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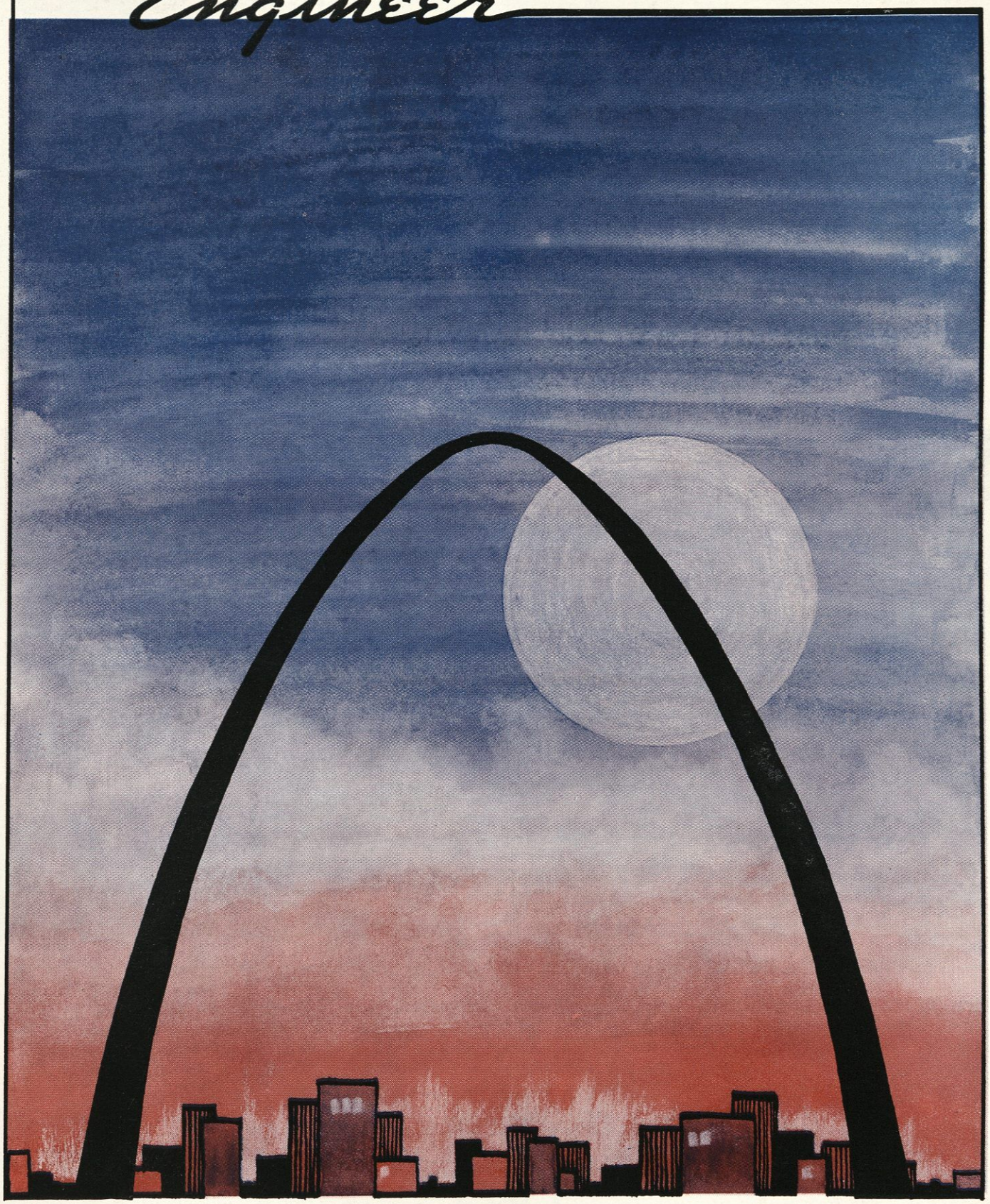

JANUARY 1966

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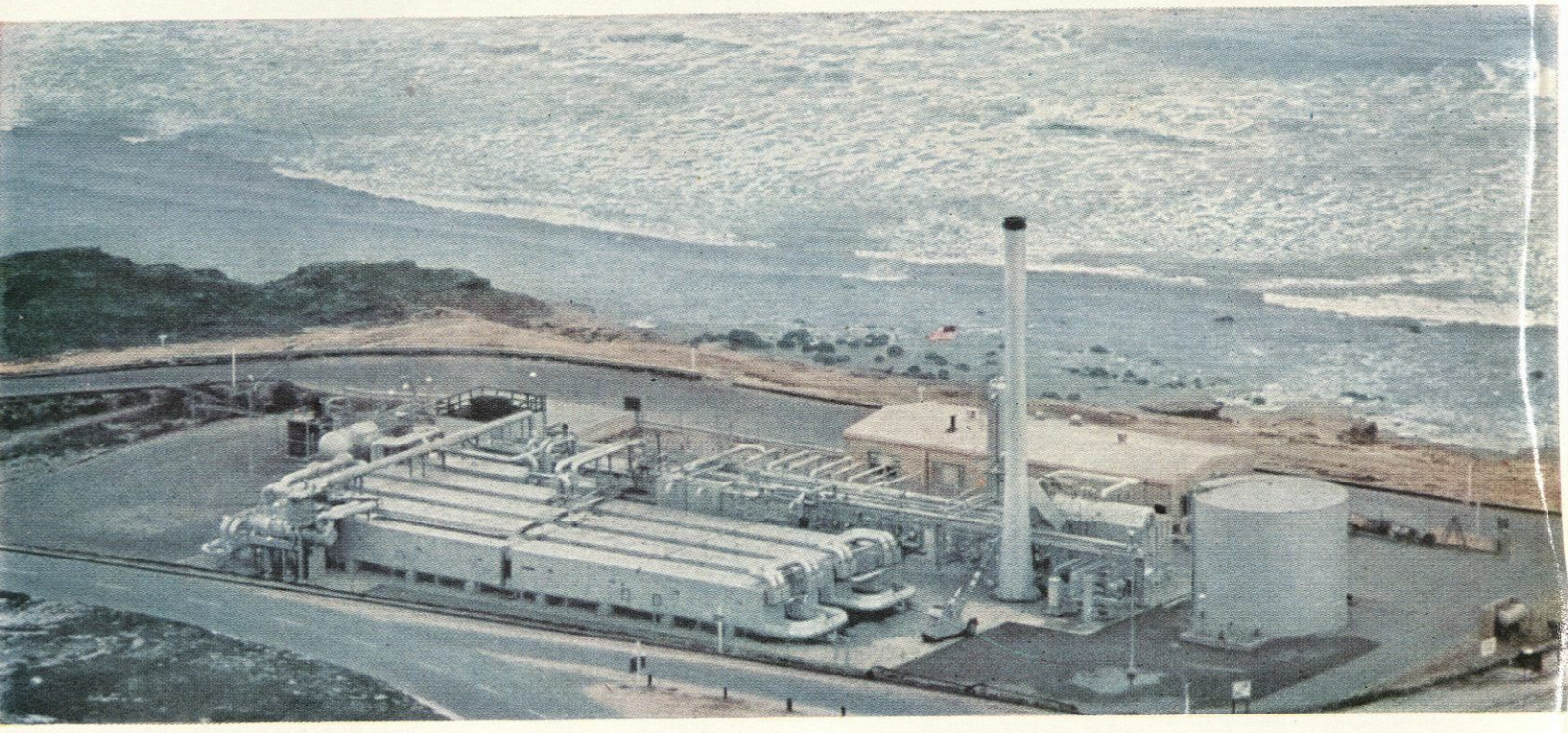

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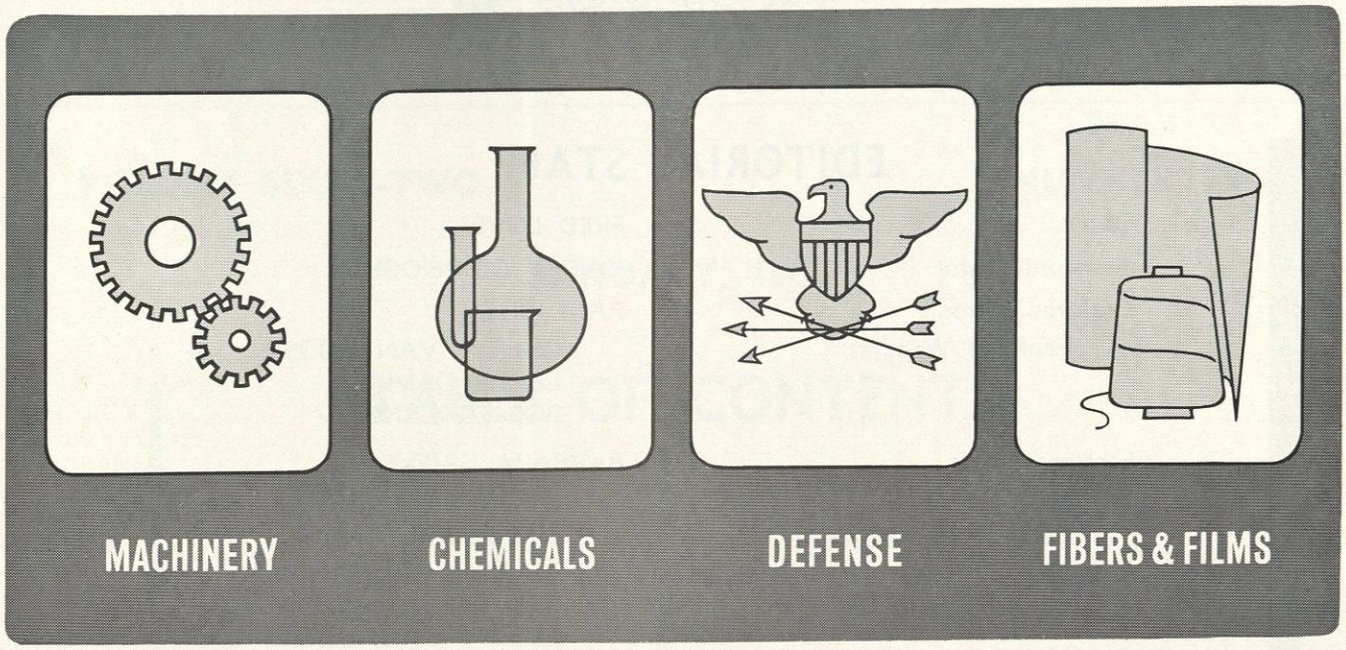

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The COLORADO Engineer

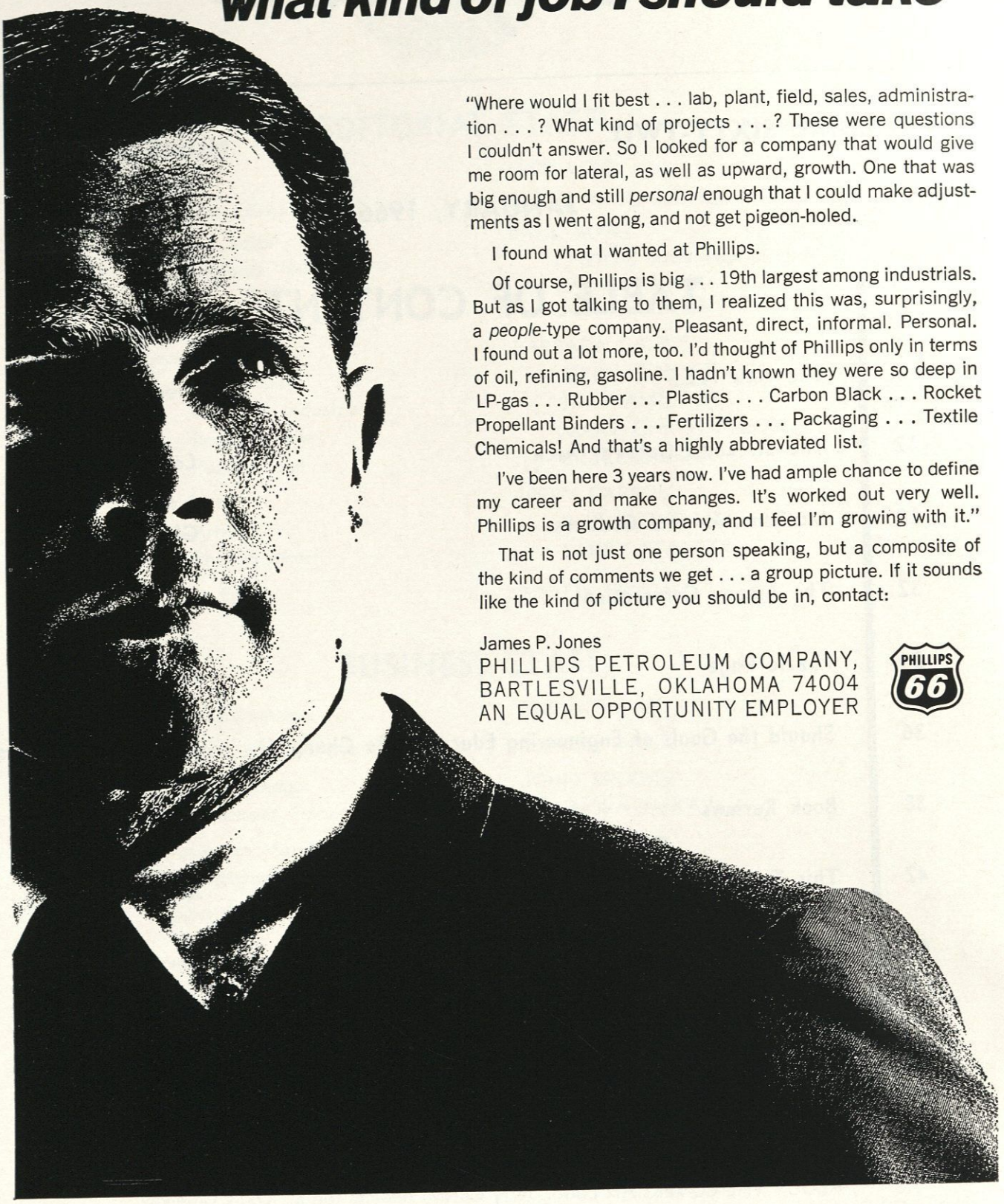
VOLUME SIXTY-TWO NUMBER TWO

JANUARY, 1966

TABLE OF CONTENTS

ABOUT THE COVER: Art Editor Jerry Carroll depicts the St. Louis Gateway Arch. For the complete story, see page 12.

"At graduation I still wasn't sure what kind of job I should take"



"Where would I fit best . . . lab, plant, field, sales, administration . . . ? What kind of projects . . . ? These were questions I couldn't answer. So I looked for a company that would give me room for lateral, as well as upward, growth. One that was big enough and still *personal* enough that I could make adjustments as I went along, and not get pigeon-holed.

I found what I wanted at Phillips.

Of course, Phillips is big . . . 19th largest among industrials. But as I got talking to them, I realized this was, surprisingly, a *people*-type company. Pleasant, direct, informal. Personal. I found out a lot more, too. I'd thought of Phillips only in terms of oil, refining, gasoline. I hadn't known they were so deep in LP-gas . . . Rubber . . . Plastics . . . Carbon Black . . . Rocket Propellant Binders . . . Fertilizers . . . Packaging . . . Textile Chemicals! And that's a highly abbreviated list.

