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December 1965

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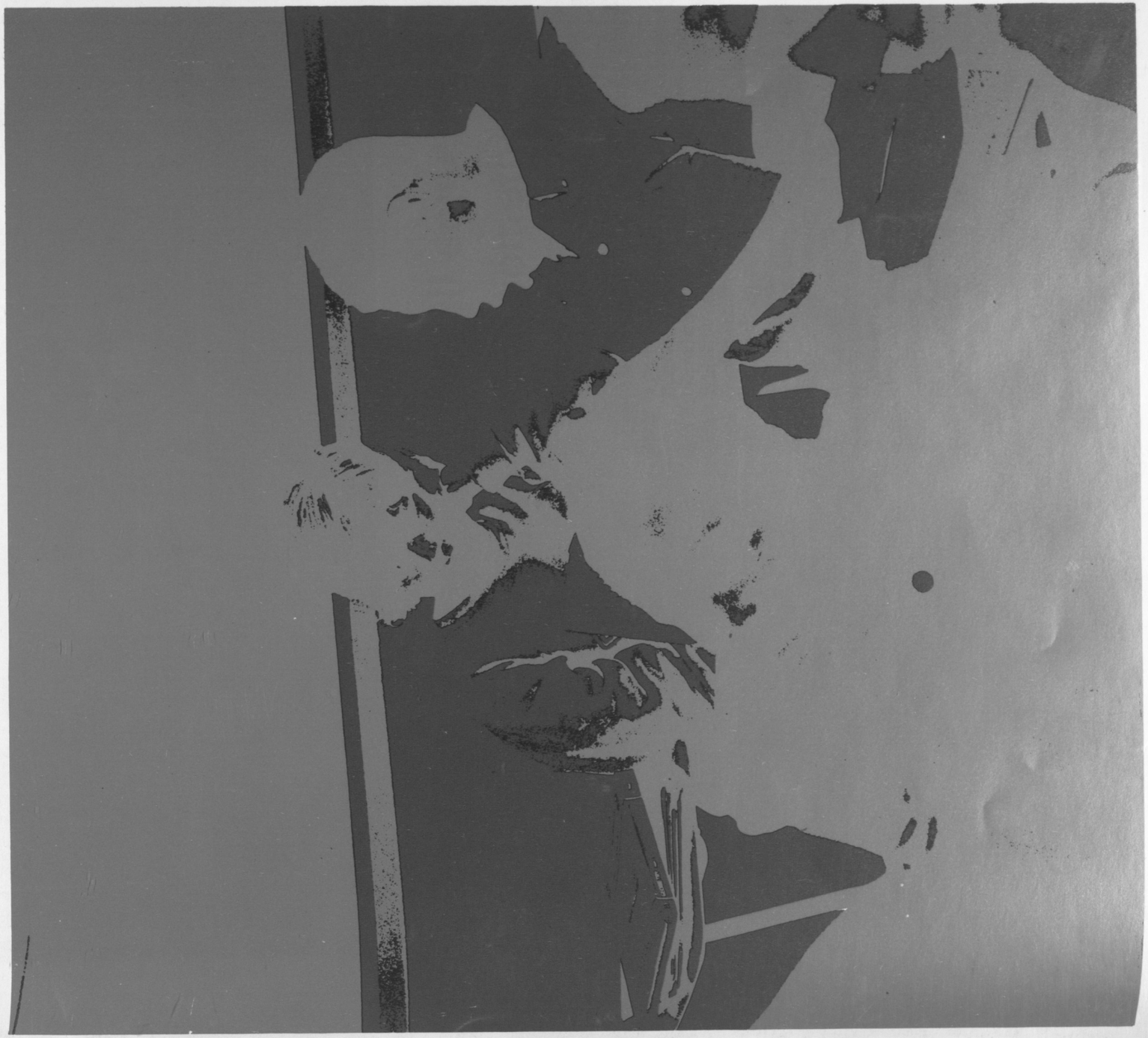

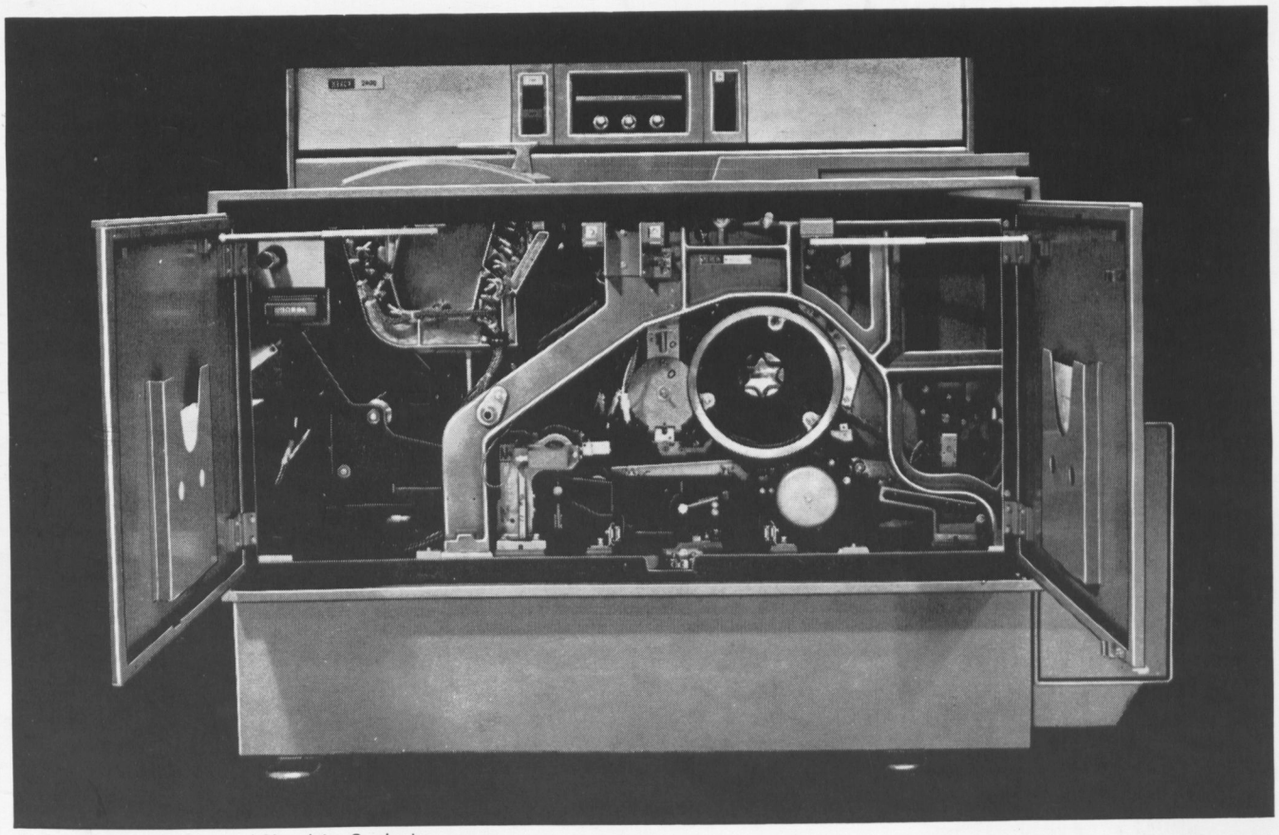

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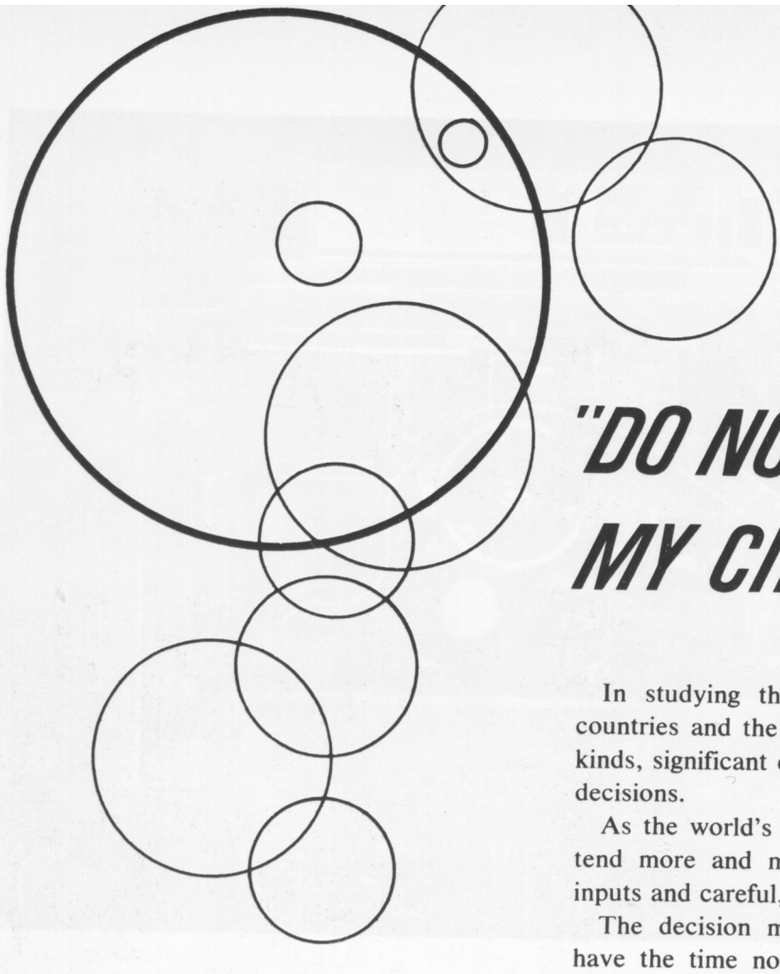

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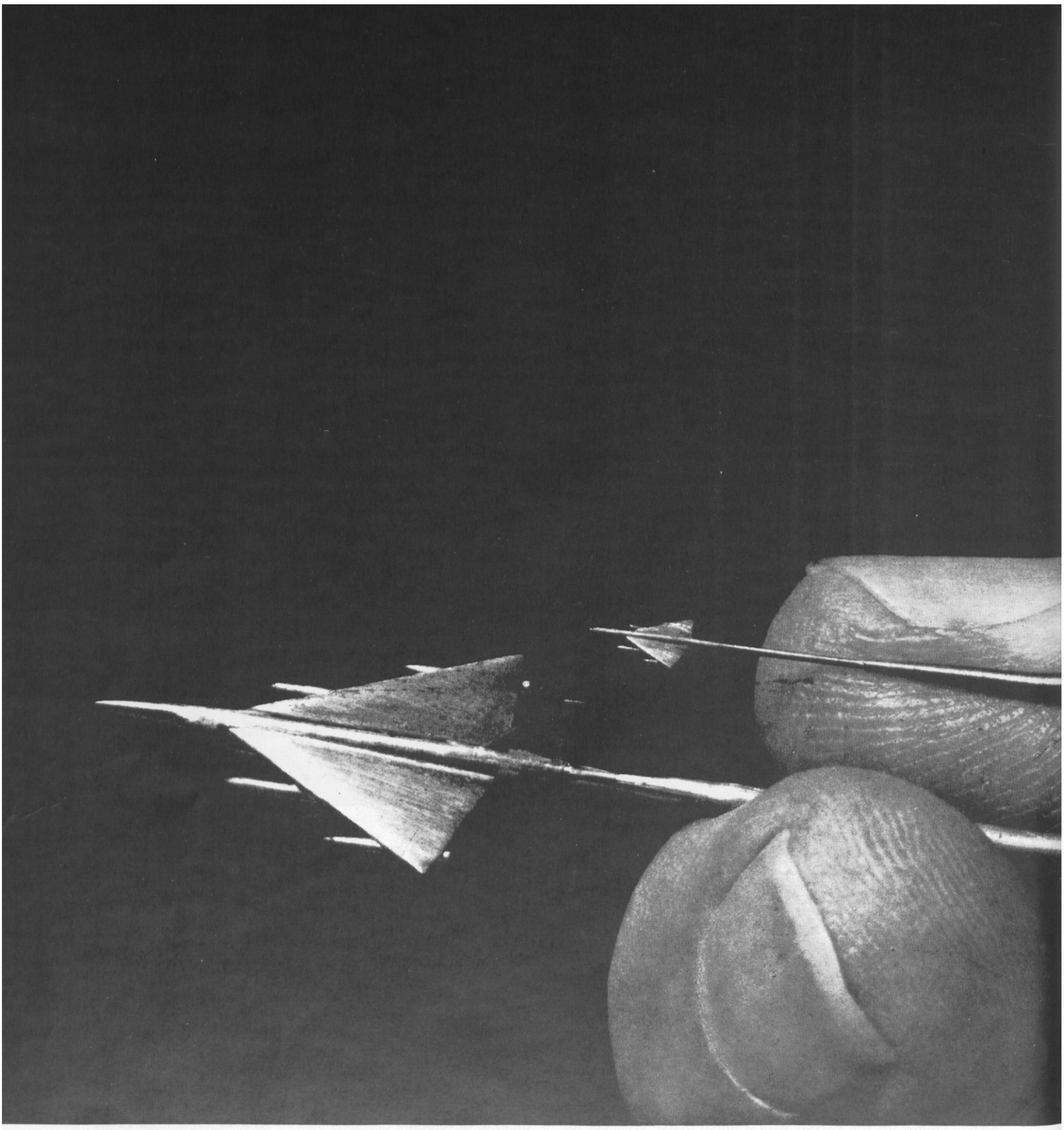

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Authors

Howard Lasnik combines his mathematical and literary interests (He is a junior math major, but plans to go to graduate school in English.) in writing Technical Musings for the *Carnegie Technical.* He is also on the literary staff of *Patterns* and a member of PiDE. His article in this issue, "The Influence of Zen on the Arts," was written to fulfill an assignment for The Art and Thought of China and Japan, but also led to a greater interest in the Orient.

Carol Kurtz's interest in the Scopp Program developed as a result of her term project for Journalistic Writing. She became so fascinated with the program that she did a follow-up report on it for Technical Writing this fall. The article printed here combines both these projects. Miss Kurtz is a senior Foods and Nutrition major. She is a member of the *Technical* and *Thistle* staffs, a justice of Student Court, and a member of Pan Hellenic Council. She is president of Omicron Nu and a member of Cwens, Phi Tau Gamma, and Mortar Board. She is also president of Kappa Alpha Theta Sorority.

We are pleased to present the second half of John Lieberman's article, Price Determination and Marketing. The first half appeared in the November issue of the *Technical.*

Beth Carten's article, "Eve," was originally written for the sophomore honors seminar in which she participated last year. Miss Carten is a Technical Writing and Biology major and would ultimately like to work in the medical field. On campus, she is President of Women's Dormitory Council, a member of Executive Council, and the Association of Women Students. She is also a member of Phi Tau Gamma and Kappa Kappa Gamma Sorority.

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Technical Musings

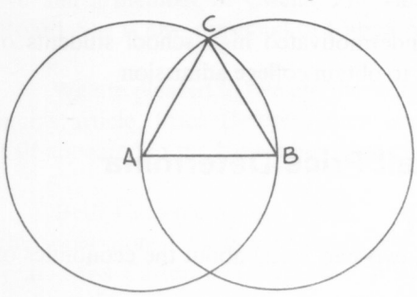
No process of sound reasoning can establish a result not contained in the premises. J. W. MELLOR

Philosophy, that lean'd on Heav'n before,
Shrinks to her second cause, and is no more.
Physic of metaphysic begs defence,
And metaphysic calls for aid on sense!
See mystery to mathematics fly! A. POPE

This month's column will be a discussion of the proof and implications of Godel's "incompatibility" theorem. Godel's result was described by the Albert Einstein Award committee as "one of the greatest contributions to the sciences in recent times." Rocking the very foundations of deductive systems, it was the most important theorem of logic of this or perhaps any other century.

To understand Godel's result, we must examine briefly the work of earlier mathematicians and logicians. If a deductive system is to be "perfect" in some sense, it must include the two elements of consistency and completeness. By consistency, we mean that given a set of axioms, the two statements T is true and T is false (alternately (not T) is true) cannot both be proved. By completeness we mean that any "truth" about the subject matter of the axioms can be deduced from the axioms. Before recent times, completeness and consistency were either taken for granted or ignored entirely.

Let us first examine Euclid's geometry, long believed to be of the highest possible standards. During the nineteenth century, however, as demands for rigor became increasingly stronger, logical gaps became evident in Euclid's "Elements." Many of Euclid's conclusions do not (and cannot) follow from his stated assumptions by formal logic alone. Consider even his very first "theorem," Proposition I, Book I: On a given line to construct an equilateral triangle, Euclid's proof calls for two circles to be drawn, one with center at point A, and the other with center at point B (Figure 1).

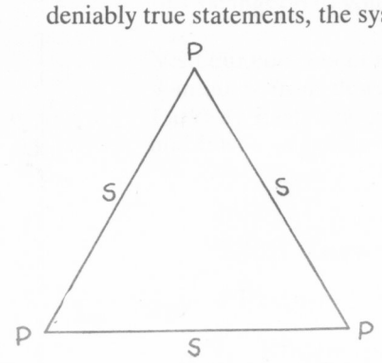


The distance between A and B is to serve as the radius of each. Immediately, Euclid speaks of point C, where the circles intersect. But do the two circles necessarily intersect? Certainly we could draw on our "experience" or our "knowledge" of the continuity of such a curve. But we wish to deal with geometry as a logical system, entire in itself. Hence, to fill this gap in the system, we need some sort of continuity theorem. Perhaps we still have reason to be optimistic: is the system with a continuity theorem now complete? Unfortunately all such hope will be shattered. Given a particular proposition, we could state the necessary assumptions for its proof. But, as we shall see, no system of assumptions will be sufficient for the class of all "true" statements.

Consistency of a system, or proof thereof, represents another kind of problem. The only obvious methods of proof for consistency of a system are painfully limited in application. First, if a system of axioms is limited enough, we could represent it as a finite model. Consider the following set of axioms (postulates, if you prefer) about two classes P and S:

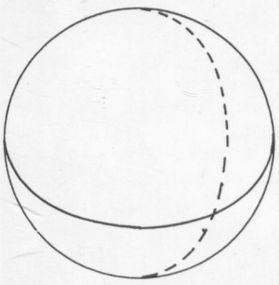
1. There are precisely three members of P
2. Any two members of P are contained in only one member of S
3. Any two members of S contain only one member of P

From this system of axioms, we can conclude, for instance, that there are precisely three members of S. Is the set of axioms consistent? Suppose we represent the system by the following model. Let P be the set of points that are the vertices of a triangle, and S the set of line segments that are the sides of the triangle. A member of P is contained in a member of S if a vertex point lies on a side (Fig. 2). Since the model "is" the system, and all the postulates have been converted into undeniably true statements, the system is consistent.



