already learned in high school). At terms end when he gets his D in Algebra from Dr. Sousley he decides that he didn't learn it all in high school and anyway D is better than the class average.

Joe was a bit of an athlete in high school and decides to meet the coaching staff. This turns out to be easy since the coach of Football, Track, Baseball, Tennis, Basketball and all intramurals is one Phil Brown. The only trouble is that Phil is teaching history and can't talk to Joe until after school.

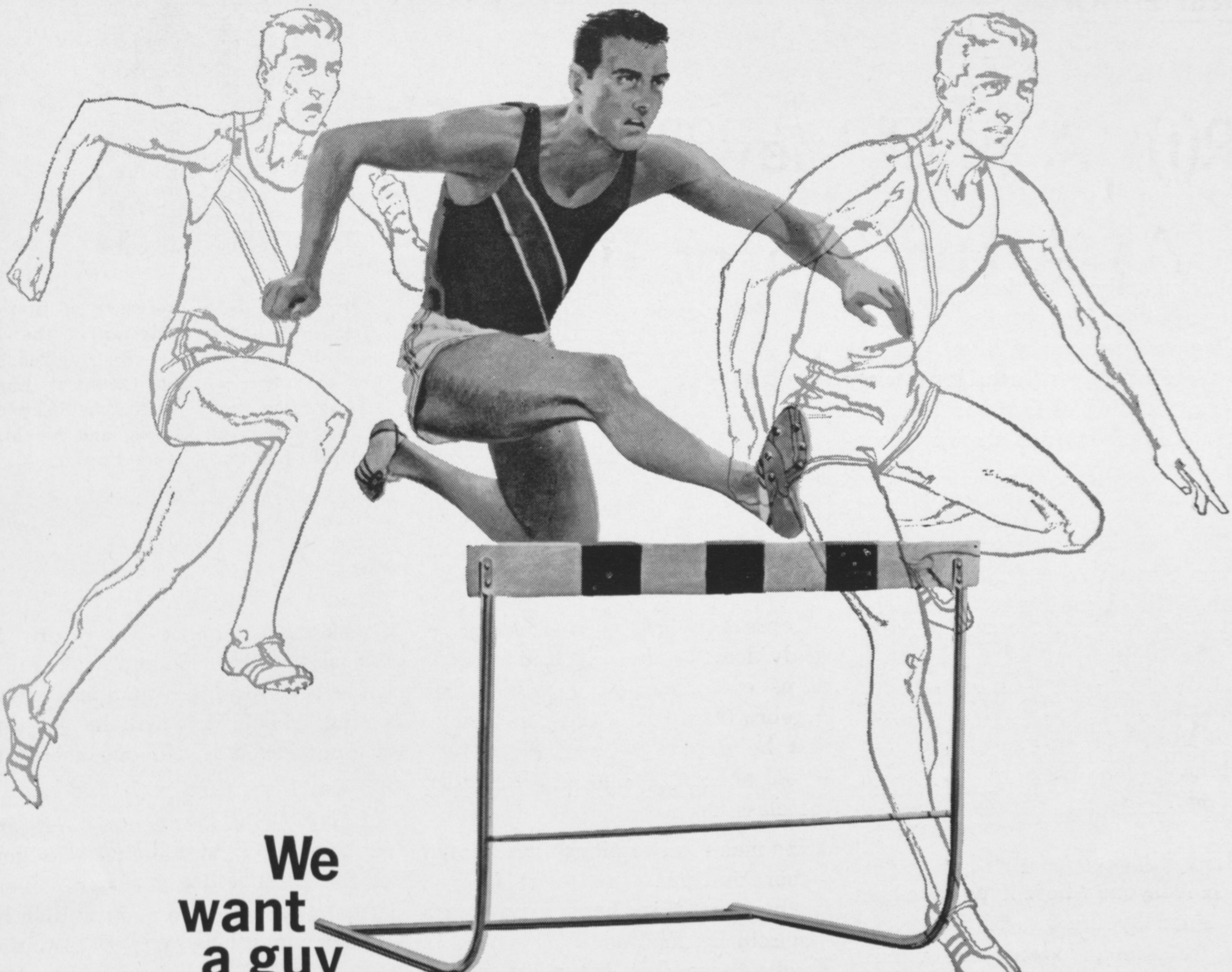
The only dorm is Deming Hall and he misses the air-conditioned dorms and classrooms, since the whole class will go to school every summer.

He looks at his schedule for coming years to see courses in Surveying, Metal Shop, and Foundry and finds no courses such as Introduction to Astrophysics, Noneuclidean Geometry, Electronics of Solids or Greek and Roman Literature in Translation. He wonders if he is in a trade school rather than an engineering school. How will he get into graduate school? No one seems to care.

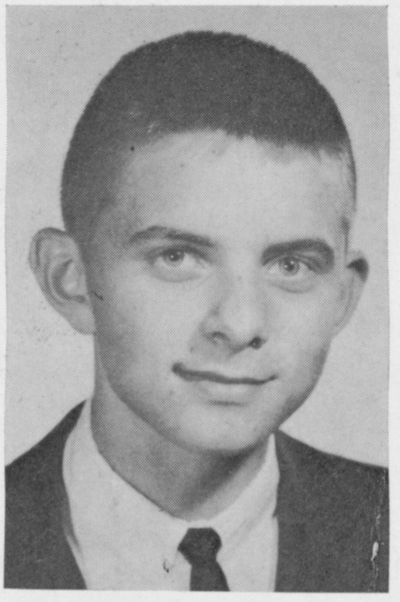
When graduation comes there are no recruiters on campus. He gets himself a job and suddenly discovers he has learned more at Rose than he thought. He has learned initiative and can formulate the problem and solve it. The fellow next to him needs to be told every step.

He marries an Indiana State girl, hopes to send his boy children to Rose, and maybe Joe will teach there someday. He thinks its not so important what is taught but how it is taught. He also thinks that he learned many things from the Rose traditions and from his fellow students.

Joe is transformed to the present and wonders what Rose will be like in the mid eighties.



From Among Our Friends



Fortunately for the rest of us tragedy does not strike the Rose collegiate community often. In one of those infrequent occasions, early in the morning of October 7 Robert Alan Johnson, senior chemistry major, was fatally injured in a two car crash.

Bob has been a member of the *Technic* staff since his freshman year. His significance to us has shown by his managership' of the feature staff. The *Technic* has not been his only activity. He was Brigade Commander of the ROTC program, and member of Blue Key and Alpha Tau Omega. His talents were diversely used. His loss has been felt.

To everyone whose lives have been saddened by the loss of this friend, we dedicate an appropriate version of *The Old Clay House.*

THE CLAY HOUSE

When I have spent this old clay house of mine
When no more lights thru the window shine
Just box it up and lay it away
With the other clay houses of yesterday.

And with it, my friends, do try if you can
To bury the wrongs since I first began
To live in this house; bury deep and forget
For I want to be square and out of your debt,
When I meet the Grand Architect Supreme
Face to face, I want to be clean.

To you, who are building, just look over mine
And make alterations while yet there is time.
Just study this house, no tears should be shed
Its like any clay house when the tenant has fled.

I've lived in this house many days,
On this old world sublime
With love, birds, and flowers and glorious sunshine
Is a wonderful place and a wonderful plan
And a wonderful, wonderful gift to man—

Yet somehow we feel when the cycle's complete
There are dear ones across, we are anxious to meet
So we open the books and check up the past
No more forced balances, this one is the last
Each item is checked; each page must be clean
It's the passport we carry to our Builder Supreme.

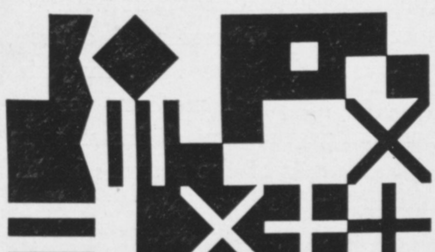
So when I am thru with this house of clay
Just box it up tight and lay it away—
For the Builder has promised when this house is spent
To have one finished with the timber I've sent.

While I loved here in this one, of course, it will be
Exactly as I here have builded, you see
Its the kind of material we each send across
And if we build poorly of course, 'tis our loss—
You ask what material is best to select
'Twas told long ago, by the Great Architect—
"A new commandment I give unto you
That ye love One Another, As I have loved you."
So the finest material to send up above
Is clear, straight-grained timber of Mercy and Love.