I've been here 3 years now. I've had ample chance to define my career and make changes. It's worked out very well. Phillips is a growth company, and I feel I'm growing with it."

That is not just one person speaking, but a composite of the kind of comments we get . . . a group picture. If it sounds like the kind of picture you should be in, contact:

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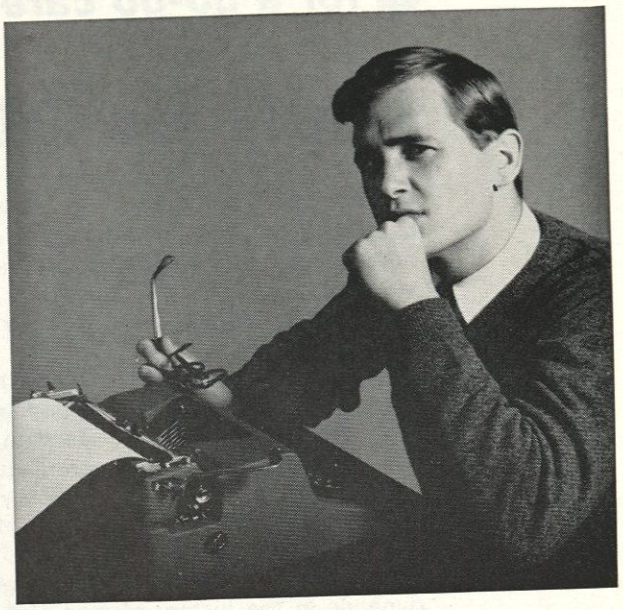

With all the companies making the same promises, how do you tell the difference?

It is difficult! Perhaps the best and only way is to study the company carefully—to see if its structure, range and operational modes permit it to make good its promises. If you scrutinize Sylvania Electronic Systems, you'll discover a number of salient facts that may help clarify the matter for you.

Note first that Sylvania employs the small group form of organization—within its nationwide complex of research and development groups, manufacturing plants and world-wide field engineering operation. This makes swift individual progress and development possible within a wide choice of current in-house projects.

Note particularly the diversity and breadth of SES projects. You may advance in a technical or administrative capacity in any of these areas: ground electronics equipment for Minuteman missile sites...research and development in electronic warfare field...electronic security systems...ASW systems...special purpose airborne computers for incorporation into U.S. Air Force large scale electronic systems...laser systems...design of spaceborne electronic and optical systems...plus world-wide engineering support systems.

Note that SES has worked out three distinct routes for advancement, all with equal rewards—technical specialist, technical manager, program/project manager.

Finally, note how SES encourages ambitious individuals to accelerate their development through participation in Division-wide conferences, in-plant courses and seminars and post-graduate study plans conducted on an unusually generous scale.

The success of the SES mission—to manage government systems programs for General Telephone & Electronics, the parent corporation—depends on the professional and intellectual growth of its personnel. In every respect, SES has created an environment to foster that growth. Be sure that any prospective employer you consider has established a growth climate of like specifications.

Making promises is one thing. Making progress is another.

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EDITORIAL

THE NEW A.E.S.

Last spring, the future of the Associated Engineering Students was rather dark and gloomy. Within one year, this insecurity has, to some degree, been replaced by hope.

The old A.E.S. tried to be the voice of the College of Engineering. Apathy came first: participation in the traditional events dwindled to nearly nothing and then A.E.S. lost its voice in student government (as epitomixed by the A.S.U.C. Senate)—the A.E.S. representative didn't even attend the session at which his seat was eliminated. As apathy increased, so did A.E.S.'s financial problems: the Regents first eliminated the mandatory A.E.S. fee; next the A.E.S. "optional" fee card was removed from engineering students' registration packets; and finally the killing blow came when A.E.S. was no longer allowed to even sell memberships in the field house during registration.

The nearly total revamping of A.E.S. last spring did essentially nothing as far as brightening the future of the organization. All of the changes made were matters of structure rather than of purpose. Fortunately, some changes did occur this fall that have done a great deal for the association.

The new A.E.S. may be able to provide what the old could not. What does the engineer want and need? Help with studies? A political voice? A unifying body? Of course not, the rigors of the engineering curriculum limit one very important part of college life—the chance for social contact.

In its first semester, our new A.E.S. has held two truly social functions with a total of four sororities. The first was well-attended by the sororities, but few engineers were there; at the second, the ratio was nearly one to one. Apparently the idea that A.E.S. can do something concrete and worthwhile for the students it claims to represent is beginning to be believed by people outside the A.E.S. hierarchy.

A.E.S. has apparently stumbled upon the secret to success, and we wish it a long and prosperous future.

—Fred E. Love

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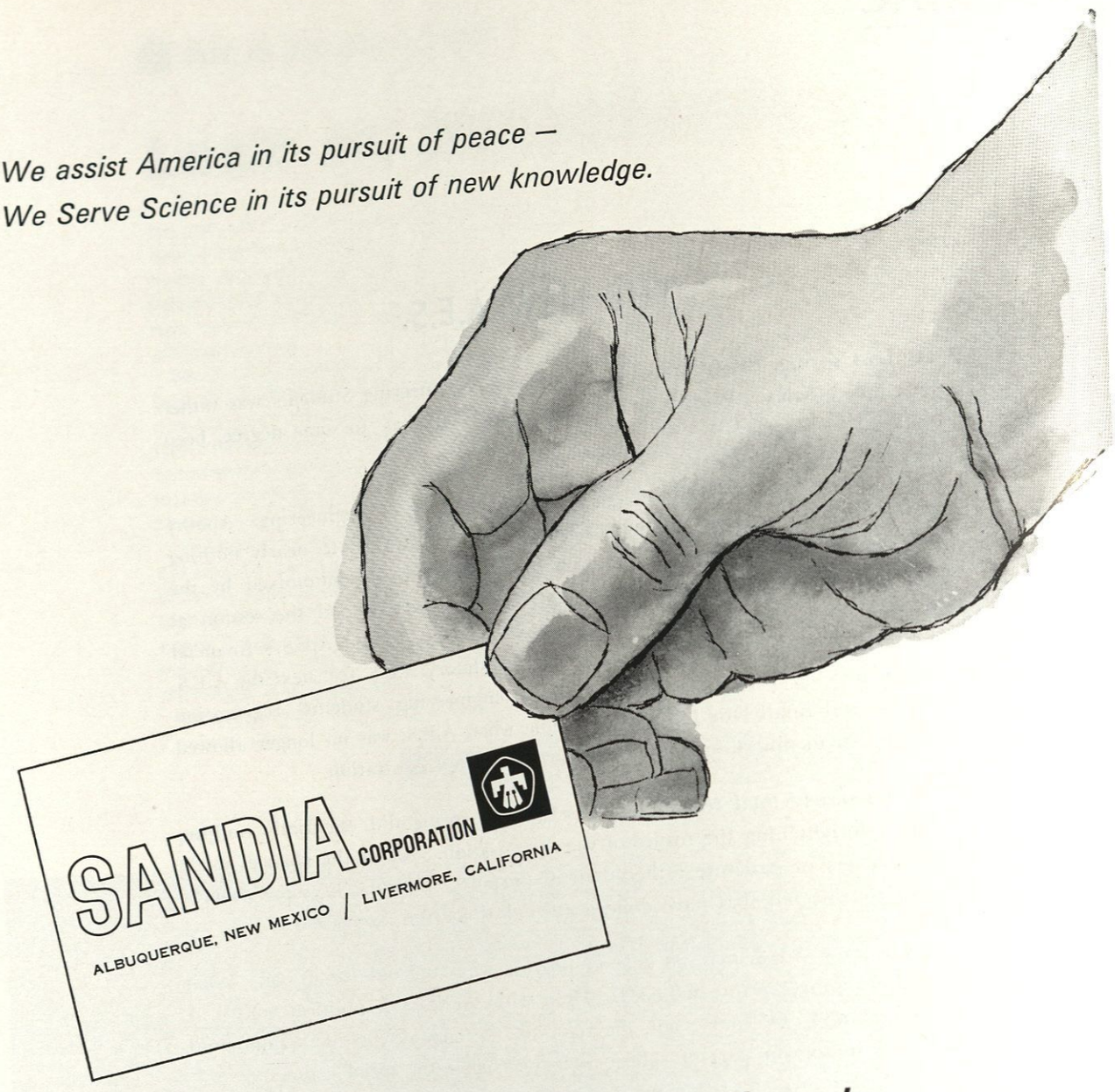

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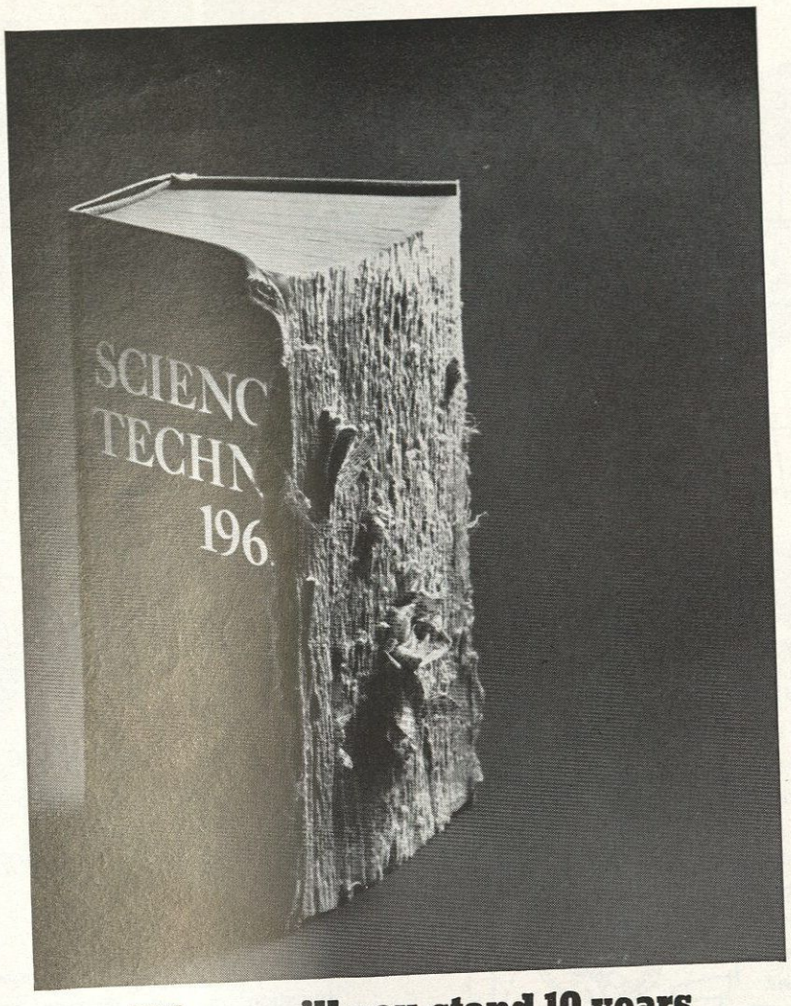

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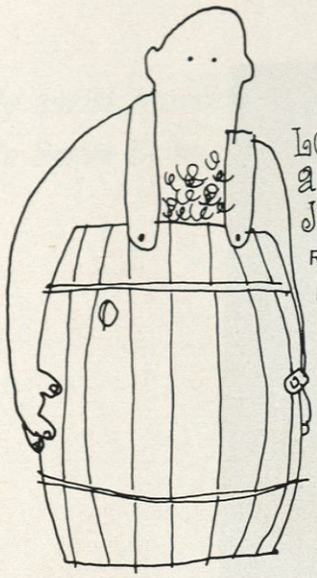

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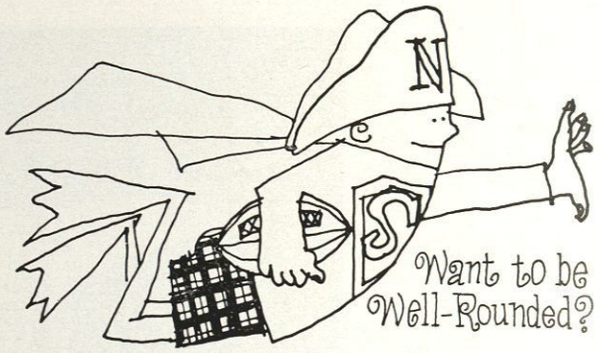

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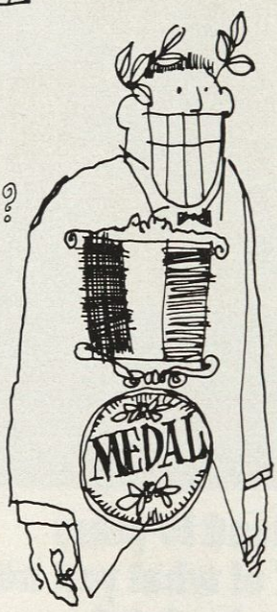

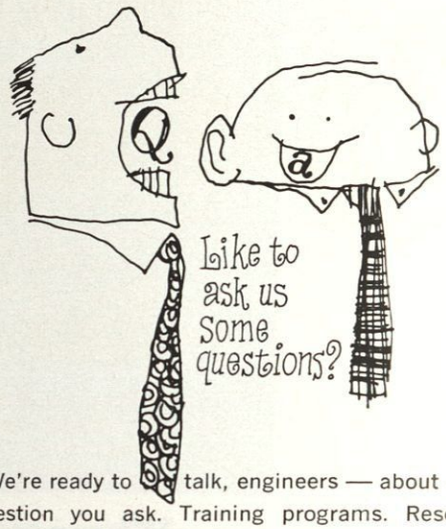

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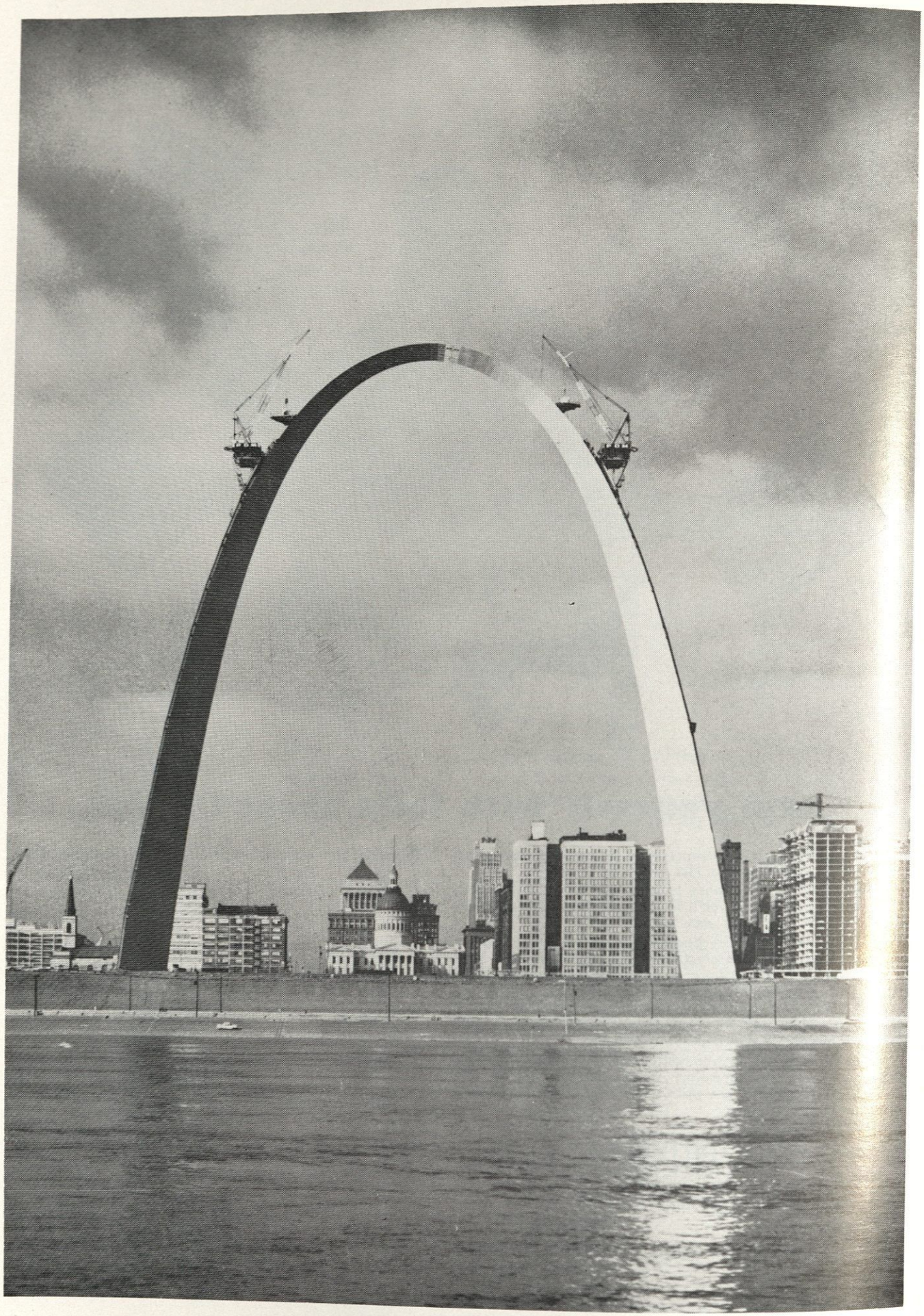


Arteaga Photos, St. Louis, Mo., by permission.