Consider now Riemann's geometry — identical with Euclid's except that the fifth postulate is changed to read, "Through a point not in a given line, *no* parallel can be drawn

to the given line." If we represent Riemann's system as the surface of a Euclidean sphere, and a line as a great circle (Fig. 3) every Riemann postulate becomes a Euclidean *theorem* (see October 1965 *Technical Musings*). From the fifth postulate, we obtain "Through a point on the surface of a sphere, no arc of a great circle can be drawn parallel to a given arc of a great circle." Hence, this system will be consistent *if* Euclid's geometry is consistent. The demonstration, then, is a *relative proof* of consistency.



We seem, then, to be faced with a dilemma. We can only prove a system consistent if it is a very "limited" system, so that we can exhaust the system finitely, or if it can be expressed in terms of another system which we know already to be consistent. (Question: Do we know that Euclidean geometry is consistent?) But absolute proofs of consistency are possible in some cases. If we "arithmetize" our logical system, and show that there exists a "formula" that is not derivable from the axioms, then the system must be consistent. (Reasoning: If the system is not consistent, statements S and (not S) are both deducible, hence every statement is deducible. The contrapositive of this is the reasoning used above.)

Now that we have the two concepts, completeness and consistency, understood, we can comprehend the vast significance of Godel's theorem. Essentially, what he demonstrated is that for some systems, consistency is incompatible with completeness. "Some systems" include among other things any axiomatization of numbers rich enough to include both addition and multiplication. Godel accomplished his proof, first, through an ingenious arithmetization of mathematics. With every symbol used in logic, he associated a number and with consecutive positions in an equation he associated consecutive primes. For example, a partial list includes the following:

Godel number	Symbol (as in *Principia Mathematica*)	Meaning
4	$\exists$	There exists a . . .
8	(	punctuation
9	)	punctuation
5	=	equals
7	s	the immediate successor of
11	x	numerical variable
13	y	numerical variable

Now consider the sentence: There exists an x such that x is the immediate successor of y.

($\exists$ x) (x = s y)

8 4 11 9 8 11 5 7 13 9

To combine these collections of numbers into unique integers, Godel associated them with numbers in the following manner:

8 4 11 9 8 11 5 7 13 9

becomes

$2^8 \times 3^4 \times 5^{11} \times 7^9 \times 11^8 \times 13^{11} \times 17^5 \times 19^7 \times 23^{13} \times 29^9$

It is a relatively easy matter to show that *every* formula has a unique representation as a Godel number. Further, every Godel number represents only one formula. (Clearly, not every number is a Godel number.) Godel next showed that all meta-mathematical statements (statements about mathematics such as "2 is an integer") can be adequately expressed in terms of the system itself. And finally, (the proof is far too detailed to even suggest here) Godel constructed a chain of inference that concluded with a formula G representing the meta-mathematical statement: The formula G is not demonstrable. Thus G is demonstrable if and only if (not G) is demonstrable. But if a formula and its formal negation are both deducible from a set of axioms, the axioms are not consistent. Therefore, if the system is consistent, neither G nor its negation is demonstrable. But if this is so, G is formally undecidable and the system is incomplete. One very unnerving result of this is that if arithmetic is consistent, its consistency can only be established relative to a system more complicated i.e., one whose consistency is even more open to conjecture.

Ultimately, then, given any finite axiomatization for arithmetic (or many other systems as well), there will always exist statements that are undecidable as logical inferences from the axioms. This logical result is disturbing enough within the realm of mathematics. If it can be applied to the realm of physical or metaphysical truth (as some writers have done), Godel's proof suggests that no matter what natural "laws" we attribute to the universe, there will be truths hidden from us. This, however, is a meta-meta-mathematical argument we wish to avoid (for sanity's sake, if nothing else).

Howard Lasnik

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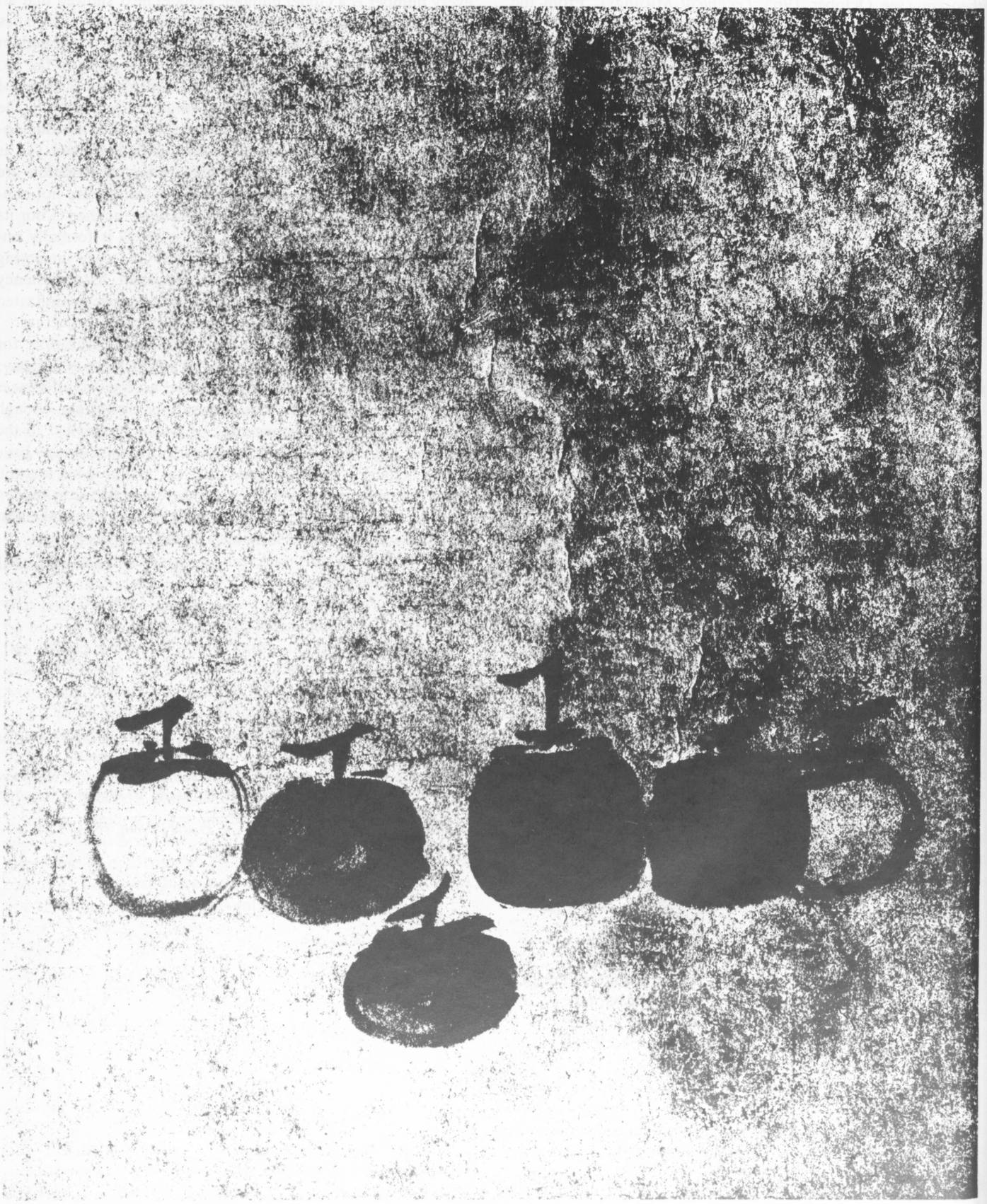

Fig. 1

The Influence of Zen on the Arts: Six Persimmons & the No Theater

Howard Lasnik

The development of Zen Buddhism had a remarkable effect on the arts of China, especially in the late Sung and early Yuan periods. The results are, perhaps, most evident in the "spontaneous" school of ink painting. The foremost practitioner of this method was Mu-ch'i; his painting *Six Persimmons* (figure 1) is a classic example of the spontaneous in art. The subject, arrangement, and brush technique of this painting are all intimately related to Zen. The influence of Zen extended to other arts and other countries as well; many of the same developments mentioned above are mirrored in the development of Japanese No drama.

The first feature worthy of note in *Six Persimmons* is the subject itself. For this simple still life represents something of a break with traditional Chinese paintings. Earlier paintings were landscapes, portraits, animals, groupings of people, but almost never still-lifes. Hence, the subject of the painting, itself, can probably be traced to Zen influence. For Zen theology includes the belief that the Buddha-nature is inherent in all objects, no matter how small or inconsequential. Because of the anti-intellectual nature of Zen, we cannot look to the scriptures themselves for verification of this point. The tenets of Zen, however, are to a degree found in the *koan*. The koan, principal tool of Zen, is a method of shocking the mind into greater awareness. (What is the sound of one hand clapping?) Many *koan,* when considered as allowing rational solutions, express the universality of the Buddha nature. One famous *koan* asks, "Who is the Buddha?" The response is, "three *chin* of flax." On one occasion, a Zen monk was reprimanded for spitting on a statue of the Buddha, asked "Where is not the Buddha?" Hence, the six persimmons of the painting in that they are not "religious" but an everyday subject have a definite relationship with Zen.

The arrangement of the fruits also has distinctly Zen overtones. The overall composition is very simple, yet has definite subtleties. Considering the lack of both complexity and complicated development, Mu-ch'i has created depth and placement amazingly well. Although the persimmons themselves can perhaps be described as flat, the slight overlap at

Fig. 2

left, and more pronounced overlap at right, are by no means simply a "layering." In both of these cases, there is no question that one solid object is located spatially "behind" another. The fruit "below" the others is decidedly in front of them. Further, in the spacing there is perfect balance with regard to perspective as well as weight. The subtlety and simplicity of this arrangement, as well as the balance, correspond to these same qualities in Zen.

In the brush technique of the painting, we have the most extreme connections with Zen. The painting is, above all, spontaneous. But the spontaneity is the spontaneity of the Zen sword-fighter.* Clearly, we are dealing here with the work of a painter so completely the master of his brush that painting has become second nature to him. Certainly, this painting has been "written," in that Mu-ch'i has accomplished the utmost with each brush stroke. His is the spontaneity of perfect control, a control reflected in the "cool" overall effect of the painting.

Closely related to the spontaneity of execution is the subtlety of modeling. For example, the impression of weight is created in an extremely skillful manner. The "heaviest" of the persimmons has been pushed down with the heaviest weight of ink. The brush-stroke defining the left-most of the persimmons is long with light thickness flowing into nearly transparent thinness. This fruit is decidedly "lighter" than the former mentioned. This subtlety reflects the doctrine in Zen Buddhism that is in opposition to ritual or elaborateness of any kind.

In the modeling of the stems and leaves as if they were Chinese characters we have a conclusive statement of Zen principles. First, there is the brusqueness and the enigmatic in these stems. For Mu-ch'i here is taking the part of a priest presenting a *koan*. He has opened his mind and is looking at the persimmons in a new and different way. Further, the effect on the observer of the painting is like that of a *koan*. Seeing persimmons represented in this "unnatural" way shocks our sensibilities into a state of heightened awareness. This *koan*-like effect is also to be found in the contrasts of the painting: the combination of sharpness and vagueness, great darkness and extreme lightnes, weight and airiness.

As we extend this analysis a bit further, the anti-intellectual quality found in Zen also becomes apparent. Zen is opposed to communication by direct statement. In Zen, the gesture, the subtle, and the un-stated are important. The same is true of this painting. First, the Chinese characters that are the stems suggest that there is something in this painting beyond what we can perceive in a rational manner. The blank space in the painting heightens the effect. Any but the most casual observer experiences a sense of breadth and universality that cannot be expressed in a photograph of six persimmons.[1] The Zen master Wen-yi was once asked: "What is the First Principle?" He replied, "If I were to tell you, it would become the second principle" (Wen-ye Ch'an-shih Yu-lu). It is this same lack of rational statement that is found in the painting. Even the instantaneous flash of inspiration is found in this painting, registered in terms of patterns of ink. Arthur Waley says of *Six Persimmons* that in it "passion has congealed into a stupendous calm."

In summary, the overall balance, simplicity, and subtlety of the painting combine with a calm atmosphere of meditation to produce a suggestion of something beyond the mere physical construction. Everywhere, form, texture, and color are suggested rather than stated, and the shapes form a unified whole. Hence, all of the elements of the technique of *Six Persimmons,* as well as the overall effect are decidedly Zen in nature. For Zen emphasizes the simple as opposed to the complicated, the spontaneous as opposed to the forced, the intuitive as opposed to the "logical," and the suggestion as opposed to the stated.

All of these Zen influences that we have discovered in *Six Persimmons* are reflected in other arts as well. In Japanese No drama, there are again simplicity and subtlety; above all, there is the importance of what is not stated.

Simplicity is basic to the physical accoutrements of the No theater. The stage is built entirely of plain wood, reflecting a purity of spirit. The backdrop is plain and the sets demonstrate suggestiveness as well as simplicity. One open framework can represent a boat, and another, a chariot. The frame in the photograph (figure 2) represents a well. Four posts with a roof can be a palace, a house, a cottage, or a hovel. The actor's fan can fulfill many functions: as a knife, a brush, a pen (or a fan). The No masks, worn by the *shite* and *shite-zure,* (protagonist and companion to protagonist) are models of simplicity with unpretentious coloring and simple features. (figure 3)

The plays themselves have a bareness of line of drama, and the verses are suggestive rather than explicit. There are no more words than are absolutely necessary; communication of emotions is generally through gestures. This means of communication leads us to a consideration of the actors. The foremost author and formulator of theory was Seami. Seami discussed the actor's art and *Yugen,* the ultimate goal of the actor. The *Yugen* of discourse, in some respects akin to the spontaneity of Mu-ch'i's painting, lies in a grace of language and a complete mastery of speech so that even the most casual utterances will be graceful. Much is conveyed by subtle gestures, and, in fact, moments of non-action are often the most important. The plays are uncluttered, including only a protagonist and an itinerant priest, and possibly friends for each of these major characters. The No, then, is a symbolic theater, in which the actor's "creation" must be spontaneous in the same sense that the art of Mu-ch'i is spontaneous. Further, the No derives its beauty from its subtlety and simplicity.

Thus, the far-reaching influence of Zen that we find in *Six Persimmons* is also very much in evidence in the representational theater of Japan. In both, simplicity, subtlety, and spontaneity, all tend to open the mind to considerations beyond physical forms, and beyond even rational conclusions.

**The Zen sword-fighter, by being attacked at unexpected moments by his teacher, becomes able unthinkingly to ward off sword blows. The appropriate Zen metaphor calls for action as natural as the noise that comes from clapping the hands.*

[1]There is a correlation between this phenomenon and the method of transmission of the Zen doctrine: A gesture of the Buddha's was understood by one man, only, his pupil, Kasyapa.

Fig. 3

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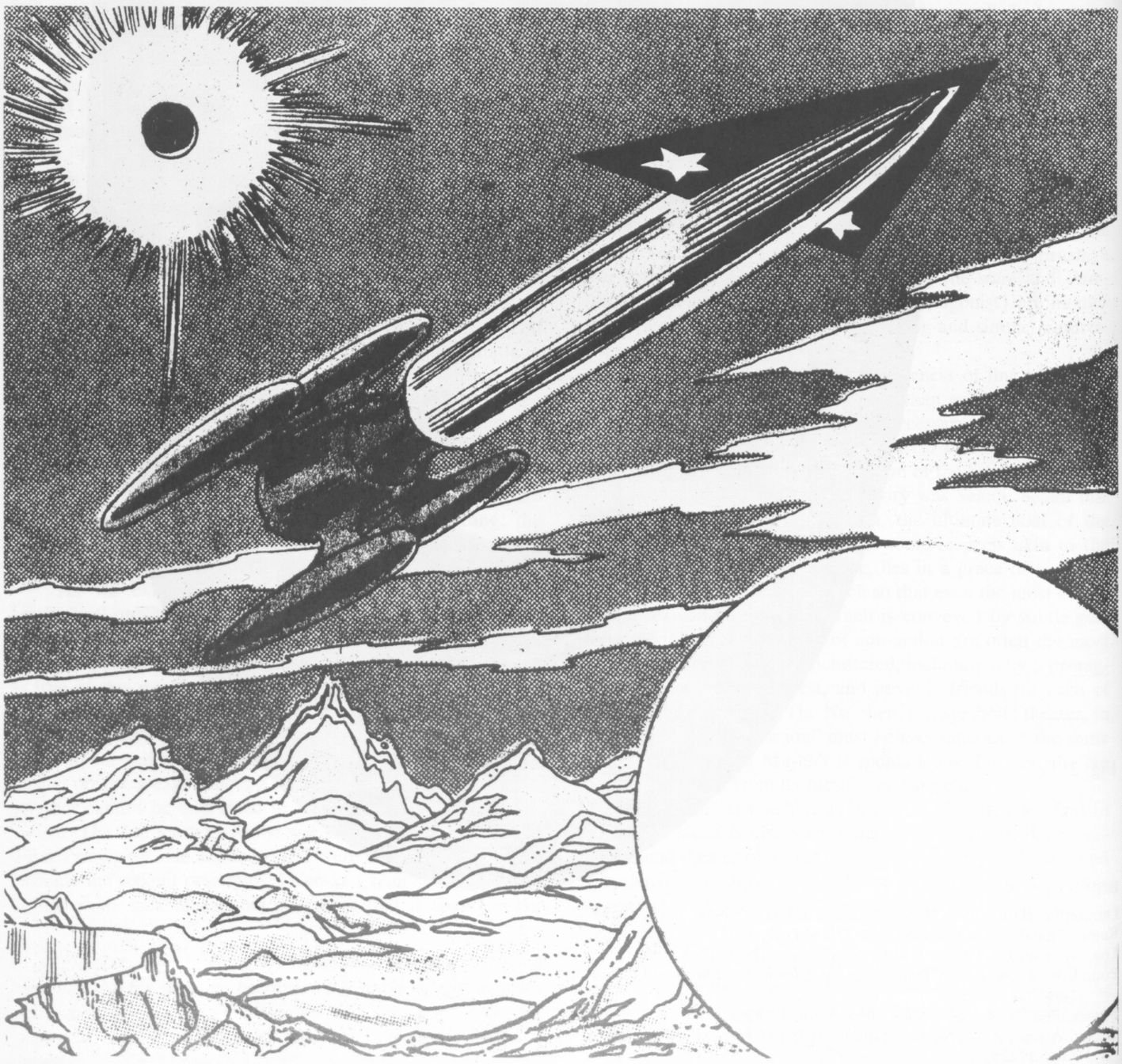


Silicon Solar Cells for Space Vehicles

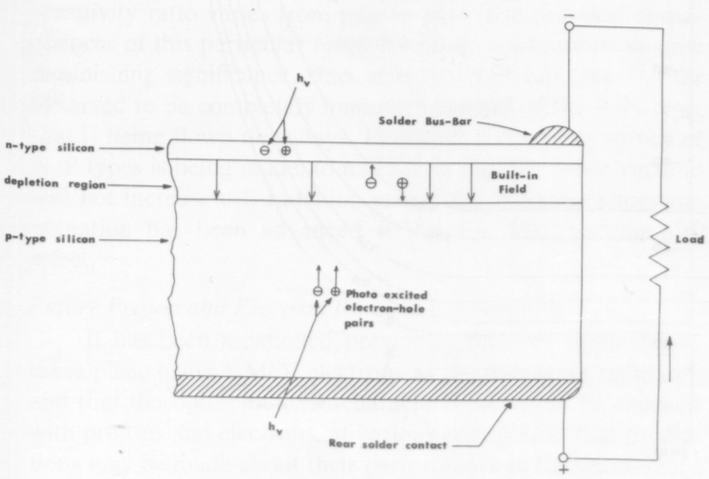
John Hicks

Introduction

My group at the Westinghouse Research Laboratories has been engaged in a three year development program for an improved solar energy converter array for space applications, using silicon solar cells. Improved performance has been sought in terms of resistance to damaging outer space radiation fluxes, and increases in the complete array "watts per pound" figure of merit. Project objectives are being attained, and the following paper is intended to illustrate some of the experimental procedures used in evaluating the radiation resistance of the developmental units.