—*Anonymous*

What is there left for you to discover?

Cyrus the Great, King of Persia, built a communications system across his empire some six centuries before the Christian Era. On each of a series of towers he posted a strong-voiced man with a megaphone. By the 17th century, even a giant megaphone built for England's King Charles II could project a man's voice no further than two miles. This same king granted Pennsylvania to Admiral William Penn as a reward for developing a fast, comprehensive communications system — ship-to-ship by signal flags.



We waited for the combined theories of Maxwell, Hertz, Marconi and Morse before men could transmit their thoughts by wireless, though only in code. Only after Bell patented his telephone and DeForest designed his audion tube could men actually talk with each other long-distance. Today nations speak face-to-face via satellite. Laser-beam transmission is just around the corner. Yet man still needs better ways to communicate across international boundaries.

In a world that has conquered distance, in a world whose destiny could hinge on seconds, man is totally dependent on the means which carry his voice and thought. It is this means that we in Western Electric, indeed the entire Bell System, have worked on together since 1882.

Our specialty at Western Electric is the manufacture and installation of dependable, low-cost communications systems for both today and tomorrow. And to meet tomorrow's needs, we will need fresh new ideas. Your ideas. There is still much for you to discover right here at Western Electric.

Paths of Progress at W. E. for Engineers and Scientists:

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To Our Readers . . . .

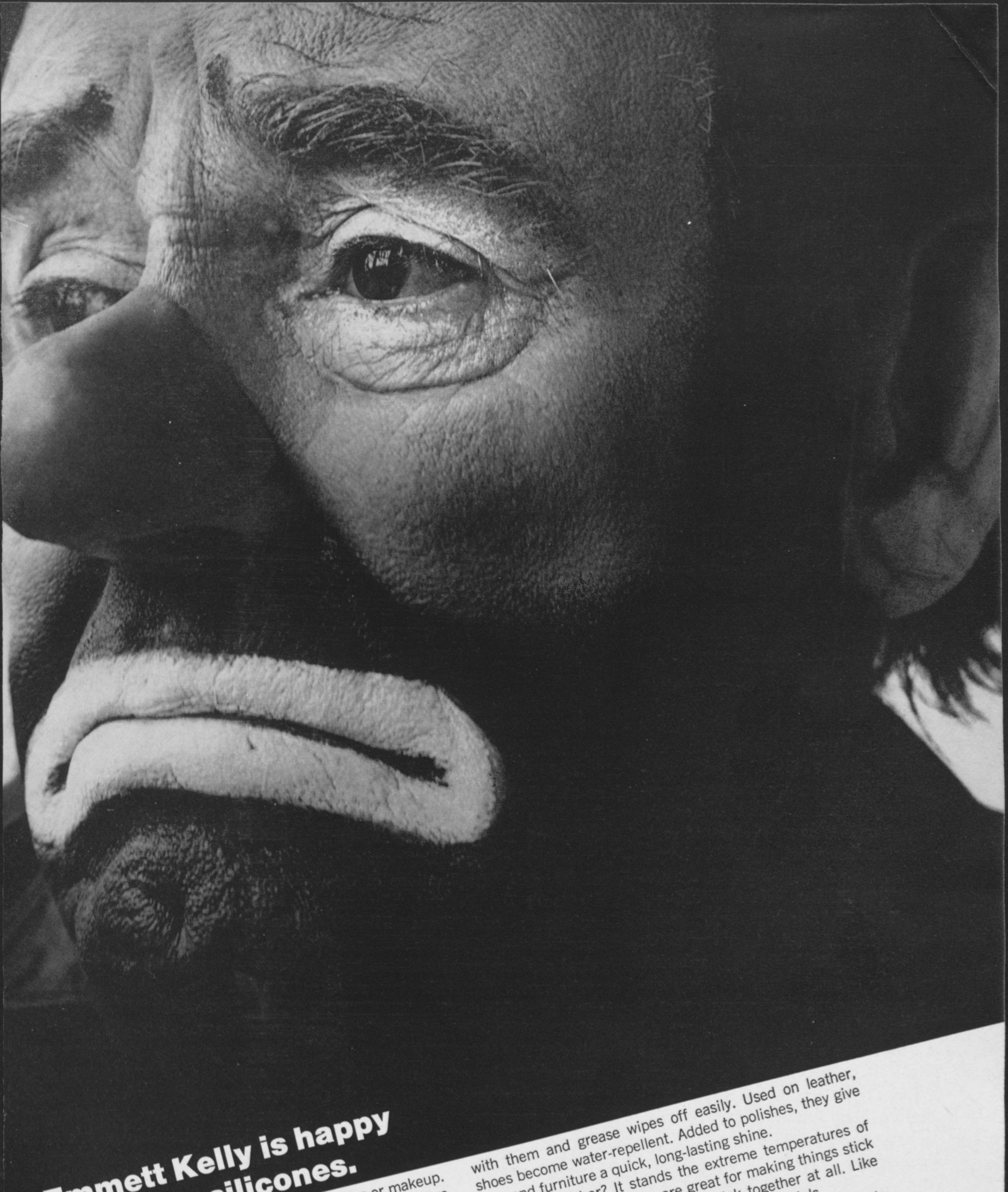
(The following editorial is excerpts from a paper given by Professor Paul Bryant at the Annual Meeting of the American Society for Engineering Education.)

What . . . can a student magazine do better than anyone else? The student engineering magazine cannot be a first rate *Popular Mechanics.* The student magazine cannot hope to be a first rate technical journal. The student engineering magazine cannot successfully be either a joke book or a "girlie" magazine.

What the student engineering magazine *can* do better than any other publication is represent its own school, talk about its own people, and focus on local material that will be read. First, a student magazine should carry news and features about its own engineering school. The . . . idea works with new (teachers), new series of courses, and curricula. The . . . magazine provides an ideal medium for the dean and department chairman to inform students of the reasons behind policies and rules in the college. Students are made aware that the rules are not arbitrary and capricious but carefully considered and made for reasons. Organized student activities provide a rich source of material for the student magazine. Local activities of interest . . . can be discussed. Most engineering colleges have . . . research program that can provide good material for the magazine. The best approach is from the student's viewpoint. Articles about careers in engineering and professional opportunities students can look forward to, can . . . be interesting and useful to students.

Student engineering magazines have great potential as a learning experience, as a forum for students, faculty, and administration; as a medium for information about . . . curricula (and) policies; as a way to stimulate student activities; as a key to a sense of community interests among students and faculty. Student magazines cannot compete with professional journals or "girlie" magazines. The student magazine must do the job it can do better than any other publication: presenting news, events, people on the engineering campus. In all of this, the magazine should try to avoid the stuffy dullness of most professional journals. Engineering is a mature, established profession that does not need to hide behind stuffiness.

JMN & DEM



Emmett Kelly is happy about our silicones.

To create "Weary Willie" takes a lot of cosmetics or makeup. Once they were hard to apply. They caked, crinkled, gave performers an unnatural look.

Today, cosmetics with silicones give a smooth, natural look. Easy to apply, easy to remove.

Union Carbide has developed silicones for an amazing range of products and purposes.

Examples: add silicones to paints and they become easier to apply; cover surfaces evenly, uniformly. Put them in spray-on starch and irons won't stick to cloth. Coat ovens with them and grease wipes off easily. Used on leather, shoes become water-repellent. Added to polishes, they give cars and furniture a quick, long-lasting shine.

Silicone rubber? It stands the extreme temperatures of outer space. And silicones are great for making things stick together that ordinarily wouldn't stick together at all. Like making glass and metals adhere to many materials.

What will we do next with the amazing silicones? There's no telling. We never stop experimenting. And here, at Union Carbide, we experiment with practically everything.

UNION CARBIDE

THE DISCOVERY COMPANY

1967 ALUMNI INSTITUTE

SYSTEMS ENGINEERING

Edited by

TONY TIETZ

Every fall many Rose alumni return to their Alma Mater at homecoming to visit old friends and classmates and to look over the changing campus. This year, in order to complement the social aspects of homecoming, Rose is presenting for the benefit of alumni the 1967 *Alumni Institute on Systems Engineering.* Consequently, the alumni will be able to acquire knowledge valuable to their business pursuits while enjoying the annual homecoming festivities.