THE ST. LOUIS GATEWAY ARCH

Larry Davis

After a long, tiring bus ride from Denver, the St. Louis bus depot was a welcome sight. Although it was late, I checked into the YMCA and began walking downtown toward the river and the arch. Finding my way was easy-the arch, pale in the reflected citylight, towered over all the downtown buildings, leading me on. The nearer I walked, the more I was impressed with its immenseness: It is 630 feet tall—as high as a 66-story building—and straddles the same distance at its base. High above me perched on their steel tracks atop the arch were the two-100-ton "creeper cranes," looking for all the world like a pair of birds perched there.

I walked down the gravel path to the visitors' observation center midway between the legs of the arch and about 400 feet back from them. As I crunched along, the city's light faded and soon the only illumination reaching my eyes was that reflected from the arch itself. Its dull stainless steel surface almost passed out of my range of vision on either side, and it loomed too high in front to see in one eyeful. There was no one there to appreciate the sight except me and the few drops of rain spitting from an overcast sky. No sound; eerie light; slight wind. At last I knew how to write this article: I would conjure up a spirit here and let him tell me what I needed to know. After all, others had exhausted almost every approach in writing about the arch: scientific; scholarly; sociological; popular. The mystical approach was all that was left me. So with effort born of desperation, I concentrated on conjuring up the spirit of the arch.

"O' great archspirit, take pity on a poor Colorado engineer and appear. Your honored remarks will appear in a nationally recognized magazine, and they are to be appreciated by fine minds the world over. Appear, appear. . . ."

"I'm afraid that won't do you much good, Mr. Engineer," said a voice behind me. "You see, the arch itself symbolizes The New Spirit of St. Louis. Anything supernatural would be superfluous."

I turned around, startled. He'd managed to come down that noisy gravel path silently—or I'd been so

busy with my own affairs that I didn't heard him. Anyway, his appearance in coincidence with my conjuring was enough to shake the self-possession of the calmest engineer, much less me.

"Sorry if I frightened you. Making dramatic entrances is a failing of mine. Would you like *me* to tell you about the arch? I can do it—I've lived here longer than anybody can remember. But befort I start, what do you know about it?"

I couldn't make out his features. He was between me and the city, silhouetted in the street lights. In the low illumination there I never did catch a look at his face, hidden under a rain hood. But his voice sounded clear and intelligent. It certainly couldn't hurt to talk with him.

"Well," I began, "the arch was designed about twenty years ago by Eero Saarinen, the late Finnish architect—First Prize in a field of about 200 entries. Its shape is that assumed by a chain when you hang it from two nails, with . . ."

"A catenary."

"Yeah . . . with progressively heavier links towards the bottom to heighten the arch effect. Its official title is The Gateway Arch, because it stands here at the gateway to the West. It is a 12 million dollar part of the 30 million dollar Jefferson National Expansion Memorial being built all around us here by St. Louis and the National Park Service. They just finished putting it together last month, but the interior won't be ready until next year. . . ."

"Stop, stop! Too much, already. Who's going to read that welter of facts and appreciate the true significance of the arch? Why did you come here, anyway, if not to get the ideas behind the figures?"

"But you asked me. . . ."

"What about the forty blocks of rotting waterfront buildings—three-quarters with no running water—that were torn down on this spot to make room for the arch? If you want ghosts, you should try to conjure some up from *that* slum. And what about the eyesores all over this area that have been . . . look towards the Mississippi there. See the traintracks?"

"What traintracks?"

"Exactly! After tearing down the buildings, they put the train underground. We're taking every pain in our effort to make this a beautiful place. Come on, I'll show you. . . ."

Perhaps it was the poor light, perhaps something else, but I never did catch a glimpse of his face as we walked along. Every time I glanced his way, I could only see dark shadows under his hood.

We walked around the north leg toward the river to a spot overlooking the beginning of a train tunnel. Down below were the tracks and a hobo sleeping on the grass beside them.

"Now, there's a ghost for you, if you *must* have one—a leftover from the days when St. Louis lay here stagnating by the river, just a poor labor town that had once been great. One was afraid to go downtown because the stench of a dying city was too much to bear. But now the 'headache ball' has smashed most of our slums to the ground, and we're working on the rest. Since St. Louis can never get any larger, being bounded by the river on one side and its suburbs on the others, we're determined to keep the area we have livable."

At this point, I sneakily thought I'd save a little research work. "You certainly do know a lot about the arch," I said slyly. "Tell me, how much does it weigh?"

"Good Lord, man. What does it matter? It's what it *stands* for that counts, the . . ."

"I see. You don't know the figures."

"If you must know, there are 16 thousand tons of concrete below the ground for each leg's foundation—thirteen thousand cubic yards of concrete per leg! And the foundation goes down 60 feet, 30 of it in solid limestone bedrock. The interior walls are carbon steel and weigh 2,200 tons. The exterior is stainless steel and weighs over 900 tons—that's more stainless steel than is in any other single project in the world!"

"Hmm, that *is* a lot of knives and forks."

"In cross-section, the arch is an equilateral triangle. These triangles are 54 feet on a side at the base, tapering to 17 feet on a side at the top. They're hollow inside, composed of two sandwiches of steel with 112 steel post-tensioning rods in between, each carrying 71 tons of stress. Concrete is poured in with the rods up to the 300-foot level. The sections themselves were preassembled and carried here by railroad. Those cranes hoisted them up—they creep up the upper surface of the arch on tracks bolted down. Those bolts are bigger than your arm, too."

"It appears to me that you're doing about the same thing I was."

"Well, the facts *do* have a certain intrinsic interest. And you have challenged my knowledge. Let's see—the legs. Oh yes. Those legs were built independently, you know. Even getting them to meet at the top was a chore. They were surveyed at night (the temperatures on all three sides are equal then) for alignment. One inch off at the base meant they wouldn't meet at the top. But they did—well within the specified six inches tolerance. And the topping-out process was interesting. The last section of the arch—the keystone—was 8½ feet long, and the two legs were only 2½ feet apart. An 80-ton scissors jack exerting 450 tons of pressure was used to widen the gap for the keystone. And while this was going on, the fire department was down below, playing hoses over the south leg (the sun's heat made it 9 inches higher than the north leg). An impressive feat—only a few months ago, too."

"I thought they were going to finish the arch for the St. Louis bicentennial celebrations in 1964."

"They were, originally. But, as one of the architects said at the beginning, "Our experience with building 630-foot arches is limited." And they had all kinds of unforeseen problems—delay after delay. Fourteen rods didn't stretch to the proper tension. Excess stress wrinkled some of the stainless steel—do you realize that, in proper sunlight, one thirty-second of an inch out of flatness shows up as a ripple on the surface? They hauled those sections down and gave them a face-lifting job. And more trouble: the contractors were always arguing and suing each other about the delays. One day, two CORE officials staged a climb-in, protesting unfair hiring. They perched midway up a leg for a few hours until they

(Continued on page 16)

(Continued from page 14)

were finally taken down. A few months ago, all the electricians but one quit, claiming it was worse working inside there with the varying tilt than in an amusement park funhouse. They had problems about placing the keystone, too. It seems that the crown stress exerted by the scissor jack was twice that which the arch was designed to take. Yep, there were problems, but they were all solved. A nationally known architect said that unfortunately the MacDonald Construction Company, the arch's builders, will probably be forgotten long before the architect."

The rain began to pour and a wind whipped up. I remembered reading somewhere that, in a 150 mph wind, the arch would only sway 18 inches. A catenary is the most stable arch form—all the thrust passes into the foundations, instead of into forcing the legs apart, as in other arch designs.

We began walking back to the city, back to the bright lights where I planned to sneak a look at my informant's face, but first I took one last look at the arch, with its 100 foot ropes at the top writhing in the wind like live things. I looked back again to remark about them to my companion, but he was gone.

Back through downtown St. Louis; past buildings proudly sporting signs "Soon to be Razed;" past the corner with the modern art exhibits; past the gigantic and astounding near-completed Busch Stadium; back to think about the night's experiences. I passed a photo shop where two men were building an arch of boxes over the door for a display.

"Took me two days to make the metal bar for stringing these on, Fred, but it was worth it. None of them pointy church arches or round foreign-type arches for this place. No sir, I bent the bar just like a genuine St. Louis arch, like what you get when you hang a chain from two nails. . . . "

"A catenary!" I shouted in passing.

"Yeah. A St. Louis catenary. . . ."

As my bus pulled out of St. Louis the next day, I thought I heard a familiar voice whispering from the empty space in the vicinity of my right ear. . . .

"Come back for the dedication next year—President Johnson will be there, and you'll be able to ride up inside the arch then. But don't forget, the arch is The New Spirit of St. Louis, the spirit that makes McDonnell aircraft build Gemini capsules, that gave us our zoo, our museum, our planetarium, our geodesic greenhouse, and art shows, the fountain of the meeting of the waters, and a hundred other things .. . don't forget, now."

. . . but it was probably my imagination.

ABOUT THE AUTHOR

LARRY DAVIS

Larry Davis, a sophomore in A. Math when he wrote this article, is now a Psychology and Philosophy major. A Boettcher Scholar from Golden, Colorado, he received a National Honor Society Grant last year. On campus, he is a writer for the Engineer and a member of Chess Club. Larry also has been a six year member of the Colorado Bird Club.

MATHEMATICS and GODLINESS

GLEN BRINK

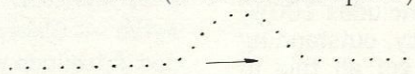
A creation of the mind is a fabulous, frantic, and funny quirk of our existence. An example of a creation by a high school mind is found in the following two pages. It is an example of a mathematical association of concepts (i.e. mathematics and reality). Though its value may be nil to the scientific world, its creation is the true act of what I call mathematics.

The Fourth Dimension

The Reasonableness of the Fourth Dimension has one qualification of a theory; it explains facts hitherto unexplained.

(except partially by Einstein's Theory of Relativity)

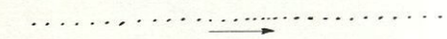
I. In one dimensional space a wave traveling through air molecules is pictured thus: (from our standpoint)



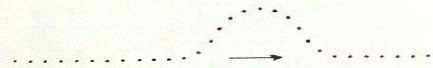
It has been shown that the movement of one air molecule is thus:[1] (from our standpoint)

(Not just straight up and then straight down.)

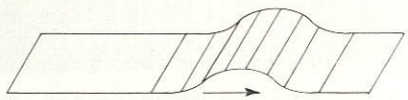
It is obvious *then* that within the (1) dimension a compression would be observed (because of the forward and backward movement of each molecule). Since a one dimensional creature cannot detect this wave *into* the (2) *dimension, he* pictures his wave as a compression of air molecules thus:



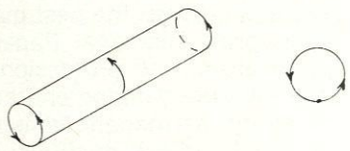
whereas we observe it thus:



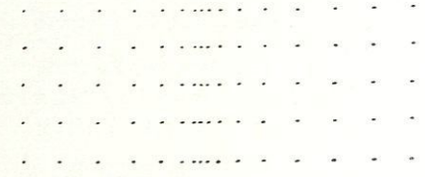
II. In the (2) dimension, a line moves just as a point did in the (1) dimension, as a wave passes by.