Theory

Solid-state solar energy converters (solar cells) have found acceptance among satellite and other spacecraft designers because of their high efficiency and their long useful life. They are ten times as efficient as other devices in converting the sun's energy into electrical energy, and typical spacecraft solar cell power supplies deliver from 2 to 200 watts of useful power. There are presently plans afoot to utilize a 10 kilowatt solar cell power supply on the moon.

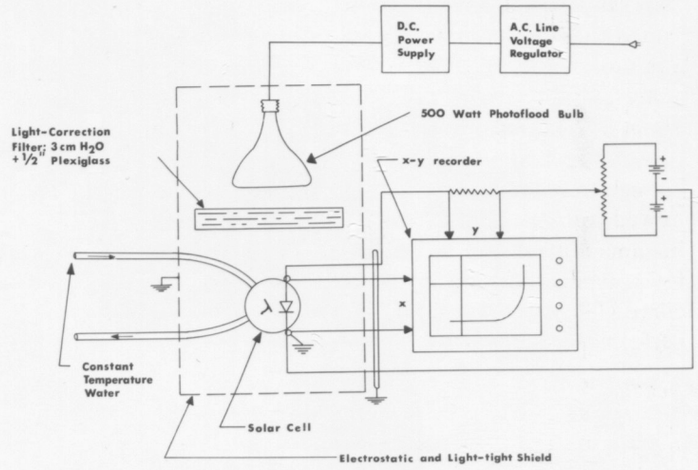


A cross section of a contemporary silicon solar cell is shown in Figure 1. The dimensions are out of proportion in order to illustrate the operation. It is basically a large-area (1 x 2 cm) P-N junction, with the junction very near (½ micron) the illuminated surface. The output current comes from electrons and holes which are generated mostly in the P-type region when light is absorbed there. These charge carriers drift to the depletion region, where they are separated by the "built-in" electric field of the P-N junction. The resulting output current is then majority carrier flow through the n and p regions, into the external circuit. The basic irreversible energy conversion takes place when valence electrons are raised into the conduction band by interaction between photons and electrons.

Efficiency Apparatus

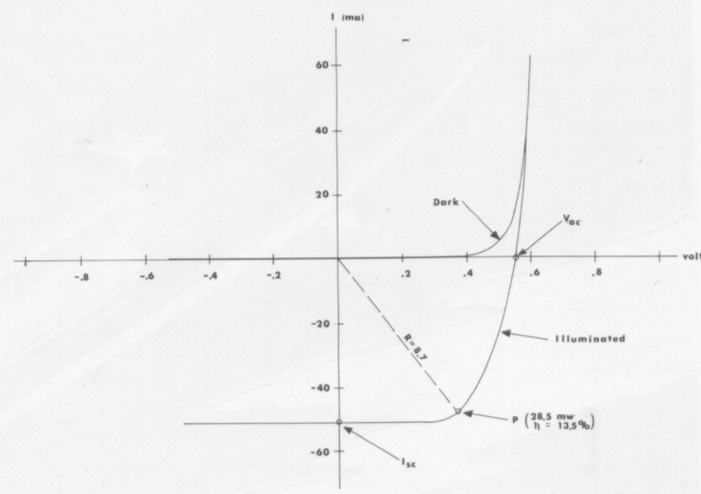
The sun is a 6000°K blackbody radiator, which is difficult to reproduce in the laboratory. However, a monitored tungsten light source plus an appropriate filter has been found to give very similar efficiency values when properly calibrated. An x-y recorder is used to plot volt-ampere curves, which are used in analyzing any electrical generator. A control console permits checking many cells easily on a routine basis, and a constant temperature water circulating system has been found necessary, since the efficiency of the cells does depend upon temperature.

A simplified schematic, or x-ray view of the efficiency apparatus is depicted in Figure 2. Separate current and voltage wires to the cell are used to eliminate contact resistance errors from plugs and switches, and D.C. current is used on the lamp to eliminate fluctuations in the solar cell output which would cause errors in the V-I curves.



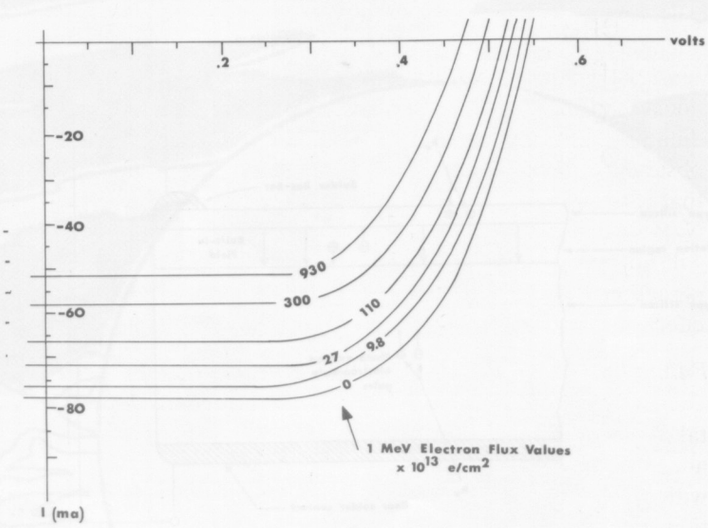
Solar Cell Characteristics

A typical solar cell volt-ampere (V-I) curve is presented in Figure 3. The "dark" trace was taken with the lamp shut off, and represents the familiar diode V-I curve. It can be seen that the action of light on the cell is approximately to shift the diode curve down on the current axis, so that part of the curve appears in the fourth quadrant. Therefore, this particular cell is delivering power when the bias is $0 < V < 0.53$ volts. The maximum power delivered is at $V = 0.42$ volt, and corresponds simply to putting an 8.7 ohm resistor across the cell terminals. With this resistor, it would be delivering 28.5 milliwatts, a sunlight efficiency of 13.5%. (The input power density is 100 milliwatts (light)/cm², and the active cell area is 1.8 cm².) This is a "watts in-watts out" number, since the light energy influx is measured in watts with a precalibrated solar cell, which in turn is checked against a thermopile in sunlight. Thus solar cells are sometimes called solar batteries, and can be hooked up in series and/or parallel combinations to yield the desired voltage and current.



Irradiation Apparatus

In common with many other solid-state devices, especially those depending upon minority carrier lifetimes, solar cells suffer degradation in the high energy nuclear radiation fields found in space. For these space applications, on satellites and interplanetary vehicles, power supply designers must know how the power generating capability of solar cells drops with exposure time. These orbital and interplanetary regions are a potpourri of low and high energy protons and electrons, and complete knowledge of solar cell damage characteristics requires damage coefficients for all the types and energies of particles found in space. However, while solar cells are being optimized for space use, it has become conventional to evaluate them with monoenergetic 1 MeV electrons from an electron accelerator. The thus-designed optimum cell is then checked for its performance against protons and electrons of various energies using other accelerators.



The apparatus used to irradiate the test cells is on a metallic conveyor belt, which continually reciprocates under a 1 MeV electron source. A square Faraday cup samples the electron beam with each traversal of the conveyor belt, and water lines keep the samples cool. The cooling is necessary because the incident beam deposits energy in and about the

samples at a rate of 100 watts, virtually all of which is converted to heat. Only about 1% of the beam displaces the silicon atoms, causing damage in the silicon. However, about 2 years of space-travel radiation damage can be simulated in about 20 hours of accelerator time.

At specified times, the irradiation is interrupted long enough to plot V-I curves for each cell. The entire tray is removed from the conveyor and taken to the efficiency measuring apparauts. In Figure 4 is displayed a family of V-I curves for a typical solar cell, taken as described. The outermost curve (labeled 0) is that of the fresh cell, and the decrease in performance can be seen as radiation damage progresses.

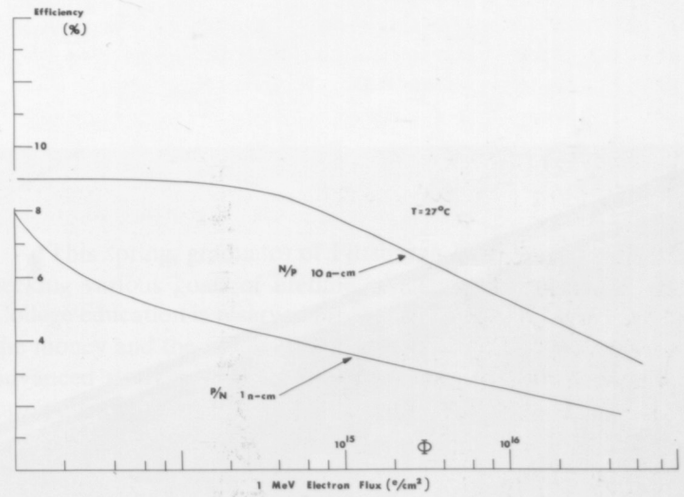
Results

When solar cells are actually used on spacecraft, the electrical operating point is determined by reference to the V-I curve. In specifying radiation damage performance, it is conventional to speak of the decrease of the maximum deliverable power with irradiation (P_{max} vs Φ). This kind of plot is displayed in Figure 5. The points used to produce the curves were taken from two families of curves similar to Figure 4, and therefore the curves in Figure 5 represent the locus of points of the maximum deliverable power with irradiation for two cell types. The interesting information displayed in Figure 5 is the greatly superior performance of the N/P, 10 Ω-cm cell (circa 1964) as compared with the P/N, 1 Ω-cm cell (used on the first satellites). The abscissa in Figure 5 is a log scale, and in practical terms, this means that the N/P cell will last about 10 times as long in space as will the P/N cell, for a given orbit or mission. The use of the N/P cell is a result of solar cell research.

A very interesting series of experiments has recently been performed, in which the degradation of selected, initially matched pairs of P/N cells has been mapped, with one cell in vacuum (1 x 10^{-5} Torr), and with the other cell in air. The striking aspect of the results is that there *is* a difference in the performance of each cell of the pair. In addition, the cell in vacuum is always worse even though the value of the radiation sensitivity ratio varies from pair to pair. The practical consequences of this particular result for space applications assume diminishing significance, since it is the N/P cell type (so far observed to be completely immune), instead of the P/N type, that is being flown nowadays. However, a complete survey of N/P types is being made, to make sure that the space vacuum will not increase cell radiation sensitivity. No satisfactory explanation has been advanced so far for this "vacuum-air" effect.

Future Proton and Electron Damage Experiments

It has been mentioned previously that cell optimization takes place using 1 MeV electrons as the damaging radiation, and that the optimum cell's characteristics would be checked with protons and electrons, at various energies, so that predictions may be made about their performance in the outer-space radiation fields. One such apparatus, for producing protons of energies from 100 MeV to 440 MeV is the cyclotron at the Saxonburg, Pa. site of Carnegie Institute of Technology. A working liaison has been established with the cyclotron personnel, and preliminary dosimetry experiments have been performed. Contrary to the 1 MeV accelerator instance, these damaging experiments must be performed inside the machine



itself, in a vacuum of about 10^{-5} Torr. since the external beam is so low in intensity. The associated technical problems are being worked out, and actual damage trials will start soon.

One very novel aspect of these proton irradiations will be the use of a special geometry. Ordinarily, the use of the internal proton beam would allow uniform irradiation of a portion of a sample only about 10 mils wide. This is due to the fact that the beam travels in an advancing spiral in the vacuum chamber, with a radial increase of about 1 mil per revolution. After about 10 passes through the sample starting at the edge, the beam's intensity is too low to be useful. This would leave most of the 1 x 2 cm area of the solar cell unaffected. We plan to use this 10 mil limitation to advantage by causing the beam to skim over the top on the first interception, and then burrow deeper on each of the ten passes. The active volume of a solar cell is limited to 10 mils or less, so there will be very nearly uniform irradiation.

Experiments are also planned with a 6 MeV electron accelerator at Magee Hospital in Pittsburgh, and the University of Pittsburgh 8 MeV proton machine. This cooperation among nucleonics laboratories is common, and in many cases is vital to the success of a project.

Acknowledgements

We would like to acknowledge the support of the Research and Technology Division of the U.S. Air Force, at Wright-Patterson A.F. Base, for their support of this solar cell work.

New Dimension in Education

Carol Kurtz

This spring, graduates of Pittsburgh high schools will be seeking various goals of lifetime education and job-training. College education is reserved for those students who have both the money and the motivation for admission into programs of advanced study or have achieved superior grades which will bring them scholarship aid.

Their colleagues with neither of these qualities, from backgrounds which do not support education or pass it by due to more critical purposes for finances, may never have the opportunity to benefit from more education than the minimum requirements for a high school diploma.

Spring, 1966, will see a somewhat different group of college-bound graduates. This group will include the participants in the School-College Orientation Program in Pittsburgh (SCOPP) who have spent their final two years of high school in a combined study plan and sociological experiment for higher education.

SCOPP (pronounced "scope") is an effort to aid these underachieving, undermotivated high school students of limited financial means toward college admission and a degree. This goal is to be reached through a four-phased program of counseling, tutoring, case work, and classroom study.

The SCOPP program was realized early in 1964 when the Carnegie Foundation allocated $106,000 to a committee of administrators from Carnegie Institute of Technology and the Board of Education of the Pittsburgh Public Schools. Dr. Erwin R. Steinberg, Dean of the Margaret Morrison College at CIT, had presented the committee's joint proposal concerning SCOPP to the foundation.

The proposal was the result of an attempt for cooperation between Carnegie Tech and the Pittsburgh school board in their similar goals for education. Staff members of SCOPP say that the original idea behind SCOPP may have been an outgrowth of the Civil Rights' movement and the impact of the movement upon Pittsburgh educators. Although most of the students in the program are Negro, the final plans were a compromise between desired aid to Negro students and the overall concern for helping all qualified high school students toward college admission. This proposal recognized the disadvantages felt by both white and Negro students in obtaining

post-high school education, and the selection of SCOPP participants was undertaken without regard to race.

SCOPP records show that, with generous donations from private citizens, the budget for the initial two-year program reached more than $115,000. The appropriations for each student cover costs for his schooling, dorm residency during summer sessions, $30 for a personal library, and $30 for attendance at specified cultural events which the staff requires for supplementary course study.

Both the 37 senior and the 45 junior students in the program were chosen at the end of their sophomore years in high school. School guidance counselors provided facts for the initial selection of students which was based on I.Q. testing, achievement tests, and classroom participation. The students chosen had test scores indicating discrepancies between their ability to do college-preparatory work and their actual assimilation of knowledge and attainment of grades necessary for entrance into college.

Students were further screened according to their families' socio-economic status since all students permitted into the program were unable to meet the financial obligations of higher education without considerable scholarship aid.

Case workers conducted home interviews with students who qualified from this criteria. The final selection was determined by the case workers' information about those students who would contribute and benefit most in SCOPP.

The students come primarily from Schenley, Westinghouse, Fifth Avenue, and Langley high schools with less than 5 each from Peabody, Taylor-Allderdice, Oliver, South Hills, Gladstone, South, and Allegheny.

The director of SCOPP is John H. Morgart who was asked to head the program upon his decision to retire as principal of Herron Hill junior high school. His administrative work from the SCOPP office in Margaret Morrison involves coordination of the scholastic aspects of SCOPP with the socio-psychological endeavors. This coordination is accomplished through a two-year program for the students which includes six-week summer sessions and Saturday classes during the school year.

During the summer of 1964, the first section of SCOPP students attended their classes in Scaife Hall on the Tech campus, residing in Hamerschlag and Morewood Gardens dormitories for their sixth week of the summer program. They continued this study by participating in Saturday classes at Margaret Morrison each week of the 1964-65 school year. This past summer, the seniors lived on campus for the entire six-weeks' class period; the new juniors spent only the fifth week of the session in the dormitories. The climax of the seniors' program is in the Saturday classes held again this winter.

The courses offered in both the summer and winter programs have been in English, mathematics, and science. Each of the three classes is taught by a team consisting of a college professor and a high school teacher. The students are divided into two sections for each course. The college and high school instructors alternate teaching their section each week. Additional private tutoring is offered to SCOPP by a volunteer group of Tech students.

Dr. A. F. Sochatoff, associate professor of English at Carnegie Tech, works with Wayne Summerfeld from Taylor-Allderdice to head the English course of SCOPP. Dr. Sochatoff explained, in an interview, that the classwork is to be given as a supplement to, not a continuation of, the high school curriculum. It is to provide basic tools in the comprehension of ideas and the solution of problems in each of the three courses.