The main speakers of this program include distinguished members of the faculties of Rose Polytechnic Institute, Indiana University, and Indiana State University. They are Dr. Denis H. Sapp, Chairman of the Civil Engineering Department at Rose; Dr. Robert M. Arthur, Chairman of the Biological Engineering Department at Rose; Prof. Herman A. Moench, Vice President for Academic Affairs at Rose; Dr. William C. Perkins, Assistant Professor of Quantitative Business Analysis at Indiana University; and Dean Donald R. Mighell, Assistant Dean of Men at Indiana State University.

Dr. Sapp will discuss "The Philosophy of Design"; Dr. Arthur, "Abstract Biological Engineering"; Prof. Moench, "Applications of Optimization"; Dr. Perkins, "Systems Simulation"; and Dean Mighell, "Community—A Systems Analysis." Several of these speakers have generously made the following summaries available to the TECHNIC prior to the date of the Institute, November 3. The TECHNIC hopes this will stimulate interest in the Institute and encourages all to attend this excellent program.

PHILOSOPHY OF ENGINEERING DESIGN

Because of today's demands, it is important that the engineer conduct his affairs as efficiently as possible. He needs a definite procedure, a methodology, a philosophy.

"A philosophy of engineering design includes three underlying principles, or parts.

1. To seek out those *principles and concepts* that are of the *greatest generality, consistent with usefulness,* and that can lead to a discipline of design.
2. To formulate a method whereby the *discipline of design* is applied in its most *general sense.*
3. To formulate an *evaluative function* to measure the value of the results.

The total socio-ecological continuum forms the matrix into which the open systems of engineering design must fit. The engineer must never forget that his creations will ultimately influence that matrix and that it is certainly his task to make that influence one of betterment.

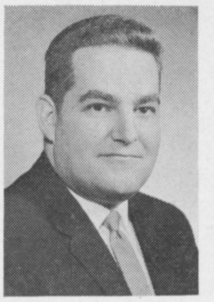
The design engineer is concerned primarily with the producer, but also must be aware of the needs of the consumer and distributor.

The five interrelated stages of the design process are (according to Krick[2]) as follows:

(*Continued on page* 26)

THE SYSTEMS APPROACH

by DR. CHARLES ROGERS



Dr. Rogers is an associate professor of Electrical Engineering and chairman of the department at Rose. He received his B.S., M.S., and Ph.D. from Purdue University.

In searching for a good definition of the "systems approach," I have been constantly perplexed by the feeling of R. E. Machol[1] that "Systems is kind of an 'okay' word. It is a sexy title and people like it." But few really seemed to understand what it is. Is it the aerospace emphasis of the mechanical engineer, the control systems of the electrical engineer, and the process control of the chemical engineer? Partially, yes.

Dean Peters of Colorado states,[1]
"Systems engineering is directed toward the analysis and implementation of an overall objective and is related to analysis of the total environment of the system."

Whereas Bacon of IBM puts it simply,[1]
"To me, the systems approach simply means to consider all aspects of a problem simultaneously, which interact significantly."

A predominate characteristic of a system is complexity.
". . . it deals with the study of an overall, usually complex or large scale system." (Siefert, MIT)[1]

And Arjay Miller, President of Ford Motor Co., has put it:[2]
"Hunches and cut-and-try methods are giving way to the systems-analysis approach, a whole new way of perceiving problems and testing in advance the consequences of alternative actions to solve those problems. Computers and other technical devices, including mathematical models, have extended greatly our ability to understand and cope with the complex problems we face in today's world."

THE BASIC BUILDING BLOCK

The systems approach focuses attention on the inter-connection pattern of the components rather than on the components themselves. The basic building blocks of every system, be it an electrical control, a missile, a transportation system, or the national economy, are the "forward" and "feedback" paths shown in the figure, with their associated inputs and outputs. A complex system usually consists of many such "loops" within "loops," and may have a multiplicity of inputs and outputs depending, in some cases, on the degree of refinement to which the system is expressed.

FEEDBACK
PATH
FORWARD
PATH
INPUT
OUTPUT

Far too often, the feedback path is completely neglected, sometimes due to the simple failure to realize that it exists. It performs a most critical function of taking information generated at the output, processing it (usually with some time delay,) and returning it to the input or some one or some thing which is controlling the system. The nature of this feedback process and the importance of the time delay is something that many non-engineers fail to understand. In fact, it is often difficult for the controller, be it an individual or a machine, to know what the output is doing unless the feedback exists, responds quickly, and is optimized. If the time delay is too long, the system can destroy itself before it has a chance to respond. Such is the case in many traffic accidents in which the driver (the feedback path) has too great a time delay to provide a correction at the input.

Though the information provided to the feedback path does not always originate directly at the output, the most reliable information is usually that which is generated nearest the output.

The diversity and degree of complexity of the problems approached by the systems engineers requires him to be knowledgable in many fields.

Mathematics

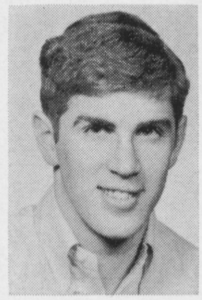
"It is clear that systems engineers need more mathematics and use more mathematics than other engineers."[1] (Cruz and Perkins, U. of Illinois)

Machol emphasizes that:[1]
". . . the people who haven't learned mathematics are either going to have to learn it or they are going to have to get out. It is unfortunate that you can't make advances in any design of systems and most of all in systems engineering without mathematics."

The true systems engineer (educated most likely, considerably beyond the BS level) will need to

(*Continued on page* 18)

Experimental Heat Capacities of Hydrogen and Deuterium at Low Temperatures



John Elzufon is a junior Chem. Eng. from Newark, New York. John is president of the Student Congress and member of A.I.Ch.E., Blue Key, Theta Xi.

by JOHN ELZUFON

The specific heat of a substance can be considered the quantity of heat required to raise the temperature of this substance by a unit degree of temperature. The terms specific heat and heat capacity seem to be often interchanged. We shall use specific heat when referring to one gram of the substance and heat capacity when referring to a more general amount, such as gram-atom, or gram-molecule. (2)

To an extent, specific heat depends on the temperature at which it is measured and on some of the changes that take place during a rise in temperature. Such a change is usually volume. Using the equation of state f (P, V, T) = O we can see that of these three variables only two can be arbitrarily varied at the same time. Hence, during a change in temperature, either P or V can be kept constant and therefore there are actually two principal heat capacities. (1)

These two capacities are easily related by use of the universal gas constant R (1.987 cal/mole-deg).

$$Cp - Cv = R$$

The proof of this relation can be easily found in any good physical chemistry book.

In our previous equation for Cp and Cv, we considered T as a variable in each case. Let us, therefore, briefly consider the relation between temperature and heat capacity.

Due to the ease of working with them, linear functions are almost always desired and linear relations are usually described as wellbehaved and "normal" relations. If we plot the heat capacity of potassium against the cube of the temperature we obtain Graph I. Such a linear relation between C and T (even though it is T^3) is typical of a well-behaved heat capacity. (2) If, on the other hand, we examine chromium methylamine alum in Graph II we notice a relation which is far from linear. (2)

But what causes such non-linear relationships which are commonly called anomalies? Using theoretical structural models and some basic formulas, it has been found that the heat capacity is governed by the manner in which the internal energy is distributed among the particles. (2)

GENERAL THEORY AND PROCEDURE OF CALORIMETRY

The vacuum calorimeter was first introduced by Nernst for the determination of heat capacities at low temperatures. In simple form, it consists of a block over which an insulated coil wire of heavy non-reactive metal (e.g. gold) is wound. The block is the container in which the substance to be studied is put. The block is suspended by leads into a vacuum-tight container which is cooled in a dewar that contains a low-temperature liquified gas such as liquid air, hydrogen or helium. Initially the vacuum-tight container is filled with helium gas at a low pressure (about one mm) and the block is then cooled to the temperature of the bath by heat transfer through the gas. Once the block has been cooled, the helium gas is pumped away and the block is then thermally isolated. Known quantities of heat are applied to the coil by passing through known currents for a definite interval of time. The resulting rise in temperature is measured by the change in the resistance in the metal wire. A common experimental method is to supply heat continuously and then calculate Cp from a continuous record of the temperatures. (2) The formula used is; (3)

$$Cp = \frac{eIt\ (W - Cc)}{AT}$$

where e = voltage across the terminals of the heater
I = amperes through the heater
t = time in seconds of heat input
W = conversion factor; I thermochemical calorie = 4.1840 joules
Cc = heat capacity of empty calorimeter
A = amount of material in calorimeter, in moles
T = change in temperature during time t

This is a basic formula and will apply to the actual calorimeters that will be described in a latter section.

