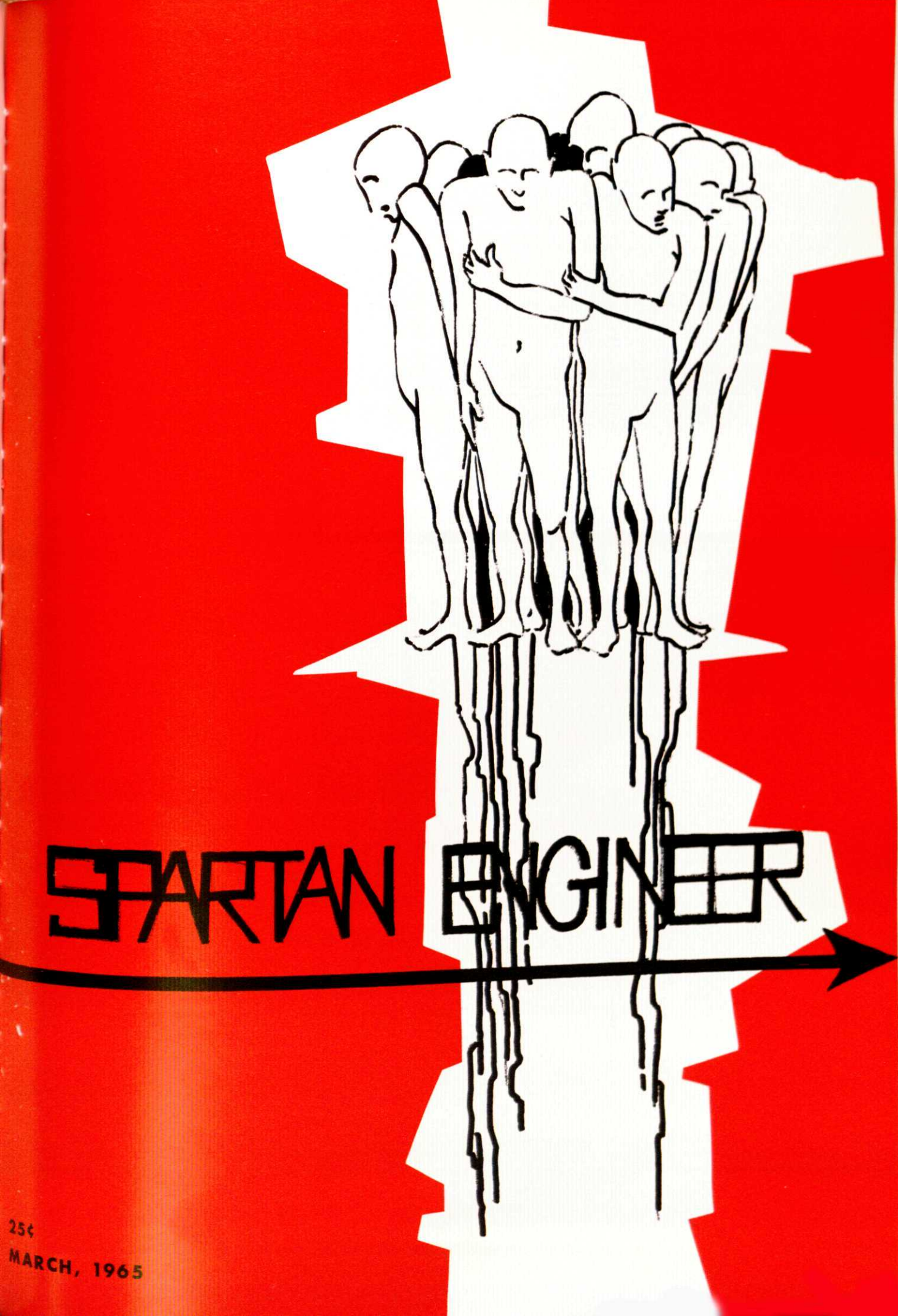
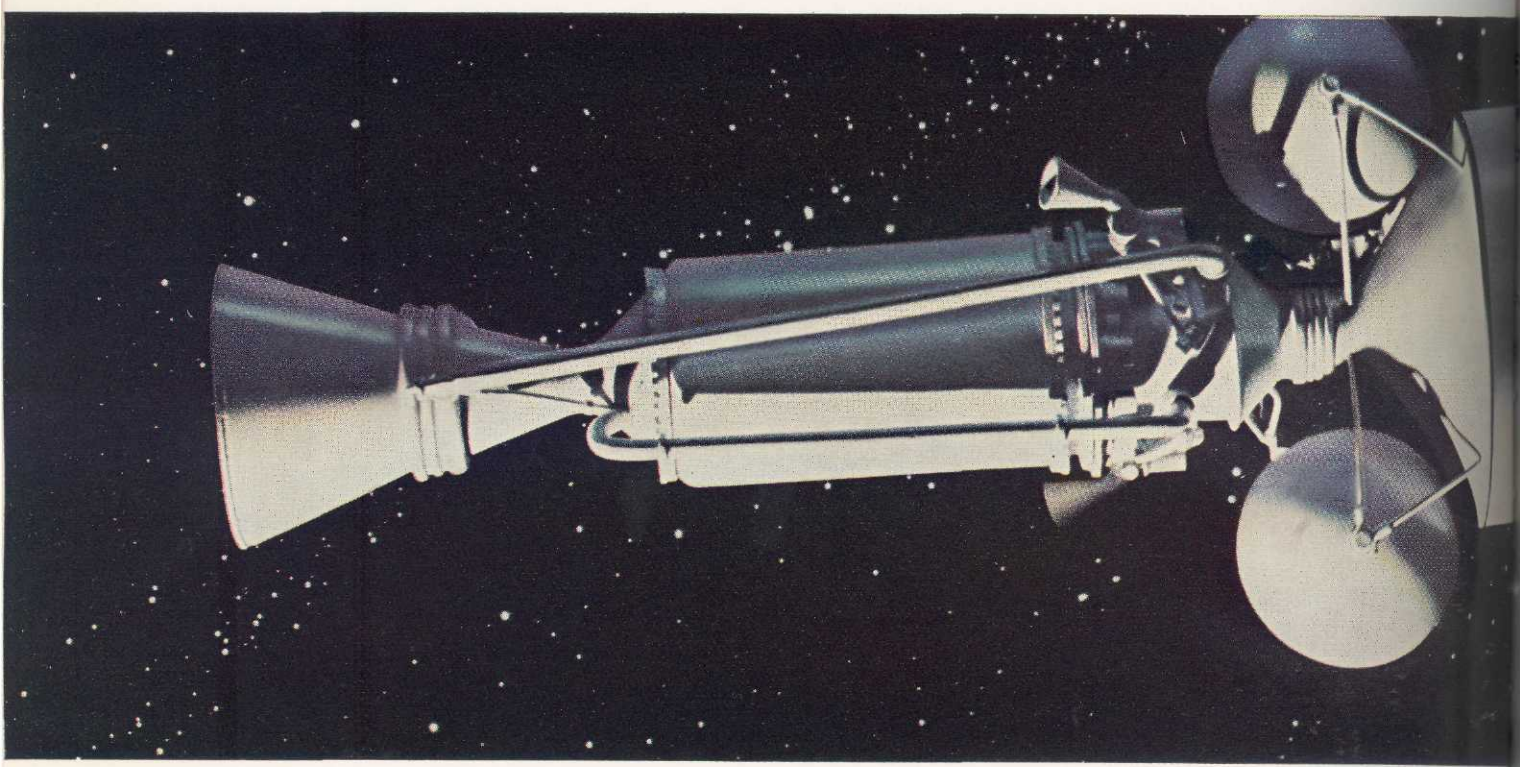


25¢
MARCH, 1965

Atomic rocket reactor successfully test fired by Westinghouse



Atomic rocket power will permit round trips to Mars, Venus and beyond

With atomic power, it is possible for rockets to carry bigger loads farther than with conventional fuels. The first full power test of the reactor for NERVA (Nuclear Engine for Rocket Vehicle Application) promises a new United States capability for voyages into deep space and to the planets.

Westinghouse designed and built the NERVA reactor. NERVA is part of the Rover Program under the management of the AEC-NASA Space Nuclear Propulsion Office. Westinghouse is the world leader in developing atomic reactors for many applications, including atomic electric generating stations.

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For information on a career at Westinghouse, an equal opportunity employer, write L. H. Noggle, Westinghouse Educational Department, Pittsburgh, Pa. 15221.

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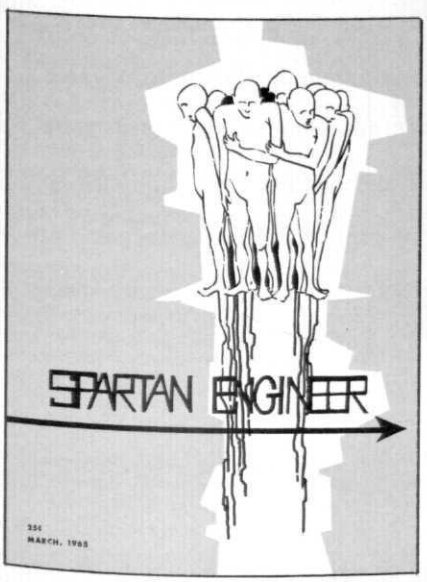
For more information, contact the Professor of Air Science. If your campus has no AFROTC, see your Air Force recruiter.

U.S. Air Force

SPARTAN ENGINEER

VOLUME 18 NUMBER 3 MARCH, 1965



FEATURES

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EDITORIAL

At the beginning of this term, a new staff took its place at the helm of the Spartan Engineer. The people involved were new both to administrative positions on campus publications and to journalism in general. As a result, the issues of the Spartan Engineer which have been published this term are not up to professional standards. However, these issues have provided an education to the staff and we are about to step out to make major improvements in the quality of this magazine. It is the goal of this new staff to provide for the College of Engineering, both students and faculty, a meaningful technical periodical which can rank among the best in the country.

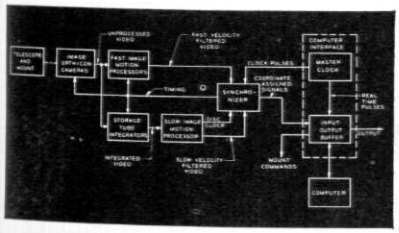
Some of the changes in the Spartan Engineer have been initiated in this particular issue. Outstanding among these changes is the appearance of science-fiction (but not science fantasy) in the form of an article presented to us by a student in engineering. This article is $2 + 2 \neq 3$. This article has been presented for a basic reason. It is the belief of the editorial staff of this publication that an engineering periodical with a distribution such as ours has a duty to not only educate but, on occasion, to entertain. In the past the Spartan Engineer has provided some entertainment in the form of Miss Engineer or the Engrineers. However, it is our desire to provide a form of entertainment a little more consistent to the collegiate atmosphere. Thus we have come up with an article which should promote some thought concerning our society and the society of the future which we create. Please, let us know your reaction to this change and let us know of any other suggestions or criticisms.

Frederick E. George

Engineering and Science at RCA

Ground Detection of Space Objects in the Night Sky

RCA has designed and installed for the Air Force a new optical satellite surveillance system that utilizes advanced techniques in several fields including physics, electronics, mathematics and astronomy. Starting in the laboratory with a bread-board experiment to prove the feasibility of using image orthicon tubes as detectors of moving targets among the



millions of stars in the night skies, a team of scientists and engineers carried the project through systems and design analysis, and produced the requisite equipment even to building an observatory on a mountain top in New Mexico. The system is now being evaluated under actual operating conditions. While performance data are security classified it can be said that the system is designed to detect, without a priori information, very dim satellites in real time, far beyond normal radar ranges.

Optical physics and engineering of the highest order were required to produce an eleven-ton, 27 inch f/1 telescope that uses 6 million optical fibers to present images to 12 orthicon cameras. Image motion processing necessary to find a tiny satellite moving slowly through a star field as dense as the Milky Way is accomplished by entirely automatic electronic signal integration, star cancellation and data association and reporting. The very latest techniques of electronic engineering have produced highly sophisticated equipment for control, data gathering and analysis of results.

System design, performance evaluation and computer programming have involved rigorous mathematical analyses applied to new combinations of scientific disciplines. Proof of the deductions are just beginning to emerge from the observatory, and much will be learned about applied astronomy as the system is used.

Reference—J. A. Hynek and J. R. Dunlap, "Image Orthicon Astronomy," Sky and Telescope, Vol. 28, No. 3, p. 130, Sept., 1964.

Color TV Receiver Automatic Degaussing

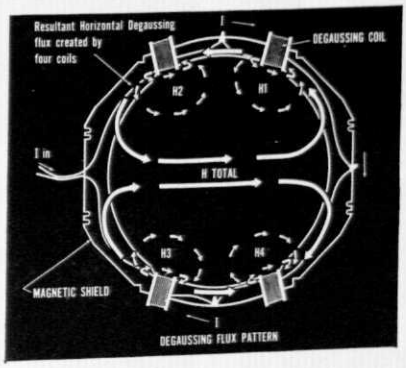
Even the comparatively small magnetic fields exhibited by the earth can cause visible errors in color television reception. To give picture tube output proper color alignment, while the TV receiver is in any desired location, an effective magnetic shield is required. But before a practical magnetic shield can perform its function, the shield must be degaussed in the specific magnetic field to be shielded.

Degaussing enables the metal in the shield to "forget" its previous magnetic orientation and to magnetically realign to counteract any new position. Degaussing affects the metal in the picture tube's shadow mask in the same manner.

Usually, a color television receiver is degaussed by driving a solenoid wound coil with 120 volt AC line voltage and moving the coil around the front of the tube . . . then slowly drawing the coil away. This operation usually is required every time the position of the color receiver, with respect to the earth's magnetic field, is changed.

Recently, RCA introduced *automatic degaussing*. This gives the color instrument freedom of movement, regardless of the earth's magnetic field. Automatic degaussing also protects the receiver from magnetic fields generated by nearby vacuum cleaners and other electrical appliances.

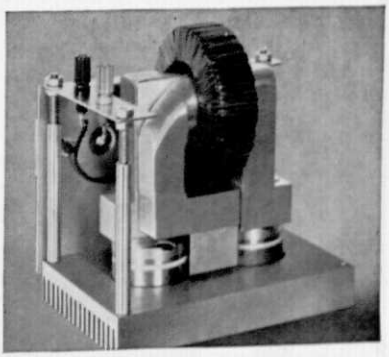
An RCA innovation, automatic degaussing is accomplished during initial warm-up—each time the color receiver is turned on from a cold start. The surge currents charging the electrolytic capacitors of the B+ supply start from a high value and decrease exponentially during the charging time. A thermistor in series with this charging current starts at approximately 110 ohms and decreases to 4 ohms as the current's heating effect changes the resistance.



A voltage-dependent resistor, in series with the degaussing coils (wound on the picture tube shield), acts as a switch to connect the coils across the thermistor only during the warm-up of the receiver. Thus, the slow drawing away of the coil in manual degaussing is simulated automatically.

Energy Conversion

One of the most attractive new methods for the direct conversion of heat to electricity is the thermionic generator. In many applications, however, the efficient use of a thermionic generator requires some form of low voltage DC to AC inversion. Such generators developed at RCA are capable of several hundred watts output at efficiencies of 20%. Because this power is generated at only 0.5 volts, techniques were needed to step up output to practical voltage levels. Under Navy and Air Force sponsorship, RCA has now developed a tunnel diode inverter system capable of inverting the output of thermionic generators and other low voltage power sources to any AC voltage desired, with efficiencies up to 80%. This is believed to be the first time that usable power has been developed from a thermionic generator.



The new system employs the use of gallium arsenide, a semiconductor material which provides larger bandgaps and hence higher efficiencies and temperature capabilities. The tunnel diode inverter system has the advantage over previous designs in the following areas:

Radiation resistance—operable at radiation levels of 10^{17} nvt with only small decreases in efficiency. *Temperature*—GaAs tunnel diodes have been operated successfully at 200°C. *Circuit simplicity*—An extremely simple circuit is required consisting of only one transformer and two tunnel diodes, while the more conventional type of transistor inverter requires several transformers, resistors, diodes and transistors. *Cost-Weight-Volume*—Due largely to their simplicity, these advantages are obvious over other circuits of comparable performance.

These advanced engineering achievements represent a real breakthrough in energy conversion that is extremely important to our defense and space efforts.

These recent achievements are indicative of the great range of activities in research, applied research, advanced development, design and development engineering at RCA. To learn more about the many scientific challenges awaiting bachelor and advanced degree candidates in Electrical or Mechanical Engineering, Physics, Chemistry or Mathematics, write: College Relations, Radio Corporation of America, Cherry Hill, New Jersey.