In the English course, Dr. Sochatoff is guiding the students toward increased reading comprehension, fluency in writing, and abilities for oral discourse. These are the main areas in which the SCOPP students lack fundamental accomplishments for college work.

These abilities are taught through an independent reading program, required written reports on the reading material, and regular discussions about the books and the cultural events.

Dr. Sochatoff said that the program is designed to help the students become discriminating in their evaluation of ideas. He feels that their ability to recognize and to analyze concepts is facilitated by discussions. He emphasized that the books read in the English course are not necessarily "fine" literature, but they do offer ideas for analysis. One discussion period was involved with the retribution reaped by evil; another was channelled toward the individual's tragedy of non-involvement with his fellow man.

A crucial point in the program is the effort to improve communication skills. Dr. Sochatoff said that there is an overall stumbling block in verbal communication because the students often find a status with their school peers by speaking "slovenly English." The team of English instructors is working to allow each student ample practice in both written and oral communication in order to overcome the uncomfortable experience the students find with improved vocabulary and grammar.

Forceful team instruction is also found in the other two areas of study. Dr. Allen F. Strehler of CIT and Elmo C. Callaway of Conroy junior high school teach mathematics. Science is taught by William Uricchio, head of the Mt. Mercy College Biology Department and by Michael M. Tomko from Langley high school.

During the experimental stage in the summer and winter of 1964, the staff realized problems arising in the study programs. Many of the students excelled in only those subjects which interested them while failing others, thus preventing their grade records from meeting college entrance requirements.

Some of the difficulty resulted from the students' lack in basic study skills; they were intellectually able to do the course work, but, due to home and social environments which did not encourage education, these students never learned the practicality of organizing notes, outlining text material, and understanding test questions. When the SCOPP curriculum offered supplementary concepts to the high school texts, many students were not prepared to study efficiently. This lack of organized study prevented students from acquiring insight to subjects which did not particularly interest them.

Still another problem existed in the tutorial aspect of the program. In the first winter, tutoring was scheduled for Saturday afternoons. The tutoring was not well-structured and the afternoon time was not available for cultural activities. Questions were raised as to how effective the tutoring sessions were since, it was discovered, many of the students were requesting

tutorial help in subjects which they enjoyed rather than in those which presented specific problems. There was little opportunity for feedback from the tutors to the staff regarding the progress of the students.

In view of these problems, the Saturday morning classes have been restructured to provide additional benefits for SCOPP students. The session now offers a course in study skills which is taught by Miss Elsie Wilts, elementary school teacher at Linden school, who is currently instructing sixth graders in this skill. She has oriented her course in SCOPP to meet the broader demands of these high school juniors and seniors, providing lessons in note taking and the organization of time and material for efficient study.

With more concern for the individual student needs, the Saturday classes are operated on a rather free schedule. The students may take one or all of the courses during the 8:30-12:30 session, allowing the extra time for tutoring. Their schedules remain flexible, not only in what subjects they take, but also in how long their particular schedules are effective. The staff may change the schedules each week, according to which areas the students need emphasis in instruction or tutoring.

Since tutoring now occurs in the morning, Saturday afternoons are open for the scheduling of cultural events or organized groups for drama study, journalistic writing, music appreciation, and art projects.

The tutors are expected to bring frequent suggestions to the staff regarding the individual student's progress in study and to function as an integral part of the SCOPP introduction to college life. Tutoring may take precedence over any of the other instruction, depending upon how much help the student requires. The staff attempts to foster close understanding between the students and the tutors so that the students may realize the thought and personalities which develop through higher education.

The socio-psychological implications of the program are as dynamic as the course study. SCOPP counselor William Green, vice-principal of Herron Hill junior high school, said, in a WQED broadcast (May, 1965), that the counseling aspects of SCOPP may be the most important part. Information and responses seen by Mrs. Ethel Landerman, psychiatric case worker for SCOPP, point out the truth in Mr. Green's statement. Mrs. Landerman found a definite impact of the program upon the students' families. Many parents have rewarded the improved grades of their son or daughter by giving their child a study lamp, desk, or room of his own. Some have gained such an interest in the cultural program that they attend the events with the students at their own expense. The sister of SCOPP student Alan Hamovitz is currently enrolled as a freshman at Bethany college, although she was not a member of SCOPP, due to interest stimulated by and guidance from her brother's counselors in the program.

Some sociological problems were revealed during the first summer in the week of dormitory residence. Kathy Thompson, a 1965 graduate of CIT, acted as counselor for the 15 girls in Morewood Gardens dormitory. Due to the short time which the girls had for adjustment to this type of living and to the experimental nature of the program, which was not specific on several policies, Miss Thompson felt that some of the rebellious situations would not have occurred in other circumstances. She reported general feelings of discrimination among the girls whenever discipline was applied by the dormitory resident administration or by the SCOPP staff, including herself.

The dormitory cooperation was challenged on the second day when an article appeared in a local paper referring to SCOPP students as being "drifters" and "underprivileged." There was emotional resentment to the article causing a vocal reaction throughout the hall which dormitory personnel were pressed to subside.

Miss Thompson also said that the SCOPP girls showed some fear that students in the CIT pre-college program, already living in the dorm, would learn why SCOPP students were there and would be critical of their lack of material possessions and their need for SCOPP instruction.

A male viewpoint of dormitory life was expressed by Alan Hamovitz, in a private interview, when he said that he enjoys the independence from his family that the dorm provides. He also finds satisfaction in bringing his high school friends to the campus and showing them the sports and cultural privileges of college which he is allowed as a SCOPP student with a Carnegie Tech identification card. Alan said that he senses being a part of college life through his exposure to campus living and to college classroom facilities.

Mrs. Landerman noted that dormitory life this past summer was not a particularly adaptable experience for the students. Many factors in their environment differentiate their readiness for dorm life from that of the Tech freshman or pre-college student. SCOPP students are not accustomed to spending time away from home and, therefore, may not have developed self-discipline or the necessary respect for authority, other than their family, in a living situation. They tend to feel a subtle discrimination (even though under the same regulations as the pre-college residents) when rules are enforced by the outside authority of counselors and dormitory administration.

Acute problems of control appeared when friends and relatives came to the dormitory to visit the students. (Such visitation is normally permitted during the day and evening hours.) Since all SCOPP students live in or very near to Pittsburgh, Tech is quite accessible for their friends. A steady influx of guests (while visiting is encouraged for relatives and friends) creates difficulty in maintaining an atmosphere conducive to study.

There was an easier adaptability seen in the one-week dormitory program for the juniors. There was less confusion and expression of resentment than during the summer of 1964 when this year's seniors spent their first week in the dormitories. Mrs. Landerman stated that this ease of adaptability may have been due to the staff's increased knowledge of what to expect in the dormitory after the "experimental" nature of the situation in the previous summer. This observation raises the question of whether the administrators of the dormitory phase need to achieve better empathy toward the student's requirements in order to enrich the dormitory experience.

As an experimentation program, SCOPP is undertaking extensive sociological research. The original head of this area was James Curran, former instructor of sociology at Carnegie Tech. His evaluation of the program began the first year with testing devices and interviews to determine the overall scho-

lastic and sociological impact on the students and to see responses by the staff. The research will be inconclusive, as Mr. Curran said, the nature of the program demands follow-up research on the students during and after their college educations. The later research will be a better indication of the success of SCOPP than any studies done prior to college enrollment.

Mr. Curran expressed questions pertinent to the program's effect: was SCOPP begun too late in the student's life to realize its full potential? He said that, while grades have improved for many students, there may not be time for the students to achieve the grade level necessary for college admission. (Most of the seniors have made application to the College Board Center for the examinations in December. Several have also sent for application forms from colleges. A form letter prepared by the staff will be included with all college applications explaining the purposes and achievements of SCOPP. At present, the application procedures are slow since the students are just beginning to realize the amount of time and the many factors needed for successful application. Some students still have not progressed to the emotional and thought level necessary for college admission, but are preparing for job-training in nursing and professional schools.)

Mr. Curran asked: in a deeper perspective, what will happen to the student if he is not admitted to college, or, if he is admitted, and cannot remain? what impact would the student's failure have on his family? how would the staff receive the program's failure? Mr. Curran said that many of the staff members have become as dedicated as the students to the goals of SCOPP and would regard any weakness as a personal failure. He expressed interest over the degree to which the students will become estranged from their present sub-culture.

The uniqueness of the program shows some advantages for the application of research findings. Dean Lawrence Canjar, formerly of CIT, explained, on "Dr. Marland Reports," (WQED, May, 1965) that SCOPP is the only program of its type which involves no more than one school district. Thus, the answers learned about problems of teaching these students can be immediately transferred to the school system. (A program at Oberlin involves students from six school districts, while Dartmouth's version of SCOPP brings in students from several areas in southern United States.) Such information transfer will be valuable in evaluating and improving the public school system.

The finances of SCOPP have expanded due to the addition of the new high school juniors. Funds for this second phase have been granted from the federal government through the Economic Opportunities Act. Some additional private grants have been made to SCOPP for the purpose of financing the college education of the present seniors. Other negotiations are being made to acquire finances for the future SCOPP students.

SCOPP affords hope for many Pittsburgh students who might, otherwise, never know the realities and depth of education. It offers the satisfaction of personal involvement with another's success. It offers potential for future high school graduates who may be helped by similar educational stimuli. But its success may never be measured due to the uncontrollable variables of human subjects. Its failure might be a psychological tragedy for the participants—both students and staff. Still, its advocators see that the chance for improving life through education is vivid with SCOPP, and the need to find out its worth is essential for progress in educational development.

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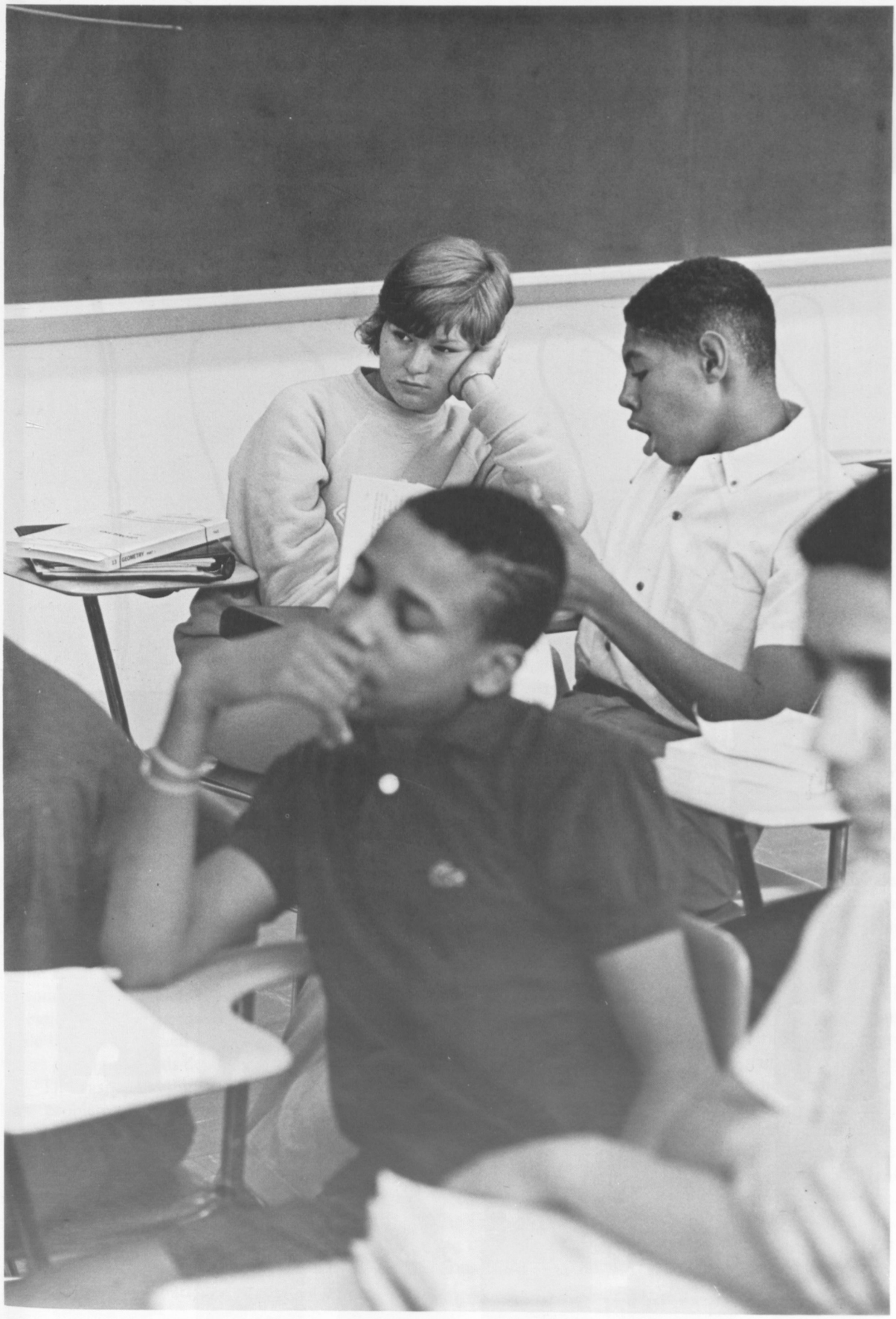
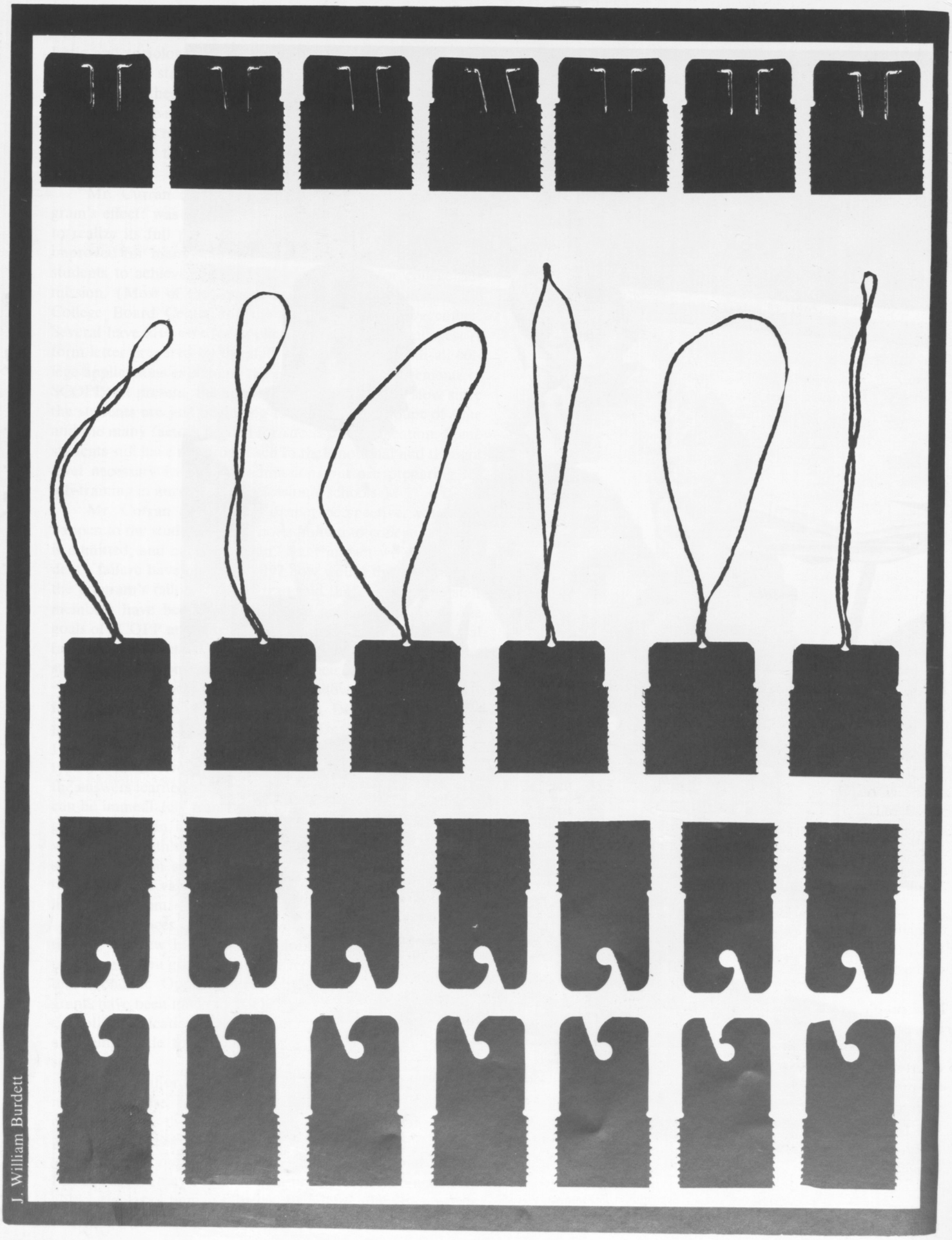




J. William Burdett

Theories of Retail Price Determination Part 2

John Lieberman

A Comparison of Decision Processes of the Small Retailers and the Large Department Store

Before any attempt is made to make the direct comparisons between the information of decision-making processes of the retail firms and the decision model developed in the book *A Behavioral Theory of the Firm,* certain assumptions must be considered. Cyert and March have chosen a large department store for their decision model. The range of influence of the different managers in the two separate operations is quite distinct. The small retailers studied have control of all operations of the firm. In the large department store, separate groups of personnel handle sales, buying of merchandise, and pricing operations. The large department store also has a profit goal, while the stores studied lack one. This goal is an integral part of the pricing methods developed by Cyert and March.

The basic procedures of the two firms are the same. Both have problems that occur in pricing, forecasting, and markdown figuring.

Certain parts of the pricing decision method developed in Cyert and March can be revised for the small retailer. In effect the price diagram (see appendix, Figs. 4, 5) will now become a searching method for the retailer to guide him in solving certain problems he faces in his business. From the pricing diagram, the retailer follows a set path in looking for solutions to problems. The last part of the diagram contains a set of constraints the retailer has set upon his operation. A majority of these problems are related to his store operation, sales personnel, and costs.

The pricing operation for retailers studied is relatively simple. To the costs of their merchandise, they add a markup of 40%. The final price is determined by the individual store's price lines. Thus, some articles will be selling at an effective markup of just over the 40% figure and some under.