(*Continued on page* 28)

Solid Connection.

It just makes good sense for the graduate engineer or scientist, contemplating the direction of his professional career, to make sure that he has all the information he needs about every company he is considering—that he has total input information—before he makes a connection.

If you're good. If you're *really* good. If you have learned to use the knowledge you have acquired as a starting point from which to launch new ideas, you probably know already that your talents are in demand. There is always a seller's market for intellect.

But there can be more to your future than buy and sell. Satisfaction is a commodity that cannot be exchanged.

When you are considering where you will start in the complex world of aerospace, while you are gathering input information, we urge you to investigate the opportunity for a *satisfying* career here at the Pomona division of General Dynamics.

Here are five reasons why it would be a wise move for you now:

1. You will work side-by-side with nationally recognized engineers and scientists who are pioneering advanced concepts in missilry. Your reputation will be balanced by association.
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3. You will pursue your profession in an area where living is pleasurable year 'round—one of the top vacation areas in the nation. Beaches, mountains, desert, a great city nearby, universities and colleges for advanced study, an atmosphere of growth and achievement.
4. Your ability will be applied to creating universally important products of engineering imagination.
5. Here at the nation's largest facility for development and manufacture of tactical guided missiles, your talents will be evaluated, recognized and rewarded.

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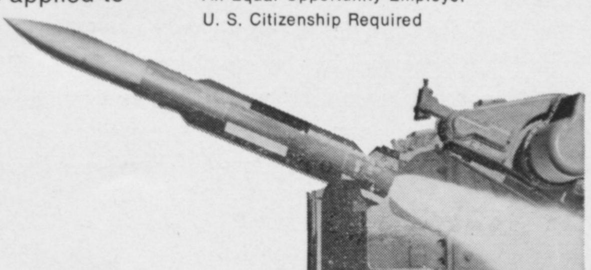

SYSTEMS APPROACH

(*Continued from page* 14)

systematically embrace: stochastic factors, human decisionary factors, and time phasing of large systems, as well as PERT and other management control techniques. Thus a multiplicity of other areas of mathematics are also mentioned: optimization and operations research, functions of matrices, vector spaces, set theory, functional analysis, queing theory, search theory, dynamic programming, network theory, and concepts of strategy.

Computers

"The computer has been responsible for bringing the systems engineer into existence and it should be the device which will insure his continued employment in the years to come." —(T. J. Williams of Monsanto)

"Anyone who calls himself a systems engineer seems to be preoccupied with computers and, I think there is some reason for this. The very expensive, the very complicated, the very deep mathematical modeling that is necessary to make any real progress in sys-engineering can only be manipulated with computers. Systems engineering in a sense wasn't even possible in early days because they simply did not have the computing power with which to do an effective job of making a mathematical model." —(A. W. Wymore, Univ. of Arizona)

Economics

". . . sophisticated utility function concepts must be employed in systems models, not just routine cook book accounting procedures. The student has to realize, for example, that he must have a basis for costing plant investment and other indirect costs . . . The costs other than dollar costs must be considered. Direct operating costs involve cost learning curve theory. Thus, somewhere in the curriculum the student needs a good training or background in the sophysticated economic costing procedures so that he can include this in his total systems optimization. This is part of the decisionary process. If this broader spectrum of techniques and economic factors is left out of engineering consideration, the engineer will be led to false answers." —(G. W. Morgenthaler, The Martin Co.)

Human Factors

Contrary to some, it is my belief that human factors form a major component of the systems approach. The *problem* is described in similar fashions by three distinguished men. Howard W. Johnson, President of M.I.T. states:[3]

"A concomitant of great organizational size has been the frequent depersonalization of administrative, political, and management control methods that sometimes deprives the individual of a sense of participation in meaningful decisions regarding his own life and work. This in turn has contributed to a sense of frustration and bafflement often expressed by young people today."

Max Ways, in *Fortune,* goes further:

"Specialization of knowledge and work requires large and complex organizations; these raised fears that individuality would be attenuated, that an 'organization man,' bland and malleable, might replace his admirably hard-nosed ancestor. This feared sacrifice of individuality, repugnant on democratic and moral grounds, would not even be compensated for by an augmented sense of social warmth or common purpose. We were moving, obviously, but weren't we adrift?"

McGeorge Bundy states the problem even more forcefully:[8]

"There has developed in this country a degree of public blandness which does us no credit. Neither in business, nor in the professions. nor in government is there enough encouragement to independent activities by young men. The 'organization man' is not merely a slick phrase. He is a growing menace to us all, not because of what he is—a decent and hard-working servant of his organization—but because of what he is *not*. He is *not* willing to annoy his organization by any action, and his organization is too easily annoyed. Foundations ought to stand against this kind of thing."

Since the history of the past decade reveals that an increasing portion of management personnel at all levels are scientist-engineers, the cause of the problem may be because

"Too many engineers tend to leave people out of their equations, and the systems technique needs many more social and life scientists embroiled in its deliberations than it has got at present. But the systems men are learning . . . This new style promises to add a missing ingredient to the quality of American life."[2]

Dr. Howard W. Johnson, states the *need* in several ways:

"In addition to being concerned with every man, technology must be concerned with the whole man. It must seek to create the large scale environment in which man can realize his full potential as a human being . . .

"The very fabric of the city creates interactions that make the quality of transportation, education, politics, economics, and citizenship all closely interconnected. In this setting, the task of the modern engineer assumes a higher order intellectually than that which is associated with understanding basic science . . .

"We must find ways to place new emphasis and attention on the systematic nature of large-scale human uses of technology . . . This human focus of technology should be a primary concern for today and for the future . . .

"We need people who, in Norbert Wiener's words, have the one quality more important than 'know-what, by which we determine not only how to accomplish our purposes, but what our purposes are to be.' "

Others feel that,[4] "There *is* an orderly way of proceeding from a realizable system which effectively

(*Continued on page* 20)

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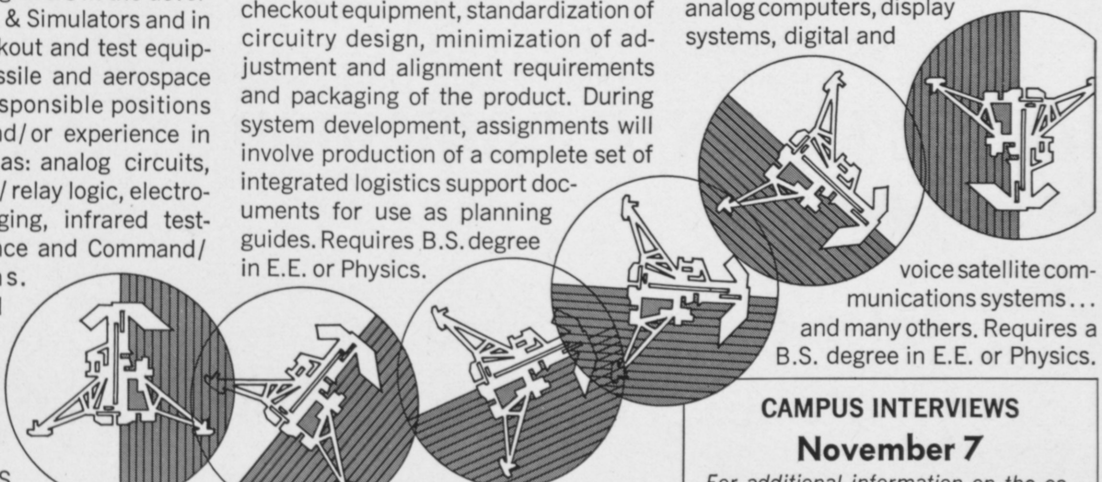

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November 7

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SYSTEMS APPROACH

(*Continued from page* 18)

and efficiently satisfies those needs."

I am convinced that more than any other thing, the systems approach is a state of mind in which the professional person is acutely aware of the social implications of his work and is guided by them.

THE T-SHAPED SYSTEMS ENGINEER

The ideal systems engineer can be described as T-shaped, meaning that he is broad and also deep in one field. There were numerous strong comments on the necessity for obtaining the stem of the T, the depth, first.