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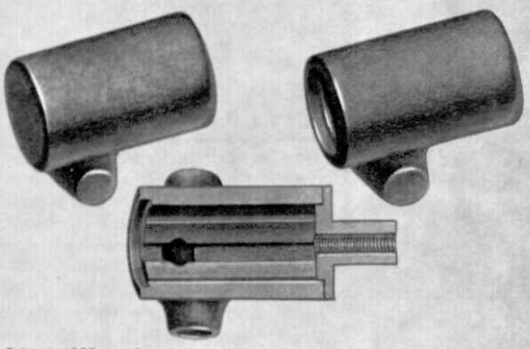
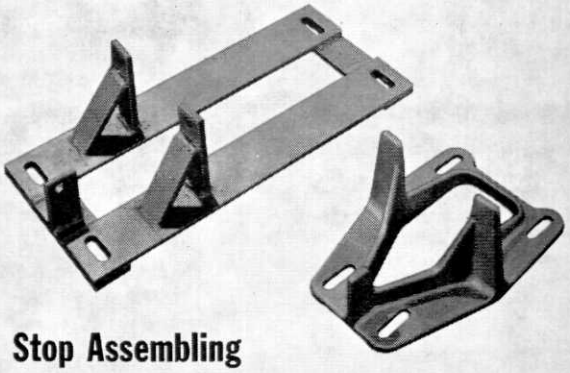
Eliminate Waste with Malleable Castings



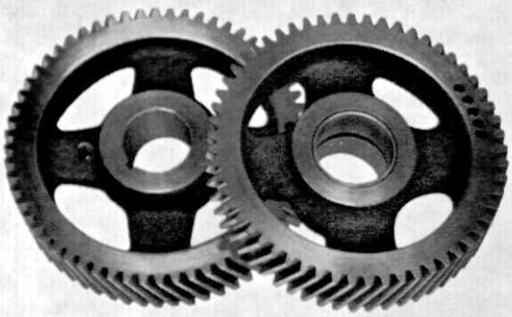
Stop Wasting Metal

Why pay for 2.8 pounds of metal . . . then machine out and scrap 1.2 pounds? Changing this snap coupler to a Malleable iron casting with a cored center reduced initial cost 31 cents and cut the first interior machining operation by 72 per cent (subsequent operations were up to 25 per cent less expensive, too). Through expert use of cores in parts that require interior design details, your Malleable foundry puts metal only where it is useful.



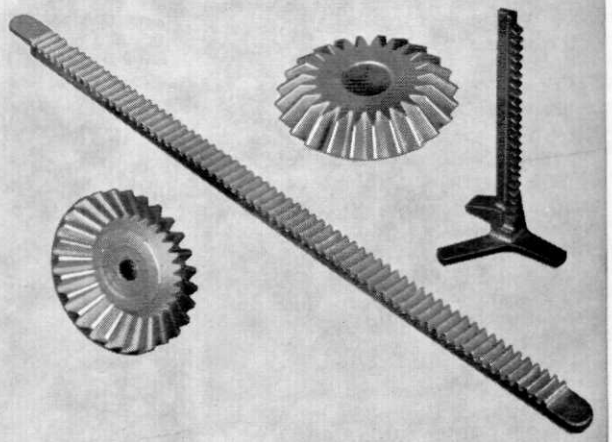
Stop Assembling

Making a bracket out of steel plate is very simple . . . until it's time to weld nine individual pieces into a finished product with the necessary dimensional accuracy. It's slow and costly. Redesigned and made as a single Malleable casting, this motor mount for an industrial overhead door opener has the required accuracy, strength and better appearance . . . and cuts costs 23%.



Stop Needless Hardening

Pearlitic Malleable provides both excellent wear resistance and bearing properties. These camshaft and idler gears wear as well without hardening as other hardened ferrous metals previously used for these parts, but tool life and machining time are greatly improved. If still harder surfaces are needed, pearlitic Malleable takes either flame or induction hardening exceptionally well.



Stop Unnecessary Machining

Malleable producers cast parts so close to finished shape that very often little or no machining is required. These Malleable iron gears, for example, are used without any machining on the teeth.

There are many ways you can do a better job at less cost with modern Malleable castings. Our new brochure, "Design Criteria for Malleable Iron Castings", tells how.

Send for your free copy today.

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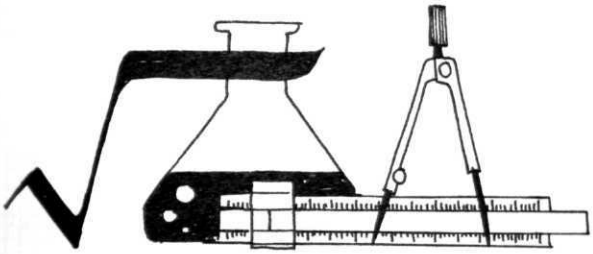


PLACEMENT BUREAU

April 7
General Motors (Summer)
Republic Steel
Indiana & Michigan Electric Co.
Pitts. Plate Glass (Summer)

April 8
Standard Oil--Amer. Oil
General Electric

April 9
U.S. Army Service Medical Corps
Wayne County Road Comm.

April 12
Goodyear Tire & Rubber
Smith, Hinchman, & Gryllis, Assoc., Inc.
Remington Rand

April 14
Power Control

April 15
Mech. Handling Systems (Summer)

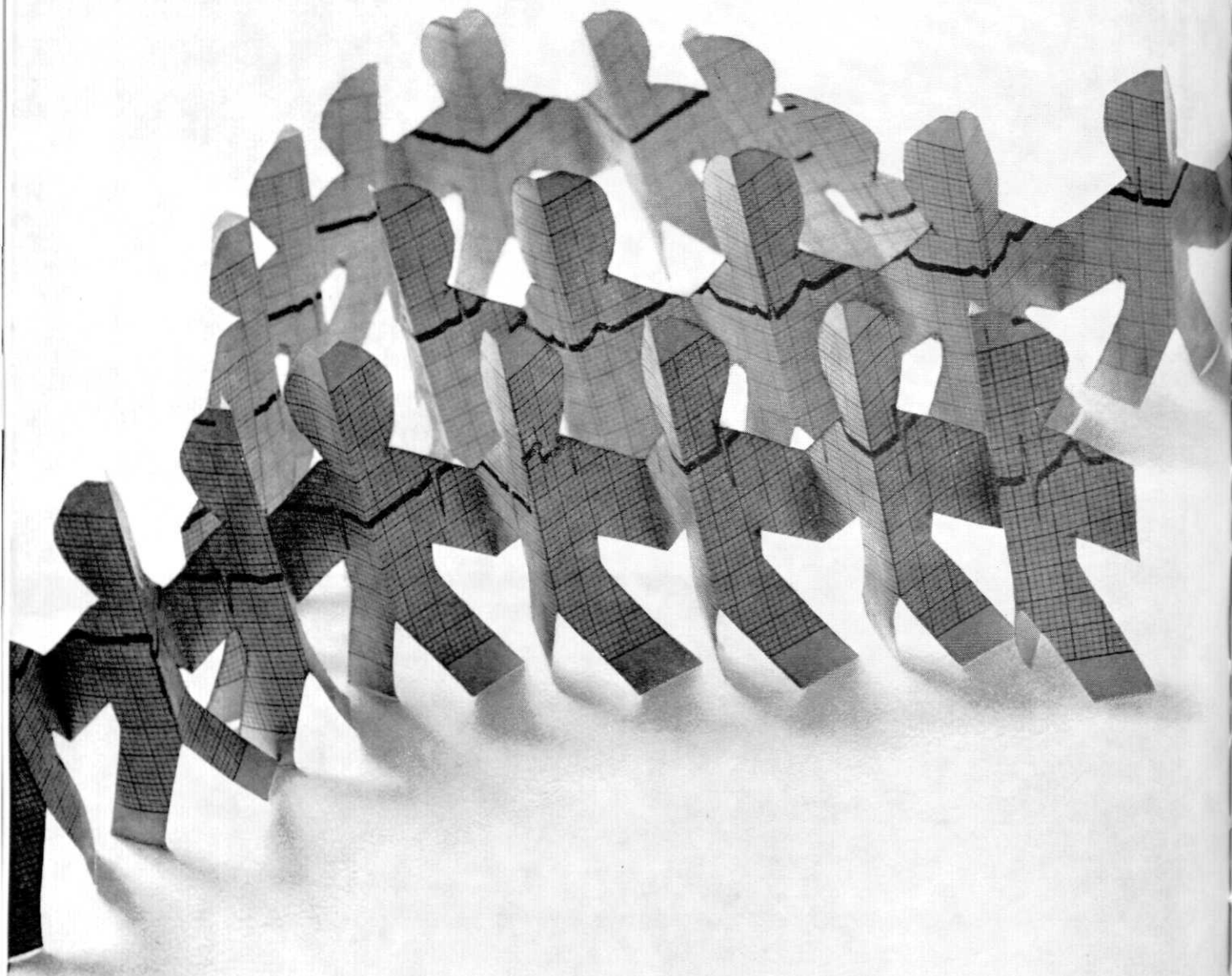
April 20
Muskegon Piston Ring Co.
Fisher Body

April 22
Corning Glass
Pure Oil Co.

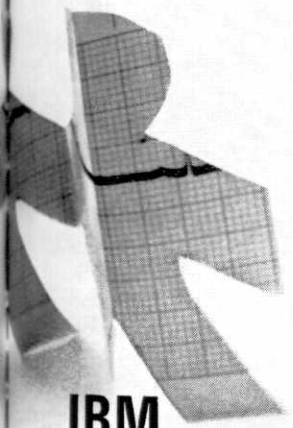
April 23
Clark, Dietz, Painter, & Assoc.

April 27
Indiana Highway Comm.

May 6
General Motors (Security)



Signals from the heart...



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Industrial Engineering, Information Retrieval,
Marketing, Manufacturing Research,
Microwaves, Optics, Programming,
Reliability Engineering,
Servomechanisms, Solid State Devices,
Systems Simulation and related areas.

This page is for

YOU

Letters sent to the Editor

containing comment,

suggestion, or

criticism, will be printed on this page.

Address letters to..

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East Lansing, Mich.

Work for a bearing and steel company? What's exciting about that?

Nothing—if you're bored by Project Mohole, turbine engines, the world's tallest crane, and biggest strip-mining shovel, a telephone cable-laying ship now crossing the Pacific, space exploration, the Spirit of America race car, the Alweg Monorail, a moveable grandstand for the new District of Columbia Stadium, Atlas missiles and defense work—

They're all recent projects involving The Timken Roller Bearing Company, world's largest manufacturer of tapered roller bearings and a leading producer of fine alloy steel.

The Timken Company is the world's largest because our engineers developed tapered roller bearings that revolutionized our "meat and potatoes" markets in the Automotive, Railroad, Farm and Construction machinery industries.

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You'll work with one of three products: Bearings, Steel or Rock Bits. Uses for these products number in the growing thousands.

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And we're still growing.

So if you're interested in our kind of work, why not get in touch with us? Write Dept. MC for our 12-page career booklet.

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2+2≠3

by Benton St. John

Man did not listen to the twentieth century prophets of doom who foretold the eminent disaster of the human race. In the late 1950's and early 1960's, numerous well-known scientists warned mankind of the consequences of the population explosion. However, some of the popular religions of the time opposed birth control and labeled those who favored it as the devil's advocates. Meanwhile, the rate of illegitimacy had risen to an astounding level, as promiscuity became acceptable. The popular religions of the time encouraged their flocks to multiply.

Charley 2122 stood and looked out over the vast plain that spread before him. He gazed for many hours this way wondering why man had let this happen. He thought back and let forth a small cry. A tear came to his eye, running down over his weather beaten face. Charley 2122 was the last man on earth. Charley let his mind wander back to the days prior to the great disaster which caused all mankind to go berserk.

Charley had been one of the privileged few before catastrophe over-took the world. He had been the son of the President of the Federated States of America. Charley was twelve when he realized what lay ahead for man. On his birthday his father took him for a tour of the cities of Federated America.

Charley saw with his own eyes the want and hunger in the faces of the people his father presided over. They were thin and ravaged with disease. In the area called Motortown - 4, a suburb of Motortown, he saw the descendants of a proud people whose ancestors had preached racism, hate and the gospel of the dollar sign.

Everywhere they went they saw the same thing -- people indifferent and doing nothing --women pregnant, women in labor, and the men for which there was no labor. Humanity spread before 2122, and he cried to his father saying, "Why, what has caused this misery and suffering?" His father turned to him, and said "2122 you have not learned your lessons well, within your life time -- son -- man -- will cease to exist on this planet." With that they went back to gov central deep in the Rocky mountains.

Local gov as was known in the twentieth century had to be abolished. There were so many cases of graft and corruption that martial law had to be declared throughout the land. All that remained of the central gov was its food allocation and food production capabilities. Congress ceased to exist in the late part of 1989 and a short time later the courts were also disbanded. The Department of Agriculture reigned supreme. With the population exploding at an exponential rate, the military and technological functions were curtailed. The universities were closed when the students demanded a decent meal.

At this point in the rise of mankind there was barely enough food. Any small disaster meant that many would starve. Every ten years the population would double, even with the rate of mortality on the rise.

Hospitals ceased to exist since the problem was not to save lives but to eliminate them. They were replaced by death factories. The government paid your family in food if the male members of the families would commit themselves for death. Many times this was not voluntary. Children were dragged screaming into the giant matter-to-energy converters. Man had lost his Judaic Christian tradition. When it came to a decision between food for the stomach or for the soul, the stomach was the overwhelming winner. In the late part of the twenti-

CONTINUED ON PAGE 16

Ford Motor Company is:

challenge

Dale Anderson
B.A., Wittenberg University

At many companies the opportunity to work on challenging projects comes after many years of apprenticeship and a few grey hairs. Not so at Ford Motor Company where your twenties can be a stimulating period. There are opportunities to prove your worth early in your career. Dale Anderson's experience is a case in point.

After receiving his B.A. in Physics in June, 1962, Dale joined our College Graduate Program and was assigned to our Research Laboratories. Recently he was given the responsibility for correcting cab vibration occurring on a particular type of truck. His studies showed that tire eccentricity was the cause of the trouble. Since little change could be effected in tire compliance, his solution lay in redesigning the suspension system. Tests of this experimental system show the problem to be reduced to an insignificant level.

That's typical of the kind of meaningful assignments given to employes while still in the College Graduate Program—regardless of their career interest. No "make work" superficial jobs. And, besides offering the opportunity to work on important problems demanding fresh solutions, we offer good salaries, a highly professional atmosphere and the proximity to leading universities.

Discover the rewarding opportunity Ford Motor Company may have for you. How? Simply schedule an interview with our representative when he visits your campus. Let your twenties be a challenging and rewarding time.

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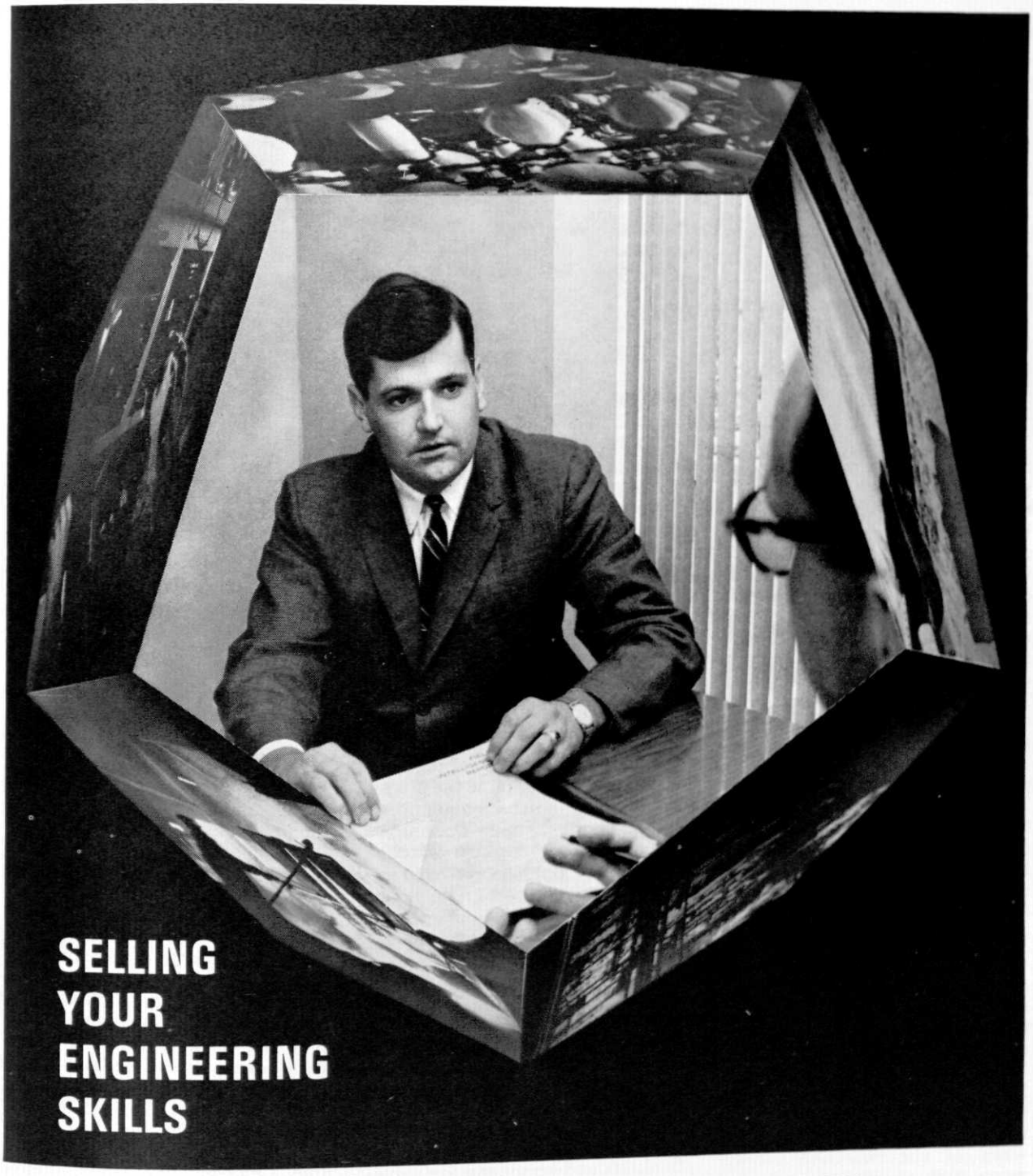

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If you like the idea of proving your ability rapidly, consider marketing for Monsanto as a career. This worldwide company (represented in 70 nations), has quadrupled sales in the last twelve years, is expanding rapidly.