Both firms did agree on the general procedure of the establishment of a sales goal. One retailer described his ordering process and how his sales goal was formed. Before ordering articles, he checked his previous year's sales and set a goal about 10% higher than this. He then would order about 60% of the anticipated articles to be sold. From this early order he would be able to see which styles and colors are selling, then he would order the rest of his stock for the item.

Another process that the retailers agreed with was the "sale pricing decision." Again, one of the retailers related the procedure he follows when he prices for the sale. Selection of the item is the first step. (Many retailers, including the two studied, will not place certain items on sale.) Next he applies a certain percentage to reduce the retail price. He then rounds this new price with the price lines he has established for sales.

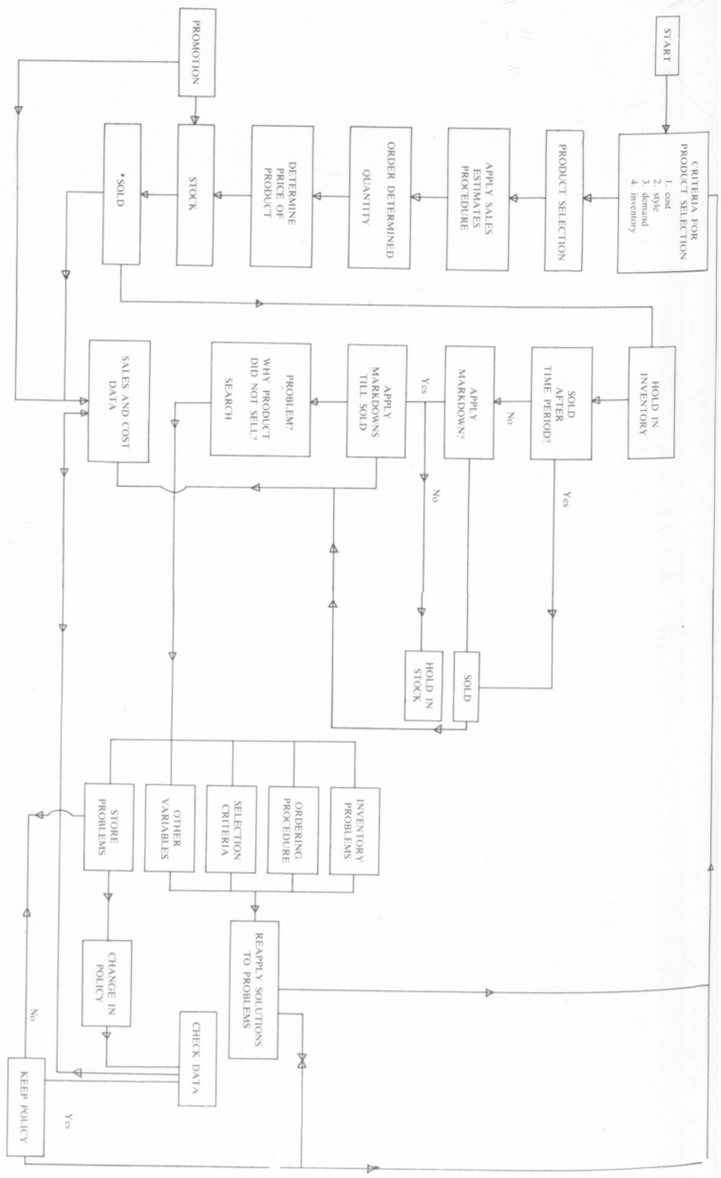
The last decision method that was discussed with the retailers was the "markup goal indicators." The opinions of each retailer were so similar that one might infer that this is common opinion in this retail field. Their first points were directed to the change of price lines and markup. In retail operation, it is almost impossible to change markup or price lines of the store.. They also discussed product mix and the measurement of the markup goal. One retailer strongly said that changes in

product mix are very difficult to do in the small retail store, which has a certain line of products associated with it. He also mentioned that space is needed for the innovation of new products. He felt it would be impossible for him or any other small retailer to change his product line without remodeling his store.

From these different studies, there are certain conclusions one might make about the decision-making processes in the small firm. Because of time and personnel shortage, the small independent retailer cannot go through a detailed process of determining his prices, sales quota, or markup. He has to spend most of his time in selecting merchandise and selling in his store.

The problems he faces are usually those of slow selling articles, large inventories and selection of merchandise and lines to carry. Pricing for the retailer is not as complicated as that of the department store when prices are raised. However, in the small store where the customer has a personal or social relationship with the store owner, a change in prices can affect the store's operations considerably. Thus, the retail store operator has certain constraints which he has to operate within. His price and sales policies are just two of them.

The decision paths in March and Cyert have their place in the large department store, where changes in lines and products are possible. One cannot apply this same type of analysis to the small retail operation. The department store has this advantage because of size and the relationships between the salespeople and the customer. The customer in the department store will travel great distances because of the larg selection of merchandise and bargain offers. Sales personnel, to, him, are only people to help him select the right size and write the bill. He rarely expects to find the same person helping him the next time he shops in the store. This completely changes when one shops in the small retail store. The salesman is often a close personal friend, or has been waiting on the same customers for many years. Thus, a degree of confidence has been developed between the retailer and the customer. Erratic changes in store policy can destroy this confidence, and the retailer will lose one of his prime competitive assets over the department store.



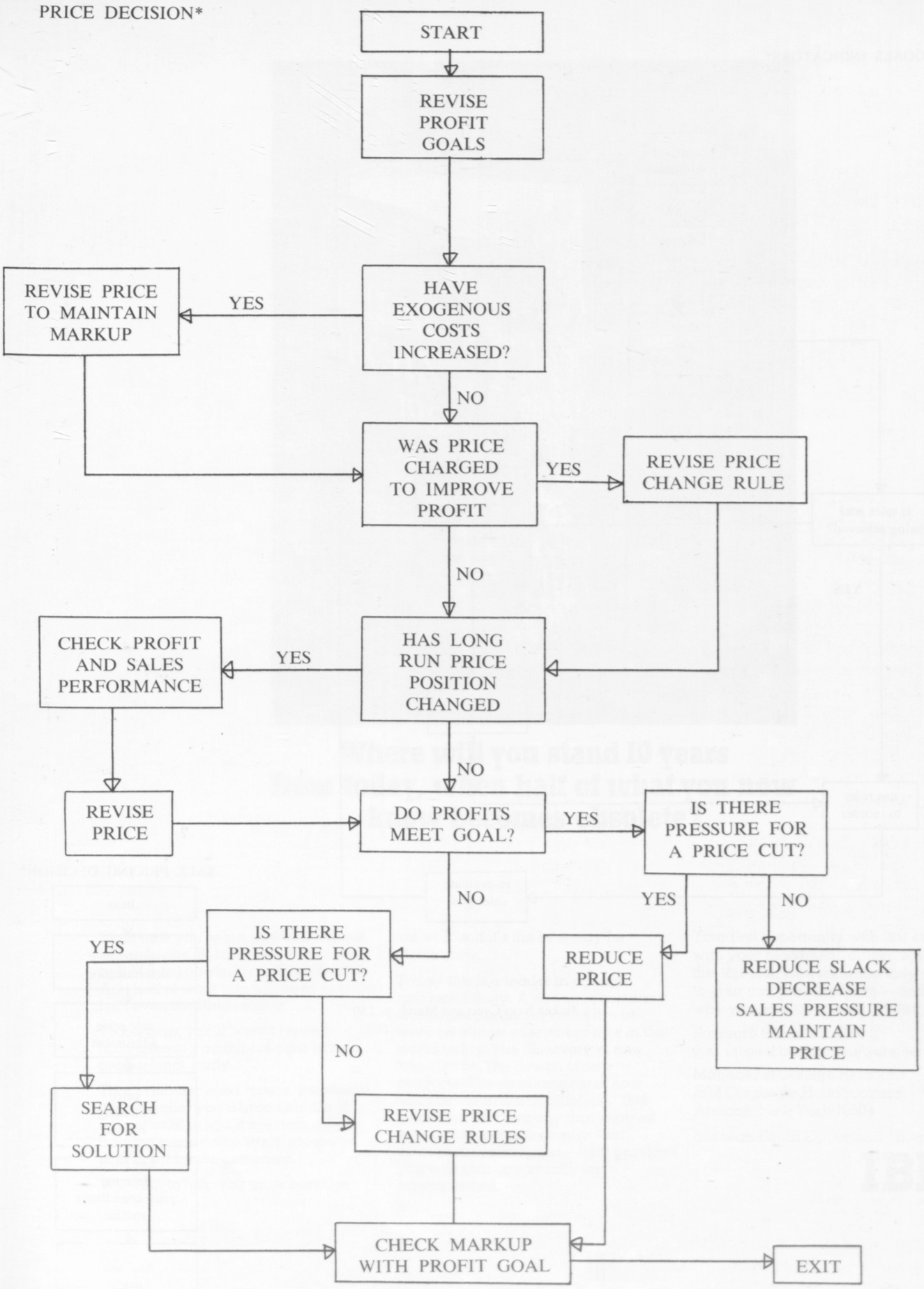
Conclusion

To tie many of the loose ends of this paper together, an attempt has been made to place the different policy decisions studied into the context of a firm. To do this, a flow diagram has been made showing the different steps the retailer takes from the selection of his merchandise to the final markdowns. (See insert. Parts of this chart represent actual decision processes that the retailer could use; the other shows the process the retailer does use.

One might go a step further, as did Cyert and March, and apply a computer program to the diagram to test its accuracy in price and policy determination.

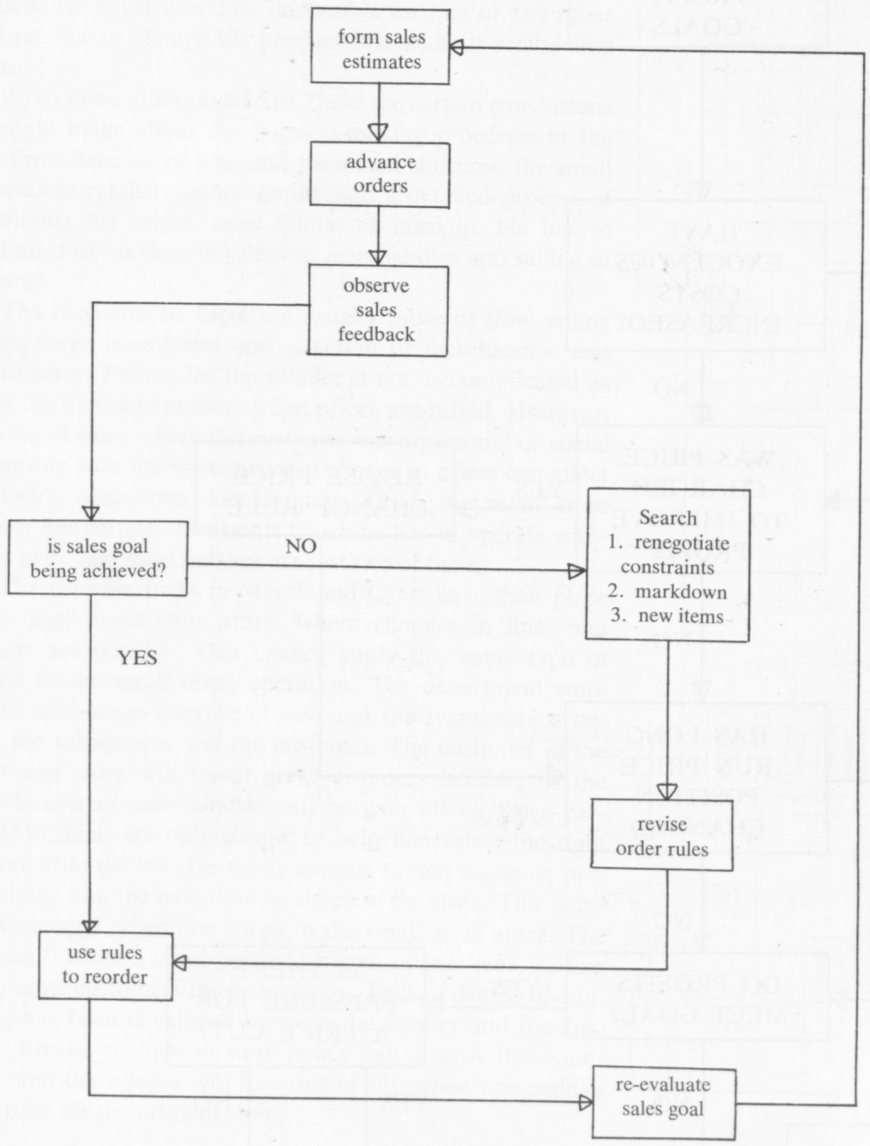
One final point about price determination should be added: the retail firm is a complex system of decision procesess and rules for procedure. To examine one of these processes and fail to note its relationships with other procedures of the firm would not be a valid study. Thus, one must always consider the firm's total environment, both external and internal, to form an accurate account of its workings.

PRICE DECISION*



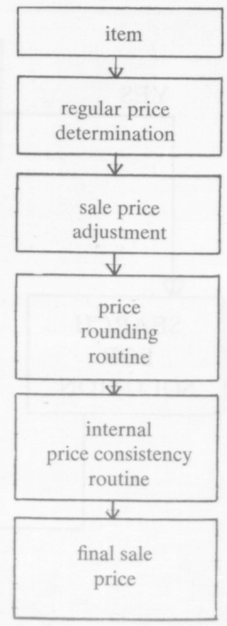
*taken from Cyert and March, p. 154

SALES GOALS INDICATORS*

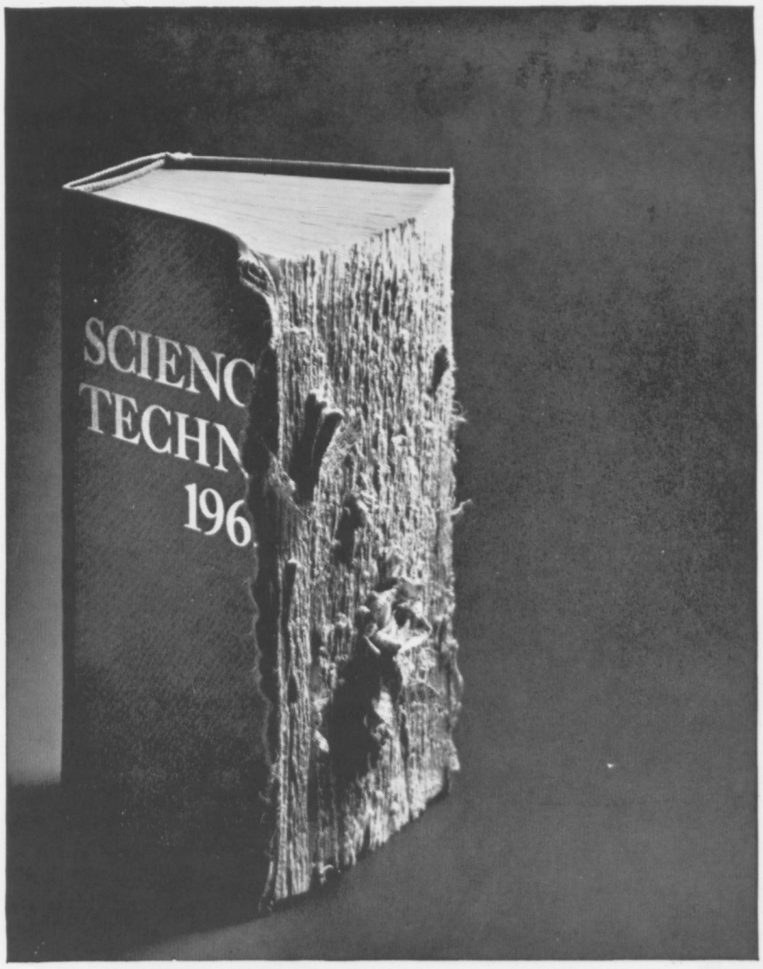


*taken from Cyert and March, p. 130

SALE PRICING DECISION*



*From Cyert and March, p. 140.



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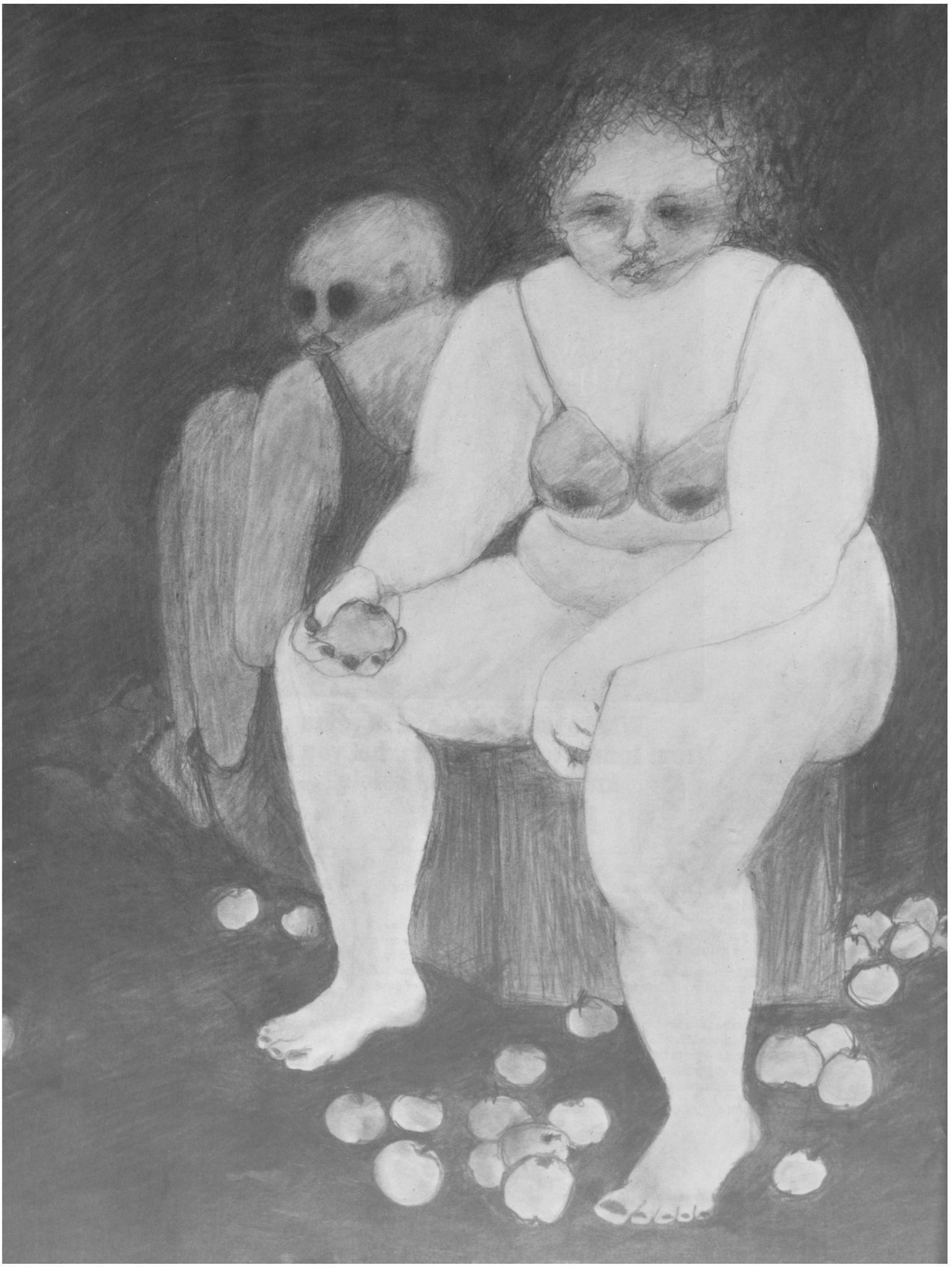

Eve

Beth Carten

"Heaven, when it strives to polish all it can
Its last best work, but forms a softer man."
(Pope, Lines 271-72)

Satan, recently come to Paradise, views Adam and Eve as lords, but both not equal as their sex showed them to be not. While Adam was formed for contemplation and valor, Eve, "For softness . . . and sweet attractive Grace," (P.L. Book IV, L 298) "is but to please." (Pope, L 212) Recognizing her formation for the God in him, Eve hails Adam as her "Guide and Head." (P.L. Book IV, L 443-44) Adam sees this creature as his inferior, "fine by defect, and delicately weak." (Pope, L 43) Though she is "in outward show elaborate, of inward less exact . . . inferior, in mind and inward Faculties . . . resembling less His image . . . and expressing less the character of that Dominion giv'n O'er other Creatures." (P.L. Book VIII, L 539-545) This, Adam's fit help given him by God.

