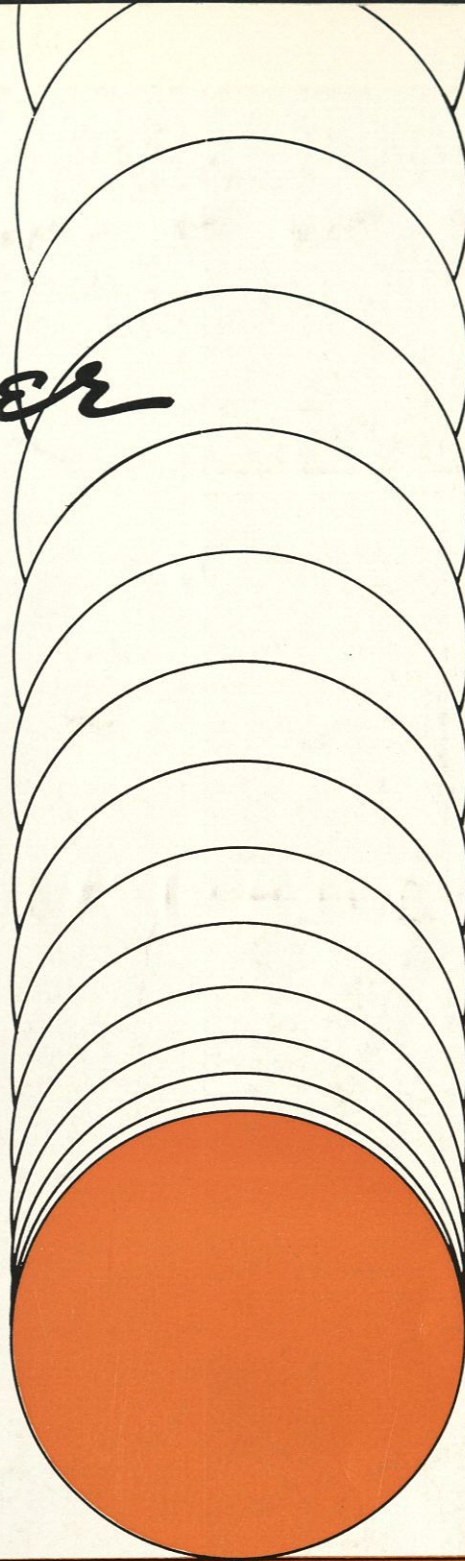


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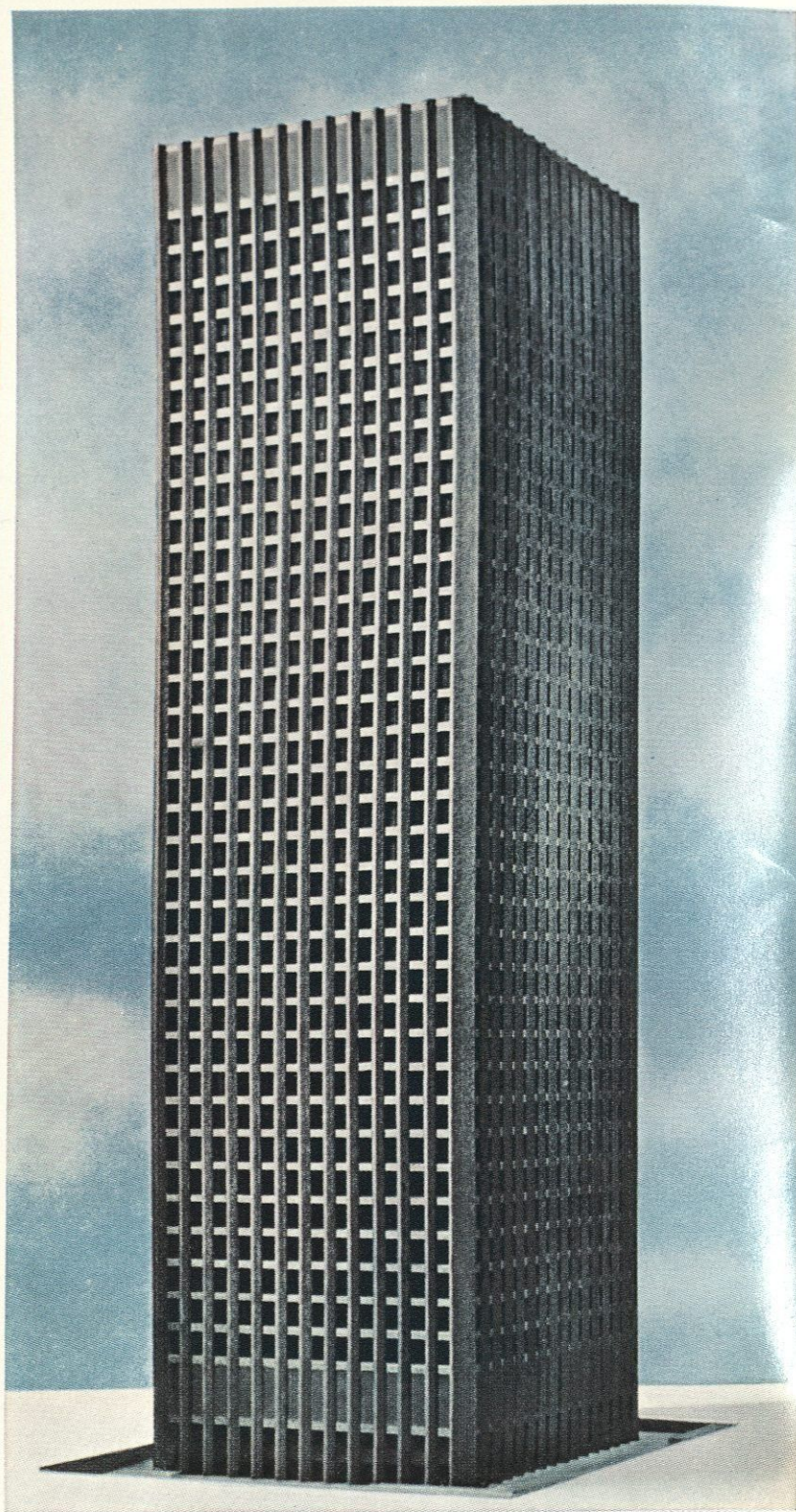
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COVER