Monsanto needs men with sales talent who also have the creative ability to anticipate and generate demand for future products. You'll have the stimulation of pioneering with new, exciting products that demand full use of your professional skills.

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Monsanto®

CONTINUED FROM PAGE 13

eth century, scientists and scholars tried to convince church and government leaders to accept birth control, but they balked, "This is not the will of God." Even the eastern regions would not heed these prophets of doom.

Europe and Asia fought many wars over small parcels of land. In the year that Charley 2122 was born the last great war overtook Europe and Asia. All forms of central gov were reduced to ashes as the result of this flesh bath.

The central gov of Europe and Asia had run the hydroponic tanks and the automated farms that the wars were fought over. With the central gov reduced to ashes and chaos sweeping the land, food production ceased. The mindless humanity of flesh that covered most of the earth knew nothing of the raising of food. Most of the domestic animals had been eaten long ago. There was little to eat on the continent. Man soon turned to eating his neighbor. The weak and diseased were herded up by those still strong enough to walk. They kept them in pens and when the food ran low they slaughtered a diseased human and feasted. In a matter of months most of Europe and Asia was inhabited by a dying race of barbaric animals.

In the Americas all the available land and all energy that remained was used to raise the food that man needed to commit suicide with. Beautiful areas like Rockefeller Center and Greenfield Village were torn up and planted. Hydroponic tanks were everywhere. The fabulous highways of the twentieth century were torn up and planted. The housing developments that advertised the "great life" were dismantled and the land used for the production of food. The great life had degenerated into filth, disease, ugliness, and sorrow for the descendants of the pleasure-seekers of the twentieth century.

Since America had to use all its resources on its disease and hunger riddled people it lost contact with the rest of the world. People in vast parts of the empire lost touch with each other. Only Charley's father and a few other officials knew how close man was to extermination.

The disaster began on a spring morning on the 22 of May in the year 2142. A snow storm from Canada brought its chilling winds and snow. It blanketed most of the area known as the United States. The storm ruined half of the crops of the Federation. Panic quickly swept through the land. Groups started attacking the gov food warehouses where the food was stored. Rather than take the food they burned these buildings. Man had gone crazy. Charley's father, realizing what had happened, ordered his son to Project Tomorrow. The few remaining statesmen of the day realized that this would happen eventually so they had prepared an advance guard that would start over where mankind today would cease. The members of this group were hand-picked and educated so this catastrophe would not happen again.

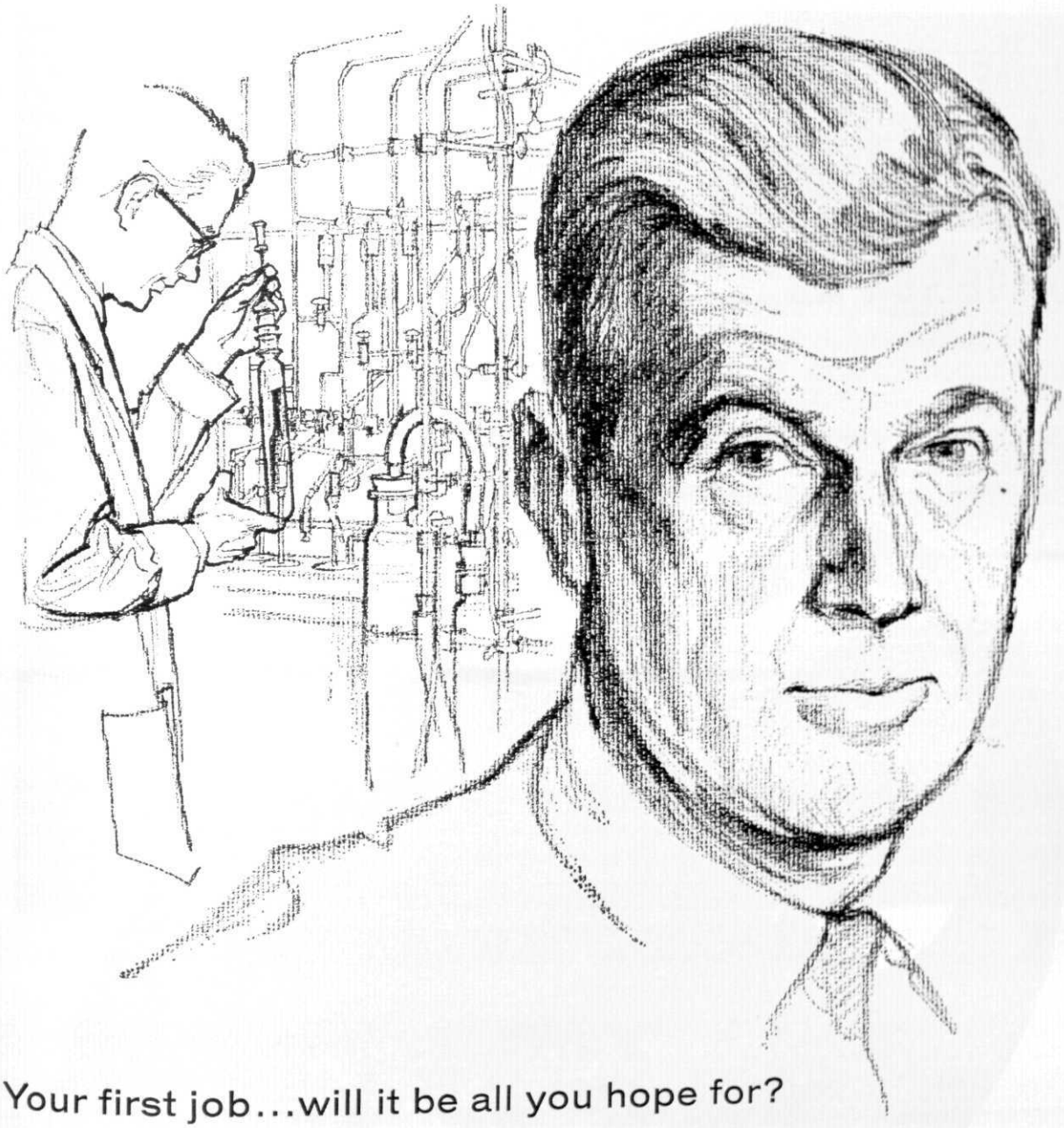
Charley descended in the long elevator to the base of the mountain to wait out the eminent disaster. From the view screen the twenty of the vanguard watched in disbelief as man destroyed everything in his path. The scene was similar everywhere in the federation. Charley saw his father killed as he fought alongside the other gov leaders trying to lock the shaft where Charley and his nineteem companions were to wait until mankind was exhausted and the earth was ready to try again. With most of the food destroyed and the mechanized apparatus of the farms destroyed there was little food left and no means for growing it. Men in rapid disorder turned to cannibalism and brutal murder. People who were sick and diseased were eaten by those who wanted to live so that they might die.

Madness spread over the land and many died, and, for those who survived, time was limited. They had never learned how to live off the land. In their lives they had been given food and shelter from birth to death. With the govs gone and the leaders destroyed, their days were numbered. The land would not support him without his help. It took two years for man to finally exterminate himself.

Charley 2122 and his vanguard emerged from their hole deep in the mountain. Almost immediately fights broke out over which woman was to go with which man. Durk 2134 was the first to die. Following his death was Joan 2111. Charley, sickened by the sight of man fighting over the flesh of another creature, went to the mountain to escape from the senseless blood bath. When Charley left, any order that remained was lost and man battled it out to see who would run the camp. In these insane fights the equipment they would need to start over again was destroyed. Only Charley had a device for making food from silicon. One woman survived. Her name was Hope 2169. After many days, her food supply ran out. She roasted her diseased companions over a dark red fire. Without realizing what she was doing, she contaminated herself with the bacteria and viruses that inhabited the bodies.

Charley woke that morning and went to the plain. It was a beautiful morning. The birds were singing, and the wind swept past Charley's body -- gently massaging him. Charley looked out over the plain and straining his vision, he saw a blond figure crawling toward him. Out of its mouth were the seethings of an animal. As it neared, Charley realized it was Hope 2169. She came within two feet, two inches of him. She let out a gasp, and died. Charley looked to the heavens. The sky darkened and the few remaining animals bowed their heads in silence. Charley, with tears in his eyes, lowered his head and walked away from Hope. The sky darkened until all the light had been extinguished. Man had been warned, but he would not listen; the earth sighed a relief and nature ceased to classify man as the highest order of animal.

SE



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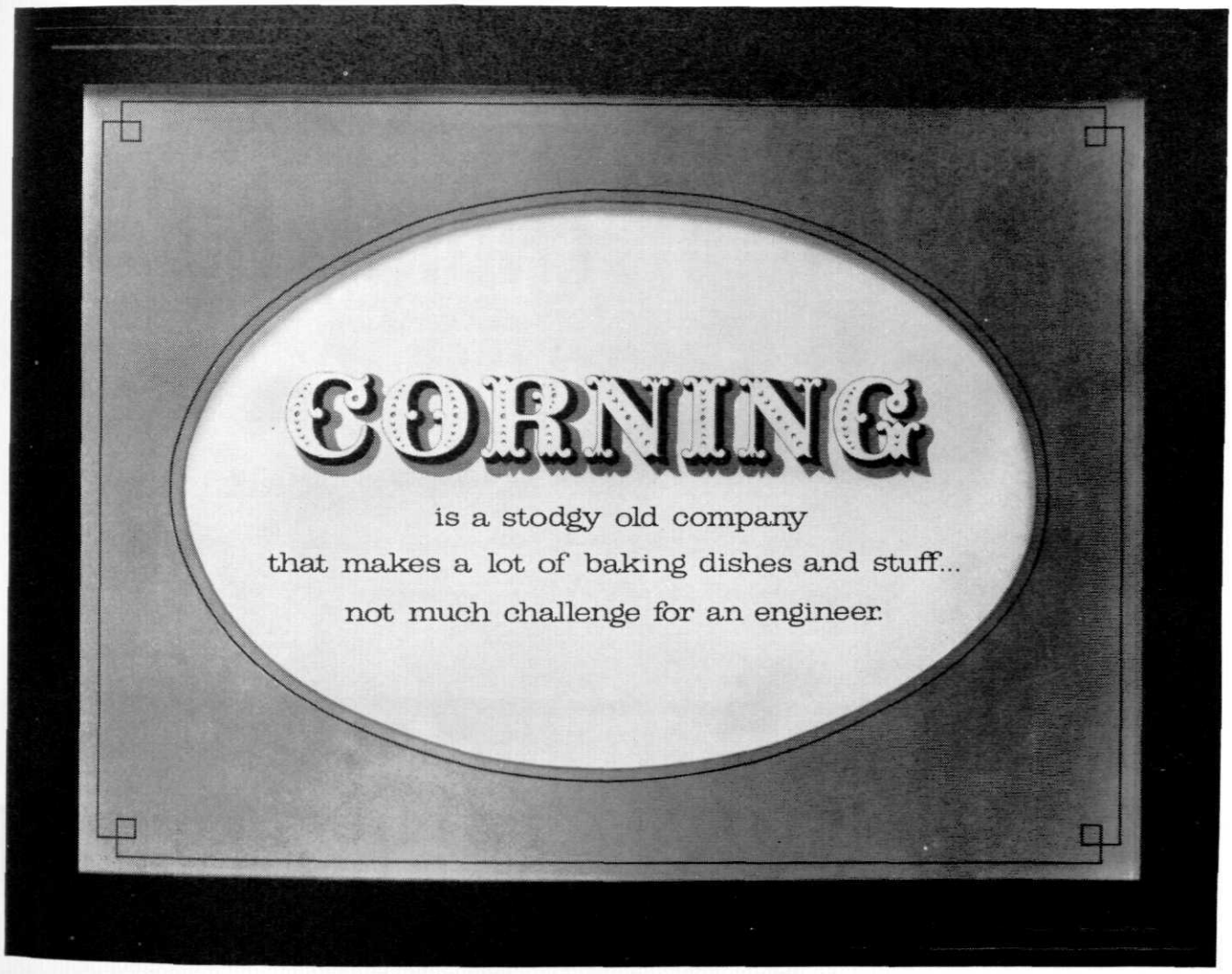

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MAY 14-16, 1965

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Miss Engineer

SANDY SARNES

Home town: Bloomfield Hills, Michigan

Age: 20

Class: Junior

Sorority: Kappa Alpha Theta

Specs: 5' 6"

Brown Eyes

Brown Hair

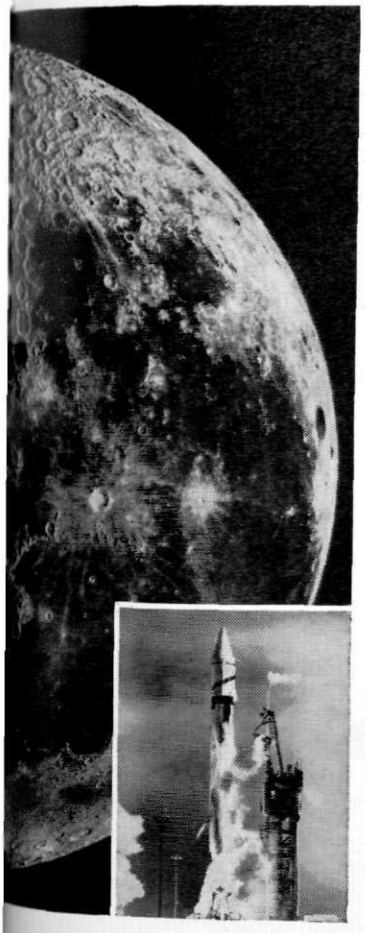
Major: Retailing

Hobbies: Boating, Swimming, Skiing (Snow and Water), Baking, and Singing.

Sandy, who has the awesome combination of captivating eyes and an ever-present cheerful smile, is both the Michigan Collegiate Snow Queen and the Moonlight Girl Of Phi Sigma Kappa. She was a member of a singing group, The Magicals, who toured Detroit and still uses her lovely singing voice at every opportunity. After graduation Sandy plans to do some traveling and to work.

Photos by James Hile

Providing power for every environment...



Being a technically trained man . . . we assume you are looking ahead to a career of exciting growth and accomplishment and that you are looking for a company possessing these same qualities.

If our assumption is correct, we would like you to take a close look at us. For this Company, while solving the problems of the day, thrives on a sort of creative restlessness which anticipates the challenges of tomorrow. And more important to you, it recognizes its engineers and scientists as the master key to its present success and future progress.

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QUALITY CONTROL

Lowered costs, dependability and uniformity is demanded by the consumer, therefore the object of the manufacturer. The guarantee of these qualities has been proven to be the following

by Gary J. Vander-Molen

EDITOR'S NOTE: Reprint from Northwestern Engineer, January, 1965.

TODAY'S customer demands greater precision, dependability and conformity in the articles he purchases. He expects his Ford Thunderbird to perform as well as his neighbor's. Only when the consumer is confident of uniform quality in the products he purchases can the manufacturer establish a reputation for dependability. This is accomplished by means of the operation known as "quality control."

Briefly stated, the purpose of quality control is the early detection of assignable causes of poor quality so that product quality may be controlled at the desired level with a minimum of rejects.[1] A "reject" is a piece, specimen or unit that does not conform to the established standards. As our technology progresses, products become increasingly complex. Hence the need for more exacting tolerances becomes of paramount importance.

Inaccuracies exist in even the most precise manufacturing operations. Variations may be attributed to inevitable chance causes or to assignable causes, which can be detected and corrected. Quality control employs statistical principles and methods to assess the magnitude of chance cause variations and to detect assignable cause variations.

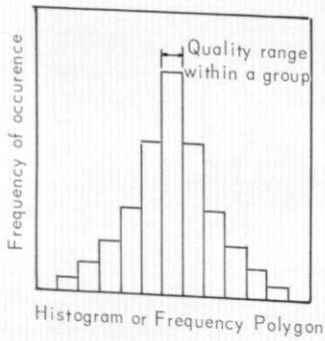


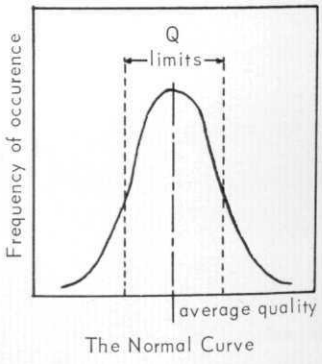
Figure 1. This is one type of portrayal of the quality level of a representative sample tested.

The activities of a particular quality control organization may be subdivided into three different categories: incoming material control, product-in-process control and special project studies.[5]

Incoming material control checks the quality of parts and subassemblies received from external vendor sources and from other plants of the same company. It is responsible for giving the supplier of raw materials and subassemblies comprehensive specifications, blueprints or diagrams which can give the supplier no chance for misinterpretation. If incoming quality control finds the percentage of defective units in a certain shipment to be excessive, it will refuse to accept the shipment. It must always be kept in mind, however, that the specifications may have been altered by the engineering department since the last shipment was ordered and received.