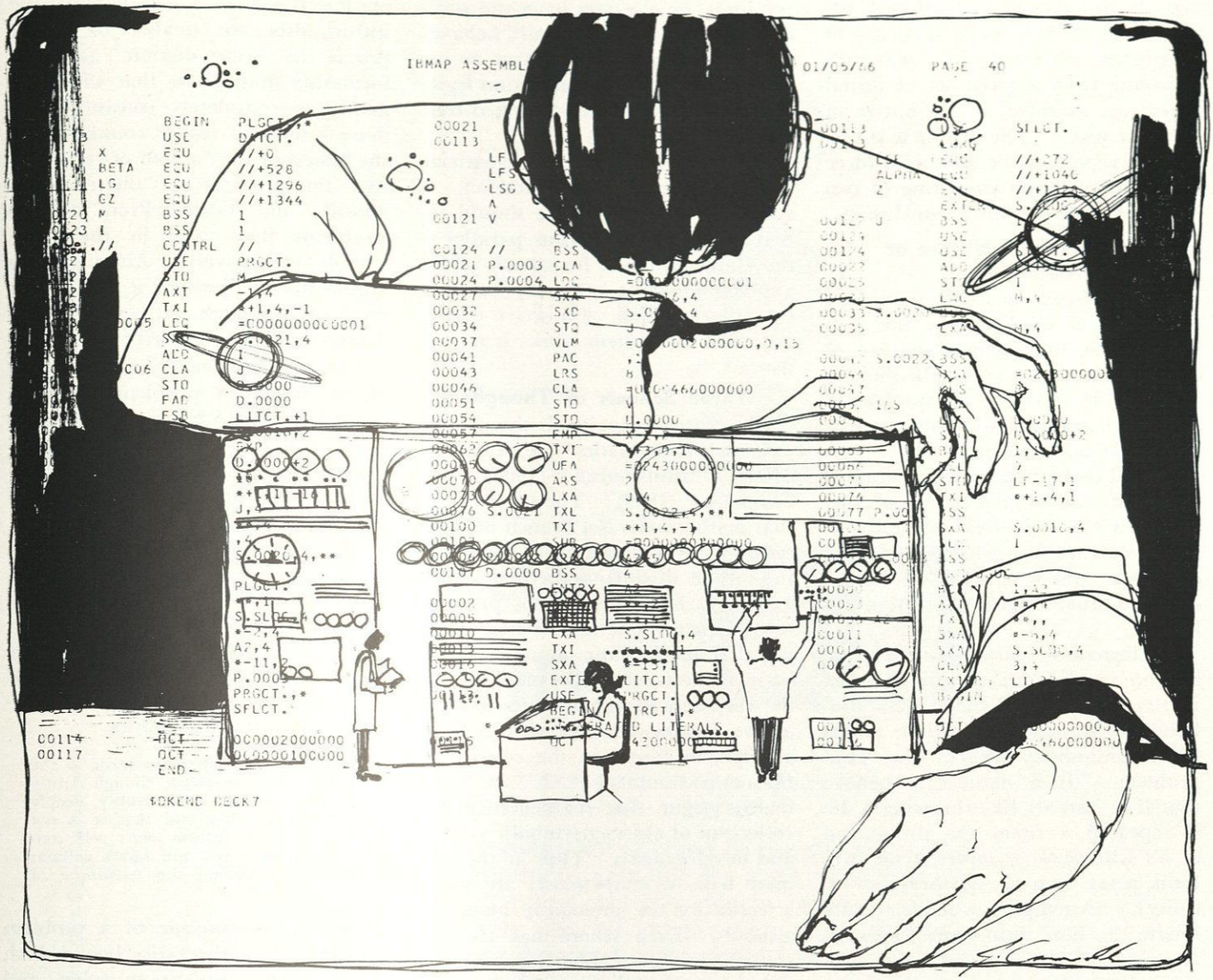
Looking at the edge of the plane the line moves thus:



Thus a two dimensional creature, who can't observe the wave movement *into* the (3) dimension, observes his wave as a compression of air molecules. Although we of the (3) dimension, considering space only, see the movement as above, he sees it:



(as a compression)



III. Therefore (it *seems* relevant) to assume that our observance of a wave in our own dimension as a *compression*, observing from our own dimension as in the above cases, is really an observance of a beat of the (3) dimension into the (4) dimension!

It is relevant to note that (5) and (6) dimensions do *not* logically come until a wave of the (4) dimension is found, when considering along these lines.

It seems to me that equations resulting from this theory would be similar to those developed by Einstein.[2] This theory would:

1. accept all present modern information.
2. explain or at least allow for the presence of curved space.
3. accept a finite universe (space twisted back upon itself as a möbius strip).
4. include an allowance for a progression of wave theory (putting waves of the 1, 2, 3 . . . ? dimensions under the same theory).
5. accept a picture of light and energy as waves again, instead of as particules, as is being speculated now. (light and energy would be a beat of the (3) dimension into the (4) dimension).
6. accept the *equivalence of* matter and energy, thought of in a different way: matter is bound in the dimension; energy is not bound in the dimension. Thus the disappearance of matter in chemical and especially in nuclear reactions.

As Einstein's Theory, this theory is possible (insofar as I have been able to see at this time) and gives a new picture of the universe; which might contain valuable explanations of the reactions between matter and energy.

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1. see P.S.S.C. Physics textbook on waves.
2. see Lillian Lieber's book, *Einstein's Theory of Relativity*.

"It is always pleasant to find others doing the silly things one does himself"[1]

"I am sure that I do not suffer from the weakness of false modesty, and to begin with I do not mind saying that I was precocious: as a matter of fact precocity in a mathematician has no particular significance one way or the other, and there are plenty of examples both ways: I happen to belong to the precocious class."[2]

"In the very elementary parts mathematics is largely inductive, but in the later stages . . . in the higher mathematics it tends more and more toward the deductive type . . . This [training in deductive thinking] alone justifies the subject as a part of the school curriculum, but it is hoped that the following pages will show that mathematics is important to you and to me for its content as well as for its method."[3]

Logic and Mathematics

Logic, the mathematicians tool and the foundation of all modern mathematical and scientific work, plays an influential role in the life of every individual (witness the list of subjects cited above). The notion of a

logical discourse was developed between 600-300 B.C. as "a sequence of statements obtained by deductive reasoning from a given set of initial statements assumed at the outset of the discourse."[4] The discourse is presently accepted in the form of a three statement syllogism consisting of two initial statements and a conclusion.

The Essential Nature of Mathematics

I will discuss not the nature of mathematical applications, not usefulness, but the essential nature of mathematics. ". . . an application of mathematics is always an application to some definite kind of subject- matter, while mathematics itself . . . is not at all concerned with any kind of subject-matter whatever."[5] Mathematics is the only field of study in which we know not what we are talking about, nor whether what we are saying is true, according to Bertrand Russell.

Mathematics (pure mathematics) has no touch with reality. Mathematics deals with theoretical probabilities in order to explain events while philosophy attacks the 'real' problem. "It is natural to believe that if . . . an act like throwing a die is repeated *n* times the proportion of 6's will, *with certainty,* tend to a limit, p say, as n . . . [approaches infinity]. (Attempts are made to sublimate the limit into some Pickwickian sense—'limit' in inverted commas. But either you *mean* the ordinary limit, or else you have the problem of explaining how 'limit' behaves, and you are no further. You do not make an illegitimate conception legitimate by putting it into inverted commas.)

The consistent pure mathematician washes his hands of application. If asked for applications he should say that the ideal world runs parallel to the real world, but he cannot justify applications—that can only be done by philosophizing. Inductive experience that the system works is no evidence.[6]

Three Schools of Thought

The three schools of thought in modern mathematics are Logicism (1666), Intuitionism (1908), and Formalism (1899). The logicist feels that mathematics is a branch of logic, rather than logic a tool of mathematics. The distinction between math and logic is merely one of practical convenience. The intuitionist would say that mathematics must be built upon finite constructive methods. At the very base of mathematics is a primitive intuition linked with a sense of time, as found in the concept of the natural numbers 1, 2, 3, . . . Formalists argue that mathematics is a collection of abstract symbolic systems and developments. Thus at the ultimate base of mathematics are found a collection of prelogical marks or symbols. Each school has its own special problems. The Logicists have a hard time reducing all of mathematical theory to a logical basis, the intuitionists are unable to accept proofs by contradiction, and the formalists must show that their formality is completely consistent. A more interested reader could consult the effects of the "axiom of reducibility," the problem of "the excluded middle," and "Godel's Proof" for the problems they raise in the three schools respectively. Although the arguments are heated, it seems that none of the three will overcome its defects and take priority very soon.

The universal meaning and appeal of mathematical problems came to me as I opened Adrian's book printed in 1825 and saw the following problem:

> The product of two numbers is 10, and the product of their sum by the sum of their squares is 203. Quere, the numbers.[7]

As I was working the problem, I thought "Who cares?" and the answer was "I do — and others have." The natural challanges, questions, and (ultimate?) satisfactions are universal appeals of mathematics.

> Indeed, a little attention leads to the feeling that this science, though rightly called "abstract," is in reality, deeply human and alive and that it is not impossible to inform one's self concerning the why's and how's without actually acquiring the technique of the doing . . .[8]

Below is an example of a problem found in a mathematics book which involves only insight to solve, and indeed is unsolvable in a purely mathematical way.

Who Is the Smartest?

Q. "Each of three friends thinks that he is the smartest. To find out who really is, a fourth friend makes the following suggestion: He will paint on each of the three men's foreheads either a black or a white spot without any of the men knowing which color adorns his own brow. After each man has been marked, all three will be simultaneously led into the same room. Each one who sees a black spot on the forehead of one or two of his friends is supposed to raise his right hand. The one who finds out first whether he himself is marked black or white and is able to prove his statement will be recognized as the smartest of the three.

The referee now marks each of his three friends with a black spot and lets them enter the room simul-

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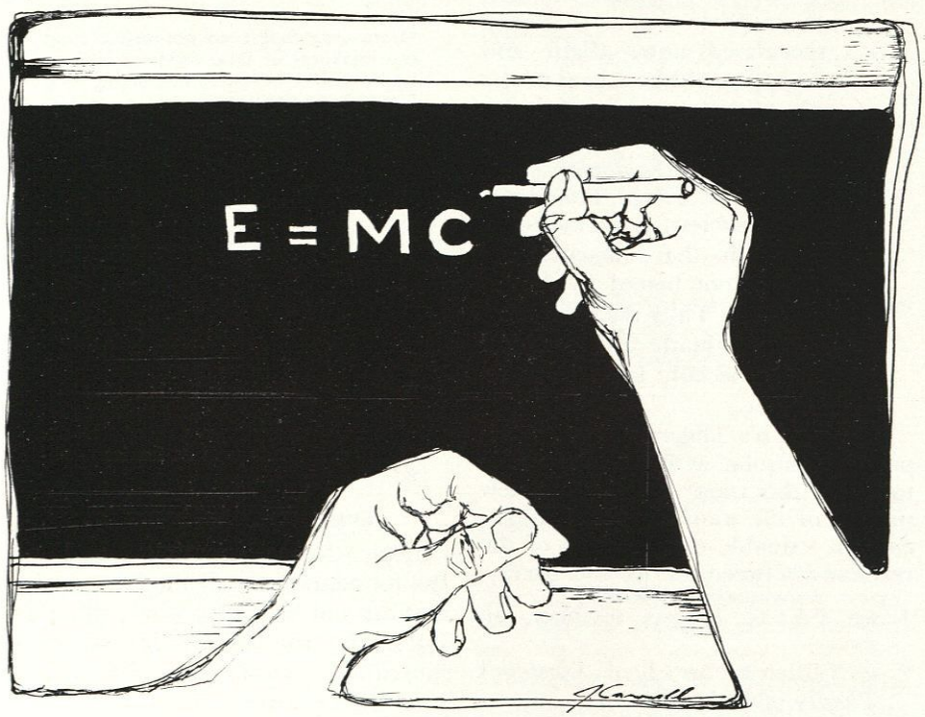
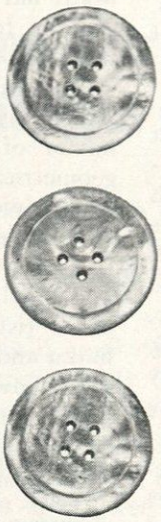
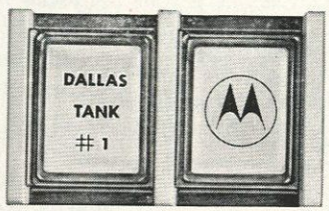


CONSUMER PRODUCTS ★ COMMUNICATIONS ★ SEMICONDUCTOR PRODUCTS ★ MILITARY ELECTRONICS ★ AUTOMOTIVE PRODUCTS ★ CONTROL SYSTEMS



button button...



Want to know how much oil is in your Dallas tanks while you're sitting in Tulsa? Push a button.

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MOTOROLA

(Continued from page 20)

taneouly. As each of them sees two black spots, all three raise their hands. After a moment's hesitation one of them states: 'I have a black spot.' How did he reason this out?"

A. "This is the way the smartest of the three — let us call him A — reasoned: 'If I had a white spot, B would immediately conclude from the fact that C raised his hand — which in that case could only be attributed to B having a black spot — that he, B himself, was marked with a black spot. Since B didn't reason that way it is impossible that I have a white spot.'"[9]

This type of "puzzle on the borderline between arithmetic and riddle,"[10] has always been a favorite of the mathematicians.

Mathematics vs. Language

> Because language is misleading, as well as because it is diffuse and inexact when applied to logic (for which it was never intended), logical symbolism is absolutely necessary to any exact or thorough treatment . . . [of mathematics][11]

Unlike words of a language, mathematical terms do not possess "mystery and difficulty of comprehension, but rather beauty, elegance, and, above all, *orderliness* and *simplicity*."[12] Math has been called the science of abstract *form*, " 'The discernment of structure is essential no less to the appreciation of a painting or a symphony than to understanding the behavior of a physical system.' "[13] A geometrical "point" though pictured as a dimensionless particle, is dealt with in matematics only as an undefined thing, a form, an "isness" (witness Euclid's first postulate — there exists (is) at least one point). Both haiku and mathematics poses "isness," math involves analysis while haiku involves synthesis.

> Beauty is an intellectual as well as an emotional experience, and from this point of view the orderliness, consistency, completeness, and conviction found in the deductive argument are very satisfying.[14]

Mathematical ". . . ideas of today [April, 1965] are no more difficult to grasp than Newton's were in his time."[15] It must be stressed that the assumptions and definitions of mathematics are arbitrary; all mathematical truth's are only "true if . . . " Even ". . . 2 x 2 = 4 must be considered to be either an unproved assumption, or else a theorem depending on other assumptions and definitions."[16] The most that can be claimed is that *if* the postulates are true *and* sound, *then* the theorems are true. ". . . . We arrive at a concept of *relative* truth (of theorems in relation to postulates, definitions, and logical reasoning) to replace the *absolute* truth point of view."[17]

Metamathematics

Mathematical and logical contradictions have been known for centuries (for example: This statement is false.). An attempt to provide for such statements arose from a fight between the formalist and the intuitionist schools. David Hilbert of the formalist school developed a *theory of proof* which was the beginning of the field of metamathematics.