And his other self was created spotless, "Virtue-proof" (P.L. Book V, L 384) and "pure of sinful thought." P.L. Book VIII, L 506) Adam can only celebrate her excellent qualities, this summation of all that is fair in the world. Grace is in her step, Heaven in her eye, in every gesture dignity and love. She, lovely fair, infuses sweetness into the heart and inspires "the spirit of love and amorous delight." (P.L. Book VIII, L 477) To Adam, Eve is a paragon of "Innocence and Virgin Modesty." (P.L. Book VIII, L 501). But surely, all these that Adam sees as virtues, may they not also be as vices? (Pope, L 206) For

"That robe of quality so struts and swells,
None see what parts of nature it conceals."
(Pope, L 189-190)

And it is in this robe that Eve's strength lies, all the means for her power. (Pope, L 220) Eve "charms by accepting, by submitting sways." (Pope, L 263) She shows subjection to Adam,

though gentle sway required; she yields to him with coy submission, modest pride and sweet reluctant amorous delay; she comes to him in surrender. Adam delights both in her submissive charms and beauty and smiles down on her with superior love. This sex as love is celebrated by God as the source of man's power to comprehend and marriage as the true source of man's strength. It is through this love that the family is to be achieved, the race that Adam and Eve are to propagate.

But Adam is enthralled by Eve's beauty whether awake or asleep. It is at her touch that he first experiences passion: "in all enjoyments else superior and unmoved, [but] here only weak against the charms of Beauty's powerful glance." (P.L. Book VIII, L 531-33) All "she wills to do or say, seems wisest, virtuousest, discretest, best; All higher knowledge in her presence falls Degraded . . . Authority and Reason on her wait." (P.L. Book VIII, L 549-53)

As Eve's beauty may be channeled into either love or lust, other qualities in her nature also have the possibility of going in either a positive or negative direction. The curiosity on her first waking at the shape within "what seemed another sky," (P.L. Book IV, L 459) is turned to vanity and used by Satan as a means to beguile her to the Tree of Knowledge. Satan hails her as Celestial Beauty (P.L. Book IX, L 540) and implants the idea of deserved power by adding to his greeting "Empress of this fair world," "Sovran of Creatures, universal Dame." (P.L. Book IX, L 612) Eve should and could be "queen for life." (Pope, L 218) Not tempted when first offered the fruit, Eve restates God's command. She and Adam live as Law to themselves, their Reason is their Law. (P.L. Book IX, L 253-254)

But the serpent is alive after having eaten of the fruit when death was the promised punishment. Could not the means which gave him human faculties raise her up to be a goddess among gods? Satan's words are "impregn'd with Reason, to her seeming, and with Truth." (P.L. Book IX, L 737-738) Eve eats of the fruit of the Tree with greed and when satiate, she, who would have been a goddess, bows down, "O Sovran, virtuous, precious of all Trees." (P.L. Book IX, L 795) "[Idolatry] and religion take their turns" (Pope, L 66) in Eve.

Her adoration concluded, she wavers as to whether to tell Adam. Should she give him of the fruit of the Tree to "partake Full happiness" (P.L. Book IX, L 818-819) with her or not whereby may be added "what wants in Female Sex, the more to draw his love . . . [or] perhaps, sometime Superior?" (P.L. Book IX, L 821-825) But what if God did see her eat of the fruit and levels the promised punishment of death? Adam wedded to another Eve. Now, in her jealousy and "dread to be alone" (Pope, L 228) she determines that Adam shall share her fate, for "without him [she could] live no life." P.L. Book IX, L 833)

To him she goes and when found, "beautifully cries" (Pope, L 11):

"Thee I have misst, and thought it long, depriv'd
Thy presence, agony of love till now
Not felt, nor shall be twice, for never more
Mean I to try, what rash untri'd I sought,
The pain of absence from thy sight."
(P.L. Book IX, L 856-861)

And to this adds:

"Thou therefore also taste, that equal Lot
May join us, equal Joy, as equal Love;
Lest thou not tasting, different degree
Disjoin us, and I then too late renounce
Diety for thee, when Fate will not permit."
(P.L. Book IX, L 881-885)

Adam, unable to live without her, without her "sweet Converse and Love so dearly join'd," (P.L. Book IX, L 909) eats. With her his resolution is to die. Their "State cannot be sever'd; [they] are one, One Flesh." (P.L. Book IX, L 958-959)

But when the fruit's intoxicant has worn off and reason returns, Adam burns with anger. Eve retorts: "Being as I am, why didst not thou the Head command me absolutely not to go?" (P.L. Book IX, 1155-1156) Eve would have "her humor most when she obeys." (Pope, L 264) And so she comes again to Adam, this time in humble repentance, Eve

"A very heathen in the carnal part,
Yet still a sad, good Christian at her heart."
(Pope, L 67-68)

". . . what thou bidd'st
Unargu'd I obey; so God ordains,
God is thy Law, thou mine: to know no more
Is woman's happiest knowledge and her praise.
(P.L. Book IV, L 435-438)

Here is Eve, woman as incentive. Could she not have learned from Pope?

"Ah, friend! to dazzle let the vain design,
To raise the thought and touch the heart be thine?"
(Pope, L 249-250)

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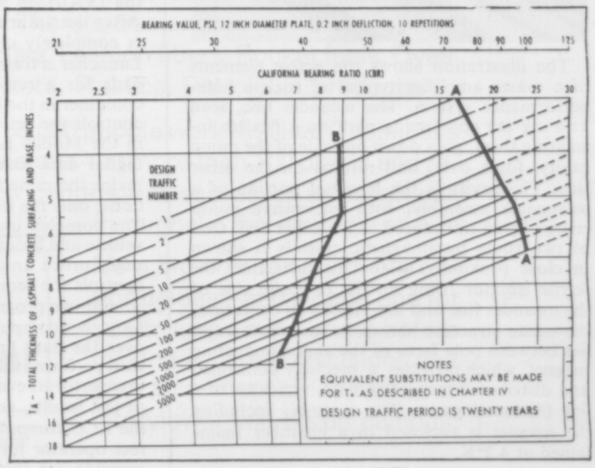

Thickness Design Charts like this (from the MS-1 manual) are used in this new computer-derived method. This chart enables the design engineer quickly to determine the over-all Asphalt pavement thickness required, based on projected traffic weight and known soil conditions.

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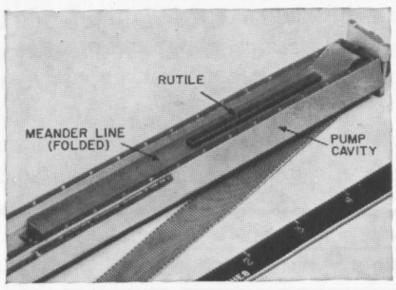
Traveling Wave Masers

RCA's recent maser research and development has yielded systems with outstanding low-noise microwave amplifier performance along with adaptability for field use. These amplifiers exhibit ultra-low noise temperature (8-10°K) and high gain (30-40 db) with extreme gain stability. Wide tunability (up to 50%) and large instantaneous bandwidth (up to 150 MHz) have been achieved.

Several technique areas involved with this work are of particular interest. Iron- and chromium-doped rutile (titanium dioxide) are employed as active paramagnetic materials, in a "meander-line" slow wave structure, providing wide bandwidth and high gain. Ferrite reverse isolators function to provide a high degree of gain unidirectionality. The requisite magnetic field is provided by a superconducting magnet within a cryogenic enclosure, and the entire system is operated by a closed-cycle refrigerator requiring no helium replenishment, so that field use in radar systems, satellite communications and radiometry is practical. Sectionalized magnet structures with independent controls permit "stagger-tuning" the maser, so that its very high gain can be traded for even greater bandwidth.



The illustration shows the active elements of a maser amplifier typical of such a high-performance system. The meander line, seen as a zig-zag conducting path on a flexible insulating sheet, goes down one side of the pump cavity, folds over, and returns on the other side. The cavity is the terminal portion of a waveguide assembly, with microwave pump energy being introduced at the other end. One of two rutile paramagnetic crystals is shown in close proximity to the meander line, the ferrite isolator being on the opposite side of the meander line and not visible. In operation, the entire structure shown in the photograph lies between pole faces of the superconducting magnet, which provides a precisely controlled and distributed transverse field, typically, of a few thousand gauss. The assembly including the magnet is enclosed in a chamber maintained at 4.2°K.

Amplifiers with performance as described above are by no means the end, however. New advances are in the offing through research in areas including optical inversion (pumping), operation at temperatures above 4.2°K, higher frequency operation, and the use of active materials in powder rather than single-crystal form.

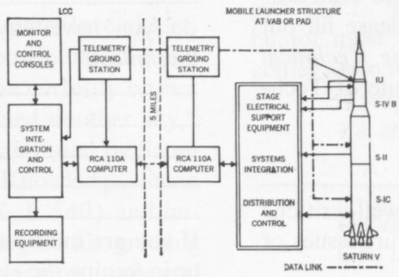
References:

(a) *L. C. Morris, "A New Class of Traveling Wave Masers," International Conference on Microwave Circuit Theory and Information Theory, Tokyo, Sept. 11, 1964.*

(b) *L. C. Morris and D. J. Miller, "Traveling Wave Masers Employing Iron-Doped Rutile," Proc. IEEE, Vol. 52, #4, p. 410, 1964.*

Integrated Launch Control and Checkout Systems for Saturn Lunar Vehicles

Highly sophisticated Saturn automatic ground checkout and launch sequencing equipment has been under development by RCA since late 1960 for the National Aeronautics and Space Administration, Marshall Space Flight Center. The original Saturn Ground Computer System (SGCS) was used on the highly successful Saturn I program; an advanced version of the SGCS is currently being readied for the Saturn IB and Saturn V programs. The RCA 110 computer was the heart of the Saturn I SGCS; the RCA 110A is the heart of the Saturn IB and Saturn V SGCS.



The block diagram shows the tandem, two computer configuration for Saturn V at Complex 39, the lunar program "space port" at NASA's Kennedy Space Center. Complex 39 is based on a mobile launch concept to gain high efficiency in launch operations. Vehicles are assembled in the Vehicle Assembly Building (VAB) on a Mobile Launcher structure. After the Saturn V with its Apollo Spacecraft is completely checked out, the vehicle in its Launcher is transported to one of three launch pads for a remotely controlled launch. The computer in the Launch Control Center (LCC) controls the activities of the "slave" computer in the Mobile Launcher via a 250 kilobit/sec digital data link. The configuration thus remains the same for both VAB and pad operations; only the length of the data link changes. The complex umbilical interface between the vehicle and ground support equipment remains undisturbed until launch. The LCC computer controls the sequence of checkout and launch countdown programs performed by the Mobile Launcher computer via commands transmitted over the data link. The "slave" computer in turn performs the detailed testing and sequencing, performs evaluation and data compression of test results, and transmits the data back to the LCC computer which relays it to the correct operator for display. LCC operators can override, via their console request keyboards, the predetermined sequence of programs stored in the Mobile Launcher computer or handle unusual test situations.

In addition to conventional serial computer functions, special parallel input/output capabilities are included for control of 1008 discrete (relay driver) outputs, monitoring of 1512 discrete (contact closure) inputs, a wide range of DC and AC analog outputs (72 in quantity), a wide range of DC and AC analog inputs (300 in quantity), telemetry interface, 3 internal interval timers, several external clock inputs, and an interface with the spaceborne computer.

In line with the developmental nature of the total Saturn program, the role of RCA's Saturn Ground Computer System is continuing to expand in factory and static testing, as well as launch operations, as automation techniques are applied to other Saturn subsystems.

Reference—J. E. Sloan and J. F. Underwood, "Systems Checkout for Apollo"—Astronautics and Aerospace Engineering, March 1963.

A Light Detector That Makes Laser Communications Practical

RCA has developed a photoconductive device that operates on an alternating current that can sense up to 100 million changes in light intensity per second. This is sufficient to distinguish as many as 25 separate television programs, all carried on a single laser beam. This major breakthrough in light detection is extremely fast, enormously sensitive and is responsive to the whole range of optical frequencies, ranging from infra-red through the visible spectrum to ultra-violet.

By contrast, previous means of detecting laser light employed photoconductors operated by direct current, photoelectric cells, semiconductor photodiodes and electron photomultiplier tubes. The major drawbacks were that these methods were either too slow, too insensitive, or too limited to the portions of the electromagnetic spectrum where most lasers operate poorly, if indeed, at all.

The laser is, to state it simply, a high frequency transmitter with the capacity to carry a fantastic amount of information. The real problem has been to develop a receiver both fast enough and sensitive enough to detect and process incoming information. This new device has the sensitivity, speed and frequency range that can make possible a practical system for laser communications.

This radical new detector is a tiny specksized piece of photoconductive material mounted in a small cavity continuously bathed in microwaves oscillating at 10 billion cycles per second.

When a laser beam bearing information in the form of intensity variations enters the cavity, it strikes the photoconductor and frees electrons. They, in turn, begin to oscillate rapidly up and down within the material, in direct response to the alternating electric field inherent in the surrounding microwaves. These electron oscillators control the amount of microwave power that leaves the cavity. The variations in the incoming light are then converted to intensity variations in the outgoing microwaves. Conventional microwave techniques make it possible to process these variations. These techniques are similar to those used in modern radar and commercial television systems.

Reference—H. S. Sommers, Jr. and E. K. Gatchell, presented at Annual Meeting, Optical Society of America, Philadelphia, October 5-8, 1965, Paper WE-1.

These are only a few of the recent achievements which are indicative of the great range of activities in engineering and science at RCA. To learn more about the many scientific challenges awaiting bachelor and advanced degree candidates in EE, ME, ChE, Physics or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

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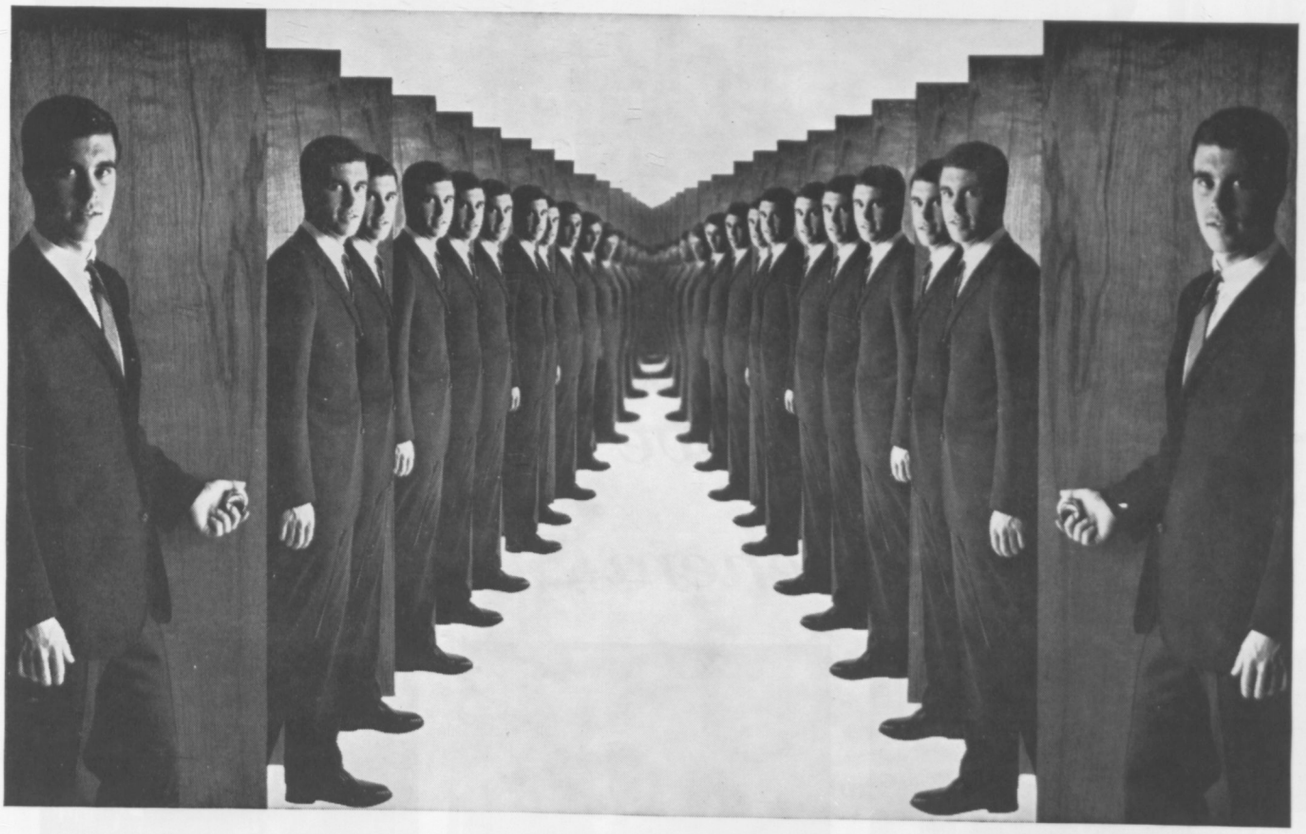