Product control checks the assembly of component parts and the proper operation and packaging of the final product. It cooperates with design engineers in suggesting changes in specifications. Such changes may be needed to improve quality or to reduce cost. Product quality control runs special life tests on the finished product to ensure its continued operation under simulated customer usage conditions. It makes "shipping tests" to ascertain that the mechanical strength of the product and the way it is packaged are adequate to survive rough handling which it may receive on railroad cars or trucks. Product quality control receives and analyzes field complaints coming from dealers throughout the company's sales territory. It reports them to production and to management and suggests corrective action.

Special quality control projects may consist of keeping employees abreast of latest statistical quality control methods by sponsoring classes and lectures. It is important to effectively communicate



The Normal Curve

Figure 2. This curve of normal distribution is an approximation for the histogram below.

the goal of the quality control program to the operators on the assembly line in order to motivate them to achieve this goal. This may be done by the company newsletter, by posters and by displays.[2] The company newsletter should contain illustrated case histories on the quality aspect of manufacturing, and it should build up the operator's role in achieving the quality goal. People like to see themselves in print. Attractive posters should be placed strategically throughout the plant and changed frequently to maintain interest. They should include cartoons and "catchy" slogans promoting the quality goal. Some companies collect scrap accumulated over a period of time, place it on a display counter and mark it with cards showing the values of the scrapped parts. Few employees realize the dollar value of the parts that have to be scrapped because of their carelessness. Such a display awakens the employee's conscience and stimulates his improvement. Firms having profit sharing plans will receive additional benefit from such a display because the employee is realistically made aware of the resulting financial loss to himself as well as to his company.

Visual and electrical inspection is used

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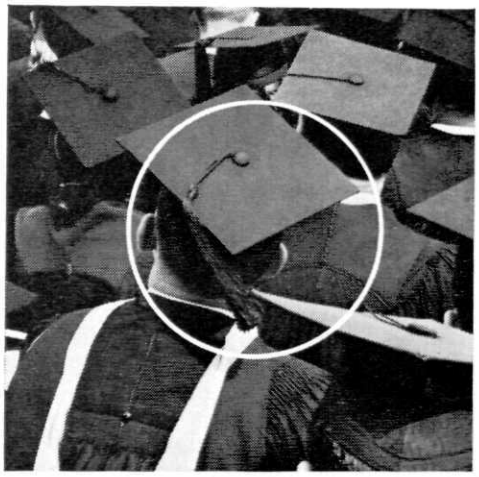

John Lauritzen wanted further knowledge

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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CONTINUED FROM PAGE 26

extensively in industry to determine the quality of the incoming, in-process and outgoing product. The importance of the use of identical testing equipment and procedures by all inspectors cannot be overemphasized.

Consider the case in the electronics industry where critical tubes in an assembled piece of electronic equipment must sometimes be checked for microphonic noise defects. One inspector may gently rub the tube with a pencil, another taps it with a rubber mallet and a third rugged individualist pounds on the tube with the heavy end of a large screwdriver. Needless to say, their observations as to what constitutes a noisy tube differ greatly. Tools and gauges used by inspectors should be checked periodically for accuracy. A worn micrometer or a drifting frequency generator may introduce errors of the same magnitude as that which one is trying to measure.

Inspection of the in-process and finished product need not be done on a 100 percent basis. For certain products, for example, the examination of five pieces out of a hundred that pass by on the assembly line ensures adequate quality control.

Obviously, destructive testing is never done on a 100 percent basis. The candy maker does not nibble every chocolate bar to be sure of its goodness before packaging it. Neither does the electronics industry measure the voltage breakdown level of every capacitor.

Another reason for not using 100 percent inspection is its time-consuming and costly nature. Fortunately the science of statistics, based on the laws of probability formulated by Pascal and Fermat in 1654, can accurately predict the quality level of an entire manufactured batch on the basis of a small representative sample tested.[5]

The quality control organization often simplifies the mass of data it collects by portraying it in a graphical manner. When a histogram, which is a graphic representation of a grouped frequency distribution, is plotted for a sample of a given manufactured product, the distribution in Figure 1 can often be seen.[7] This curve may be approximated by the curve of normal distribution, Figure 2.[2] The distribution of frequency which a given quality characteristic occurs within the sample of product being checked will show the average quality and its spread.

Deviations from the curve of normal distribution may often be traced to "flinching" on the part of the operator.[1] For example, the specifications for a certain product require that it contain no less than 0.70 percent of element X. The operator makes a chemical test and obtains a result of 0.694 percent which he must report to two decimal places. If he reports the result as being 0.69 percent the batch will be rejected. The operator, being a "good company man," immediately questions his test and reports it as being 0.70 percent. The quality control man however can discover such "flinching." As he constructs a frequency distribution a "hole" will appear at the 0.69 percent value, as in Figure 3. In addition the entire curve may be skewed. This type of graphic analysis is used by the quality control organization to police well-meaning operators who feel compelled to "help" the company by slightly misreporting the results of their tests.

The random sampling technique is employed by quality control inspectors. Data taken from a random sampling is plotted on a "control chart." This gives an immediate view of quality conditions on the assembly line at that time. Simplified, it might look as in Figure 4. The slanting lines are known as "limits." Points are plotted on the charts by the inspector as he proceeds with his sequential sampling of the in-process product. A steeply upward sloping plot warns him that the assembly line will soon go "out of control." When the "reject" line is passed the assembly line will often be stopped and not allowed to continue until the cause of the high rate of rejects is found and remedied. The quality control manager will often order a 100 percent reinspection of units produced immediately prior to the "out of control" condition. The control chart tells him that this lot is likely to contain a high percentage of defective units. Even though these units have already passed by the inspector due to his random, therefore limited, sampling, the manufacturer will not take a chance on placing this lot on the market without reinspection. He is likely to risk his good business name if he does. The technique of random sampling and the use of the control chart thus afford the manufacturing industry an economical means of keeping a tight check on the quality level of its products without having to resort to the expensive and time-consuming process of 100 percent inspection.

One may begin to wonder whether the monetary cost of employing an extensive quality control organization is worth whatever cost-saving it accomplishes. In 1949 the *Wall Street Journal* quoted professor Joseph M. Juran of New York University: "Each year the production of goods not up to specifications costs $500 to $1000 per productive worker. Half of that loss would be saved by quality control. A potential saving by industry of between two billion and three billion dollars a year can be made through the reduction of rejected goods, reworking and inspection costs, and out-and-out waste."[4]

Naturally, everything can be overdone. If quality control becomes too extensive, its cost will increase the price of the product, resulting in reduced sales. But if insufficient quality control is employed there will be customer dissatisfaction due to too frequent occurrence of malfunctioning products. It is up to the cost accounting department of a firm to determine the optimum operating point.

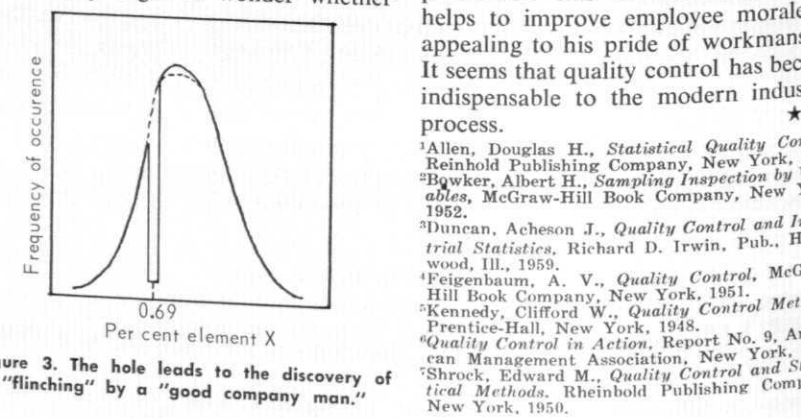


Figure 3. The hole leads to the discovery of "flinching" by a "good company man."

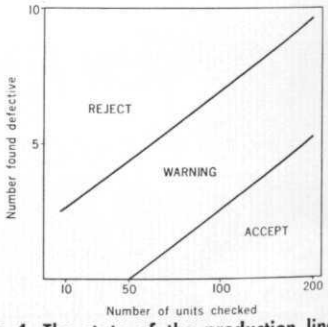
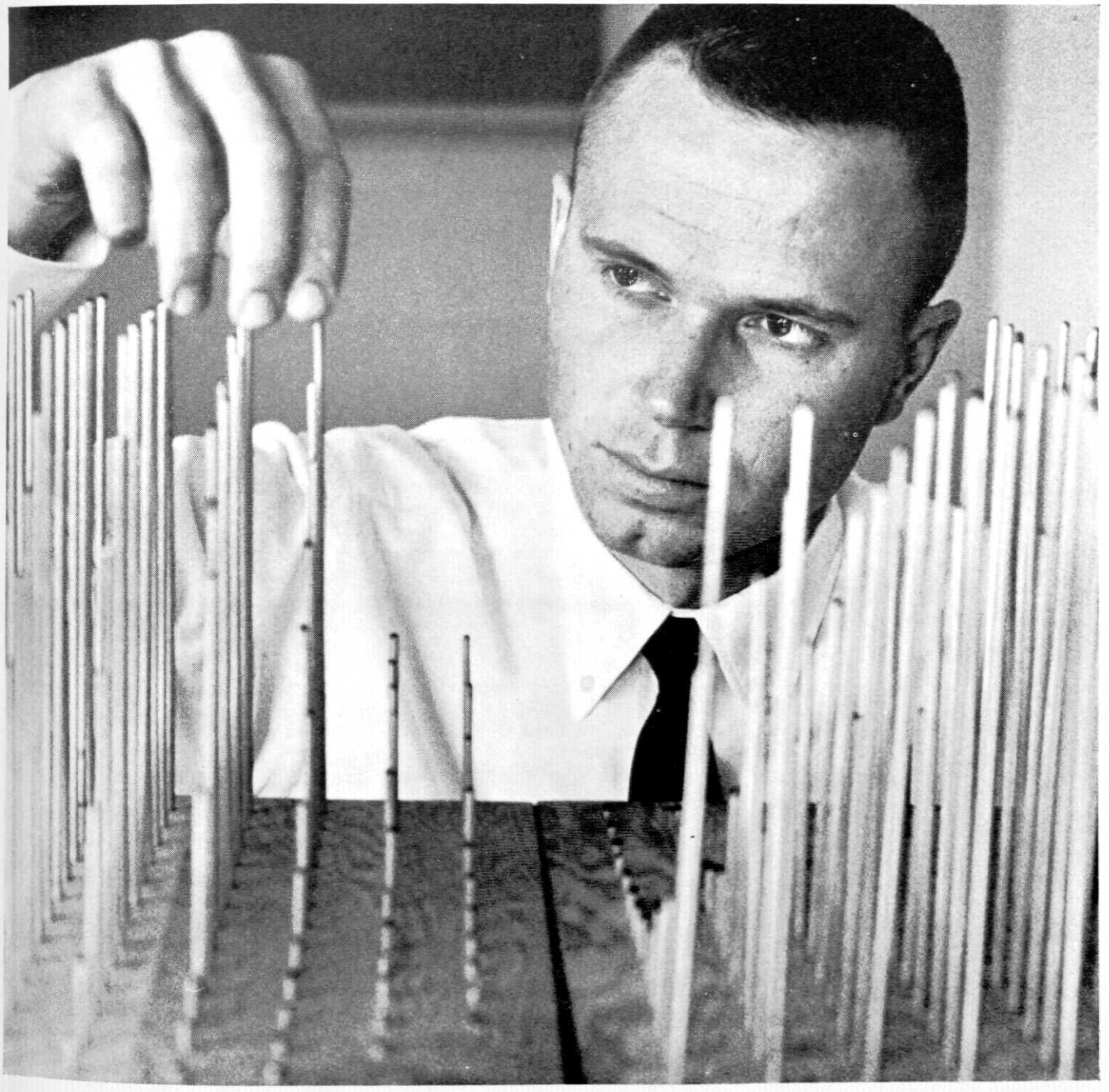


Figure 4. The state of the production line can be determined when plotted above.

We have seen that the modern quality control organization extends its operation to all phases of the industrial production process. It begins with customer specifications, consults with engineering, controls materials purchasing, oversees the manufacturing process, designs and runs the physical and electrical inspection procedures, checks packing and shipping and analyzes field complaints, thus reaching all the way to the customer. Quality control helps improve the quality of the product, ensures the safety and feasibility of the product design, reduces operating costs, pinpoints production line difficulties and even helps to improve employee morale by appealing to his pride of workmanship. It seems that quality control has become indispensable to the modern industrial process. ★★★

[1]Allen, Douglas H., *Statistical Quality Control*, Reinhold Publishing Company, New York, 1959.
[2]Bowker, Albert H., *Sampling Inspection by Variables*, McGraw-Hill Book Company, New York, 1952.
[3]Duncan, Acheson J., *Quality Control and Industrial Statistics*, Richard D. Irwin, Pub., Homewood, Ill., 1959.
[4]Feigenbaum, A. V., *Quality Control*, McGraw-Hill Book Company, New York, 1951.
[5]Kennedy, Clifford W., *Quality Control Methods*, Prentice-Hall, New York, 1948.
[6]*Quality Control in Action*, Report No. 9, American Management Association, New York, 1952.
[7]Shrock, Edward M., *Quality Control and Statistical Methods*, Rheinbold Publishing Company, New York, 1950.



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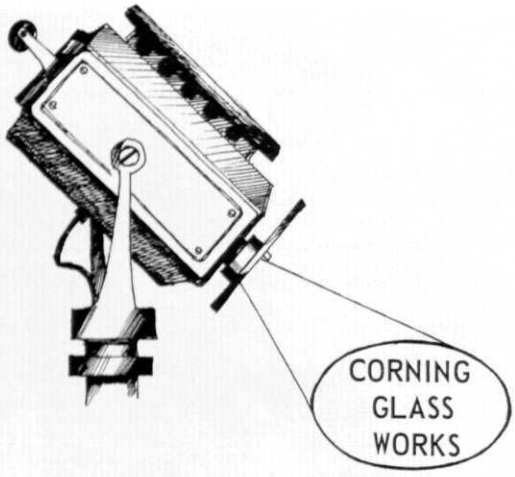


INDUSTRIAL SPOTLIGHT

GEMINI SPACECRAFT WINDOWS

by Dick Marett

The success of the National Aeronautics and Space Administration's Project Mercury is already a well established fact. The next step in the United States' space program is the Gemini program. In this program two men will be orbited around the earth instead of the one man as in Project Mercury. NASA's Manned Spacecraft Center calls the project the intermediate step between Mercury and the Apollo "man - on - the-moon" program. The Manned Spacecraft Center cites the objectives as:

"1. To provide early manned rendezvous capability by:

(a) developing techniques,
(b) assessing pilot functions,
(c) developing propulsion and control,
(d) developing pilot displays, and
(e) training pilots and providing them with rendezvous experience.

"2. To provide long-duration manned-flight by:

(a) studying effects of weightlessness,
(b) determining physiological reactions to long-duration missions,
(c) developing performance capabilities of the crew.

"These objectives have tremendous possibilities and will give NASA the necessary experience to go to the moon. The experience and knowledge of rendezvous techniques have other potential uses such as supply and crew transfer, a taxi to ferry personnel to orbiting space stations, to approach and look over objects orbiting in space, and later, maintenance and crew rescue."

Almost all of these objectives will require viewing capability.

The Gemini mission concept gives primary control responsibilities to astronauts -- more than was given under the Mercury concept. Mercury flights proved that man had capabilities, both psychologically and practically, to control his vehicle under trying conditions. More than once the windows in the Mercury spacecraft gave astronauts practical information and psychological assurance.

Similarly, the Gemini windows are designed to help astronauts meet mission objectives of:

1. Orbital flights of up to two weeks to determine man's performance under prolonged weightlessness.
2. Scientific investigations of space requiring human supervision and observation.
3. Rendezvous and docking with a target vehicle in earth orbit as an operational technique.
4. Controlled re - entry and landing at a pre-selected point.

In each of these, the astronauts will have to put the windows to efficient use.

It is the Corning Glass Works of Corning, New York who made the windows for Project Mercury and make the Gemini Windows.

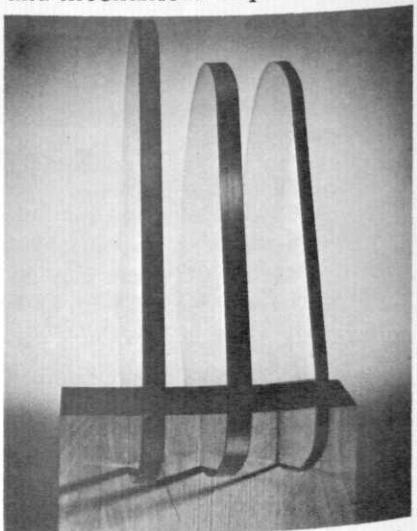
Each of the Gemini windows consists of three flat, parallel panels, with space between to cut down transfer of re-entry heat to the inside of the vehicle. Size of the window is about eight by seventeen inches. The two windows are set close to each other so that the two astronauts will each look almost directly through his own window while sitting beside his companion.

Because of the structure of the spacecraft and the fields of vision required by the astronauts, the windows are nearly eye-shaped. The peculiar shape is formed by a top and bottom arc joined at one end and a short straight line enclosing the other end.

The window's outer panel is a heat shield. It is made of Corning's high temperature 96 per cent silica glass, similar to that used by Corning for its Vycor brand products.