"We end up sometimes with the so-called 'big-picture' boys who tend to be superficial; who feel that they can ignore the component completely and design a system. You cannot completely connect the black boxes without understanding what is inside the boxes." (Machol, U. of Illinois)

"I am making a similar plea here that, in order to be a systems engineer, you must first be something . . . then if you have the inclination and ability you can spread out." (Siefert, MIT)

"I would be a little bit afraid that the people your program will generate will be the ones who have a broad spectrum, but who don't have the depth in any one field." (Bollay, Stanford)

"I am saying that I don't want these persons with a broad, shallow spectrum. I don't know what to do with them." (Bacon, IBM)

"Thus, our industry would want to insist that the systems engineer must first of all be a good chemical engineer . . . the engineering science programs, while extremely valuable in the original intent, have gone much too far toward producing a 'jack of all trades and master of none' type of individual." (Williams, Monsanto)

Dr. H. W. Johnson[3] describes the exchange between teachers and student as taking place at three distinct levels, the first two of which bear a striking resemblance to th stem and the cap of the T:

(1) *Technical competence* . . the student learns to maste new knowledge and ideas i depth.

(2) Integrating diversity for th purpose of *decision makin* The training of the mind t analyze and to ask the righ question, to choose, to judg and discriminate, to conside the human factors, to orde chaotic situations, and to dea with ambiguity . . .

The third level, the gold-plating o the T (that part the BUILD repor nearly forgot), seems closely relate to the human approach; educatio at the level of

(3) *personal responsibility an contribution to society.*

Thus it seems evident that a nev and dynamic approach to engineer ing, in the form of the systems ap proach, must be accompanied by similar reconstruction in the atti tudes and approaches of the engi neers themselves.

MISS

BECKY CARROLL

Our Miss Technic for October is Becky Carroll. Becky is a freshman at I.S.U. and hails from Frankfort, Indiana. She plans on majoring in speech and theatre. Her hobbies include singing and acting. On graduation, Becky hopes to teach high school speech and drama. Becky is a 5′ 8″ blond with green eyes and a charming personality.

Photos by Charles Rupp

TECHNIC

SYSTEMS ENG.

(*Continued from page* 12)

A. Formulation
B. Analysis
C. Search
D. Decision
E. Specification

Formulation

The first step in engineering design, that of problem formulation, or definition, is undoubtedly the most important. It is of fundamental importance that as broad a definition as possible be made. The designer must ask: "What is it I am in fact trying to accomplish?"

Analysis

The object of the analysis phase is to determine a set of solution variables which maximize the criteria.

Search

Once the problem has been analyzed and the criteria and the restrictions are well in the designer's mind, the search for alternative solutions is ready to begin. It is at this point in the design process that the designer has the opportunity to display his creative ability.

Decision

Once a group of possible alternative solution ideas have been assembled and it is considered inadvisable to spend more time in the search, the designer is ready to begin the decision phase. This phase consists of a feasibility study, followed by a process of discrimination to determine the optimum solution.

Specification

Once the final design solution has been determined the designer must reevaluate it based on all the criteria, restrictions and limitations of all the preceding phases of the design process to see if it does represent his optimum solution.

ABSTRACT
BIOLOGICAL ENGINEERING

Biologists have long been faced with the task of trying to understand a system having a large number of variables. New developments in biological instrumentation provide considerably more data and more information about these variables. Systems analysis assists in developing experiments and in analyzing the data.

An example of systems analysis to the design of an artificial limb is presented. Part of this design is the electrical stimulation of muscle.

The problem: neural control of muscular action. A brief discussion of the physiological components and their mechanisms of action will introduce the audience to the properly functioning system. The nonfunctioning or pathological conditions will then be presented.

The solution: In order to restore "normal muscular function" to a paralyzed limb, several theoretical techniques are presently being developed by workers in the field of medical engineering. One of the efforts designed to evaluate the feasibility of restoring this functioning will be the main topic for consideration. It involves the control of a single skeletal joint (the elbow) by electrical stimulation of the appropriate muscles. The application of systems analysis in evaluating this effort will be considered.

General discussion: Showing application to other problems in environmental health and medical engineering will follow.

OPTIMIZATION

When we *optimize* a design or a process we do more than merely "improve" it—rather, we are seeking out *the best* way to do the job. Every student of differential calculus knows how to find that point on the graph of a mathematical relation where a maximum value or a minimum value of the dependent variable occurs. But optimization implies much more than a straightforward mathematics solution—it involves three steps in sequence: first, a thorough knowledge of the system to be optimized so that a "model" can be constructed that truly represents what is happening in the system; second, finding a *single measure,* such as profit, cost, or efficiency, of the effectiveness of the system; and third, the application of appropriate mathematical techniques such as linear programming, recognizing constraints imposed on algebraic inequalities by convexity, non-negativity and complementary slackness to select the one best choice.

It is significant that step two in this process often involves value judgments—the assigning of numerical measures to the various factors or variables entering the problem. Certainly in social or political systems this may be very difficult since the varied goals may be in direct conflict. For example, what numerical measure of value should be assigned to clean water or to clean air in an urban environment?

Nevertheless, managers of enterprises and offices of governmental agencies must make decisions which optimize the goals sought. Optimization theory helps develop decisions through skill in recognizing the proper form of the optimal solution even when a problem is not completely formulated in mathematical terms.

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[1]Asimow, Morris. INTRODUCTION TO DESIGN, Prentice-Hall, 1962.

[2]Krick, Edward V. AN INTRODUCTION TO ENGINEERING AND ENGINEERING DESIGN, John Wiley & Sons, 1965.

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TEAR OUT AND SAVE.

HEAT CAPACITIES

(*Continued from page* 16)

GENERAL THEORY OF LOW TEMPERATURE HYDROGEN

Hydrogen is known to exist in two forms. These are called ortho-hydrogen and para-hydrogen. The explanation of these terms involves the direction of the spin of the nuclei in the hydrogen molecule. When the spin of the two nuclei are parallel (same direction), then we have what is defined as ortho-hydrogen. Obviously, anti-parallel spin of the nuclei is defined as para-hydrogen. The distribution of these two states is a function of temperature. It is found that at low temperatures ortho-para conversions are most likely to occur. An ortho-para conversion involves a change in the rotational quantum number of the nuclei involved. In hydrogen, the ortho state is associated with odd quantum rotational numbers while the para state is associated with even quantum rotational numbers. The amount of energy needed for an ortho-para shift is 337 cal/mole. (4) The actual theories involving this shift are very complicated and require a working knowledge of quantum mechanics and/or chemical statistics. Since both are above the scope of this paper, references (5) and (6) are suggested if further information is desired.

From this theory, it is found that in a hydrogen (as opposed to deuterium or tritium) system at low temperatures we are dealing with essentially the purely para state. (4)

However, if we are considering a system in which there is either deuterium or tritium, we cannot be so fortunate as to be able to have a pure system.

One interesting fact which might be worth mentioning is that the quantum rotational numbers for deuterium are reversed. (2) For ortho-deuterium the quantum rotational numbers are even as opposed to odd numbers for ortho-hydrogen.

At low temperatures, the following reactions are taking place:

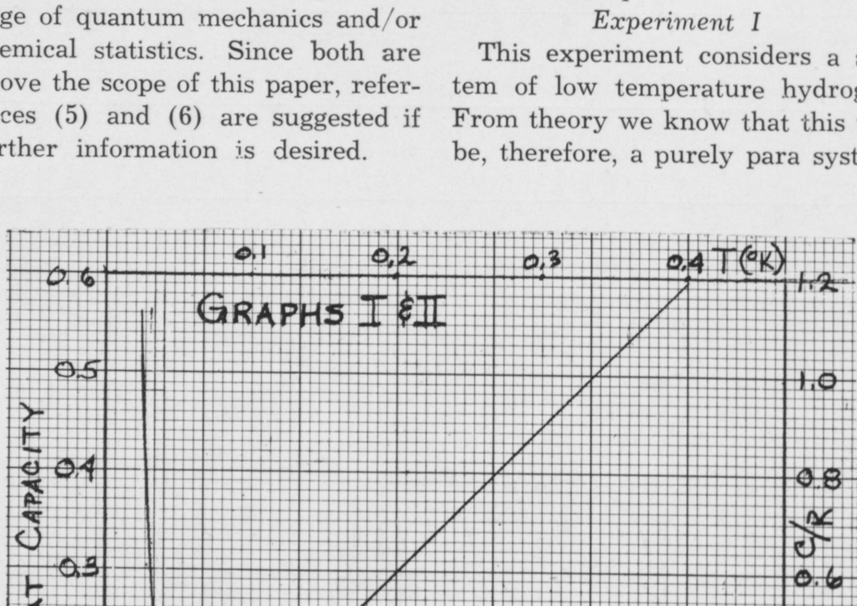
$$H_2 + D_2 = 2HD$$
$$H_2 + T_2 = 2HT$$
$$D_2 + T_2 = 2DT$$

H = hydrogen
D = deuterium
T = tritium

Since the molecular weights of H, D, and T are different, it will be important to know the percentage of each in a given system for this will affect the value of A in our basic calorimeter equation.