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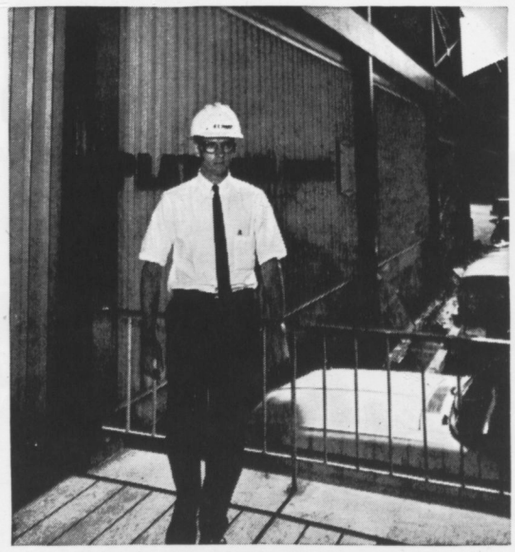

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Men on the move at Bethlehem Steel

BETHLEHEM STEEL

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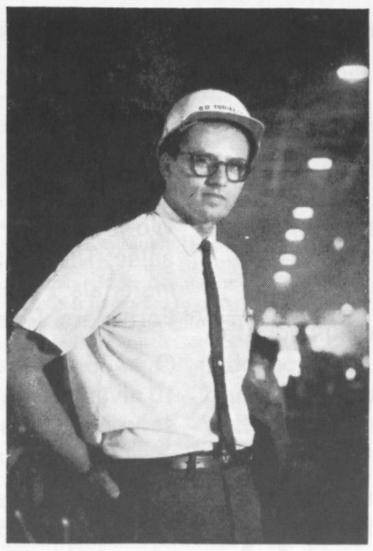

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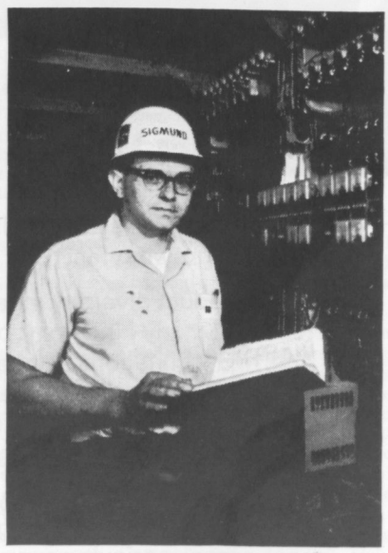

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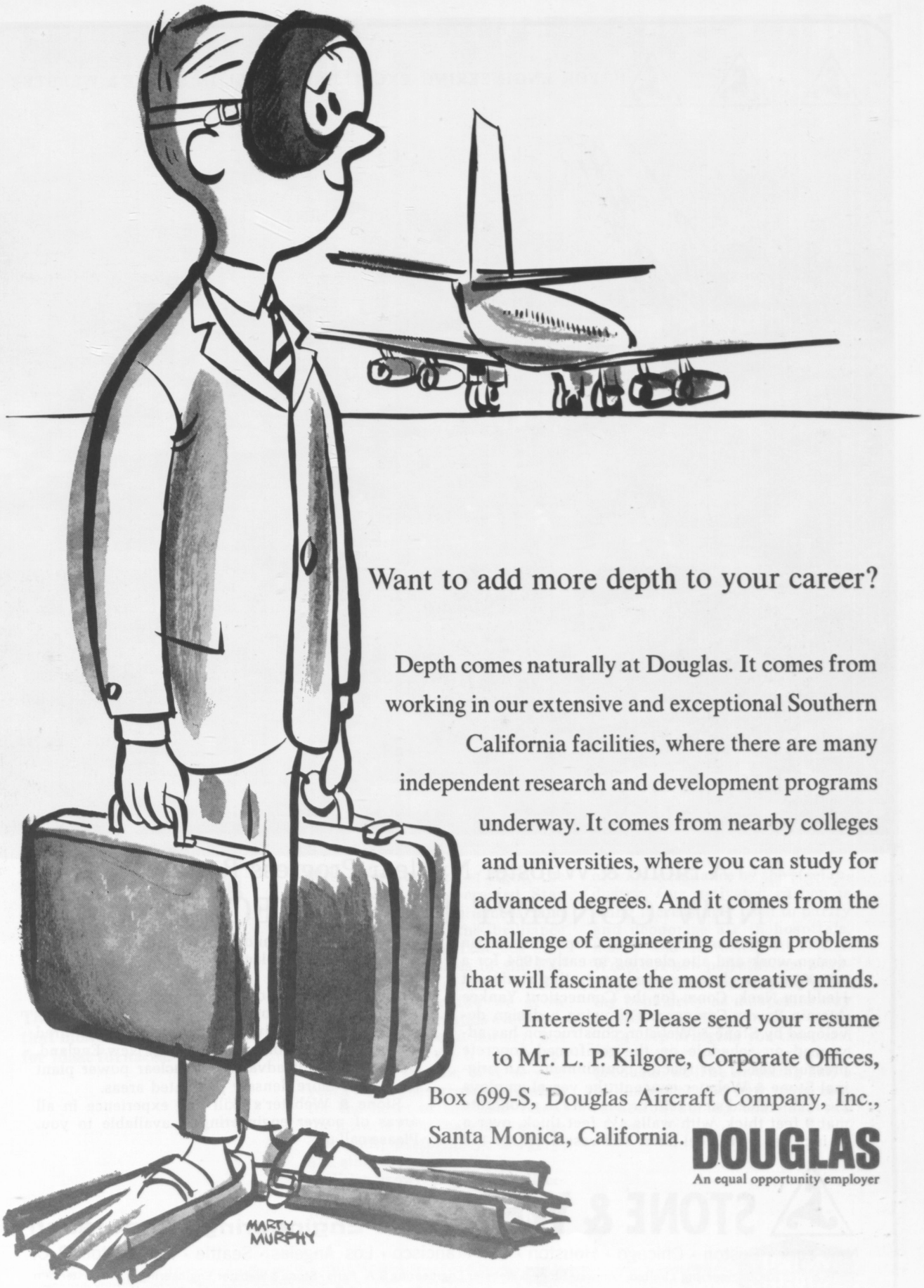

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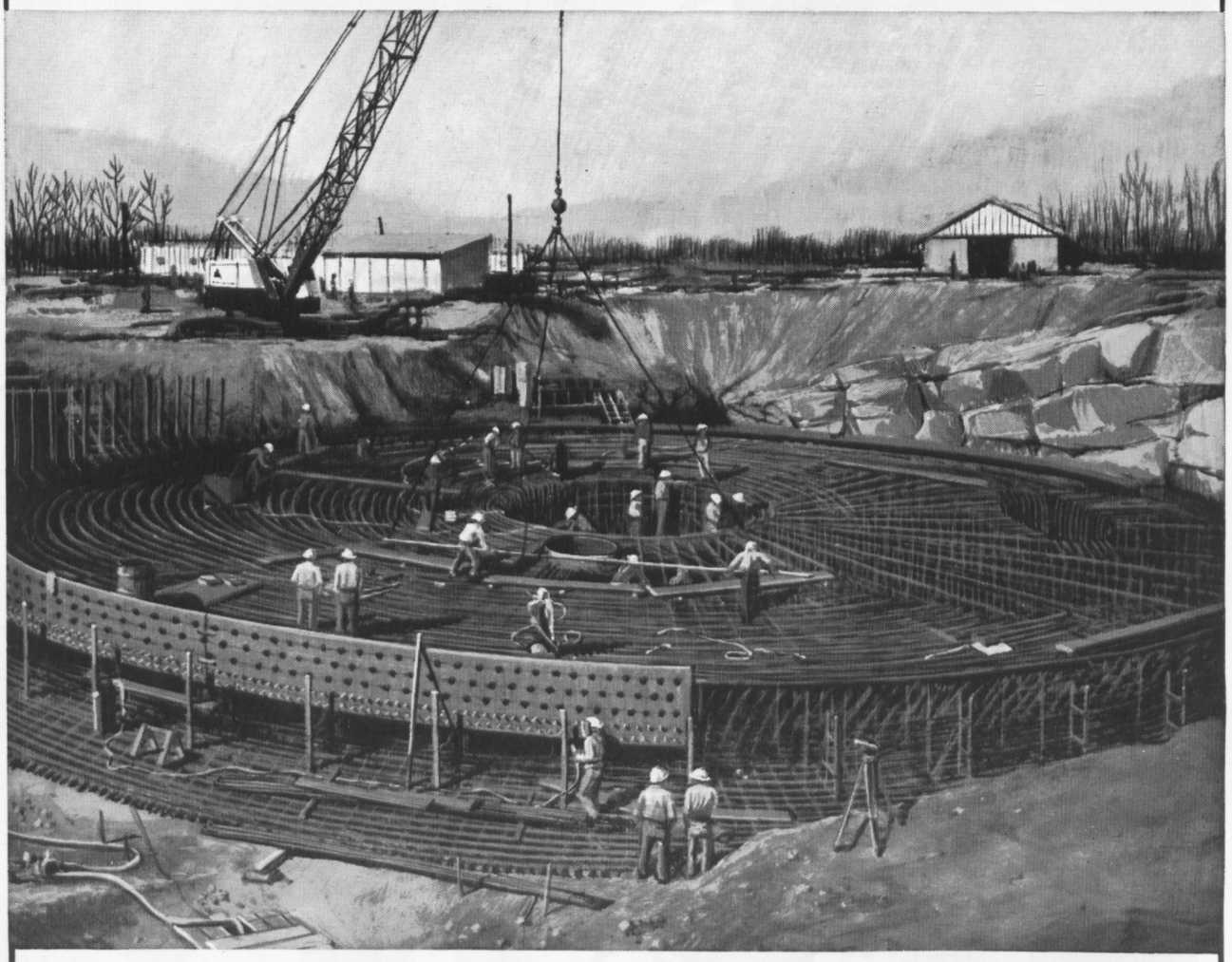

A Stone & Webster Nuclear Progress Report:

NEW CONCEPT IN CONNECTICUT

Stone & Webster Engineering Corporation began design work and site clearing in early 1964 for a 500,000 kw nuclear-powered generating station at Haddam Neck, Conn. for the Connecticut Yankee Atomic Power Company. Following a design developed by Stone & Webster, construction has advanced on schedule on the reinforced concrete pressure vessel for reactor containment. An original Stone & Webster concept, the vessel employs 2¼ inch welded steel reinforcing bars in a concrete mat 9 feet thick, with walls 4½ feet thick, over a ⅜ inch gas tight steel liner. The vessel will be 170 feet above grade and will require 29,000 cubic yards of concrete placed around 6,100 tons of reinforcing steel.

The plant will be operating commercially by the end of 1967 and should not only prove to be economically competitive with new oil or coal-fired power plants of comparable size in New England, but a significant advance in nuclear power plant design for more densely populated areas.

Stone & Webster's skill and experience in all areas of power engineering is available to you. Please call us.

STONE & WEBSTER Engineering Corporation

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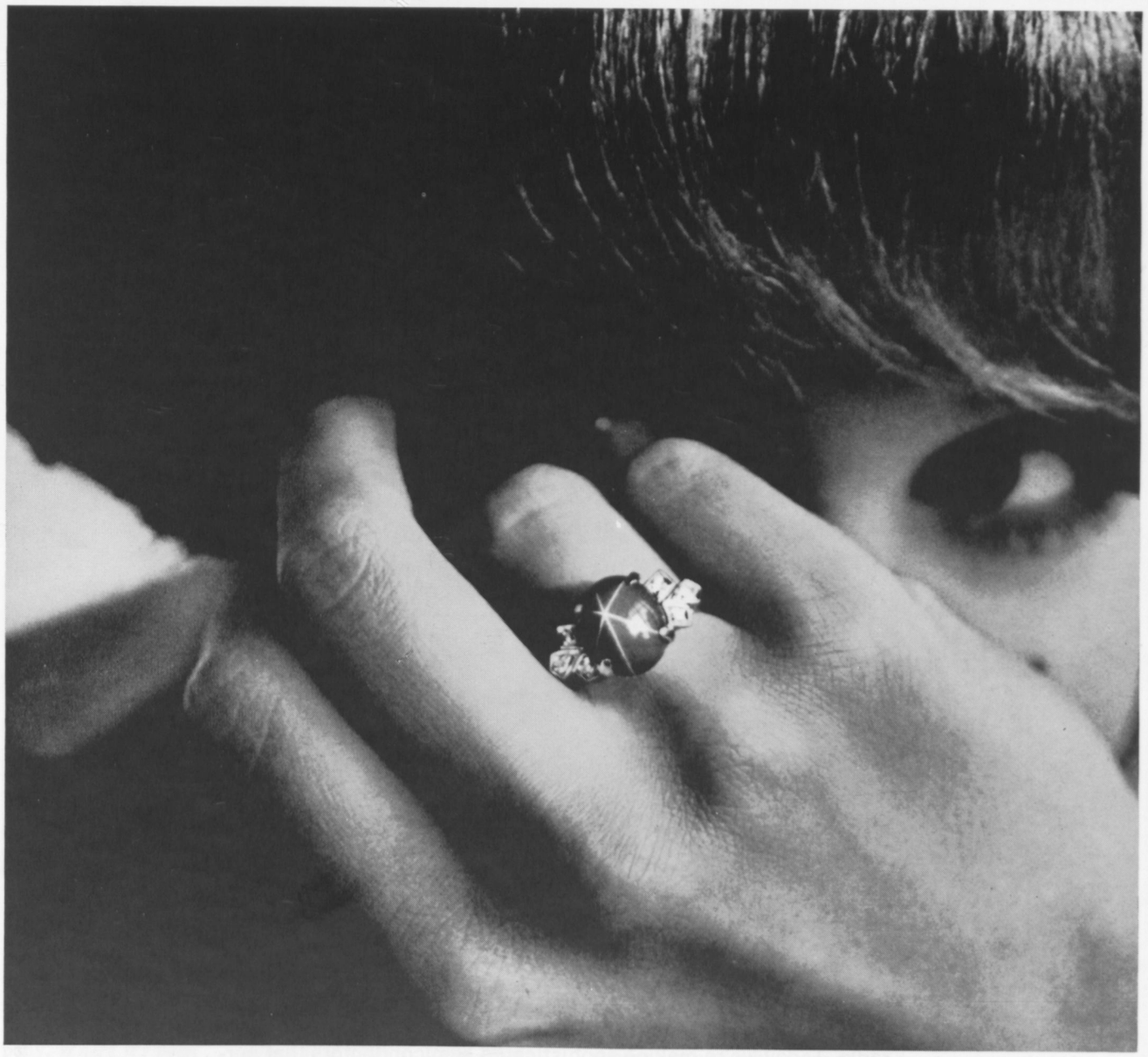

Who creates the "star" that dances?

The same Union Carbide that makes carbon floors for blast furnaces.

With every change of light, the star in the Linde created Star Sapphire moves, shimmers, and dances—matching the brilliance and beauty of the fabulous star rubies and sapphires of the Far East.

At Union Carbide we grow these and other crystals every day—not only for use in jewelry, but also for use in electronic equipment. And for the past several years we've been growing crystals for the heart of the laser beam, the miracle light that can vaporize diamonds, perform eye surgery, and slice through metal.

We're growing in lots of directions. Our carbon floors for blast furnaces have reached the point of wide acceptance by the steel industry. Our activated carbon is being increasingly used to purify and deodorize air in hospitals, homes and factories. And Glad Wrap, our new polyethylene wrapping for home use, is rapidly gaining popularity as a superior way to keep foods fresh longer.

To keep bringing you these and many other new and improved products, we'll be investing half a billion dollars on new plant construction during the next two years.

Union Carbide Corporation, 270 Park Avenue, New York, N. Y. 10017. In Canada: Union Carbide Canada Limited, Toronto • Divisions: Carbon Products, Chemicals, Consumer Products, Fibers & Fabrics, Food Products, International, Linde, Mining & Metals, Nuclear, Olefins, Plastics, Silicones, Stellite

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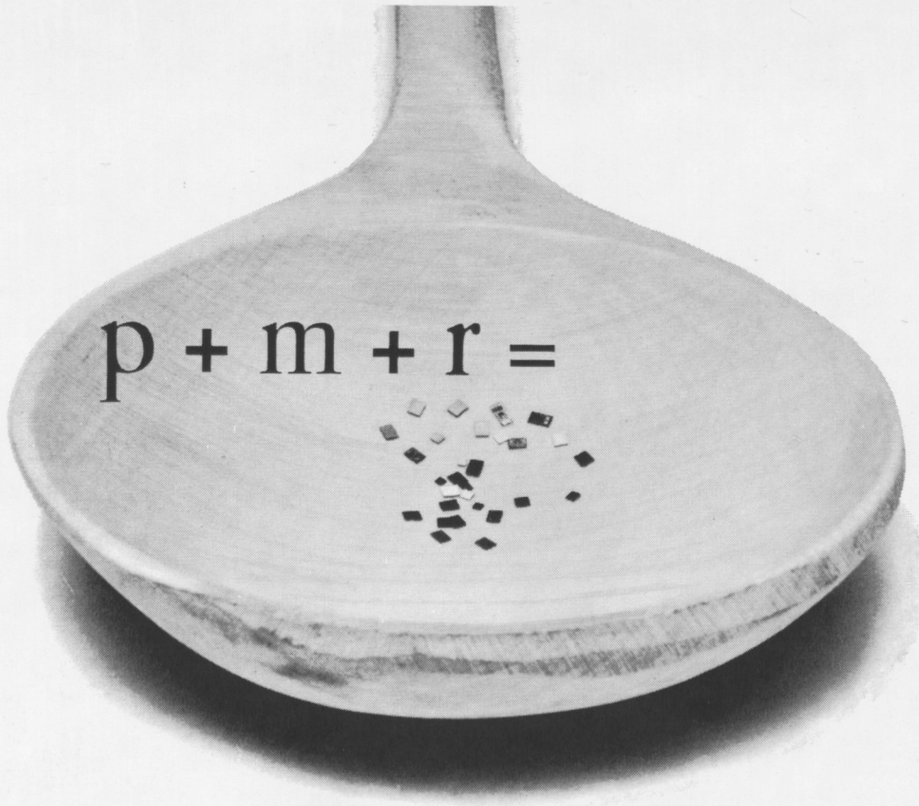

Ten years ago we were making only a handful of relatively simple semiconductor devices for a limited number of applications. Today, with highly advanced and exotic processes, we are producing hundreds of different and sophisticated semiconductors — for thousands of applications. Our technicians can now control material composition down to the molecules with precise regulation of impurity levels — and on a daily production line basis.