> First of all, there are more or less informal theories of specific fields of knowledge. Secondly, there are formal abstract postulational developments having these specific fields as models. Thirdly, there is a theory which studies the properties possessed by formal abstract postulational developments. It is this third, and highest of the three levels, that Hilbert Christened *metamathematics*.[18]

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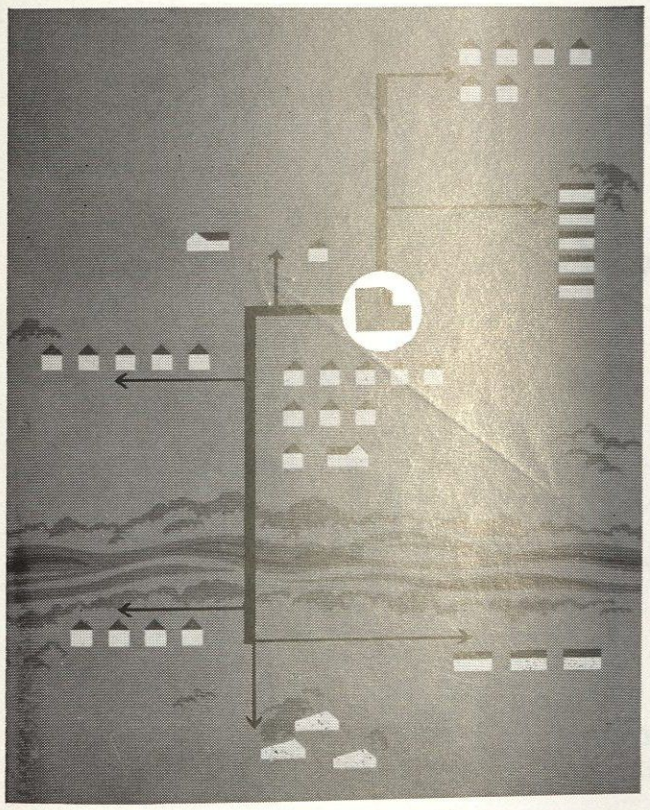

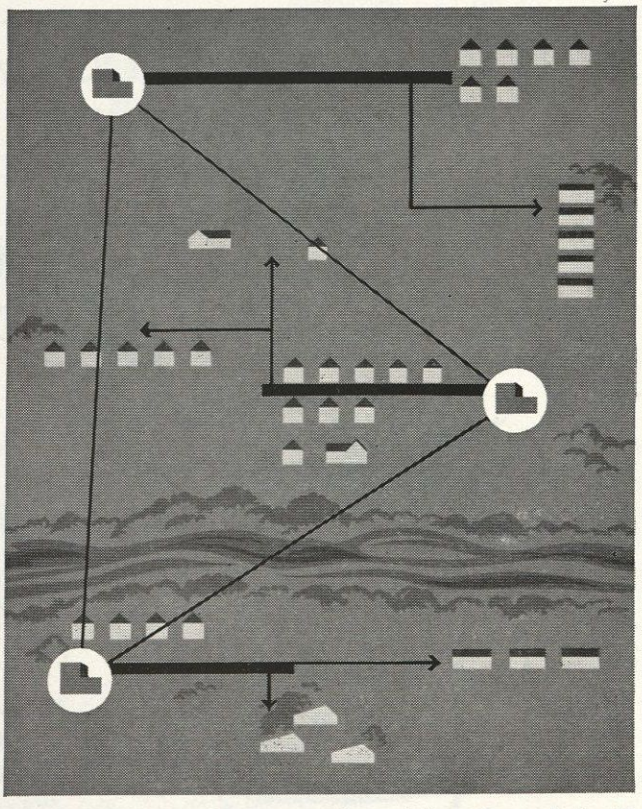

This? In this hypothetical geographical area, communications could be supplied with one large telephone switching office and a network of cables (left), or with three smaller offices and a different network (right). Many other combinations of offices and cable networks might be possible. This situation, although hypothetical, is typical of the complex telephone engineering problems that are being solved with the aid of computer programs designed at Bell Laboratories. **Or this?**

(Continued from page 22)

K. Gödel retaliated for the intuitionist school with his controversial proof that the consistency of metamathematics could never be guaranteed. Gödel's proof also extends to other systems, like arithmetic, and has had a profound effect on both mathematics and philosophy.

More Theories on Proofs

The book *Principia Mathematica* by Whitehead and Russell began with logic. Hilbert claimed that beyond logic are found prelogical objects (marks or symbols) which proceed logical thinking and about which we seem to have intuitive knowledge. Hilbert used ideas of this kind to develop a formal *theory of proof,* including a system of symbolic logic. He desired to show the consistency of the logical structure of ordinary mathematics, it was termed *metamathematics.*

Gödel around 1930 demonstrated that, "it is impossible to prove consistency of a system by methods belonging to that system. Thus the consistency of metamathematics itself could not be guaranteed. However, parts of Hilbert's theory are still of lasting value.

Prior to Gödel, Hilbert had been accused of degenerating mathematics into a game. He admitted that his proof theory was similiar to a game, but claimed that it was a game with a serious purpose for all of mathematics. The discussion here is sketchy because of the complexity of the topics, but the theories have and will continue to have beneficial results for mathematical philosophy.[19]

Gödel's Proof is often misunderstood; it was stated by one high school math teacher as "a proof that nothing can be proven." This is not the case, in actuality he has "merely" shown that: ". . . no absolutely impeccable guarantee can be given that many significant branches of mathematical thought are entirely free from internal contradiction."

The importance of Gödel's conclusions is far reaching, and has not yet been fully developed. He has not shown that consistency proofs are impossible, but only that one cannot justify complex systems without the use of one even more complex which cannot be proven without adding further complexity to the system itself, and so on *ad infinitum.* Perhaps we have here the herald of a meta- metamathematics and a meta-meta-meta . . . until the mathematician tires of justifications.

Gödel's conclusions have a bearing on the relationship of computers to human brains. The machines today have a fixed set of directives, corresponding to a rule of inference of formalized axiomatic procedure. Gödel's incompleteness theorem has shown that innumerable unsolvable problems exist within the system used, but outside the axiomatic procedure. In other words there is no immediate prospect of replacing the human mind by robots.

Many Valued Logics

Gödel's proof should not be taken as an excuse for mystery-mongering. It does not mean that there are "inelutable limits to human reason;" but it means that the resources of the human intellect have not been, and cannot be, fully formalized, and that new principles of demonstration forever await invention and discovery. He has produced not a limit to, but an example of the powers of creative human reason.[20]

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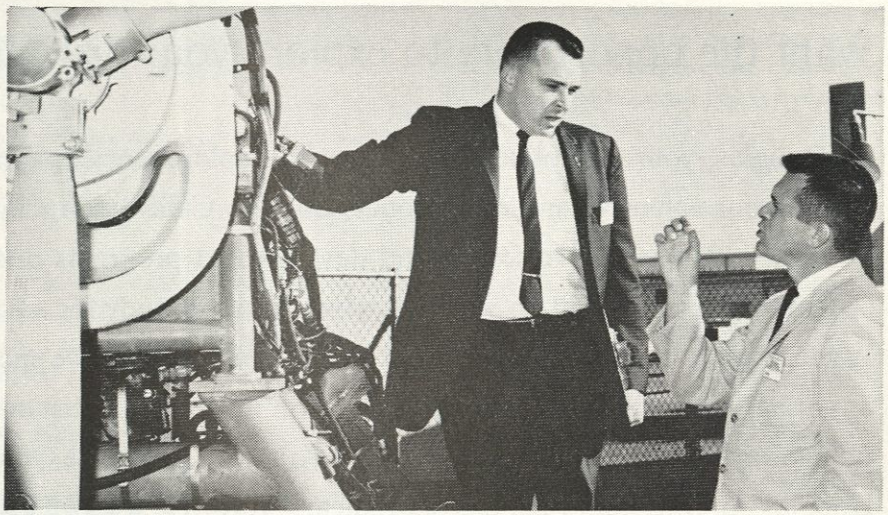

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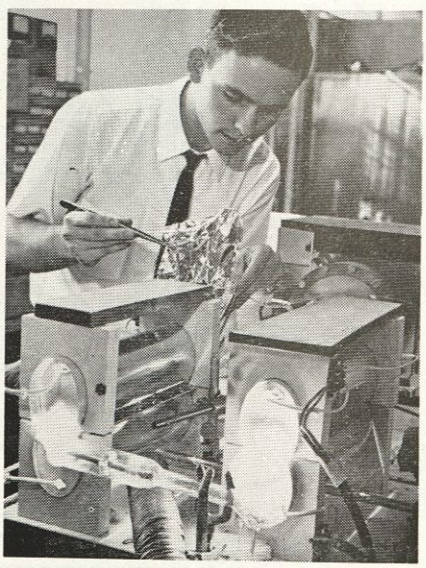

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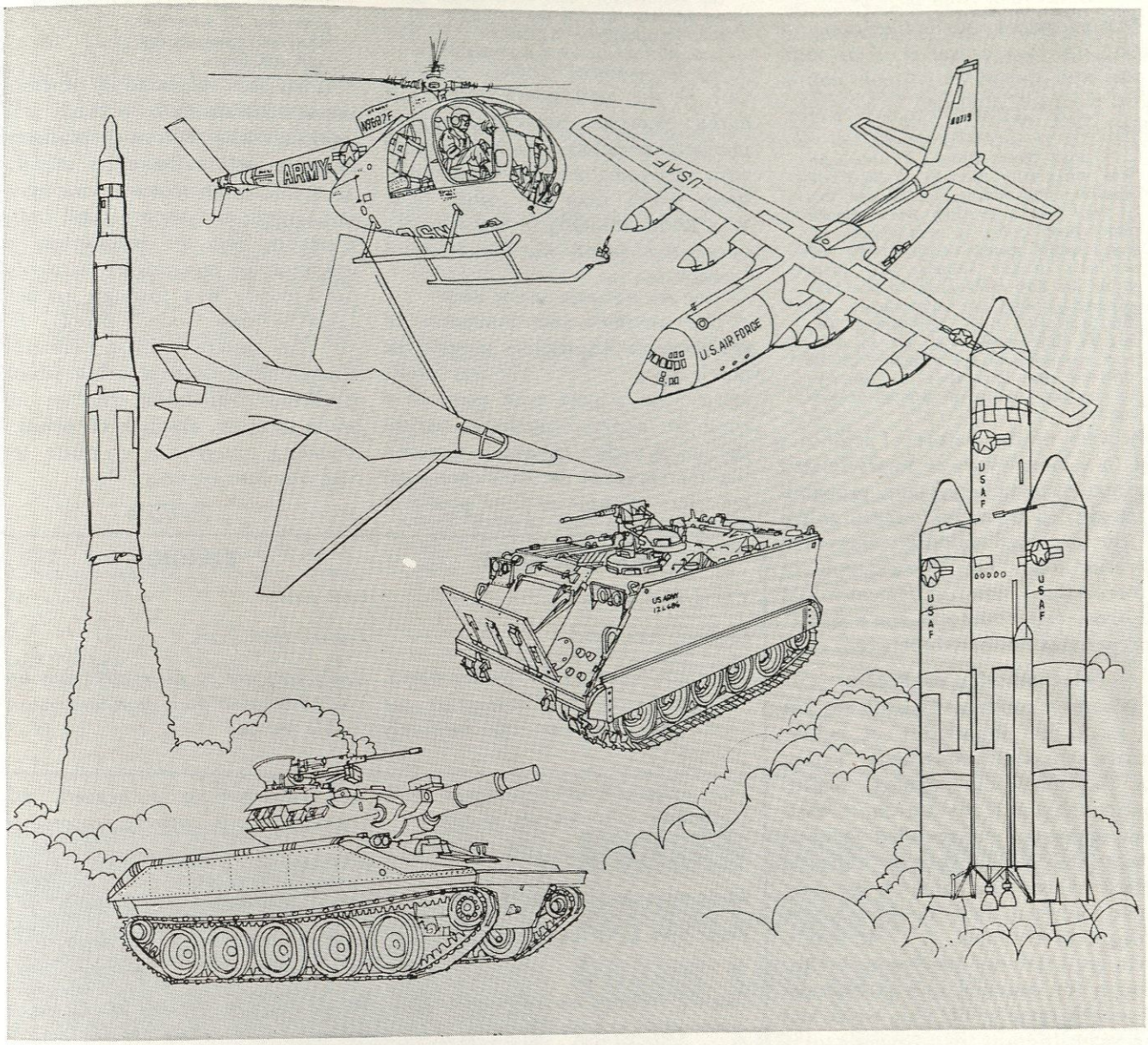

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Mathematics's incompleteness of ideas, arbitrary character of assumptions, and dependence upon definitions has been discussed.

However,

> . . . until recent times . . . the logic, was universally thought to be fixed, absolute, and immutable. Indeed, this is still the prevailing view among most people, for it seems quite inconceivable, except to the very few students of the subject, that there could be any alternative to the laws of logic stated by Aristotle in the fourth century B.C. The general feeling is that these laws are in some way attributes of the structure of the universe and that they are inherent in the very nature of human reasoning.[21]

Discovery of the nature of logic has led to various types of logics related to: many-valued logics and probability logics (both without the problem of the excluded middle), strict implication logics, etc. For example, in a three valued logic a statement would be true, false, and "I don't know" (or perhaps neither, inbetween, etc.)

Mathematics as Poetry

Whatever modern thought has left us as to the foundation of mathematics, it is still known that, "except for the study of language, mathematics may well be the most basic component of a so-called general education."[22] One of the universal beliefs of mathematicians is the similiarity between their though, and the thought of the poet. ". . . It took a fortnight's damned hard work. (But though the essential idea takes pages to state it came to me on a walk, and this time literally in a *fraction* of a second.)"[23] The closeness of ideas expressed by mathematics and religion is illustrated in fig. 1. Indeed, ". . . religious sensibility . . . can be fostered by science."[25]

Henry David Thoreau wrote:

> We have heard much about the poetry of mathematics, but very little of it has been sung. The ancients had a juster notion of their poetic value than we. The most distinct and beautiful statements of any truth must take at last the mathematical form.[26]

Both mathematics and poetry reveal the beauties of symmetry and "logical" arrangement. Both are in contact with the infinitely large and the infinitely small. Both have ". . . an instinct of the race, the instinct that separates it from the brute."[27]

> The Mathematics are usually considered as being the very antipodes of Poesy. Yet Mathesis and Poesy are of the closest kindred, for they are both works of the imagination. Poesy is a creation, a making, a fiction; and the Mathematics have been called, by an admirer of them, the sublimest and most stupendous of fictions. It is true, they are not only mathesis, learning, but poesis, a creation . . ."[28]

One of the most poetic forms, the *haiku,* expresses noble thought in precisely seventeen words. Aligned with poetry, mathematics says more in fewer words than any other field. Was Byron thinking of mathematics, or was it of poetry when he wrote:

> The power of
> Thought—the magic of the mind.

The rhythm and symmetry of mathematical expressions suggest the poetic form. ". . . To him whose master was a poet such expressions combine perfect symmetry, perfect rhythm, a perfect geometric picture—like the façade of the Parthenon—and a perfect example of "the power of thought—the magic of the mind."

> Poets are all who love—
> who feel great truths
> And tell them,

It has been suggested by others that mathematicians exist to teach mathematicians who will teach mathematicians to teach mathematics, etc. I disagree. Though mathematics may be not a rigorous system of well defined elements; but an incomplete congregation of meaningless symbols in an arbitrary way through an act of faith (witness Godel's proof), it is: ". . . an austere goddess, demanding, though never quite securing, absolute precision; demanding though never quite securing, absolute clearness, demanding, though never quite securing, absolute cogency."[29]

MATHEMATICS	RELIGION
The Infinite exists.	*God exists.*
Eternal laws exist.	*Eternal laws exist.*
The laws relating to finite magnitudes do not hold respecting the infinitely large or the infinitely small.	*God's laws are so different from ours as to be absolutely non-understandable by us.*
The existence of hyperspace with gradations, is entirely reasonable.	*The existence of a heaven, with gradations, is entirely reasonable.*
No factor is ever lost.	*The soul is eternal.*
Time may be a closed curve.	*God looks at time as a whole.*
Time may be a fourth dimension.	*In the next world, the direction of time may actually be seen.*
Positive infinity may physically coincide with negative infinity, if lines curve through four space.	*In God's sight the infinite past and the infinite future are the same.*
A Flatlander has enough of the third dimension in his being to give him some feeling of that dimension; and so this may explain the fact that we have some feeling of the fourth dimension.	*The human soul has enough of the divine within it to have some feeling of the reality of divinity and of the world beyond.*
Mathematics is a vast storehouse of the discoveries of the human intellect. We cannot afford to discard this material.	*Religion is a vast storehouse of the discoveries of the human spirit. We cannot afford to discard this material.*
It is not necessary that the solution of a problem, by limited means—say the trisection of an angle—should be found in order that we may feel certain that the problem can be solved by some means.	*It is not necessary that the solution of the problem of religion, by our limited human means, should be found in order that we may feel certain that the problem can be solved by some means.*
Every term in an infinite sequence is in a small way a part of infinity.	*Lucretius spoke wisely when he said, "Every one is in a small way the image of God."*[24]

FIGURE 1.