Staley F. Adams' article, "Ceramic under Impact," was the inspiration for this month's cover by Jerry Carroll.

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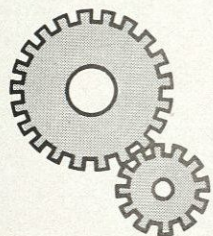
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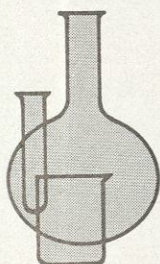


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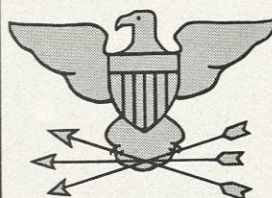
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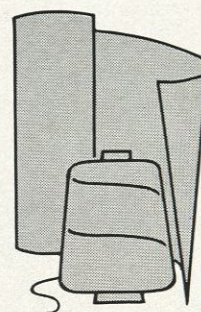
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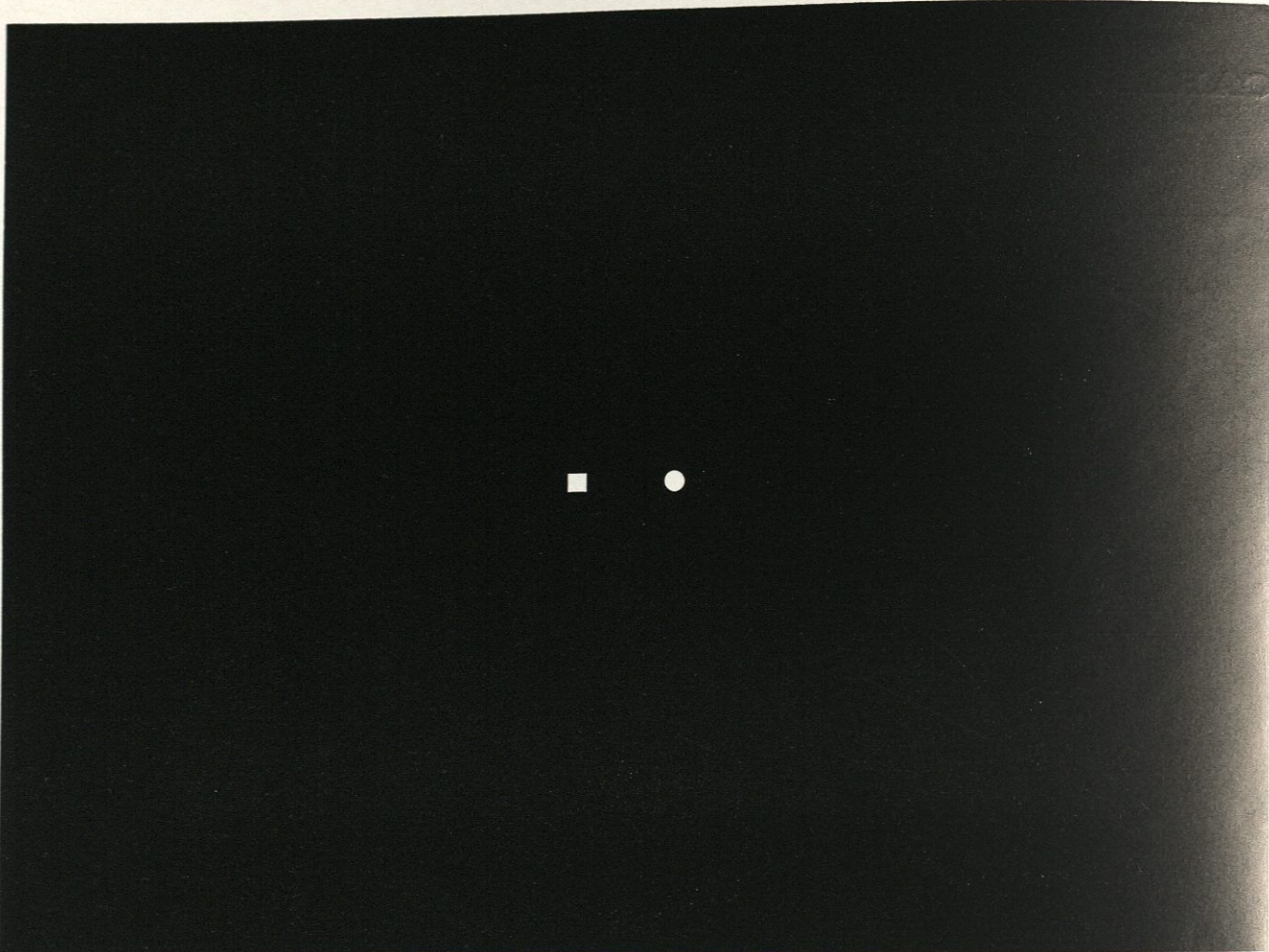
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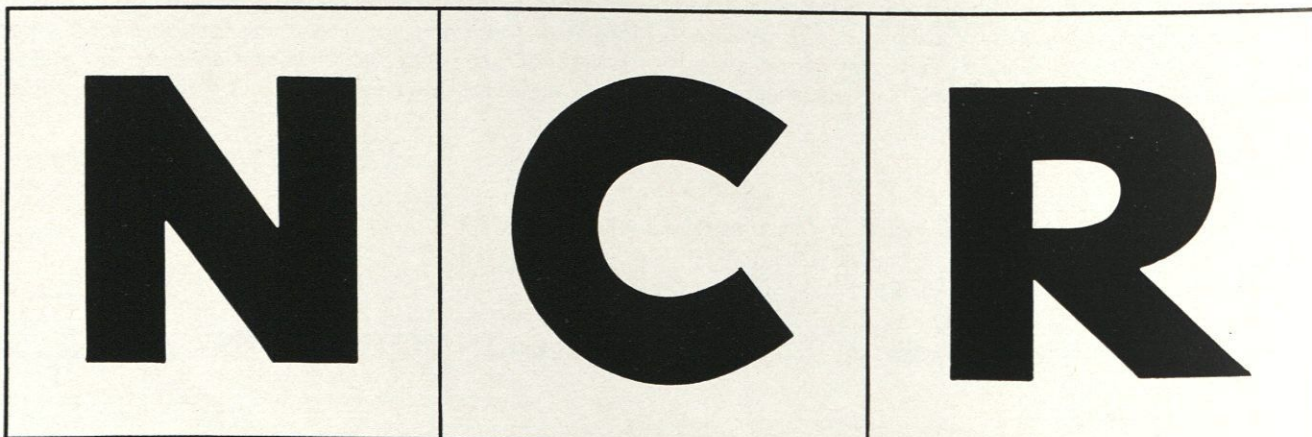
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THE ENGINEER AS A PROFESSIONAL

The term "profession" immediately brings to mind the fields of medicine and law, both of which are quite similar. In each case, practice is permitted only after extensive education and examination, and in either field, there is a rigid code of ethics which must be followed. Unethical practice means expulsion from the profession.

Thus, in general, professionalism is nothing more than public confidence in the quality of the individual members of that profession, and such confidence can be maintained only through continuing high standards of ability and ethics. The advocates of professionalism in engineering have sought to establish these standards through the creation of an all-encompassing professional society. The lack of success in this respect is mainly due to the heterogeneity of engineering. The feeling of unity necessary for the existence of professionalism is not found in the general field.