Experiment I

This experiment considers a system of low temperature hydrogen. From theory we know that this will be, therefore, a purely para system.



In addition, since we are dealin with pure hydrogen we will not hav to consider mole percentages of deu terium and tritium.

Apparatus: The equipment use is a calorimeter and cryostat appa ratus as developed by Johnsto Clarke, Rifkin, and Kerr. (8) Th calorimeter proper is a cylindric container of copper that has a vo ume of 119.2 ml. The copper cylinde is about 9.5 cm long, 3.8 cm in d ameter, and 0.079 cm in wall-thick ness. Thermal equilibrium is estab lished through the use of twelv radial copper fins (0.013 cm. thick that are soldered to the inside of th cylinder. The gas inlet tube is mad of monel tubing (i.d. of 0.011 cm an o.d. of 0.0157 cm) which is connecte to the top of the calorimeter b means of a soldered sleeve. Th calorimeter is wound with a nylo covered gold wire which functio as a combination resistance the mometer and heater. A copper- co stantan thermocouple is soldered t the bottom of the calorimeter. Th thermocouple is wrapped tightl around the calorimeter to insu good thermal contact.

The upper block is a lead-fille copper cylinder which has an O.D of 6.8 cm. and a height of 0.3 cm The lower block is a copper cylinde 20 cm. high with an O.D. of 6.8 cm and a wall thickness of one cm. Whe positioned, it surrounds the calori meter and thus functions as both heat sink and a radiation shiel A brass container surrounds th block assembly and is connected t the vacuum system by means of monel tube which also serves as support. The brass container is se in a 36 by 5.5 inch glass dewar (use to prevent heat transfer) which i turn is set in a brass cryostat (use to maintain a constant low tempera ture. This cryostat is made vacuu tight and can be connected to eithe the hydrogen return line or to th vacuum pump; the latter being use to reduce temperature in the dewa by adiabatic evaporation.

The gas measuring system that i employed is identical to the one de veloped and used by Giauque an

Johnson, Fig. I. (3). The measuring bulb A is made from a five-liter pyrex flask and is supported in a hemispherical casting B. Fused to the top tween A and B. Fused to the top and the bottom of A are small diameter glass tubes, D and E, which bear etched scales showing volume intervals of 0-1 cc. The lower end of E is fused to a glass tube leading to the bottom of a six-liter cast-iron mercury reservoir F. This entire apparatus is immersed in a 25° (or k) thermostat which maintained a temperature constant to 0.01.

To measure the amount of substance present in the calorimeter, pressure is applied through valve 1 to force mercury into A. Then a portion of the substance in the calorimeter is then vaporized and collected in A. Simultaneously, pressure was released in F by action of the electromagnetic valve H, so that the mercury will return to the reservoir and the gas will collect in A at atmospheric pressure.

When A is almost filled with gas, as evidenced by the height of the mercury in the capillary manometer J, the vaporization is stopped and valve S_1 is closed. Further pressure is released in F by hand manipulation of the valves until the mercury meniscus is brought into the lower scale E. The pressure is then read on the large-diameter manometer M. This is enclosed in an air-jacketed case and connected to A through a capillary tubing which serves to diminish the volume internal to the thermostat. This process is repeated until all of the material in the calorimeter is vaporized.

The following relationship is employed for calculating the amount of gas: (3)

$$\text{Moles} = \frac{VPd}{M}\left(\frac{I}{I+KT}\right)[1+2\,(I-P)]$$

where V = volume in liters
P = pressure in atmospheres
d = density of gas per liter at standard conditions
M = molecular weight
k = mean coefficient of thermal expansion from 0 to 25
T = temperature in degrees C
a = coefficient of deviation from Boyle's Law per atmosphere.

The values used for the equation are:

d = 1.42898 (3)
k = 0.003672 (3)
a = -0.00087 (3)

The uncertainty of these constants is so small that error from this source may be neglected.

The electrical energy for heating the calorimeter is supplied by a battery of Edison cells. A resistance of approximately 10,000 ohms is connected in paralled with the calorimeter heater. For energy and resistance measurements a White double potentiometer is used and a Wenner potentiometer is used for thermocouple readings. The resistance thermometer has a (dR/dT) of 1 ohm per degree. (8)

Due to the importance of having accurate low temperature readings, two methods of temperature determination are used. The resistance thermometer readings were checked by use of a formula which used the pressures read off the capillary manometer. This is the Leiden equation: $t = -260.397 + 1.0270 \log P + 1.7303 \log^2 P$ (8)

where t = degrees centigrade
P = pressure in centimeters of Hg

To convert degrees centigrade into absolute temperature, a formula developed by Johnson, Clarke, Rifkin, and Kerr was used. (8)

$T = (1 - 2.13 \times 10^{-4})\ t + 273.082$

where T = degrees Kelvin
t = degrees Centigrade

With the apparatus assembled the heat capacity of the empty calorimeter is determined. Then a current of known voltage was applied to the heater. Over a know time t, the change in temperature. the actual temperature, and the amount of material in the calorimeter are measured.

Re-examining our basic equation we can see that for the duration of this experiment the voltage (e), amperes (I), time (t), conversion factor (w), and heat capacity of empty calorimeter (Cc) will all be constant. Therefore, the Cp that we calculate is a function (once the above have been determined and thus made constant) of the moles of material (A) and the change in temperature ($\triangle$T). That is Cp = f (A,$\triangle$T).

(*Continued on page* 32)

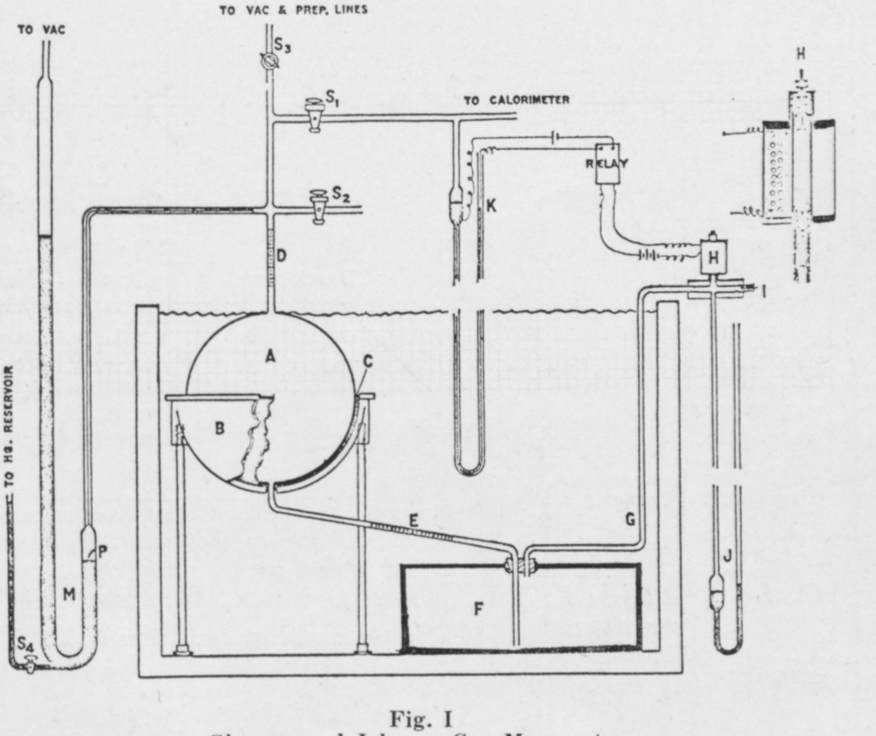


Fig. I
Giauque and Johnson Gas Manometer.