The inner panel is a specially strengthened aluminosilicate glass. It is designed to give as much mechanical protection to the astronauts as the metal walls of the vehicle.

The middle panel also is 96 per cent silica glass. Thicker than the other panels, it is designed to meet both thermal and mechanical requirements.



Edge-on view of panels of glass for the Gemini window illustrates relative thicknesses. Outer panel is at left; location of astronaut's eyes is at near-normal angle to the glass, at right.

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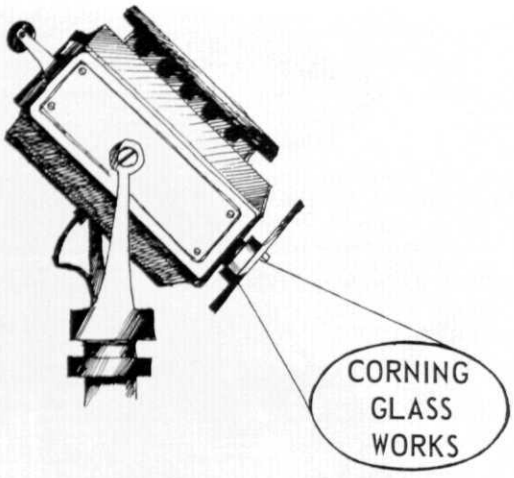


INDUSTRIAL SPOTLIGHT

GEMINI SPACECRAFT WINDOWS

by Dick Marett

The success of the National Aeronautics and Space Administration's Project Mercury is already a well established fact. The next step in the United States' space program is the Gemini program. In this program two men will be orbited around the earth instead of the one man as in Project Mercury. NASA's Manned Spacecraft Center calls the project the intermediate step between Mercury and the Apollo "man - on - the-moon" program. The Manned Spacecraft Center cites the objectives as:

"1. To provide early manned rendezvous capability by:

(a) developing techniques,
(b) assessing pilot functions,
(c) developing propulsion and control,
(d) developing pilot displays, and
(e) training pilots and providing them with rendezvous experience.

"2. To provide long-duration manned-flight by:

(a) studying effects of weightlessness,
(b) determining physiological reactions to long-duration missions,
(c) developing performance capabilities of the crew.

"These objectives have tremendous possibilities and will give NASA the necessary experience to go to the moon. The experience and knowledge of rendezvous techniques have other potential uses such as supply and crew transfer, a taxi to ferry personnel to orbiting space stations, to approach and look over objects orbiting in space, and later, maintenance and crew rescue."

Almost all of these objectives will require viewing capability.

The Gemini mission concept gives primary control responsibilities to astronauts -- more than was given under the Mercury concept. Mercury flights proved that man had capabilities, both psychologically and practically, to control his vehicle under trying conditions. More than once the windows in the Mercury spacecraft gave astronauts practical information and psychological assurance.

Similarly, the Gemini windows are designed to help astronauts meet mission objectives of:

1. Orbital flights of up to two weeks to determine man's performance under prolonged weightlessness.
2. Scientific investigations of space requiring human supervision and observation.
3. Rendezvous and docking with a target vehicle in earth orbit as an operational technique.
4. Controlled re - entry and landing at a pre-selected point.

In each of these, the astronauts will have to put the windows to efficient use.

It is the Corning Glass Works of Corning, New York who made the windows for Project Mercury and make the Gemini Windows.

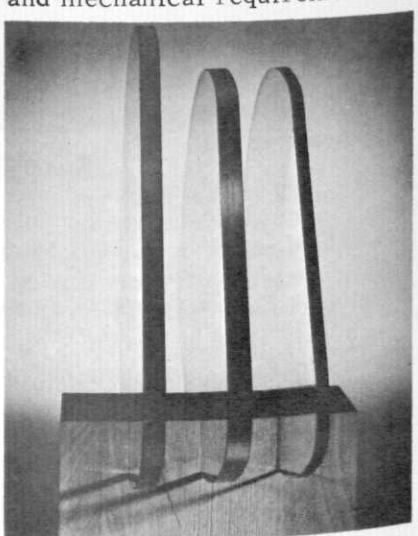
Each of the Gemini windows consists of three flat, parallel panels, with space between to cut down transfer of re-entry heat to the inside of the vehicle. Size of the window is about eight by seventeen inches. The two windows are set close to each other so that the two astronauts will each look almost directly through his own window while sitting beside his companion.

Because of the structure of the spacecraft and the fields of vision required by the astronauts, the windows are nearly eye-shaped. The peculiar shape is formed by a top and bottom arc joined at one end and a short straight line enclosing the other end.

The window's outer panel is a heat shield. It is made of Corning's high temperature 96 per cent silica glass, similar to that used by Corning for its Vycor brand products.

The inner panel is a specially strengthened aluminosilicate glass. It is designed to give as much mechanical protection to the astronauts as the metal walls of the vehicle.

The middle panel also is 96 per cent silica glass. Thicker than the other panels, it is designed to meet both thermal and mechanical requirements.



Edge-on view of panels of glass for the Gemini window illustrates relative thicknesses. Outer panel is at left; location of astronaut's eyes is at near-normal angle to the glass, at right.

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■ One of the many rewarding advantages of an engineering career at Allison is the association—in a creative environment—with outstanding scientists and engineers in their respective fields.

Dr. Y. S. Tang, Group Project Engineer in the Heat Transfer and Fluid Dynamics Section, is the calibre of man we believe you'd like to be associated with when you embark on your professional career.

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

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

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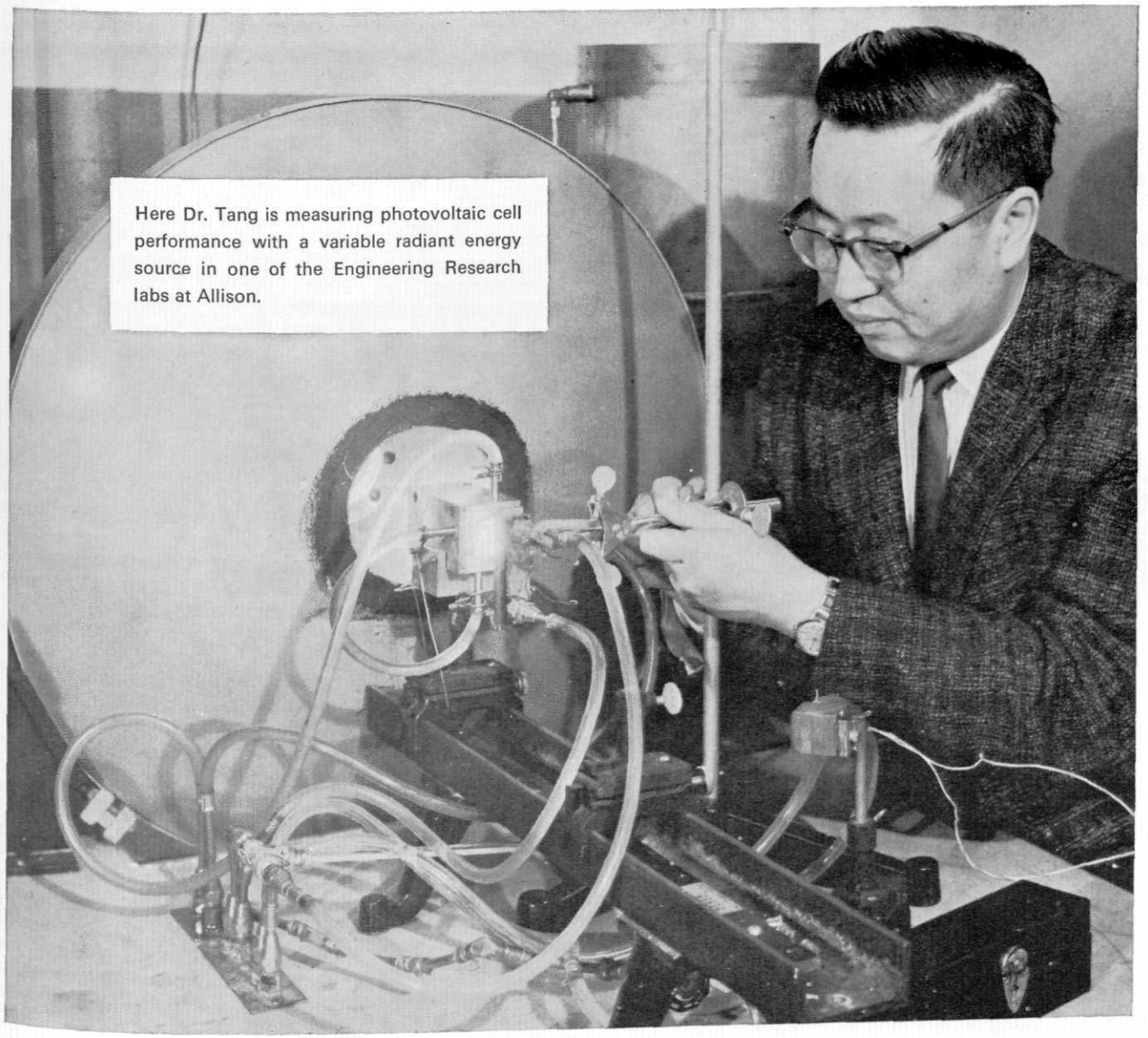


Here Dr. Tang is measuring photovoltaic cell performance with a variable radiant energy source in one of the Engineering Research labs at Allison.

CONTINUED FROM PAGE 30

The 96 per cent silica glass has a normal temperature service limit of 1,650 degrees Fahrenheit and an extreme service limit of almost 2,200 degrees. This enormous heat can be grasped more fully by contrasting it to a kitchen oven, which uses only a few hundred degrees to roast meat.

This glass is also highly resistant to thermal shock -- sudden and extreme changes in temperature -- because it has a relatively low coefficient of thermal expansion. The coefficient is approximately 4.4 X 10-7 degrees F. This low coefficient means that the glass doesn't change its shape under temperature changes.

The aluminosilicate glass doesn't match the thermal capabilities of the 96 per cent silica glass, but it is one of the strongest optical glasses known. For example, in a non-scientific test, one pound steel balls were dropped on panels of aluminosilicate glass from a height of several feet, without damage.

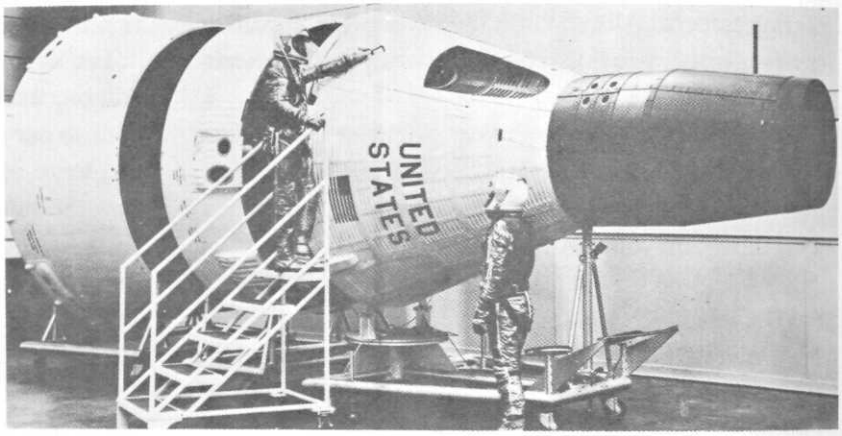
Expansion coefficient of this glass is approximately 25.5 X 10-7 degrees F., which is high enough to allow the glass to be significantly strengthened mechanically.

The longest dimension on the outer Gemini panel is 17.28-inch, the shortest is 8.33-inch and thickness is 0.33-inch.

On the two inner panels, the longest dimension is 15.30-inch and the shortest is 7.60-inch. The middle panel is 0.38-inch thick and the inner panel is 0.22-inch thick.

Special optical coatings on the panels are designed to reduce reflections from inside and outside light sources to a minimum. The coatings are necessary because, unless compensated, reflections are a usual outcome of multi-panel composite windows, especially if a viewer happens to look through them at an angle.

In the Gemini spacecraft, the windows are not set flush with the outside contour of the craft. Instead, they are set in wells so that they are almost vertical to the astronauts' line of vision. One reason for this design is that it allows an astronaut to look through his window at a nearly normal angle. Another is that it allows him to look down the nose of his spacecraft directly at the vehicle he is approaching during rendezvous and docking maneuvers in orbit.



Side view of Gemini engineering mockup shows that windows are set in wells.

Examples of maneuvers which might be attempted while in orbit or landing are:

Rendezvous with an unmanned Agena D vehicle, a modified version of the Agena B used in other space projects;

or, astronaut-controlled landing in a pre-selected area, necessarily using windows all the way to the point where the vehicle comes to a halt.

Thus, Corning plays an important role in fabricating the Gemini windows, considered by NASA's Human Factors Engineers to be one of the invaluable items for the welfare of the astronauts.

GAS TURBINE HEAT EXCHANGERS

The Rover B.R.M. is a gas turbine car built by the Rover Company and the Owen Organization, both of England. In 1963, it was the first gas turbine car to complete the French Le Mans 24-Hour Race, running without heat exchangers and bettering the required minimum speed of 93.225 miles per hour.

This year the car was entered in the two liter class with an engine utilizing two Corning regenerative heat exchangers.

In describing work with heat exchangers, Rover's chief turbine engineer, Noel Penny, emphasized, "We are confident that no other heat exchanger can take the place of the glass-ceramic regenerators."

One of the chief advantages of the glass-ceramic units, he said, is their temperature capability. The present Rover B.R.M. gas inlet temperature at the exchangers is 1300 degrees F. He noted that the exchangers have a design temperature limit of 2000°

Corning's Cercor disc regenerators for the Rover are made of a matrix containing triangular cell passages of thin-walled Pyroceram glass-ceramic, with solid hubs and rims of the same composition. The entire disc is 17.5 inches in diameter and three inches thick.

The exchanger contributes to operating economy and performance because a portion of the disc is heated by exhaust gases, then rotates into the stream of cool intake air. It thereby preheats the air before it reaches the combustion chamber.

With the Corning glass-ceramic heat exchangers, sealing and seal wear problems are solved. Penny said he is currently running engines with less than two per cent total air loss due to leakage under the seals and through the matrix walls. Seal and matrix wear in 1000 hours is nearly zero. He pointed out that Corning virtually eliminated matrix wall porosity during Le Mans race preparation.

Properly mounted in the engine the Corning glass-ceramic exchangers withstood extreme vibration and shock without damage when a car was driven 500 miles over test roads made of Belgian blocks.

Penny reported, "If simple cycle small gas turbine engines are ever to be acceptable for vehicle propulsion, it would seem imperative that this form of heat exchanger is used, as no other now used or being developed will be able to withstand the general and continuous increase in cycle temperatures at a realistic price.

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The Pre-Registration Data Processing System at MSU

Registration at MSU has been made considerably faster and more efficient this year through the advent of a machine oriented Pre-Registration System. Utilizing the IBM 1401 computer and the IBM 1230 optical reader, this system allows a growing student body to complete the registration process in two days.

The student, under this new system, must still confer with his academic advisor to decide upon the courses he wishes to take, schedule his courses according to the time schedule for the coming term, and put this information on a Student Schedule Card. Then, however, during the fifth or sixth week of the current term, he must fill out a Registration Section Request form, blocking in with a pencil the appropriate spaces for his student number and the course sequence numbers for the sections of the courses in which he wishes to enroll. Thus the student's roll in pre-registration is completed.

Several times during each day of pre-registration the Registration Section Request forms are sent to Olds Hall, where they are processed by an IBM 1230 Optical Mark Scoring Reader. There are two of these machines in Olds Hall whose function is to read positional marks on standard 8 1/2" x 11" paper. Normally, as in scoring tests for the University College, the IBM 1230 will merely count the number of marks in certain positions and print the total in the right hand margin of the paper, but for use in pre-registration there is a card punch attached which punches first the student number and then the schedule sequence numbers read by the IBM 1230 on an 80-space IBM card. Any Registration Section Request which is incorrect, with multiple marks or stray marks on the form, is automatically dumped by the machine for clerical evaluation before punching.