ABOUT THE AUTHOR

GLEN BRINK

Glen Brink, a senior in A. Math, holds a Tipton Scholarship for one year of liberal arts study and will thus graduate next year. Two summers ago, he participated in the NSF Summer Research Program, working with Dr. Neil Ashby of the Physics Dept., and plans to do so again this summer. Currently, he is working for NBS doing "derivations on far-out EE program." He is President of Delta Upsilon fraternity and belongs to Sigma Tau.

NOTES

[1]Littlewood, J. E. *A Mathematician's Miscellany*. Methuen and Co. Ltd. London. (1957). p. 24.

[2]*Ibid*. p. 66.

[3]Logsdon, Mayme I. *A Mathematician Explains*. University of Chicago Press. Chicago, Illinois. (1936). p. 11.

[4]Eves, Howard and Newsom, Carroll U. *An Introduction to the Foundations and Fundamental Concepts of Mathematics*. Holt, Rinehart, and Winston. New York. (1958). p. 13.

[5]Keyser, Cassius Jackson. *Mathematics and the Question of Cosmic Mind*. Scripta Mathematica. New York, N.Y. (1935) p. 3.

[6]taken from Littlewood, *op. cit*. pp. 54-57.

[7]Adrian, R. *The Mathematical Diary Containing New Researches and Improvements in the Mathematics with Collections of Questions Proposed and Resolved by Ingenious Correspondents*. No. I James Ryan Pub. New York. (1825).

[8]Logsdon. *op. cit*. p. 2.

[9]Degrazia, Joseph, Ph. D. *Math is Fun*. Emerson Books Inc. New York. (1954). p. 15.

[10]*Ibid*. p. 14.

[11]Russell, Bertrand. *Introduction to Mathematical Philosophy*. George Allen an Unwin London. (1956). p. 205.

[12]Logsdon. *op. cit*. p. 2.

[13]Eves. *op. cit*. p. ix. quoting from report by Harvard Committee of 1945 entitled "General Education in a Free Society."

[14]*Ibid*. p. 10.

[15]Green, Martin. *Science and the Shabby Curate of Poetry*. W. W. Norton and Company. New York. (April 28, 1965). p. 46.

[16]Stabler, E. R. *An Introduction to Mathematical Thought*. Addison-Wesley Publ. Co. Inc. Cambridge, Mass. (1953). p. 23.

[17]*Ibid*. p. 24.

[18]Eves. *op. cit*. p. 174.

[19]taken from Littlewood. *op. cit*. pp. 6, 250-253.

[20]taken from Nagel, Ernest and Newman, James R. *Godel's Proof*. New York University Press. (1958). pp. 98-102.

[21]Eves. *op. cit*. p. 276.

[22]*Ibid*. p. ix.

[23]Littlewood. *op. cit*. p. 134.

[24]Smith, David Eugene. *The Poetry of Mathematics*. Scripta Mathematica. New York, N. Y. (1923). p. 46.

[25]Green. *op. cit*. p. 137.

[26]Smith. *op. cit*. p. 1.

[27]*Ibid*. p. 3.

[28]*Ibid*. p. 3.

[29]Keyser. *op. cit*. p. 40.

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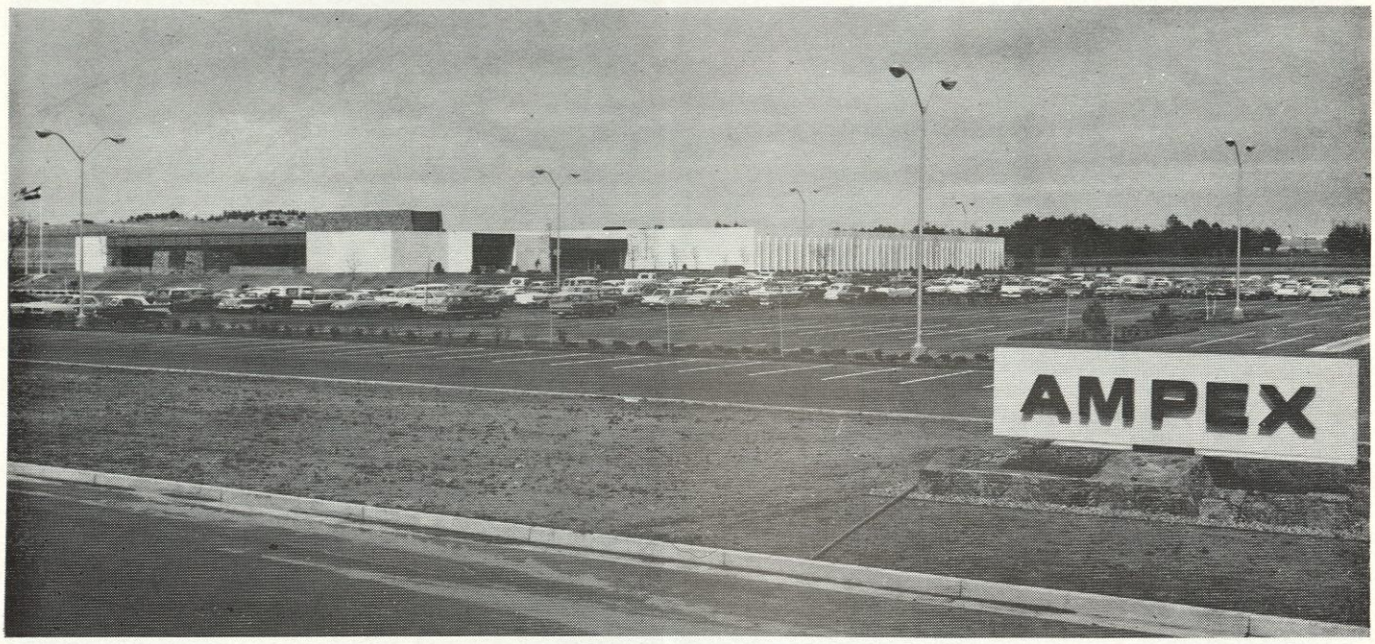


THE AMPEX CORPORATION

JIM HAMILTON

Nearly everyone has heard of the Ampex Corporation as a leader in the recording industry. Probably not so many know, however, that Ampex now has a new plant in Colorado Springs. They moved into a new 90,000 square foot building in December of 1964. This plant is primarily intended for manufacturing and, as such, very little engineering work is done there, except in the areas of manufacturing engineering, test engineering, and maintenance of product design. The actual research and design is all done at their home office in Redwood City, California.

Ampex decided to expand for a very typical reason: more productive space was needed to meet the demand for their products. Their specific requirements included an area with available land at a reasonable cost, so that room would be allowed for expansion; transportation facilities to provide efficient shipping of materials and products; an available labor source, and a community which could supply the necessary civic, residential, recreational, and educational facilities. Colorado Springs was chosen as the location which best filled these requirements.

The new plant is located on thirty acres of land and houses about 420 employees, almost all of whom are locally hired. One noteworthy feature of this plant is a unique conveyor system used in the assembly areas, which allows for the delivery of parts and materials to an assembly station and the return of a completed operation by means of a two level, two directional conveyor. One conveyor operator can service up to 60 individual stations. They are presently operating five conveyors, with about thirty stations each.

The Ampex Corporation is, of course, known as a producer of recording equipment, predominately audio, which makes up about 85% of their operation, the other 15% being video recording. Although Ampex does produce home hi-fi equipment, their major product is professional equipment and, as such, their primary customers are radio and television stations, and master recording companies.

One of their most important and widely used recorders is their "350 Line." This is a series of versatile, all-purpose machines which have been used in many applications, such as broadcasting, acoustic research for sound recording and analysis, medical research and therapy, vibration analysis, quality control, programming, and many more. These recorders are available with almost any combination of sterophonic or monophonic, record/reproduce or reproduce only and various mounting configurations, tape speeds, tape head assemblies, operating voltages, equalization curves, etc. Accessories available include mixing and remote control. The electronics are carefully designed for maximum reliability as well as good specifications. The circuits employ generous amounts of feedback stabilization. Separate record and play amplifiers and heads allow monitoring of the tape while recording. The transport is sturdily designed, and provides special features to minimize flutter and wow, and to eliminate the possibility of damage to the tape such as spilling or stretching. It will switch from a stop condition to a record or play condition in less than 1/10 second, an essential for special effects or tight programming. The capstan is driven directly by a hysteresis synchronous motor. The heads are designed to maintain high quality even after severe wear; many have been operated for 36,000 hours with no decrease from published specifications. Their surface can only be inspected by reflected light waves, since they are polished to an accuracy beyond mechanical measurement.

A recently developed product is the MR-70 Master Recorder which incorporates many of the recent developments in audio engineering. For example, due to an improvement in the noise properties of tape, an improvement of 10db in signal to noise can be realized. Additional features include the ability to record up to eight channels on one recorder; a variable speed wind/rewind, from creeping to 400 ips in either direction; elimination of frequency modulation noise ("scrape flutter") through special head assembly design; electronics so conservatively designed that distortion, at 25db above operating levels, is less than 1%; special equalization curves; and improvements in reliability.

Some other audio recording equipment produced by Ampex includes a tape duplication system capable of making over 75 copies a day, and a recorder called "Cue-Matic," an instrument of considerable value to the broadcasting industry, which records material on a magnetic mat, called a "cue-mat" so that the recorder can be cued to any point on the mat.

The Highly Automated Assembly Area at the New Ampex Plant

PUZZLE PAGE

BRUCE DUNN

1) One of the workmen over at the new Engineering Building was told to carpet one of the rooms in the Dean's office. For this he was given two pieces of carpet: one 10' x 10', and the other 1' x 8'. The only problem is that the room is 9' x 12' (typical CU efficiency). But fortunately for Dean Peters the man is an expert in his field, and soon sees that the problem can be solved by a single cut of the 10' square carpet. How does he cut the carpet and combine the three pieces to fit the room exactly?

2) While we are on the subject of geometry, here is one for all the triangle people in the crowd. If a triangle has a 10 inch base, and the other two sides are in the ratio of 2:3, what is the greatest height the figure can have?

3) Continuing on the geometry theme, what is the radius of the largest sphere that can be inscribed in a regular tetrahedron having 2" sides?

4) Lastly, Washington was admitted as a state 18 years prior to Oklahoma. By 1911 the number of years since Washington was admitted was 4 times greater than the corresponding number of years for Oklalahoma plus one year and 6 months. Anyone for finding the year of admittance for each state?

References and thanks go to Michae Leeds for the first puzzle, Sharon Varian for the second, and Jerry Zimmerman for the third.

ANSWERS TO THE NOVEMBER PUZZLES

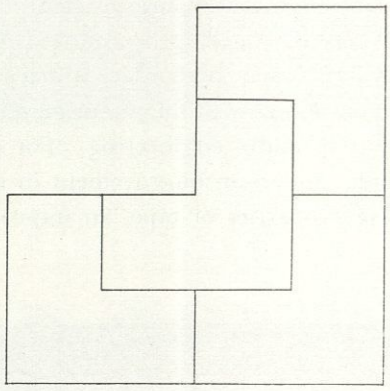


FIGURE 1.

1) The trick to this problem was knowing that such a series of circles is infinite. Furthermore, the total of all the radii will approach the height of the triangle, "a." Thus, the total of the circumferences is πa.

2) The division of the property is as shown in figure one. For those of you who don't remember high school geometry, congruent means that the figures can be made to coincide exactly.

3) It doesn't exactly take a genius to figure out that the number which is to be divided is not 1717. So it is easier to approach the problem from the following angle:

$$\frac{1717 + x}{2} + \frac{1717 + x}{3} + \frac{1717 + x}{9} = 1717$$

From this equation, $x = \$101$. $1717 \pm x = 1818$. Now, if the lawyer, or some other opportunist, will agree to settle the estate for a fee of $101, he would simply add the fee to the value of the estate, make the necessary division, which will leave his $101 untouched so that he can reclaim his money.

4) The solution for this problem comes from one of the techniques you should know from basic algebra. You can assume that the number of pigs (P) is an independant variable, and the two equations can be written in the form of two unknowns.

$$\text{i.e., } C + S = 100 - P \text{ and}$$
$$8C + 5S = 200 - P$$

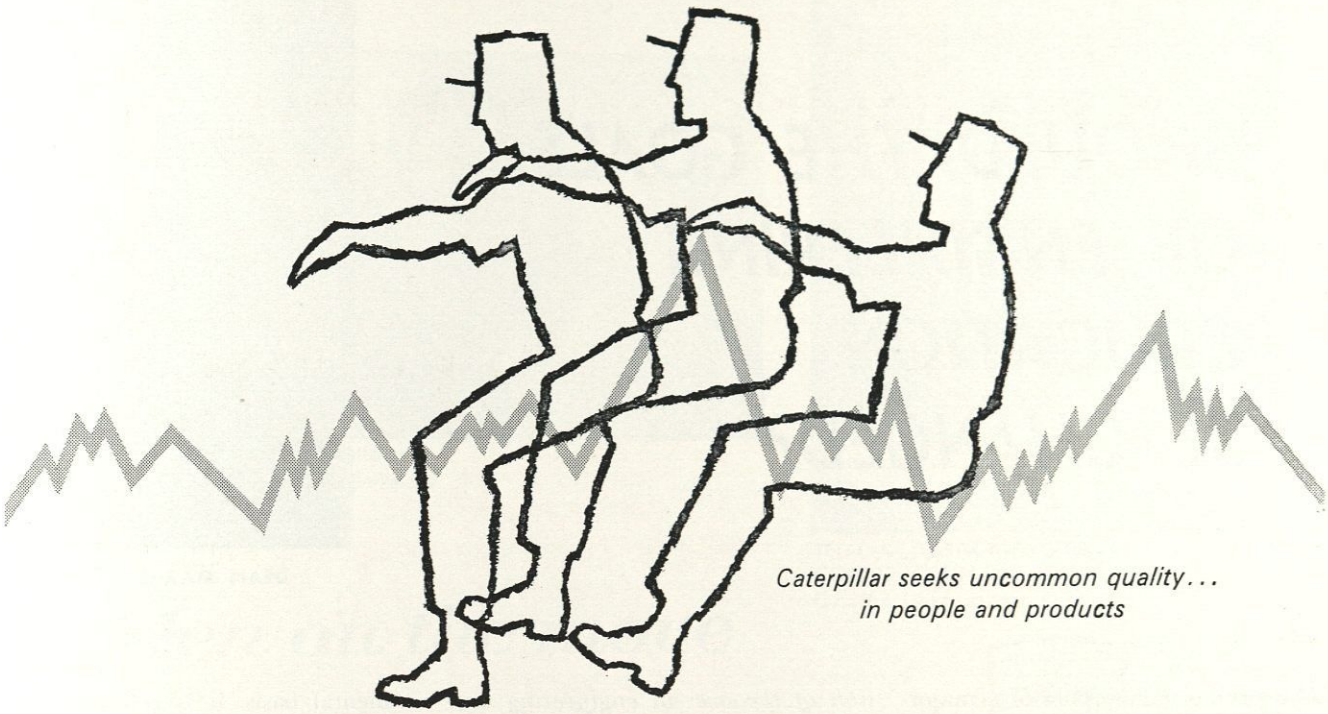
You can now set up two determinant forms of solution of these two equations and get the relations:

$$C = (4P - 300)/3 \text{ and}$$
$$S = (600 - 7P)/3$$

It is now a simple task to search for integral values of C and S.