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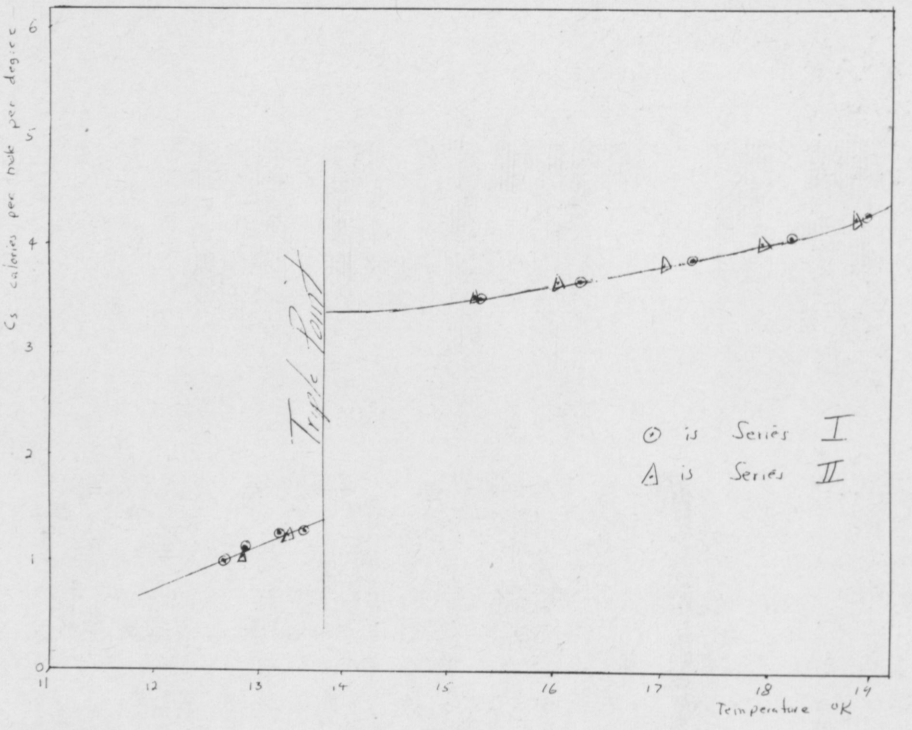


hydrogen is quite well-behaved. The liquid is fairly well behaved too but not quite as well as the solid para-hydrogen. This conclusion is not based on just Graph III. Graphs of experiments done by Johnston, Clarke, Rifkin. and Kerr, and by Clusius and Miller revealed the same type of behavior. (8) We must note also that this conclusion is for the temperature ranges only in which we are dealing with. This is especially true of the behavior of the solid para-hydrogen.

HEAT CAPACITIES

(*Continued from page* 29)

The heat capacity obtained in two series of runs is shown in the following Graph III:

On the graph, we can easily notice the vertical line at the triple point. This is located at 13.84 degrees. Three determinations were made of the triple point. During the runs, the calorimeter was kept only half full so as to avoid the superheating of the surface by heat leak down the monel tube. An extended time period of approximately 15 minutes to one-half hour was allowed for the attainment of thermal equilibrium in the calorimeter with the solid a little less than half melted. The three determinations yielded values of 5.278, 5.274, and 5.276 cm. of mercury. (8). By substituting 5.276 for P in the Leiden equation and then using the equation of Johnston, Clarke, Rifkin and Kerr we obtain the value of 13.845 for the triple point of pure para hydrogen.

OBSERVATIONS AND CONCLUSIONS

An examination of Graph III shows that at low temperatures, the heat capacity of para hydrogen is anomalous. The most obvious deviation from what would be considered well-behaved is the leap in the value of the heat capacity at the triple point. Thus we can conclude that the liquid para-hydrogen has a higher heat capacity than the solid para-hydrogen. However, we might notice that taking solid and liquid as separate entities, we can see that the heat capacity for the solid para-

BIBLIOGRAPHY

[1]W. J. Moore, *Physical Chemistry*, 3rd Ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1962.

[2]E.S.R. Gopal, *Specific Heats at Low Temperatures*, Plenum Press, New York, 1966.

[3]W. T. Giaugue and H. L. Johnston, *Journal of American Chemical Society*, 51, 2300, (1929).

[4]G. E. Schmauch and A. H. Singleton, *Cryogenic Engineering*, June, 42, (1966).

[5]G. N. Lewis and M. Randall, rev. by K. S. Pitzer and L. Brewer, *Thermodynamics*, McGraw-Hill Book Co., New York, 1961.

[6]A. Farkas, *Orthohydrogen, Parahydrogen and Heavy Hydrogen*, Cambridge, University Press, 1935.

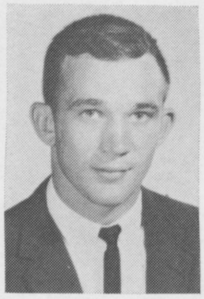
[7]S. Akhtar and H. Smith, *Chemical Review*, 64, 261, (1964).

[8]H. L. Johnston, J. T. Clarke, E. B. Rifkin, and E. C. Kerr, *Journal of American Chemical Society*, 72, 3933, (1950).

[9]W. F. Giaque and G. E. Gibson, *Journal of American Chemical Society*, 45, 93, (1923).

SPORTS

Tribute To The Seniors



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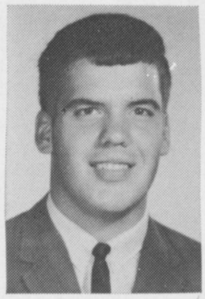

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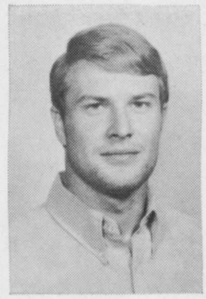

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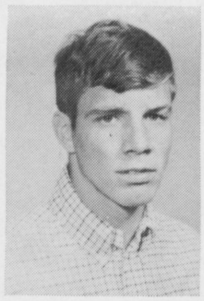

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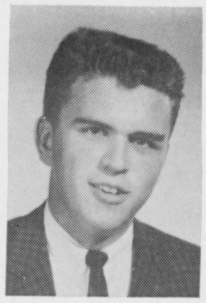
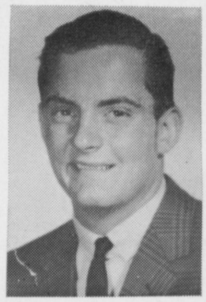
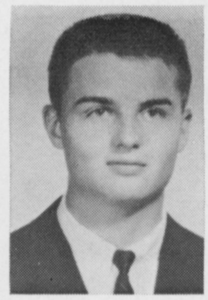


Jose Ibanez Mech. E.



Steve Mueller Mech. E.



Jerry Novotny Elec. E.

Homecoming 1967 is upon us. A fine schedule of events makes this weekend THE WEEKEND on the Rose campus for students and alumni. Freshmen burn their bonfire, fraternities compete for the Homecoming Display Trophy, and all is ushered out with the Homecoming Dance on Saturday evening. But, Homecoming this year, means something special to eight men on the Engineers football squad. Eight men will be playing before their last Homecoming crowd. Therefore, it is appropriate at this time to pay tribute to the eight seniors on the football team.

Mike Mefford, John Shambach, and Fred Valenti are the tri-captains for the Fightin Engineers. Mike is a primary receiver from his flanker back position. Mike came to Rose from Bloomington, Indiana and is earning his fourth letter this year. John plays tackle on the offensive squad. He hails from Shelbyville and has lettered for three years, presently working on his fourth. Fred is the workhorse of the offense. He runs from the fullback position with the power to mow down the defense. Fred is from Ossining, New York.

Steve Mueller is the Rose Poly middle guard. Steve is from Chicago and is currently working on a fourth letter. Pete Hodapp is a new face on the team this year. He is a transfer student from the Naval Academy, and resides in Adrian, Michigan. It appears Pete will earn his first letter this year running from his tight end slot.

Jerry Novotny is the Big Red "jack of all trades." Jerry can play defensive end and has many times nailed the quarterback behind the line of scrimmage. Jerry is now playing left end and working for his third letter. Jerry hails from Chicago.

Denny Fritz is a fine guard from Brookville, Indiana. Denny is a steady player and helps clear out the middle of the line for the backs. He is working for his third letter.