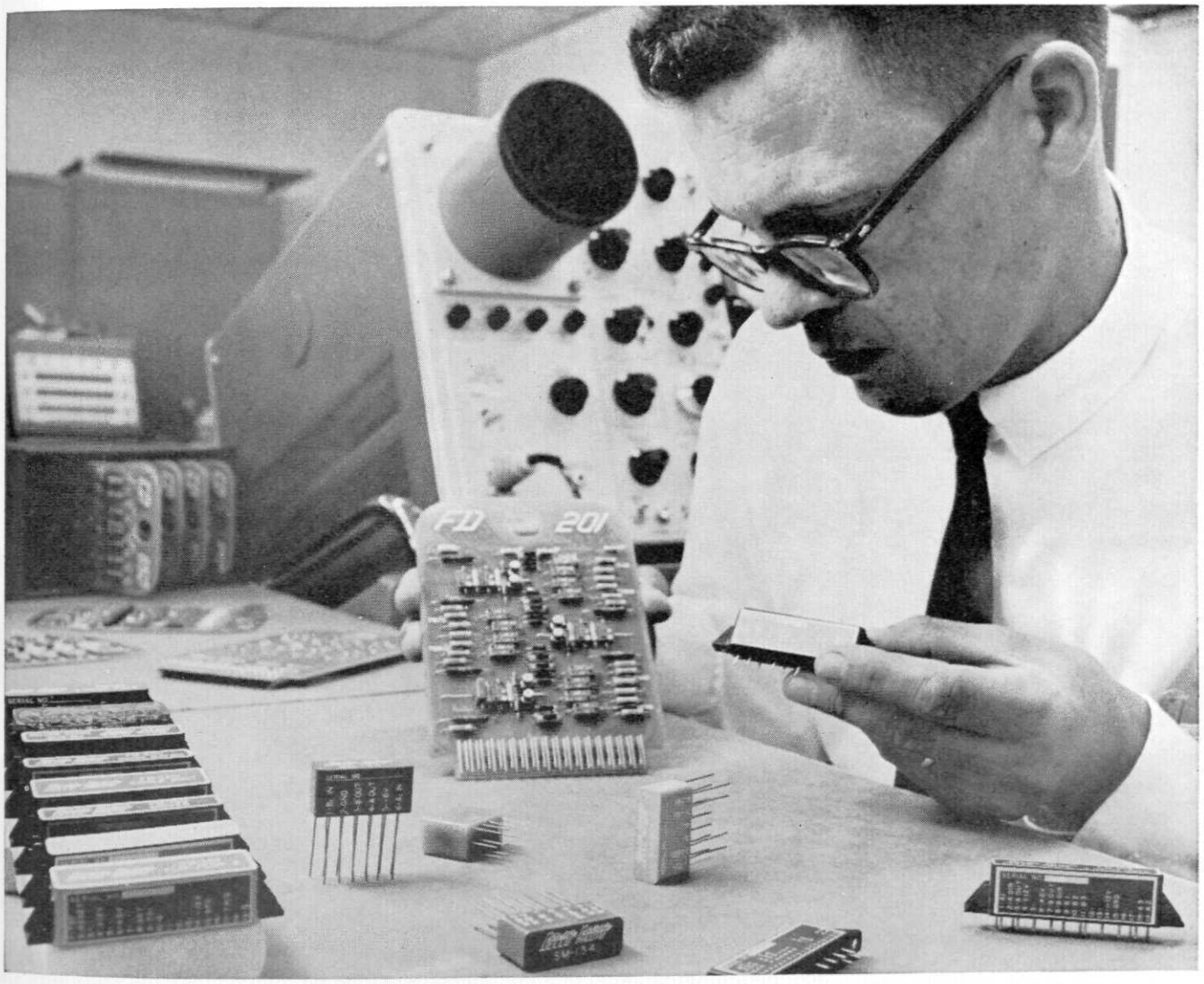
The information on these punched cards is read onto tape and fed to an IBM 1401 Model C 5 Processing Unit. With the installation of a second IBM 1401 on last January fourth, there are now two of these computers located in Olds Hall, each complete with an IBM 1402 Model 1 Card Read Punch, an IBM 1403 Model 2 Printer, an IBM 1406 Model 2 Storage Unit, and four IBM 729 Model II Magnetic Tape Units. Running twenty-four hours a day, five or six days a week, these two computer systems should be adequate to handle all university business and the registration processes besides until Fall, 1966. The IBM 1401 takes the data from the day's Registration Section Requests and compares it to the student master tape, reading out to the IBM 1403 Printer the student master data, such as the curriculum, class, name and sex of each student. It then compares the data to the master class tape, and reads out to the Printer the course descriptions, sections and credits for which each student has pre-registered. The totals of students pre-registered in each section of each course are compiled each day, then added to the totals for the previous days of pre-registration. Then, each evening, a report of current class enrollment is prepared. Closed sections are identified and posted in the pre-registration area by 8:00 AM the next morning.

Of course, since this day by day record of pre-registration is made, many changes and corrections of clerical errors can be made within the pre-registration process. For example, if a Chemistry section with a capacity of sixty students has been mistakenly listed as having a capacity of twenty, and is therefore closed after one day of pre-registration, it is not a difficult matter to have the section reopened with its correct capacity of sixty within a day after the mistake is found.

After the last day of pre-registration, the IBM 1401 finally reads out to the Printer preliminary class lists, a report of student credits by course, level, department, and college, a pilot enrollment report, and a report of students per major per college per level. These reports are distributed by the next week to each college for review by assistant deans and departmental chairmen. Decisions about splitting sections, adding sections, and dropping sections can then be made before final registration. These Preliminary Registration Reports, after being corrected by each college, are then returned to the IBM 1401 and corrections made in the master class tape.

Pre-Registration Section Reservation Reports are finally made for each student, to be obtained by the students during the eighth week of the current term. Students are assured space in any course for which they are pre-registered if they complete their final registration at the proper time. Sections for which a student did not receive reservations may be changed to sections which are still open at the time that these Pre-Registration Section Reservation Reports are picked up, or a student may change courses at this time through add-forms or drop-forms from his academic advisor.

Through the use of this computerized pre-registration procedure, there were only 17 out of 4,000 sections changed at the time of final registration, as compared with a norm of several hundred changes at final registration in previous terms. Seventy-two per cent of all sections were filled and finalized during pre-registration. With the speed and increased accuracy of this new system, the university has no major problems concerning the processing of students for registration which would prohibit indefinite expansion of the number of students.



FROM CAMPUS TO CAREER WITH DELCO RADIO

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

Like other talented young engineers at Delco, Dewey can enjoy the prospects of a longtime, satisfying career with this stable electronics division of General Motors. He can look forward to a happy future for his family in the friendly, growing environment of Kokomo, Indiana where schooling is tops ... desirable new homes and apartments plentiful . . . cultural and recreational attractions nearly endless. And both Purdue and Indiana Universities offer undergraduate and graduate work locally.

As a young graduate engineer you, too, might soon be on your way to a challenging and rewarding career with Delco Radio. You'll find abundant opportunities in such areas as silicon and germanium device development, ferrites, solid state diffusion, creative packaging of semiconductor products, development of laboratory equipment, reliability techniques, and applications and manufacturing engineering.

Our brochure detailing the opportunities to share in forging the future of electronics with this outstanding Delco-GM team is yours for the asking. Watch for Delco Radio interview dates on your campus, or write to Mr. C. D. Longshore, Dept. CR, Delco Radio Division, General Motors Corporation, Kokomo, Indiana

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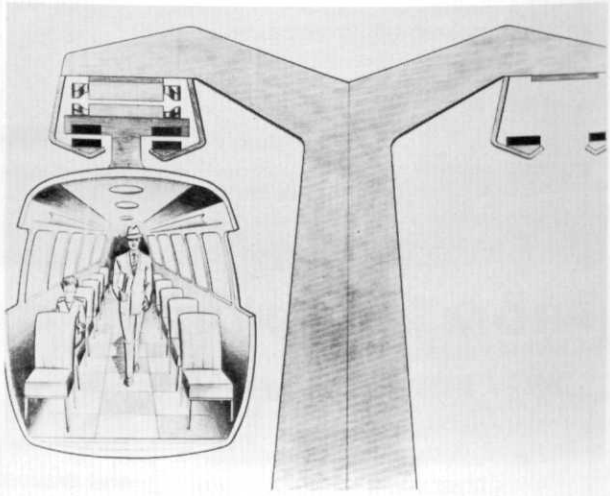
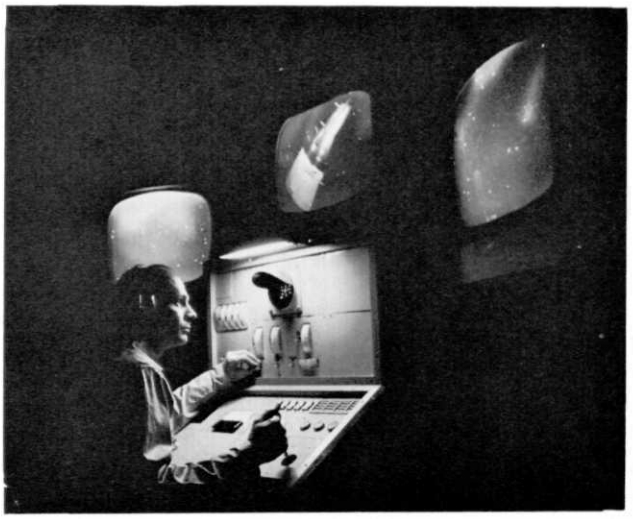
Industrial News

These new longspan steel joists by Ceco Steel Corporation are one-piece units which come in sizes up to 144 feet long and 72 inches high. Here, a gymnasium roof is constructed of 111 foot by 52 inch joists. They provide direct support of roof decks between widely spaced masonry walls, thus eliminating the need for pillars, crossbeams, or other supports. They were designed specifically for longer clear-span construction of supermarkets, gymnasiums, industrial plants, bowling alleys, and other buildings requiring column-free floor area. There are two series of these joists, the stronger of which is hot-rolled high-strength steel with a load-carrying capacity of 50,000 psi.

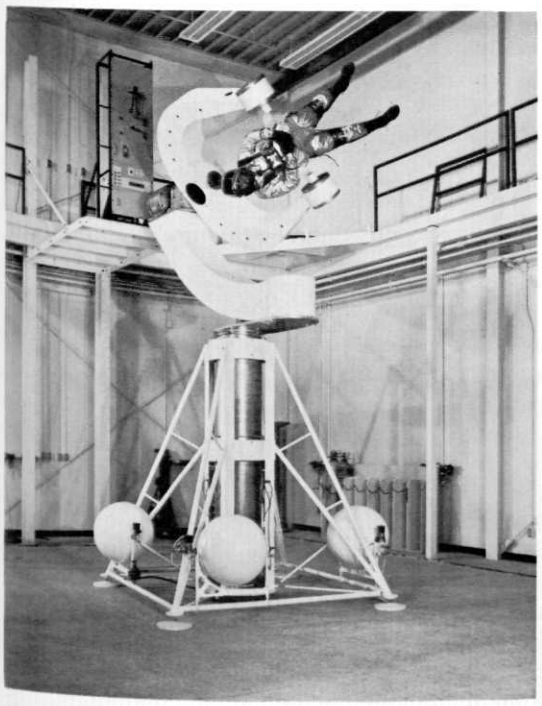
This artist's drawing shows the essential elements of a new concept in mass transit – an elevate "magnetic highway" over which wheel-less vehicles safely travel at speeds above 150 miles an hour. Proposed as a future system by Westinghouse research engineers, permanent magnets built into both cars and roadway would "float" the vehicles by magnetic repulsion. The cars would be driven by a linear electric motor, that is, one which is cut apart and stretched out lengthwise along the top of the cars and the underside of the roadway. Electricity, flowing through the motor, would drag the vehicles along without friction between them and the track.



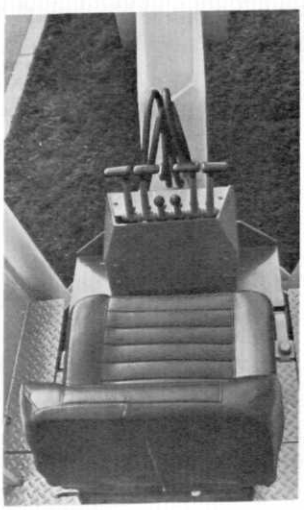
This transparent glass tube, nearly five feet long and 16 inches in diameter, is designed to carry recording instruments 20,000 feet beneath the sea this spring in a U. S. Navy research program. The borosilicate glass capsule was made by Corning Glass Works and is being tested by Pennsylvania State University's Ordnance Research Laboratories. Glass was specified because of its great strength and buoyancy. The capsule, which will be fitted with aluminum end plates, is formed by sealing together seven ribbed sections, and is designed to withstand undersea pressures greater than 9,000 pounds per square inch.

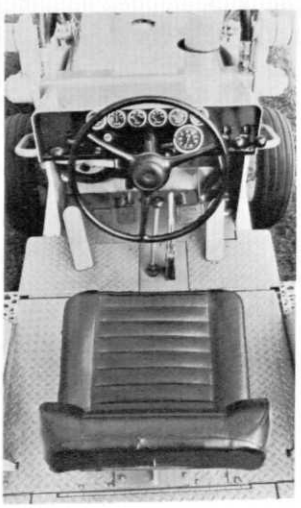


These TV screens are actually computer-driven views of exactly what would be seen by an astronaut. The manned orbital laboratory simulator shown here is part of an advanced system, called an Integrated Manned Space Systems Simulator, which is nearing completion at the Astronautics division of General Dynamics Corp., San Diego. When completed, the entire system will be capable of simulating in detail every conceivable manned mission in earth orbit, to the moon, or to any planet in the solar system. Its purpose is to study man's role in space to gain a better understanding of the requirements for crew systems and spacecraft design.



This machine is designed to test what manner of tasks can be performed in space by a weightless astronaut. The fifteen foot vehicle, operating on near-frictionless air bearings, is under development by the Convair division of General Dynamics Corp., San Diego. It is the first weightlessness simulator to permit an "astronaut" to float in mid-air, essentially completely free of friction in all modes and directions including up and down, lateral motion, rolling, tumbling, and spinning. The vehicle will be used as a tool for studying the spacecraft design requirements for astronauts who will fly orbital laboratories and other future spacecraft.





Detroit's race to the bucket seat has infected even the manufacturers of heavy-duty machinery. The Clark Equipment Company has introduced a new backhoe loader which features a single, contoured, upholstered seat that adjusts in or out, tilts up or back, and turns a full 360 degrees to give the driver full control of all operations without getting up. Ditching, moving up, loading and traveling are controlled without time lost in moving to and adjusting a second seat to control various operations.

THE STRESS ANALYSIS OF AN EVENING GOWN

by Hugh Jardon

SINCE THE beginning of recorded history, the human being has worn some type of clothing either for protection or warmth. However, the present trend among the "fair sex" is to wear clothing not for protection or warmth, but solely to attract the attention of the opposite sex. To be more specific, it is through the use of clothing that the female most effectively catches the eye of every appreciative but totally unsuspecting male.

A variety of methods are employed to bring about this libido awakening infliction on the poor male. One very popular method employed by the female is to wear transparent, or seemingly transparent cloth to good advantage in certain areas. A common example of this type of clothing is the transparent nylon blouse. Another powerful attention-gathering device is the tightly fitting garment. A well known example of this type of weapon is the sweater. Yet another provoking method is by actually reducing the amount of body area covered by cloth. A good example of this method is the modern bathing suit. A delightful device which has sufficiently aroused the notice and curiosity of the masculine sex is the use of durable but fragile appearing cloth which gives the impression that at any moment the garment will slip down or that, better yet, certain parts might slip out of place. The best example of this method of attracting the attention of the weak and susceptible male is the strapless evening gown.

Effective as the strapless evening gown is in attracting attention, it presents tremendous engineering problems to the structural engineer. He is faced with the problem of designing a dress which appears as if it will fall off at any moment and yet actually stays up with some small factor of safety. Some of the problems faced by the engineer readily appear from the following structural analysis of strapless evening gowns.

If a small elemental strip of cloth from a strapless evening gown is isolated as a free body in the area of plane A of Fig. 1, it can be seen that the tangential force F is balanced by the equal and opposite tangential force F. Also the downward vertical force W caused by the weight of the dress below plane A is balanced by the force F acting vertically upward due to the stress in the cloth above plane A. Therefore, since the algebraic summation of vertical and horizontal force is zero, and no moments are acting, the elemental strip is in equilibrium. But consider an elemental strip of cloth isolated as a free body in the area of plane B of Fig. 1. The two tangential forces F_1 and F_2 are equal and opposite as before, but the force W due to the weight of the dress below plane B is not balanced by an upward force F because there is no cloth above plane B to supply this force. The algebraic summation of horizontal forces is zero but the algebraic summation of vertical forces is not. Therefore, this elemental strip is not in equilibrium but it is imperative, for social reasons, that this elemental strip be in equilibrium. If the female is naturally blessed with sufficient pectoral development, she can supply this very vital force and thereby place the elemental strip in equilibrium. If she is not, the engineer has to supply this force by artificial methods.

In some instances the engineer has made use of friction to supply this force. The friction force is expressed by $F = fN$ where F is the frictional force, f is the coefficient of friction and N is the normal force acting perpendicularly to F. Since for a given female and a given dress, f is constant; then to increase F, the normal force N has to be increased. One obvious method of increasing the normal force is to make the diameter of the dress at line C, Fig. 2, smaller than the diameter of the female at this point. This has, however, the disadvantage of causing the fibers along line C to collapse and if too much force is developed the wearer will experience undue discomfort.

As if the problem were not complex enough, some females require that the back of the gown be lowered to increase the exposure and correspondingly attract more attention. In this case the horizontal forces F_1 and F_2 are no longer acting horizontally, but are acting downward at an angle α with the horizontal as shown by T_1 and T_2 of Fig. 1. Therefore, there is a total downward force equal to the weight of the dress below plane B plus the vector summation of F_1 of the two inclined forces, T_1 and T_2. But this vector sum F_1 increases in magnitude as the back is lowered because $F_1 = 2T$ since the angle α increases as the back is lowered. Thus the vertical upward force F which has to be supplied for equilibrium is greatly increased for low-back gowns. Also since there is no cloth around the back of the wearer, the force acting through the elemental strip B, perpendicular to the vertical axis of the female, is greatly reduced and it is this force which keeps the evening gown of the lady from falling forward, away from the wearer—attracting attention by this method is considered unfair tactics among females. Therefore, for very low-back evening gowns the engineer has to resort to bone or wire frameworks to supply sufficient and perpendicular forces.