The three solutions to this problem are: Pigs, 78, 81, 84; Sheep 18, 11, 4; and Cows 4, 8, 12 respectively.

5) The roll of bad coins can be found in one weighing. Simply take one coin from the first roll, two from the second, three from the third, and so forth and put the whole batch on the scale (Note that the problem said scale, not balance). Now you note the size of the discrepency between the actual weight and the weight if all the coins were good. The number of ounces the actual weight is lighter than it should be is also the number of the roll which has the counterfeit coins.



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DEAN'S COLUMN:

SHOULD THE GOALS OF ENGINEERING EDUCATION BE CHANGED?

DEAN MAX S. PETERS

The preliminary report of a major study of the Goals of Engineering Education has recently been released and has resulted in considerable discussion among engineers. The report is based on a comprehensive survey made of education and industry viewpoints and is supported by a $300,000 grant from the National Science Foundation.

Of the 14 recommendations made in the preliminary report, the following three are of particular significance:

Recommendation 1. The *first professional degree* in engineering should be the Master's degree, awarded upon completion of an integrated program of at least five-years duration "in one or another of the conventional fields of engineering, or in new fields, or in combinations of these fields*." This degree should be uniformly identified as the Master of Engineering degree, without qualifying adjectives or phrases. It is expected that implementation of this recommendation can be accomplished within a period of 5 to 7 years.

*This portion in quotation marks is proposed to be added for the final report.

Recommendation 2. Four-year Bachelor's degree programs leading to an *introductory engineering degree* should continue to be offered.

Recommendation 12. Accreditation by ECPD should be changed from specific curricula accreditation to *accreditation of the over-all engineering unit* (e.g., the Engineering College). Such accreditation will then be an assurance that all first professional degrees (Master of Engineering) offered by that unit are judged to be of acceptable professional quality.

Your faculty in the College of Engineering has given careful consideration to the preliminary report and has had a special meeting at which the following statement was adopted as representative of the view of the faculty in the College of Engineering at the University of Colorado.

Recommendations 1, 2, and 12 of the Preliminary Report should be deleted. In their place should be substituted the following recomendations:

> The Bachelor of Science Degree in engineering represents a firm educational foundation on which to build further professional activities as an engineer including graduate work and industrial functions. While some schools should be encouraged to develop programs which may represent integrated sequences leading to a five-year Master's program, the major emphasis for the first professional degree in engineering should remain upon the Bachelor of Science Degree.
>
> Although generalized engineering degrees without specific designation should be encouraged for some schools on an experimental basis, it is recommended that a specific degree designation representing an appropriate specialized area of engineering be included with the normal Bachelor of Science curricula in engineering.
>
> Accreditation by ECPD should be based on the ability of a specific engineering curriculum to meet requirements judged to be of acceptable professional quality.
>
> Post-high-school college-level programs of two-years duration leading to technology certificates should be encouraged. These should be developed as high-status terminal programs on a non-professional level directed toward training technicians and should not be considered as introductory engineering programs.

It will be interesting to see the national response to the Preliminary Report on the Goals of Engineering Education. If the final report remains essentially unchanged from the preliminary report, we will undoubtedly see some major changes in the approach to engineering education in the near future. Any views the students would wish to express on this matter, would be much appreciated.

Max S. Peters
Dean

DICK FOWLER, MECHANICAL ENGINEER
M.E., '64, University of California (Berkeley)

TED LAKE, FABRICATED STEEL CONSTRUCTION ENGINEER
C.E., '61, Duke University

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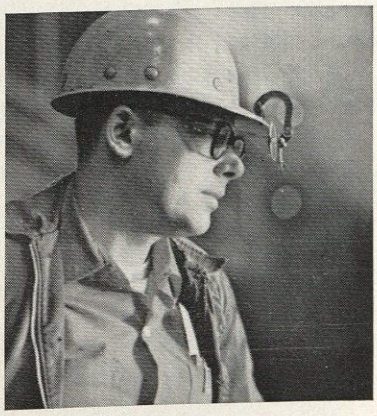
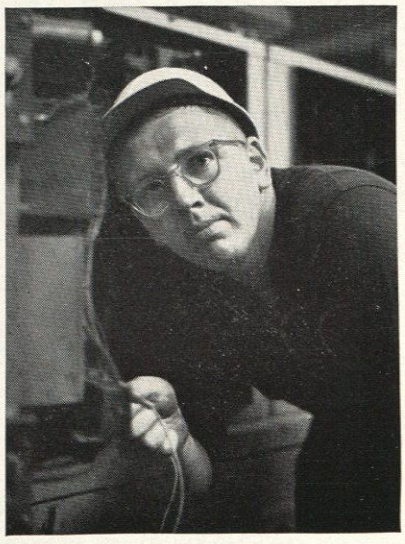
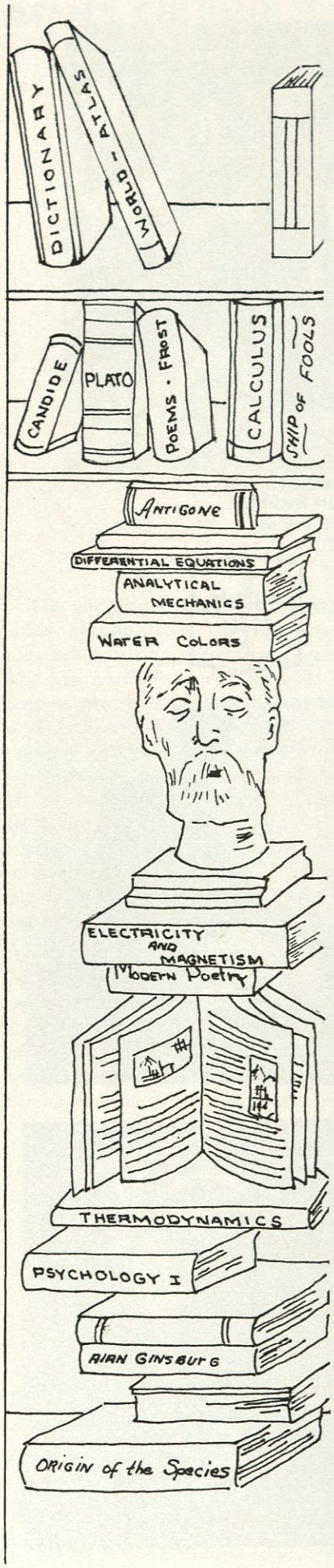


DON YOUNG, ELECTRIC FURNACE FOREMAN
Met.E., 62, Drexel Institute of Technology



JOE DUNNE, ELECTRICAL ENGINEER
E.E., '63, Johns Hopkins University



BOOK REVIEWS

Mary Christenson

Energy Does Matter

by Werner Emmerich, Milton Gottlieb, Carl Helstrom, and William Stewart; Walger and Company, 1964, 256 pp.

"If" statements are nearly always provocative. One of the most curious "if's" I've found is in Dr. Emmerich's introduction to *Energy Does Matter*: "If we were to convert the mass of a copper penny entirely into energy, we could drive the ocean liner Queen Mary clear around the world at top speed." Regardless of the feasibility of such a trick, this is one example revealing the nature of energy though one of the most famous equations in science: $E = Mc^2$.

The physicist, Dr. Gottleib, follows up with a discussion of energy forms leading into a rational explanation of natural phenomena including conservation of energy, laws of thermodynamics, Carnot cycle, black body radiation and others, quickly bringing the subject down to earth and into the proper perspective. A deliberate review of rudimentary ideas forms the basis for the presentation of more advanced concepts.

Dr. Helstrom relates the abstract discussions of the mathematics of energy to the above foundations. He is especially concerned with the themes relativity and quantum mechanics which "have brought about a revolution in the world of physics which has affected its very foundation."

Dr. Stewart concluded with the engineer's point of view. Looking at economics as well as engineering, he describes the applications of the theories which allow development of more efficient machines for converting energy into useful forms. A bit of speculating is involved in his estimates of the ultimate supply of energy needed to maintain life as we know it. Lastly, he presents the realistic challenge to science and technology of anticipating energy demands and discovering practical ways to supply them.

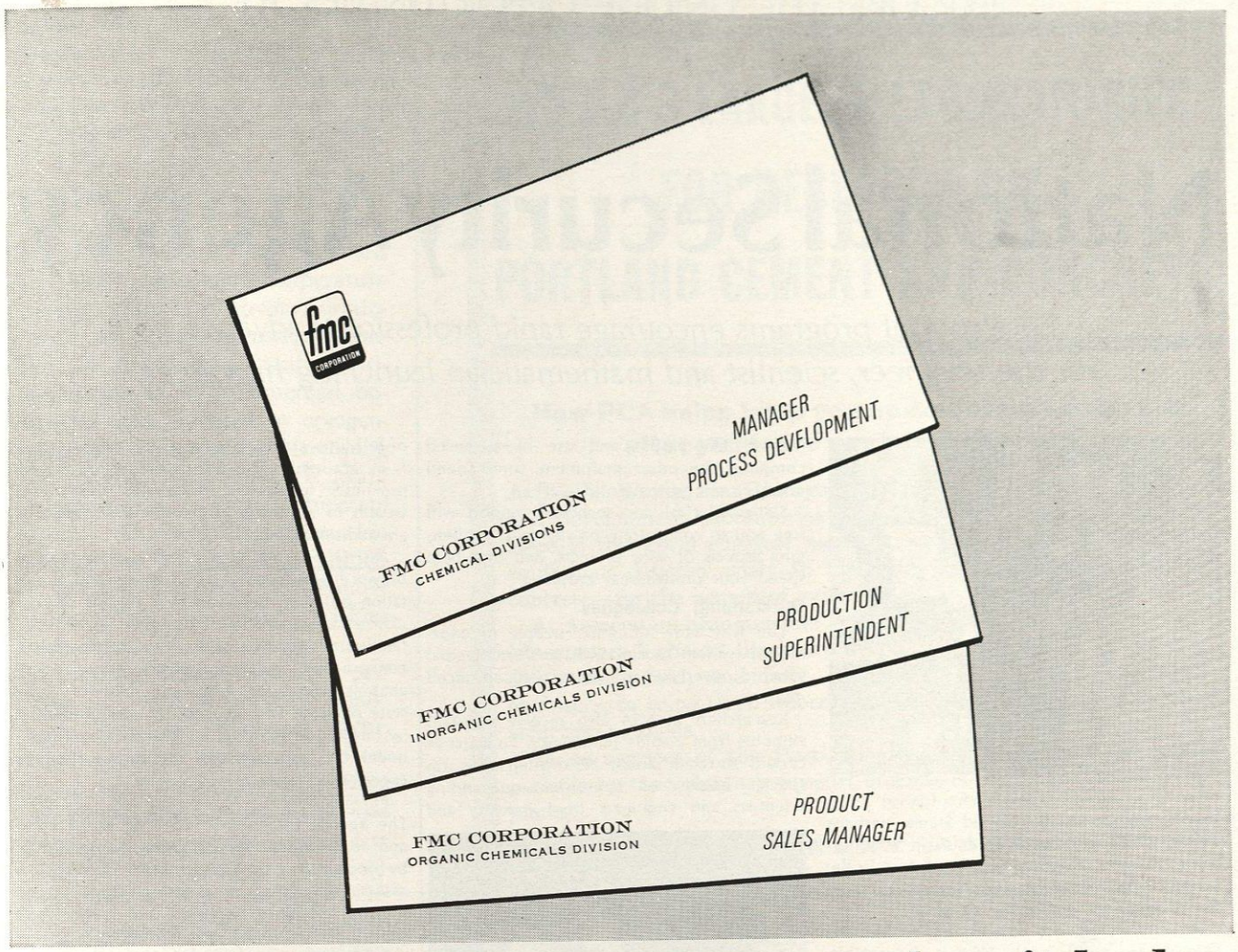
Machining Principles and Cost Control

by Robert G. Brierley and H. J. Seikmann, McGraw-Hill, 1964, 250 pp.

According to the authors, "the application of efficient machining standards, practices, and techniques is contingent on a knowledge of the funddamentals of tool design, application and maintenance of the basic tool, machine and operating relationships. The establishment of machining conditions which will produce parts at minimum cost or at maximum rate requires the elimination of causes of unpredictable tool life." Therefore, in their work they have kept these considerations foremost; theory has been kept at a minimum. A particular high point of the book is the presentation of the Hi-E concept and the inclusion of a unique slide rule called the Hi-E Calculator, making it possible to solve minimum costs and maximum production cutting speeds without resorting to complex mathematical calculations.

Beginning with an explanation of the economics of machining, the authors proceed to a comparison of cutting tool materials, their physical properties and characteristics. The principles of chip control, chip control devices and their applications are thoroughly presented. The final chapters describe the application of machining fundamentals and economics by use of the above mentioned Hi-E Calculator.

(Continued on page 41)



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(Continued from page 38)

Further information on *Machining Principles and Cost Control* may be obtained from the McGraw-Hill Book Information Service, 327 West 41st Street, New York, New York, 10036.

Hypercryogenics

Plenum Press, New York.

The new Science for Business Source Book on low temperature technology, *Hypercryogenics*, evaluates the cryogenics industry, illuminating for the business and scientific world the many commercial opportunities being created by cryogenics research. This rapidly developing field is covered from currently available components to exotic future applications. A wealth of information is presented in language easily understood by non-scientists, particularly executives who must make decisions on investments in technology.

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Equivalent to a battery of scientific and investment consultants, *Hypercryogenics* may be obtained by the general business, investment, and scientific communities through Plenum Press, 227 West 17th Street, New York, New York, 10011. Science for Business Inc. is a corporation owned and operated by a group of scientists and professional people in a range of scientific disciplines, in managements, and in investments.

Linear Elastic Theory of Thin Shells

by J. E. Gibson, Pergamon Press, New York, 1965, 179 pp.

Mr. Gibson's purpose in his book has been to introduce the theory of the elastic behavior of shells on an intermediate level. He has especially directed his work toward final year and post-graduate engineering students. Only an elementary knowledge of differential and integral calculus has been assumed, and the author has included complete mathematical derivations in many cases.

Familiar shell structures are liquid containers, aircraft fuselages and submarine hulls. In the past many problems were encountered in obtaining suitable materials for construction of shell structures. Today they are generally constructed of steel, light alloy, plastics, wood and reinforced concrete.

Well over half of the book is concerned with membrane and bending theories for open and closed cylindrical shells and shells of arbitrary shape. Examples are often given, allowing the reader to arrive at numerical results by an orderly method which is suitable for design calculations.

Mr. Gibson then proceeds to a short discussion of more complicated shell structures through the use of computer programming. Lastly he shows how theoretical figures are related to actual stresses determined through experiment. Mr. Gibson is a reader in civil engineering at the University of Manchester.

THIS TODAY

JERRY ZIMMERMAN

TYPE SETTING

A system of generating and setting any style of type—in any language—on the screen of a television-like (cathode ray) tube has been invented at Bell Telephone Laboratories. This system already has been used to generate and set 150 letters a second of typewriter quality. The method has the potential of generating and setting several thousand characters a second—much faster than any other way of setting type—with a quality comparable to that of book type.

The new system also makes it possible to produce a great variety of typefaces, line drawings, mathematical equations, musical scores, and scientific graphs. Images or letters displayed on the screen are photographed and the film negative then can be used to make, by conventional techniques, a plate for subsequent printing.