Last, but certainly not least, is Jose Ibanez from Jamaica, New York. Jose is the spirit man of the team. Although he doesn't play much, Jose has the job of rousing the spirit of the back-up men.

This tribute is a small portion of the gratitude we owe these men. We can pay them a bigger tribute by being in the stands on Homecoming Day 1967.

Somehow we think these lads have promise.

They look about ready for the *really* big league, where Bethlehem Steel has always fielded a winning team. You, too, can learn the score, by reading "Careers with Bethlehem Steel and the Loop Course." Pick up a copy at your placement office, or write Manager of Personnel, Bethlehem Steel Corporation, Bethlehem, Pa. 18016.

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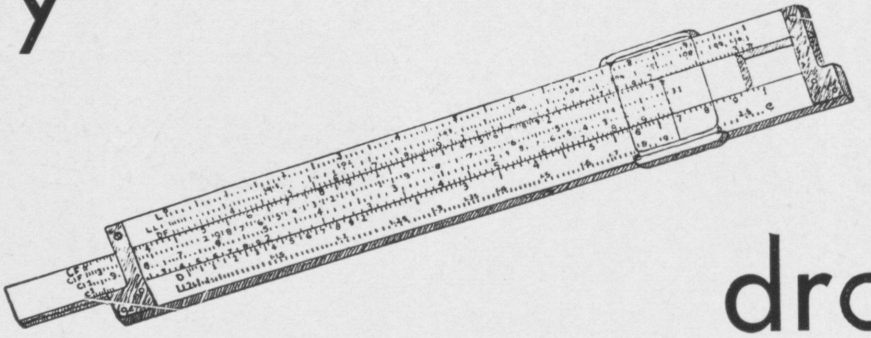


droolings

Stolen by Gary Kelm, Soph, M.E.

The mother took her young daughter to a psychiatrist and explained that the girl thought she was a chicken. The mother added that this condition had existed for nearly two years.

"Two years," exclaimed the psychiatrist. "Why did you wait so long before bringing her in for help?"

"Well, Uh, . . . " the embarrassed woman explained, "We needed the eggs, doctor."

* * *

Irritated Professor: "If there are any morons in this room, please stand up." A long silence, and a lone freshman rose.

Professor: "What, do you consider yourself a moron?"

Frosh: "Well, not exactly, sir, but I do hate to see you standing alone."

* * *

Scene: A field hospital in S. Viet Nam. A correspondent is talking to a soldier bandaged from head to foot. The correspondent, eager for the gruesome details, asked for the soldier's story.

"It's a long story," said the soldier. "When I first got here, I was told how to recognize friend from foe. I was told when I came upon a man to yell 'Ho Chi Minh is a rat!' and if he smiles, he's a friend; but if he gets angry, he's a foe and I was to shoot him. Well, I was here for about six months and then as I was walking along this jungle road, I saw a man. With my weapon at the ready, I yelled. 'Ho Chi Minh is a rat!' But he did not smile or get angry. Instead, he cupped his hands and yelled 'Lyndon Johnson is a fink.' And as we were shaking hands in the middle of the road, a truck ran over me."

* * *

We finally psyched them out—professors are people who tell students how to solve all the involved problems of life which they avoided by becoming professors.

* * *

Famous Tom Swifteys:

"I just had brain surgery," declared the patient absentmindedly.

"I hate my mother-in-law," yelled the hen-pecked husband relatively speaking.

"Look at the 144 dancing girls," said Jeff grossly.

"You'll never make it to first," cried Harry basely.

* * *

The couple, after twenty years of marriage, had decided to leave on a second honeymoon. As they made their plans, the husband glanced over his shoulder at the little old lady behind them who sat knitting.

"Just once," he whispered, "I'd like to take a trip without having your mother along."

"My mother," the wife exclaimed. "I thought she was your mother!"

* * *

"I shall now illustrate what I have on my mind," declared the Professor as he erased the board.

* * *

The little boy wanted $100 so badly he decided to pray for it. He prayed for several weeks with no results; so he wrote a letter to God. The post office finally forwarded the letter to the White House. The President chuckled and ordered $5 sent to the boy. The lad, delighted that his prayers had been answered, in part at least, wrote a thank-you to God but added this P.S.: "I noticed you routed my letter through Washington, and as usual those bureaucrats deducted 95%.

* * *

Professor to noisy class: "Order please."

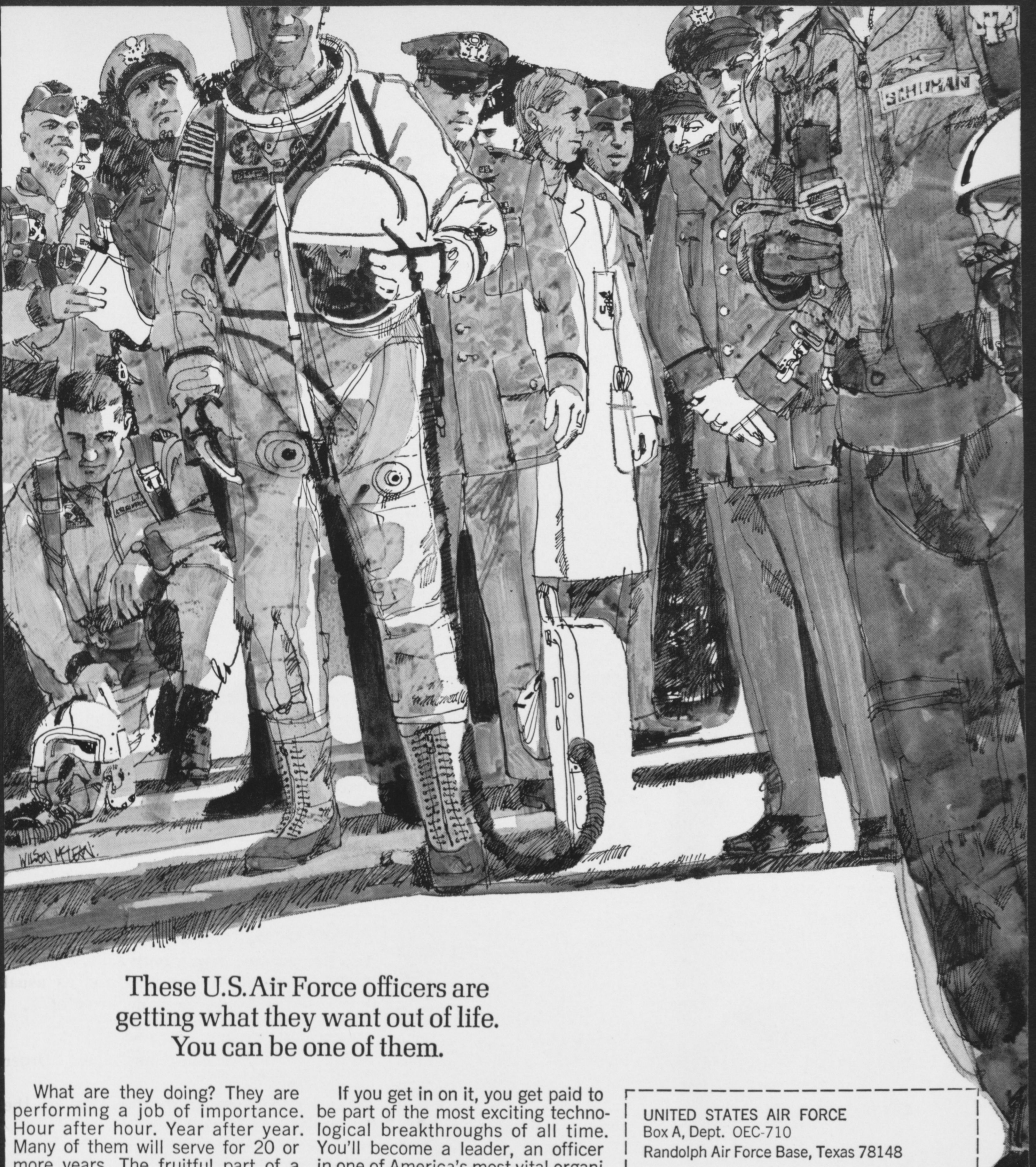
A voice from the back of the room: "Two beers."

* * *

A sweet young thing breezed into a florist shop dashed up to an elderly chap puttering around a plant and inquired, "Have you any passion poppy?"

The old boy looked surprised.

"Gol ding it!" he exclaimed. "You just wait until I get through prunin' this rose."



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