If the actual force supplied is divided by the minimum force that is required to hold the dress up, the resulting quotient defines a factor of safety. This factor of safety should be as large as possible, but there the engineers run into the difficulty of keeping frameworks light and inconspicuous. Therefore, a compromise must be made between a heavy framework and a low factor of safety. With ingenious use of these frameworks, the backs of strapless gowns may be lowered until cleavage is impending. Assuming the female is naturally endowed to supply the vertical force F still leaves the problem incomplete unless an analysis is made of the structures supplying this force. These structures are of the nature of cantilever beams. Fig. 2 shows one of these cantilever beams (minus any aesthetic details) removed as a free-body (and indeed many such beams can be, in reality, removed as free-bodies). Since there are usually two such divided, the force acting on any one beam is F/2. This force is distributed over the beam from A to F of Fig. 2. More exposure and correspondingly more attention can be had by moving the dress line from A toward B. Unfortunately there is a limit stress, P = vertical force F/2, and A = area over which the bearing stress acts, then

$$S = P/A = \frac{F}{2} X \frac{1}{A}.$$

Since F/2 is constant, if the area A is decreased, the bearing stress S must increase. The limit of exposure is reached when the area between B and C is reduced to a value which causes the bearing stress to increase to the "danger point."

A second condition exists which also limits the amount of exposure. The vertical force, F/2, is balanced by a shear force S acting on the area from D to E and by an internal moment M, Fig. 2. The moment M causes tension in the fibers of the beams between E and A and compression in the fibers between C and D. As the dress line is moved from A toward B the moment M is increased, thereby increasing the tension and compression of the fibers. The second limit of exposure is reached when the tension and compression stresses in these critical areas reach the "danger point."

Since these evening gowns are worn to dances, an occasional force F shown in Fig. 2, is accidentally delivered to the end of the beam causing impact loading. This impact loading causes compression in all the fibers of the beam. This compression tends to cancel the tension in the fibers between E and B but it increases the compression in the fibers between C and D. The critical area is at point D, as the fibers here are subjected not only to compression due to moment and impact, but also to shear force due to the force S. With the combination of a low, heavy dress and impact loading, the fibers at point D can be stressed to the "danger point."

There are several reasons why these properties have never been determined. For one, there is a scarcity of these beams for experimental investigation. Many females have been asked to volunteer for experiments along these lines in the interest of science, but, unfortunately, there have been no cooperative subjects. Also, there is the difficulty of the investigator having the strength of mind to ascertain purely the scientific facts. Meanwhile, trial and error and shrewd guesses will have to be used by the engineer in the design of strapless evening gowns until thorough investigations can be made.

From *California Engineer*,
by Charles E. Siem

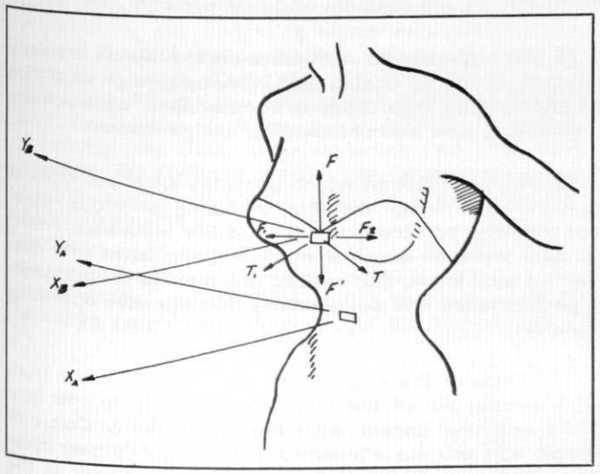


Fig. 1 above shows the free body of the material in question. Due to the irregularity of the supporting body many forces must be considered in the analysis.

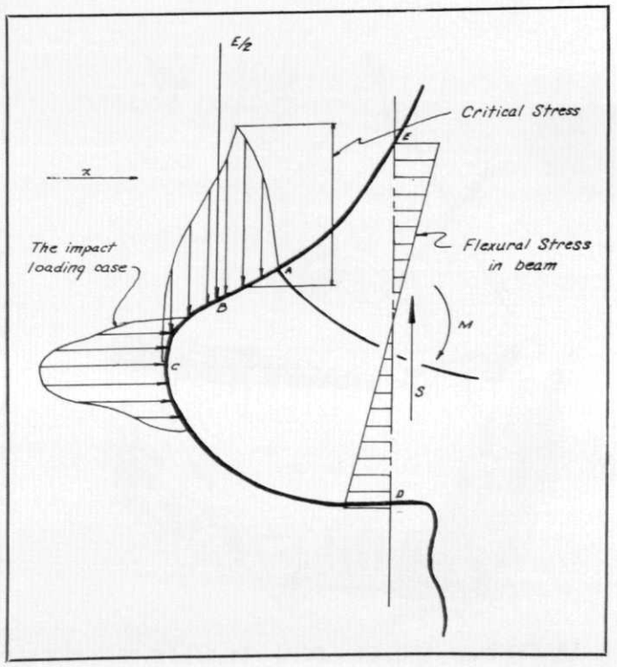


Fig. 2 at right is the bending moment diagram of the beam under shear stress and impact loading.

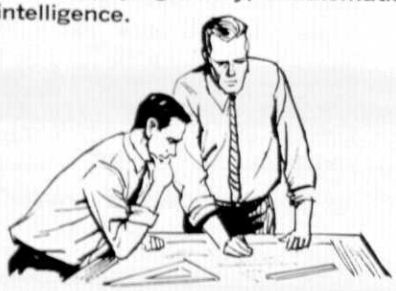
CONSTRUCTION

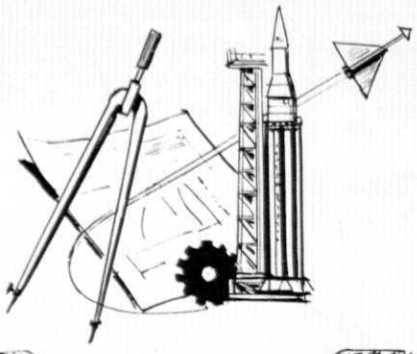
THE ARMY CORPS OF ENGINEERS

offers you a challenging civilian career with:

■ The world's foremost and largest engineering organization in the construction field, pioneering new and advanced engineering practices and concepts.

■ An organization whose work embraces virtually the entire range of modern engineering in the construction field. Projects include research into basic science, engineering investigations and regional planning; design, construction, operations, maintenance, and management of hydro-electric power dams, flood control facilities, harbors and navigable streams; design, construction and maintenance of family housing, runways, hangars, roadways, hospitals, and nuclear power installations; and construction of intercontinental ballistic missile and space launching sites. In addition are the allied fields of cartography, geodesy, mathematics, and engineer intelligence.





■ An organization that recognizes each engineer as an individual, providing well-rounded career development programs with on-the-job training; courses at government expense in colleges, universities, and seminars as necessary to assure steady progression to top professional and managerial levels; encouragement and assistance in attaining professional registration and recognition; and an opportunity to win national and international awards.

■ An organization with offices and projects in nearly every one of the 50 States and in many foreign countries that encourages employees to further their development by accepting new and challenging assignments.

■ An organization which provides excellent rates of pay with liberal fringe benefits, including generous retirement annuity, complete health and life insurance coverage, paid vacation leave, military training leave with pay, generous sick leave; and special pay awards for outstanding performance and suggestions that improve operating efficiency.

If you're thinking this is all too good to be true, you're wrong! All of the above is available to you in a civilian engineer career with the U. S. Army Corps of Engineers. If you are interested, you can get further information from the Chief of Engineers, Department of the Army, Washington, D.C. 20315.

AN EQUAL OPPORTUNITY EMPLOYER

WRITE FOR AN ILLUSTRATED BROCHURE "YOUR CAREER."

Uncertain about these career decisions?

a. Join a large company? ( ) or medium? ( ) or small company? ( )

b. Prefer to work in systems analysis and techniques? ( ) or on equipment design? ( ) or multi-unit large systems? ( )

c. Aim to be a Technical Specialist? ( ) or Administrative Manager? ( ) or Program/Project Manager? ( )

d. Have an advanced degree in your sights? ( ) or feel BS is sufficient for satisfying career growth? ( )

Don't worry!

For those graduates who are uncertain regarding their career plans, we welcome the opportunity to discuss the wide variety of interesting and challenging assignments available with Sylvania Electronic Systems. SES is equipped to foster the professional growth of graduates with widely differing goals. This is possible primarily because SES is actually a highly diversified complex which encompasses 19 R&D laboratories, 4 manufacturing plants and a world-wide field engineering operation. The Division's mission is to manage government systems programs for General Telephone & Electronics, the parent corporation.

The small group form of organization — a traditional small company advantage — is practiced at SES to encourage individual progress and development. SES offers its personnel absorbing assignments to perform, yet also affords a bird's-eye view of the total picture in advanced electronics.

A wide variety of current in-house projects enables you to move right into the heart of today's most advanced developments in electronic systems. You may start here in a technical or administrative capacity in any one of these broad areas: **space/earth communications · electronic reconnaissance · detection · countermeasures · information handling · arms disarmament and control · sophisticated electronic networks such as the ground electronics system supporting Minuteman command and control functions.**

Finally, opportunities are numerous for ambitious individuals to accelerate their advancement through participation in division-wide conferences, in-plant courses and seminars, and post graduate study plans conducted on an unusually generous scale.

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GENERAL TELEPHONE & ELECTRONICS

Total Communications from a single source through

SYLVANIA ELECTRONIC SYSTEMS

SES LABORATORIES ARE LOCATED SUBURBAN TO SAN FRANCISCO, BUFFALO AND BOSTON

For further information about any of these locations, see your college placement officer or write to Mr. Robert T. Morton

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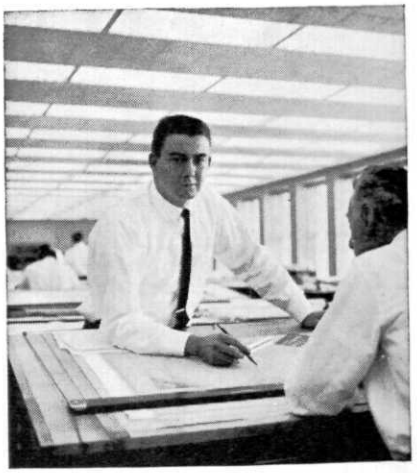
Men on the move at Bethlehem Steel

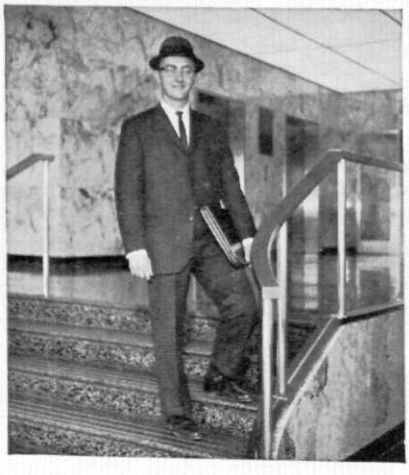
BRUCE SHAFEBOOK, MET.E., LEHIGH '60—Bruce supervises the metallurgical lab that watchdogs the quality of alloy, tool, and bearing steels made at our Bethlehem, Pa., Plant.

JACK LAMBERT, E.E., KENTUCKY '60—Jack works on design, installation, and maintenance of power stations, distribution networks, motors, and drive systems at our Steelton, Pa., Plant.



DON McCANN, M.E., PRATT '60—After experience as a maintenance, design, and construction engineer, Don became a cost-control specialist at our Lackawanna Plant, near Buffalo, N.Y.

BERNIE BAST, CH.E., PENN STATE '61—An engineer in our research laboratories in Bethlehem, Pa., Bernie is shown making distillation studies for a research project on coal chemicals.

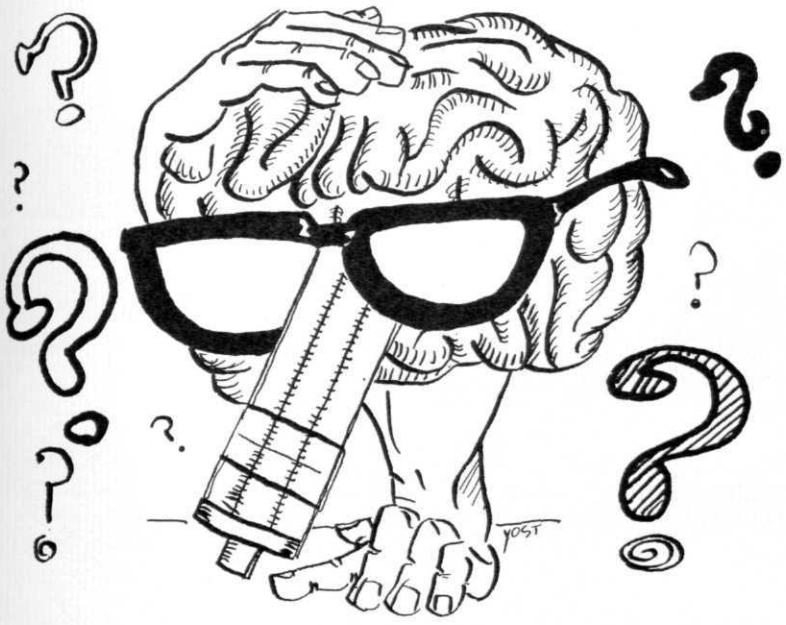


ALVIN TYLER, MET.E., CASE INSTITUTE '60—"Tim" is a salesman assigned to our Buffalo District. His technical training is a valuable asset in selling steel products.

DON DIXON, C.E., MASSACHUSETTS '60—A field engineer in our Fabricated Steel Construction Division, Don supervises steel erection for major buildings and bridges.

These alert young men are a few of the many recent graduates who joined the Bethlehem Loop Course, one of industry's best-known management development programs. Want more information? We suggest you read our booklet, "Careers with Bethlehem Steel and the Loop Course." Pick up a copy at your Placement Office, or write to our Manager of Personnel, Bethlehem, Pa.

An equal opportunity employer



BRAIN SPRAINERS

EDITOR'S NOTE: Answers to the following puzzles will appear in the next issue of the Spartan Engineer.

Wishes are horses, provided that horses cannot fly. Beggars will not ride, provided that wishes are not horses. If it cannot be the case that both beggars will ride and wishes are non-equine, then horses can fly. If the inability of horses to fly, and the non-riding of beggars, cannot be set up as valid alternatives, then beggars are not always rich. But beggars will ride. Are beggars rich?

SE

From each of 2 diagonally opposite corners of an 8" x 8" board, a 1" x 1" square is cut. Can the remainder of the board be completely covered by 2" x 1" strips without lapping?

SE

Two flights of bombers were flying at 300 mph on converging courses 30 degrees apart, each flight being 240 miles from the rendezvous. From above each flight a fighter plane, flying at 500 mph, flew to the other bomber flight and returned, continuing the shuttle until the bomber flights met. One fighter always headed directly toward his objective, while the other fighter always flew an interception course. Which fighter flew the greater distance, and how much farther did he fly?

SE

Find the smallest number with 28 divisors.

SE

A cube of wood 3" on each edge is to be cut into cubes 1" on each edge. If, after each cut with a saw, the pieces may be piled in any desired manner before making the next cut, what is the smallest number of different "cuts through the pile" that will accomplish the desired disection?

There are two numbers formed of the same two digits in reverse order. The sum of the numbers is 33 times the difference between the two digits, and the difference between the squares of the two numbers is 4752. Find the numbers.

SE

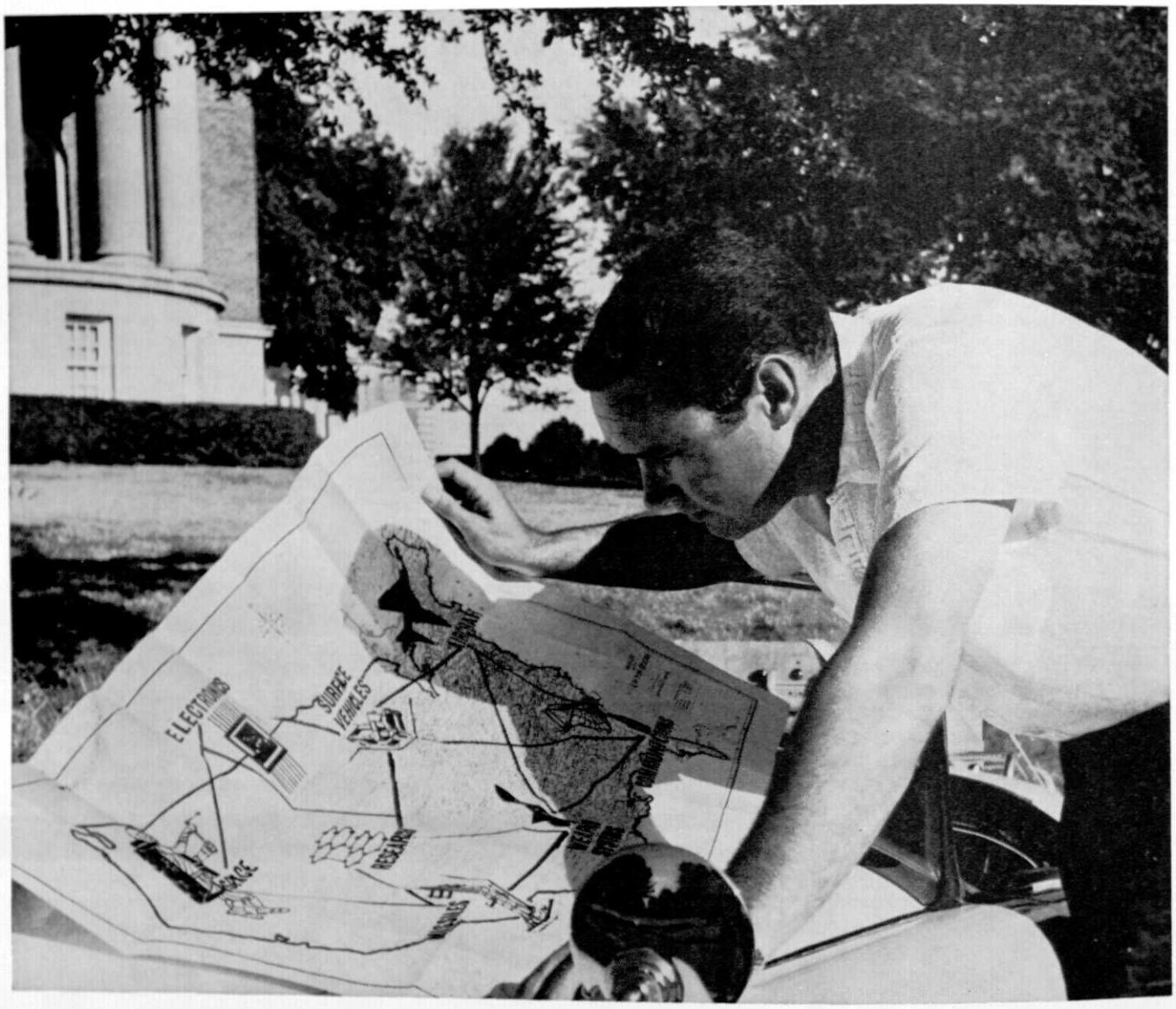
A man looking at a portrait says: "That person's father was my father's son. I have no brothers and no sons." What was the relationship of the person in the portrait to him? Don't jump to any conclusions.