This we call PERFORMANCE.

Five years ago we produced semiconductor packages the size of a pencil eraser that replaced the big glass vacuum tubes in your radio. Today we're making sophisticated semiconductors that perform giant-sized tasks — yet fit on a soupspoon like grains of rice.

We call this MINIATURIZATION.

Drop the old time vacuum tube and it would smash. Its parts wore out pretty regularly too. Shake it or shock it beyond relatively modest limits and you were in trouble. Now you can launch a space vehicle with thousands of semiconductor components to go all the way to the moon and back . . . and make it go back around all over again. And a couple of times more after that.

That's RELIABILITY.

Shake 'em, shock 'em, squeeze 'em or freeze 'em — today's electronic devices have got to be able to take it . . . and perform. Motorola makes them as though they're a matter of life or death.

Sometimes they are.

TRUST THIS EMSIGNIA WHEREVER YOU FIND IT

MOTOROLA

A career decision needn't be a headache.

Not if you apply facts as criteria in making your choice. And the facts that count are the "dimensions" of a company. *Where it's been . . . where it is today . . .* and *where it's going.*

Let's apply these measurements to Sikorsky Aircraft. First of all, we are an "engineer's" company. We earned that title during our early years of pioneering in a dynamic, young industry. Today, our trail-blazing assumes the form of the most advanced VTOL aircraft systems. Ultra-sophisticated vehicles . . . combining the challenging technologies of the *VTOL airframe* and *complex electronic systems* to create the world's most versatile means of transportation. As for tomorrow? Steady, solid advancement is a habit with us. And our programs for the exciting future ahead assure a most rewarding environment for young engineers who can keep pace with our growth.

WHERE WOULD YOU FIT IN? In any number of demanding areas. If you are an original thinker — an innovator — you'll be asked to take on tough, responsible assignments. And you would be working in small, interdependent groups with some of the most respected engineers in the aerospace industry . . . helping to solve problems in such fields as **aerodynamics • human factors engineering • automatic controls • structures engineering • weight prediction • systems analysis • operations research • reliability/maintainability engineering • autonavigation systems • computer technology** . . . among others.

Are you our kind of engineer? Then the opportunity for individual recognition and growth is here . . . *now.*

And professional goals can be further advanced through our corporation-financed Graduate Education Program available in many outstanding schools within the area.

Please consult your College Placement Office for campus interview dates — or — for further information, write to Mr. Leo J. Shalvoy, Engineering Personnel.

Sikorsky Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

STRATFORD, CONNECTICUT

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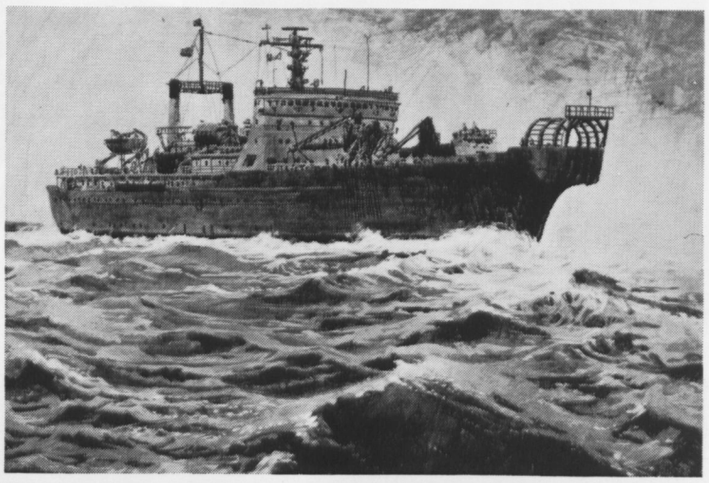
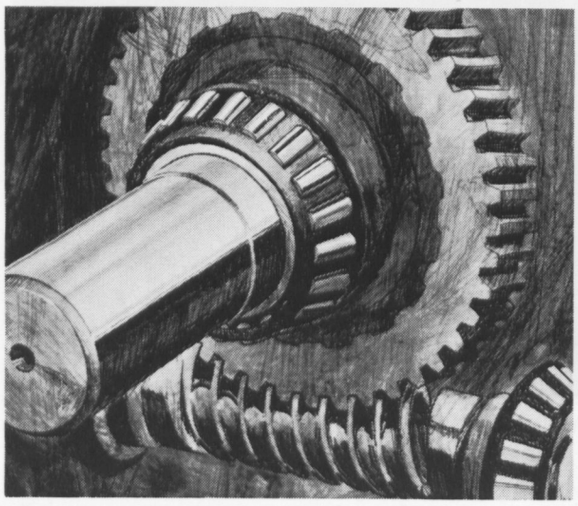
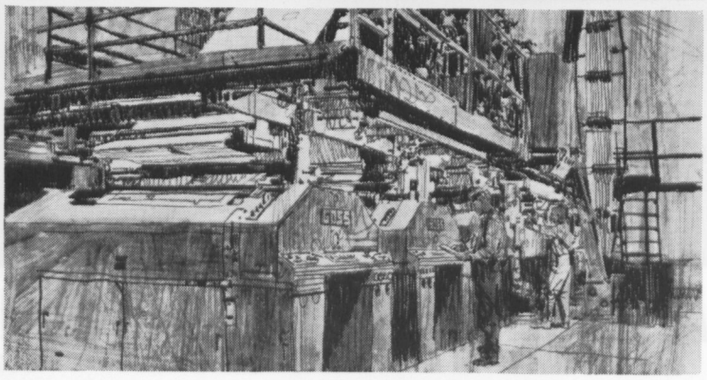
NEWS TRAVELS FASTER ON TIMKEN® BEARINGS







"NEITHER RAIN NOR . . ." In snow country, the mail goes through on a Ski-Doo Bombardier power-sled, made by Bombardier Snowmobile Ltd., Quebec. It is also used on trap lines, for sports and for hauling supplies. Timken® bearings in the clutch give it extra capacity in a small space.

WHEELS AND SHAFTS. Whatever you build—wheelbarrows to steel rolling mills—Timken tapered roller bearings can help it perform better, longer. They're precision-made of nickel-rich steel by: The Timken Roller Bearing Company, Canton, Ohio. Also makers of Fine Alloy Steel and Rock Bits.

WORLD-WIDE CABLES. The C.S. Long Lines, new Bell System cable-laying ship, is on the high seas. In its wake, thousands of miles of cable, paid out at eight knots. 2,816 Timken bearings keep the ship's linear cable engine operating.

EXTRA! EXTRA! This Goss Headliner Mark II press runs 70,000 newspapers an hour. It prints in color. It folds. It delivers the papers to the loading dock. Not one Timken bearing has required premature replacement.

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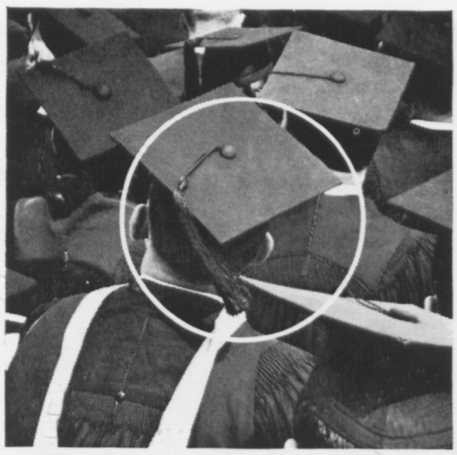

John Lauritzen wanted further knowledge

He's finding it at Western Electric

When the University of Nevada awarded John Lauritzen his B.S.E.E. in 1961, it was only the first big step in the learning program he envisions for himself. This led him to Western Electric. For WE agrees that ever-increasing knowledge is essential to the development of its engineers—and is helping John in furthering his education.

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

If you set high standards for yourself, educationally and professionally, let's talk. Western Electric's vast communications job as manufacturing unit of the Bell System provides many opportunities for fast-moving careers for electrical, mechanical and industrial engineers, as well as for physical science, liberal arts and business majors. Get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

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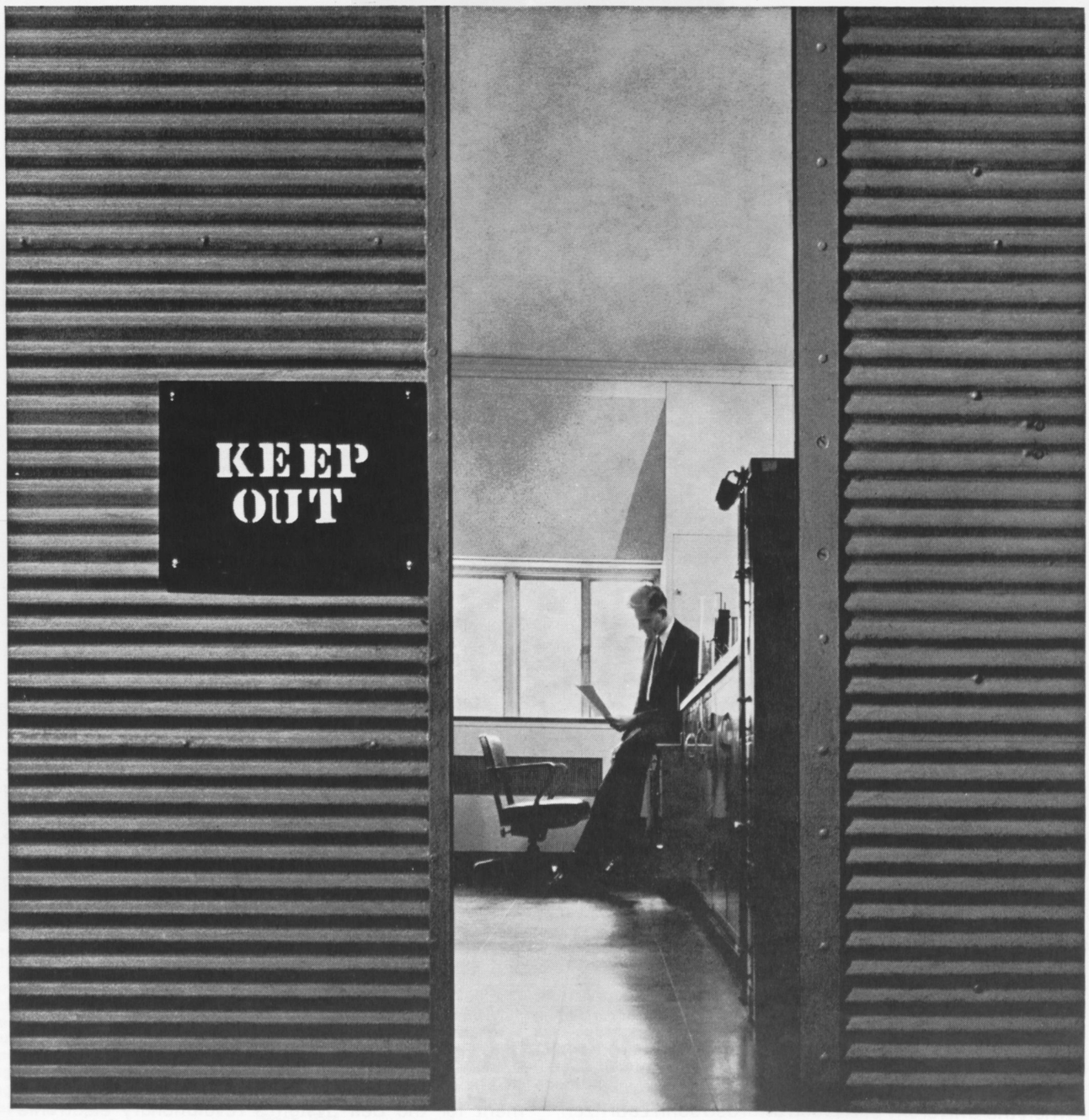

What's Tom Milling's secret?

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Tom is helping design a new process system for making the monomers—with Amoco Chemicals Corporation, our sister company. The system must be right, and right on time to meet an accelerating development deadline.

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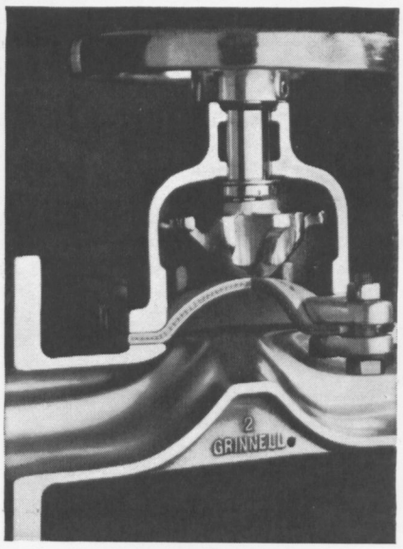

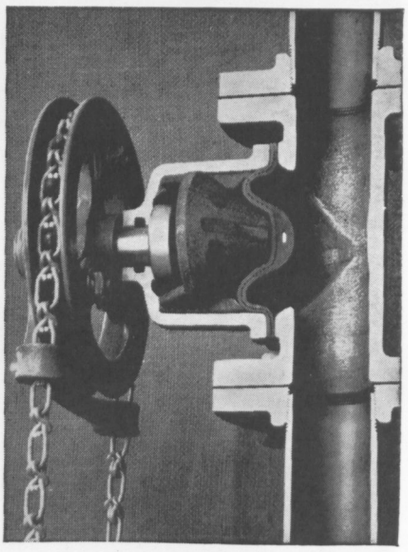

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The many features inherent in the basically simple design of Grinnell diaphragm valves make these valves industry's choice for severe service. The diaphragm, for example, provides two-way protection against contamination: (1) valve lubricants, dirt, or other foreign matter can't enter the product stream; (2) the product stream is sealed off from contact with the bonnet mechanism. In addition, valve body and body linings, as well as diaphragms, are available in a wide choice of materials to meet virtually any requirement.

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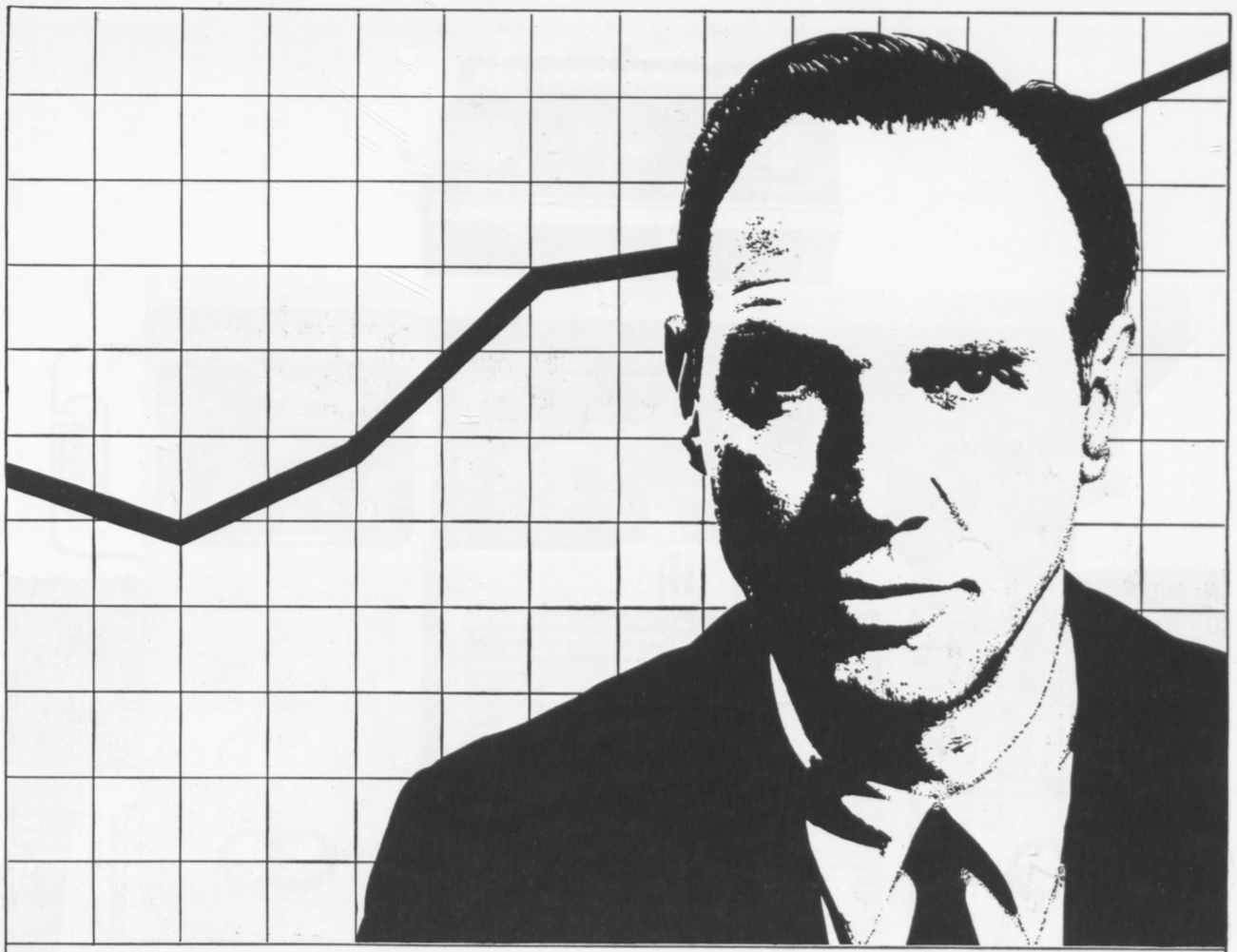

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