The system is considerably more flexible than any other way of setting type. In other methods of type setting, type faces are stored as shapes on metal, glass, or film. To change styles, it is necessary to manipulate metal forms, glass wheels, or strips of film. In the new Bell Laboratories system, the type faces are stored in digital form. To change type faces, only the program instruction must be changed. A change could be made quickly, for example, from English to Chinese characters. The digitally controlled beam traces small segments or "patches" on the screen. Although the patches rapidly disappear, they are captured on film by a camera set for a time exposure. Letters and images are built up on the film negative from these small segments appearing and disappearing on the cathode ray tube.

BALL BROTHERS

The National Aeronautics and Space Administration has awarded a $117,175 study contract to Ball Brothers Research Corp. here in Boulder to define and determine the engineering requirements for a solar telescope mount to be used on proposed Earth-orbiting Apollo manned missions.

Bell's New Photographic Typesetting Machine

The six-month, cost-plus-fixed-fee contract is based on an unsolicited proposal by Ball Brothers for an Apollo Telescope Orientation Mount. The concept would provide for the use of astronauts to assist in positioning the mount. Final precision pointing would be accomplished automatically.

The system would provide a capability of observing the Sun with relatively large astronomical-type telescopes and in having an astronaut available to correct errors in alignment and to make other adjustments of the mechanism.

Ball Brothers, prime contractor for NASA's orbiting solar observations, will determine what hardware must be developed for the mount so that a minimum of modifications are necessary in the service module.

SIGHT AND SOUND ARE COMBINED ON THE RECORD IN THIS NEW WESTINGHOUSE SYSTEM.

NEW GLASS

New ophthalmic glass made by Corning Glass Works for prescription eyeglasses darkens on exposure to sunlight and then becomes clear again indoors or after sundown. The new material, called Bestlite photochromic glass, is the first application of the photochromic materials announced as a Corning research achievement in 1964.

Before exposure to sunlight the new glass is essentially colorless and has a light transmittance of more than 90 per cent. This is about the same transmittance as clear ophthalmic crown glass used for most spectacle lenses. After a one-hour exposure to direct sunlight at 85°F, transmittance of the new glass drops to 66 per cent (compared with 64 per cent for the standard light Shade A green sunglass). After the same exposure at 25°F, transmittance is about 36 per cent (compared with 39 per cent for the standard drak Shade C green sunglass). In direct sunlight the new glass becomes about half as dark in one minute as it does in an hour. It becomes about ¾ as dark in five minutes as it does in an hour. On change from sunlight to interior lighting, the glass recovers about halfway to its unexposed transmittance in five minutes, and about ¾ of the way in 20 minutes.

The new material is darkened by the near ultraviolet radiation in sunlight, but is not significantly affected by tungsten or fluorescent lighting at normal distances. Thus it does not react to oncoming auto headlights at night, or even to mercury vapor lamps used for highway illumination.

NEW COMPUTER

The IBM 1130 Computing System, announced in the first quarter of 1965, has had phenomenal success. There have been over fourteen hundred systems ordered.

The 1130 is a small scientific-engineering machine. The 4096 word memory, consisting of 16 bits per word, can be expanded to 8192 words. Memory cycle time is 3.6 microseconds and is capable of performing 120,000 additions per second. Additional memory can be added in the form of a 512 word disk or a magnetic tape unit. The internal logic of the computer consists of completely integrated solid state components.

Coupling the fast internal speed, comparable to an IBM 7090, with the inexpensive input-output equipment, comparable to UR model 50, has produced a low cost, much needed data processing system.

Several programs have been developed by IBM to aid the engineer in programming the machine. Coordinate geometry, matrix inversion, simultaneous equation solution, real and complex roots of polynomials, and regression analysis are a few of the special programs. FORTRAN, SAP, COGO, and COMET will also be supplied to aid the engineer with this new tool.

PICTURES FROM PHONOGRAPHS

The head of research for Westinghouse Electric Corporation has unveiled an electronic system that plays television pictures from a phonograph record. Along with a series of still pictures, voice and music come from the same long-play disc.

The record is not just an audio recording that triggers pictures from a slide projector. Both the audio signal and the video signal are present in the grooves of the record and both are picked up by the phonograph needle. Up to 400 pictures and 40 minutes of voice and music can be present on the two sides of a 12-inch, 33⅓ rpm recording. The pictures can be line drawings, charts, printed text, or photographs. Phonovid, thus provides a complete 400-page picture book on a single long-play phonograph record. The accompanying sound is equal in quality to that broadcast by an AM radio station.

The system is considered an important advance in the art of electronic communications. It appears to hold unusual promise as a flexible, easy-to-operate, inexpensive audio-visual system for educational instruction.

TAU BETA PI PLEDGE ESSAY

AMERICAN DISSENTION OVER THE WAR IN VIETNAM

Steve Noren

For nearly five years the United States has been waging an undeclared war in South Viet Nam, using ever-increasing aggressiveness and dedication. Until fairly recently, however, this conflict aroused little interest among the American people: the land was so remote; the place was too unfamiliar.

Within recent months, though, the concern of some Americans has climbed to such heights that a new conflict has evolved: a struggle whose sole resolve is to terminate this war in Southwest Asia. The combatants in the conflict are ordinary citizens, and their arsenal consists of their personal convictions and self-determination. They "fight" with peace rallies, protest parades, "teach-ins," and organized picketing, and a few of them have shown their great discontent by "draft-card burning" and self-immolation.

The Viet Nam war created this conflict, and the results of this "protest war" are becoming increasingly apparent. One can begin to comprehend the magnitude of the struggle by noting recent newspaper headlines: "25,000 in D.C. Peace Rally," "Five Set Fire to Draft Cards," "Pentagon Aides Watch Pacifist Die in Flames." These "Vietniks" are anxious to protest the war in Viet Nam, and their efforts are leaving a strong impression upon the nation.

To counter these anti-war demonstrators, another section of the United States populace has recently evolved. The "hawks" fully favor the Vietnamese war, and they freely demonstrate their all-out support of it. They reveal this support through fund drives, "bleed-ins," the circulation of petitions backing U.S. policy, and "support parades." The "hawks" have also expanded their fight to the actual battlefield in Viet Nam: they are supplying U.S. troops in Viet Nam with moral support by sending them such things as Christmas cards, cookies, letters, and telegrams.

This is the struggle as it exists, and the "Vietniks" and "hawks" continue the conflict employing their numerous demonstrations and counter-demonstrations. Though such dissention and disagreement is a common thing in a free democracy such as America, the magnitude of these demonstrations—and the dedication shown by the participants—makes one wonder what has caused the conflict to reach such a great proportion: what are these people fighting for—and why?

As has previously been stated, the "Vietniks" are much opposed to the war. Supporting their beliefs are the "doves:" those opposing the role of the United States in Vietnam, though shunning demonstrations. Basically, the members of these two groups are pacifists, concerned over "the great

loss of life and human suffering caused by the war in Viet Nam." The above belief was held by Norman Morrison, who burned himself to death in protest of the war. There are also other, more specific reasons for these antiwar demonstrators. As Dr. Benjamin Spock declared at a recent peace rally in Washington D.C.: "I believe that our government only confuses itself and the American people when it sets up a puppet dictatorship in Viet Nam and then calls the Vietnamese people aggressors and attacks them with napalm when they revolt against it. . . ." A similar belief was held by David Miller, the first American citizen arraigned under a new law making it a federal offense to burn one's draft card. Before setting fire to his card Miller announced: "I believe the napalming of villages in Viet Nam is an immoral act. . . ." Other opponents to the war may call it "cruelly immoral and politically stupid" or quote the Fifth Commandment: "Thou shalt not kill."

To oppose these antiwar demonstrators, the "hawks" and "pragmatists" have arisen. Though the "pragmatists" have little enthusiasm for the war, they feel that America is committed to fight it, and, together with the "hawks," they are quite concerned and disturbed over the rash of antiwar demonstrations. They believe—as stated by Mery Garber in the U.S.C. Daily Trojan—that "if the U.S. doesn't make a stand in South Viet Nam, it will have to do so somewhere else." They also feel that these demonstrations are discouraging the Viet Cong from seeking a peaceful settlement in Viet Nam. As Andy Borg, National Commander of the Veterans of Foreign Wars, recently stated: "the protests confuse U.S. allies and encourage Red leaders to keep fighting because they believe our country is divided." The "hawks" and "pragmatists" are also basically supporters of President Johnson's Viet Nam policy: communist aggression must be countered and frustrated in Southeast Asia, and a peaceful settlement must be diligently sought in Viet Nam. Some feel that our success concerns not only the future of South Viet Nam and Southeast Asia, but also the future of the whole Pacific and the security of the Western hemisphere.

As the conflict in Viet Nam continues, these demonstrations and counter-demonstrations will continue—possibly becoming even greater in magnitude and more frequent in appearance. One may wonder as to their effect on the policies and attitudes of the United States—both in Viet Nam and in America. No doubt some influence will be—and has been—accomplished by these demonstrations. The important fact remains, however, that these people are allowed to freely express these dissentions and disagreements. As was recently expressed by President Johnson, these protests are "a healthy sign of free debate." The battle in Viet Nam may continue to grow—and may throw America into a deeper conflict—but the right to free expression will remain unscathed.

INDEX TO ADVERTISERS

We're sending some of our representatives back to school

They won't be matriculating but they'll be studying ways to have some lengthy talks with you.

Their assignment is to search out graduates who have the talent and imagination to handle sophisticated assignments and the determination to do a job better than most.

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The **Colorado Engineer** exchanges magazines with a large number of other engineering college magazines, and it is interesting to note the circulation and recirculation of jokes among us. During the move to our new offices last month, we noticed some of the supposedly current humor in some of our not so current back issues of the **Engineer.** A little further research produced the following nominees for revival:

"What's the matter, little boy?"

"Ma's gone and drowned all the kittens."

"Dear me, that's too bad."

"Yeah, she promised me I could do it."

—November, 1944

Passionate M.E., "What would I have to give you for just one little kiss?"

Horrified Coed, "Chloroform."

—March, 1951

This month's absent-minded prize goes to the druggist who was asked if he had a wife and replied, "No, but I have something that will do just as well."

—November, 1950

Prof, "And so, students, we can come to the conclusion that nothing is impossible."

Frosh, "Well, I'd like to see you ram this umbrella down your throat and open it."

—March, 1942

Did you know that 80 per cent of the heat output from the Valmont Power Plant is used for warming the ducks' feet on the lake?

—January, 1942

"I'll teach you to make love to my daughter, young man."

"I wish you would, sir, for I don't seem to be making very much headway."

—January, 1950

We hear some freshmen engineers think that a neckerchief is the president of a sorority.

— November, 1941

"Who was driving when you collided with that car?"

"None of us. We were all in the back seat."

—November, 1949

Bride (viewing twin beds), "Ooohh!!"

Husband, "What's the matter, dear?"

Bride, "I thought we were going to have a room to ourselves."

—January, 1951

When Jane returned from a ride, her mother noticed that one of her shoes was muddy.

"Why is just your right shoe muddy and not your left?" she asked.

"I changed my mind," Jane answered simply.

—March, 1950

Mother (on entering the room unexpectedly), "Well, I never . . ."

Daughter, "Oh, Mother, you must have!"

—March, 1951

We would like to know who it was that was supposed to have gone into the "Sink" recently and asked if their ice cream was pure. When answered, "Pure as the girl of your dreams," the engineer bought a package of cigarettes and walked out.

—November, 1940

"I wanna come in."

"You can't come in."

"Why not?"

"Because Mama says little boys shouldn't see little girls in their nightgowns. . . ." (short silence) "You may come in now. I took it off."

—March, 1951

"Darling, the maid has burned the eggs. Would you be satisfied with a couple of kisses for breakfast?"

"Sure, send her in."

—March, 1950

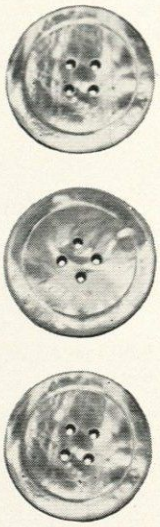
"Say you love me—say it! Say it!"

"You love me."

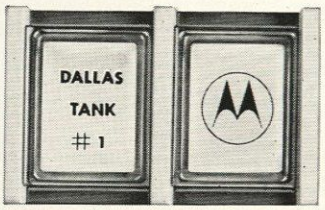
—November, 1944

—Fred Love

CONSUMER PRODUCTS * COMMUNICATIONS * SEMICONDUCTOR PRODUCTS * MILITARY ELECTRONICS * AUTOMOTIVE PRODUCTS * CONTROL SYSTEMS



button button...



Want to know how much oil is in your Dallas tanks while you're sitting in Tulsa? Push a button.

Making salad dressing? Not at home by the spoonful—but industrially by enormous vats-full. No more hand pouring or mechanical dumping. Hit the vinegar button and it's measured precisely. The oil—to the drop. Lace the concoction with zesty oregano? Just push a button.

Load a gas truck with gasoline, check the gallons left in the storage tanks, make out the statement, give the driver a receipt, and then record the whole transaction. Tough? Just have the driver push a button (or a lever). You don't even have to be there.

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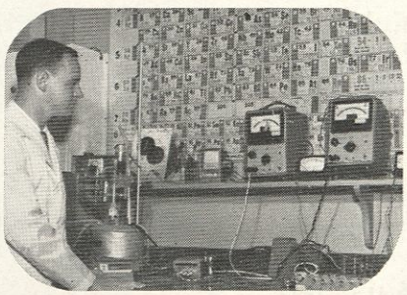
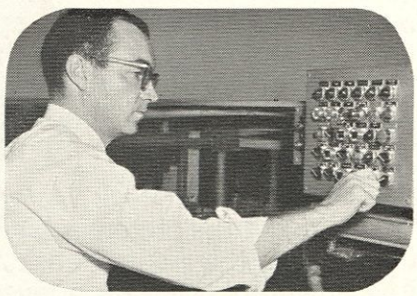


OUTPUT VOLTAGES from nickel-cadmium cells are examined by engineer John Bliven, BSEE, Union College '63 on assignment at G.E.'s Battery Business Section.



PRODUCT RELIABILITY of electric slicing knife components is the responsibility of Mike Reynolds, BSME, New Mexico State, a recent Manufacturing Training Program graduate.

PRICE AND DELIVERY information on nickel-cadmium batteries is supplied by Bob Cook, BSME, Univ. of Florida '65 on a Technical Marketing Program assignment in Gainesville.

A PREVIEW OF YOUR CAREER AT GENERAL ELECTRIC:

Creating New Growth Businesses

At our Brockport, N. Y., plant, the new business of manufacturing cordless slicing knives is **rush.** So is that of the rechargeable-battery supplier, our two-year-old plant at Gainesville, Fla., which has just doubled its working area. Its sealed, nickel-cadmium batteries, in hundreds of shapes, sizes and ratings, are meeting growing customer demands in the consumer, defense, and aerospace industries—with applications from power tools to satellites. At General Electric, new ventures are a way of life. In both their formative and growth stages, these ventures call on the skills and enthusiasms of experts in more than 120 product departments—in engineering, manufacturing and technical marketing. To define your career interest at General Electric, talk with your placement officer, or write us now. Section 699-15, Schenectady, N. Y. An Equal Opportunity Employer.

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