SE

Answers to Last Month's Questions:

1. The train is traveling 15 mph.
2. The garrison had 49,500 lbs. of bread.
3. If x equals width, then 600 - 2x equals the length, since one entire length is replaced by the pond. Maximum area is 45,000 sq. yds.
4. The winning abilities of the players from highest to lowest is: Frank, Joe, Jim, Tom and John.
5. The computation is in the duodecimal scale (to the base 12), so 1/5 of 10 is 2 2/5.
6. There are 52 people at the party.

SE



GOING OUR WAY?

If you're mapping out your career destination, Ling-Temco-Vought offers a wide choice of exciting and challenging routes to your personalized goal.

Here at LTV, young, alert engineers are "going places" in the fields of aircraft, missiles, space, mobile surface vehicles, weapons systems, ground and airborne communications, electronics, and range services. Supporting these activities is an excellent engineering climate providing the opportunity to contribute and professional advancement which is a direct function of the contribution. Assignments are diversified and stimulating in such areas as: **aerodynamics • avionics and instrumentation • dynamics • systems design • propulsion • stress analysis • communications design • telemetry and tracking • reconnaissance systems • amplifier and computer design • electromagnetic interference control • technical administration . . .** among others.

In addition to a rewarding professional environment, LTV offers engineers the opportunity to earn advanced degrees through company-financed graduate education programs.

Before selecting your industrial home, investigate the career avenues available with Ling-Temco-Vought. Get complete details from your Placement Office or write College Relations Office, Ling-Temco-Vought, P. O. Box 5907, Dallas, Texas 75222. LTV is an equal opportunity employer.

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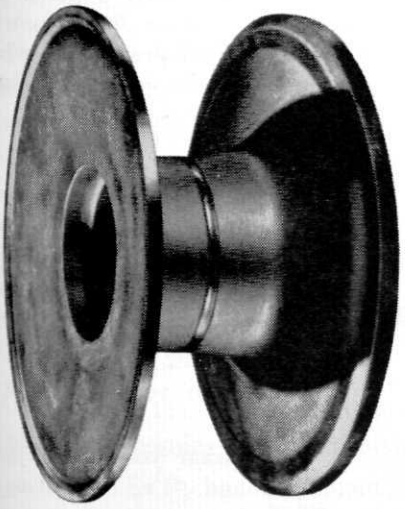


FORGINGS ELIMINATED REJECTS ON THIS EARTHMOVER HUB . . . *and cut cost 16%*

Originally, this earthmover wheel hub was not a forging. Now it is **forged** in steel. Here's why . . .

While reviewing costs of the original part, the earthmover manufacturer discovered that: (1) Cost of the hub was too high; (2) rejection rates during machining were high because of voids and inclusions; and (3) hidden flaws required costly salvage operation.

By converting to **forged** steel hubs, the manufacturer has saved 16%, has completely eliminated rejects and repairs of parts in process, has achieved 100% reliability of the part.

Forgings have greater inherent reliability and strength because they:

1. Are solid, void-free metal
2. Have higher resistance to fatigue
3. Are strongest in withstanding impact and sudden load
4. Have high modulus of elasticity
5. Have low mechanical hysteresis
6. Have unique stress-oriented fiber structure

Memo to future engineers:

"Make it lighter and make it stronger" is the demand today. No other metalworking process meets these two requirements so well as the forging process. Be sure you know all about forgings, their design and production. Write for Case History No. 104, with engineering data on the earthmover hub forging shown above.

DROP FORGING ASSOCIATION

55 Public Square • Cleveland 13, Ohio

When it's a vital part, design it to be

FORGED

AN ENGINEERING PRIMER

Did you arrive at State not knowing anything about our College of Engineering? This beginning reader is designed to start all future engineers off on the right foot.

I. See Johnny.
Johnny is a freshman.
He is learning how to program computers.
See Johnny in Room 372.
He is punching out his program deck.
It is 9 A.M.
He is punching his first card.
The deck is twenty cards long.
It is noon.
Johnny is punching his twentieth card.
Johnny is going over to the printer.
He wants to print out his program deck.
See Johnny cry.
The printer is ripping his cards to shreds.

II. See Jane.
Jane is majoring in Electrical Engineering.
Jane is a girl.
Jane is pretty.
She is an engineering major because she is the only girl in all of her classes.
The boys all like Jane.
She is the only girl they ever see.
See Jane in the laboratory.
See the two wires coming out of the machine.
Jane is grabbing the wires.
Hear Jane scream.
Jane is running to the Home Economics Building.
She is changing her major.

III. See Tom.
Tom is an English major.
See Jim.
Jim is Tom's roommate.
Jim is an engineering major.
Hear Tom call Jim unculturated.
Hear Jim smack Tom.
See Tom hit Jim with a book of Thoreau.
Tom is screaming, "Nietzsche, Kant, Schopenhauer, Spinoza," over and over.
Jim is setting up a laser beam.
He is pointing it at Tom.
Don't Jim!
Too late.
Tom is now energy.

IV. See Fred George.
He is the editor of this magazine.
See his staff.
No?
Where is his staff?
Are they all hiding?
There aren't many people on his staff.
Fred is looking all over for some staff.
See Fred's funny smile.
He is laughing at the Good Humor man.
Oh! too bad.
The Good Humor man put Fred in a net.
They are taking him to the funny farm.
Why don't you help Fred?
Join the staff of the Spartan Engineer.

SE

Oriental Wisdom: "Football season great stuff . . . Only time man walk down street with blonde on arm and blanket on other and not encounter raised eyebrows."

SE

The M.E. hit a rooster while driving along a country road. Anxious to do the right thing, he located the farmer who owned it and said apologetically, "I just ran over your rooster and I'm willing to replace him."

"Fine," said the farmer. "Let's hear you crow."

SE

While out of town, a stingy husband sent his wife a check for a million kisses. The little woman, quite provoked, sent back a postal card which read: "Dear Jim: Thanks for the lovely check you sent. The milkman cashed it for me this morning."

SE

Talk at the party was getting around to hi-fi. "We have been getting the most wonderful results from stereophonic sound," said one guest. "You sit in the middle of the room and sounds come to you from right and left."

"I know what you mean," said a rueful husband. "I've been living with my wife and her mother for ten years."

SE

The salesman, noticing a sweet young thing standing on the corner, leaned out of his car and called: "Pardon me, Miss, but-er-"

"No," she retorted, "You've never met me in Atlantic City. I wasn't at the party last month or at Charlie's bar. I know I'm good looking and I'm not bashful. I'm not waiting for a bus or going your way. I'm not lonely and I just had dinner. I've got lots of boy friends and my sweetie weighs 220 pounds and plays left tackle. Now were you going to say something?"

"Yes, dammit," the salesman said. "You're losing your pants."

SE

"I don't like Bill," confided a coed to her roommate. "He knows too many naughty songs."

"Does he sing them to you?" asked her friend.

"Well, no—but he whistles them."

SE

The things men like to hear a girl say:
1. "No, I've never seen the golf course at night."
2. "Why bother, there's no one home here."
3. "You don't think this bathing suit is too tight, do you?"
4. "Let's go dutch."
5. "Chaperone? What chaperone?"
6. "No, it really doesn't make any difference whether I get back at all tonight."
7. "My, but I'm COLD."
8. "YES."

The legend is told that in the days of ancient Rome an officer, called away to wars, locked his beautiful young wife in armor and gave the key to his best friend, with the admonition: "If I don't return in six months, use this key. To you, my dear friend, I entrust it."

Ten miles away from home, he saw a cloud of dust approaching and waited.

His frend, on horseback, galloped up saying: "You gave me the wrong key."

"O.K., Moses, take out your tablet and number from one to ten, we're going to have a little quiz."

SE

A young engineer got a job in a remote mining camp. On his first day off, he approached his boss and asked, "Say, boss, what do you do around here for amusement?"

The boss replied, "Well all of us usually watch Sam, the cook, drink a gallon of whiskey, gasoline, and red pepper juice. It's the funniest thing you ever saw. Why don't you come along?"

The young engineer was obviously shocked. "No thanks," he said, I don't go for that kind of amusement."

"Well," answered the boss, "I sure wish you'd come. We really need six men for this thing."

"Why is that?" asked the new man.

"Some of the boys have to hold Sam. He doesn't go for that kind of amusement either."

Notice in want ads—
Young man transferring from engineering to art would like to trade one good study lamp for a comfortable bed.

SE

THE ADVERTISER'S INDEX

YOU CAN SHARE IN A GROWTH LIKE THIS

Whose growth? Fisher Governor Company, manufacturer of automatic controls for any and all fluids, gases or air that flow through pipe. We are the leader in our growing industry. Our sales have shown a relatively steady rise during the past decade (from 18-million to 41.5-million—a 130% increase in just ten years). See chart above. Our products—control valves, pressure regulators, liquid level controls and instruments—are key elements in industrial automation.

Location: Fisher is basically an "Engineering" company with 1,500 employees located in a pleasant Iowa community of 22,000. It's less than 10 minutes to the modern Fisher plant and engineering facilities from any home in Marshalltown. The community has an outstanding cultural and educational environment.

Type of work: Fisher offers a rewarding challenge to the graduate engineer (BS and MS) who is interested in design and development, research and test, sales or manufacturing.

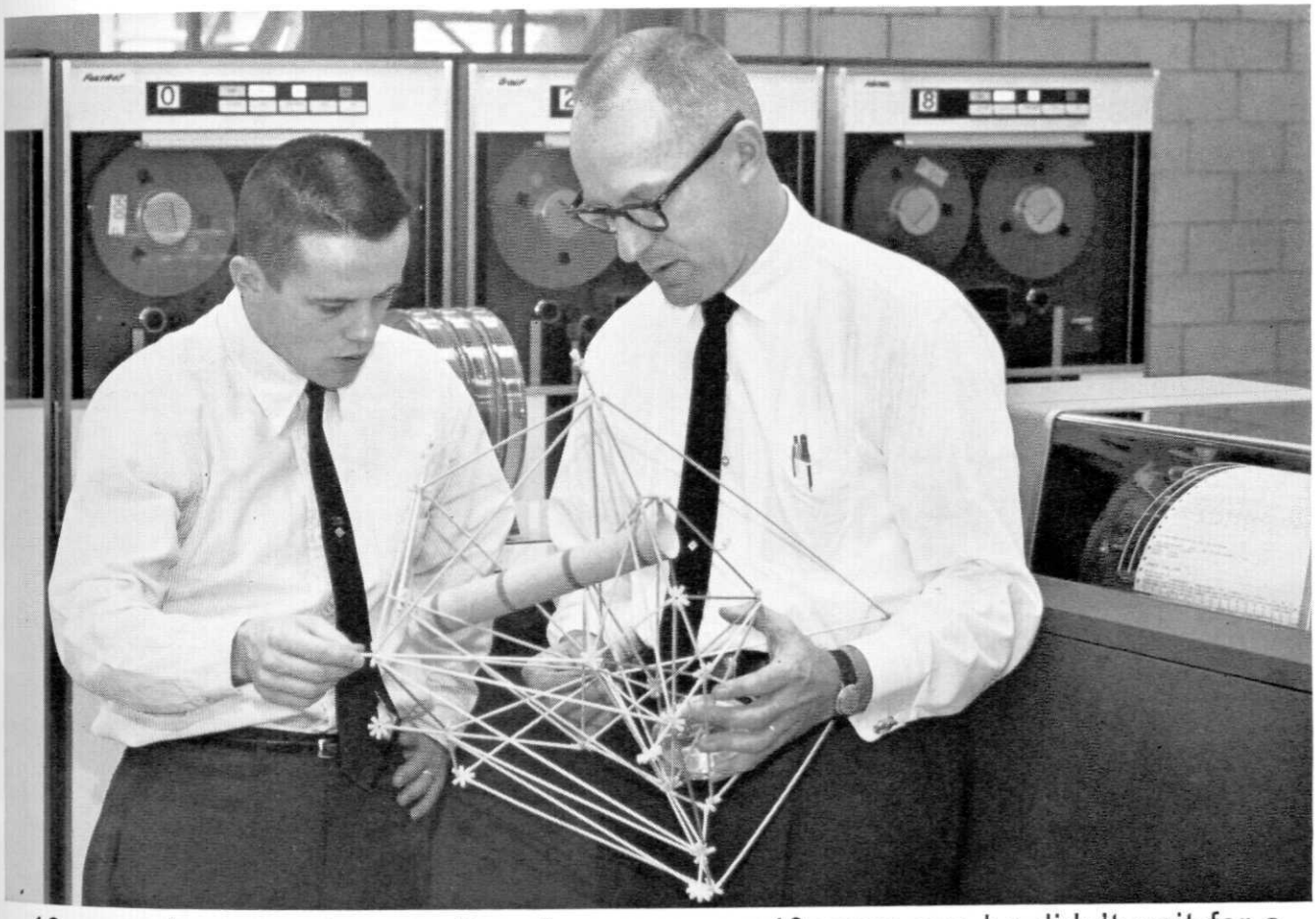
Advancement: Coupled with Fisher's policy to promote from within, advancement opportunities reflect a growing company within a growing industry.

If a growing company like ours appeals to you, consult your placement office or write directly to Mr. John Mullen, Employee Relations Manager, FISHER GOVERNOR COMPANY, Marshalltown, Iowa.

An Equal Opportunity Employer

If it flows through pipe, chances are it's controlled by

FISHER® Controls SINCE 1880



10 years from now he may tire of working with computers

10 years ago he didn't wait for a computer's verdict

People matter more than computers

To lure smart young engineers, we feature up-to-date computer facilities. That's one good reason to have computers. We have even more compelling reasons, not all to be found in our widely advertised product lines like family cameras, film, textile fibers, office equipment, plastics, etc.

What prudence prevents us from publicly spilling is what occupies and fascinates a large corps of mechanical engineers like Edward T. Kern *(right)* and his younger colleague, William S. Walsh. To more colleagues from among the mechanical engineers of the Class of 1965, we hereby offer our persuasive combination of long-haul stability and internal mobility.

We respect an engineer for requesting a chance to broaden himself by a change of assignment. Both men pictured here did so.

When we hired Ed fresh out of college in 1947, we had him spend a year personally running a lathe and doing bench assembly on new production equipment for film manufacture. (We rarely start engineers that way any more.) Then, until 1955, he developed machinery for paper-sensitizing and film-emulsion coating. Next came a stint bossing a 75-man crew that erected, maintained, and repaired buildings and equipment for processing KODACOLOR Prints and other large-volume photographic products. Feeling his feet all too firmly on the ground after three years of this, he decided to grapple with a subtler form of reality than concerns the average pipefitter, electrician, or bricklayer.

This decision he made just in time to join his present team, then forming. For a while he found himself pitching in with proposal preparation, customer contact, subcontract technical co-ordination, customer briefings, etc. Gradually the assignment evolved from communicating *about* technical matters to generating rather fundamental technical content of his own. This he does today, living the life of the systems engineer, surrounded by logic, concepts, and limiting parameters.

Bill, a 1962 graduate, spent his first year in vibration analysis and learned how unimportant is the distinction between an E.E. (which his diploma calls him) and an M.E., under which heading he now ventures on the same frontier with Kern. Before we throw him his retirement party, for all we know, he may win honors as the greatest living expert on knitting machinery. We have many interests.

Drop us a line.

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Business and Technical Personnel Department, Rochester, N.Y. 14650
An equal-opportunity employer offering a choice of three communities:
Rochester, N.Y., Kingsport, Tenn., and Longview, Tex.

Kodak

Should You Work for a Big Company?

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

S. W. CORBIN

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

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

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

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

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

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

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

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

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

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

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

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

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