If professionalism is to be the goal of engineering, a system of standards must be developed and enforced. However, success would be more probable if the system were established through the existing and more specialized engineering societies.

—Fred E. Love

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of management
is essential
to our goal of
great growth"**



At the 1964 stockholders' meeting, Arjay Miller, President of Ford Motor Company, emphasized the Company's far-sighted recruitment program and its accent on developing management talent:

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"In the longer run, our future depends on what we are doing at the present time to attract and develop the people who will be making the major decisions 10 to 20 years from now. We are developing management competence in depth in order to attack the problems that will confront a company of great growth—and great growth (both in profits and sales) is exactly the goal we have established for Ford Motor Company.

"We are continuing to emphasize recruiting. Last spring, 180 of our management people devoted part of their time to recruiting outstanding graduates from colleges and universities throughout the U.S. Last year, these efforts resulted in our hiring over 1,000 graduates, 220 more than the year before.

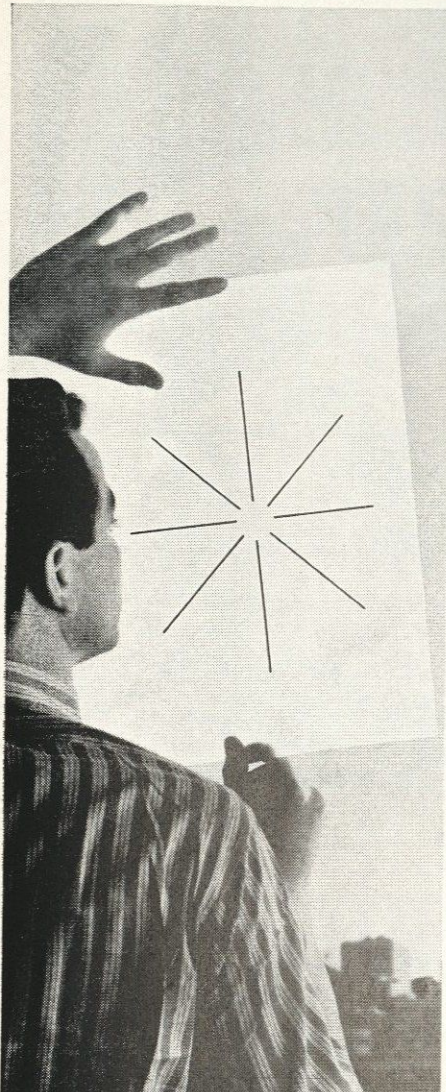
"We are seeking and we are finding young men—and young women, too—with brains and backbone—people who have the ability and the desire to make room for themselves at the top. We give our trainees challenging assignments with as much responsibility as they can carry. We promote them as fast as they are ready. Those who are interested in easy security soon drop out. Those who have what we want stay with us, and move up quickly to increased responsibility and the pay that goes with it. Thanks to the quality of the people we are recruiting and developing, I am firmly convinced that our outlook is most promising."



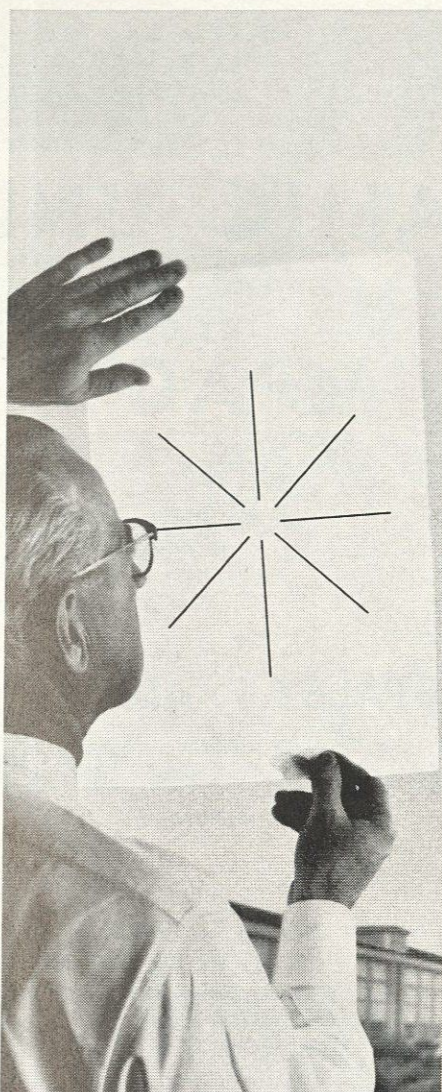
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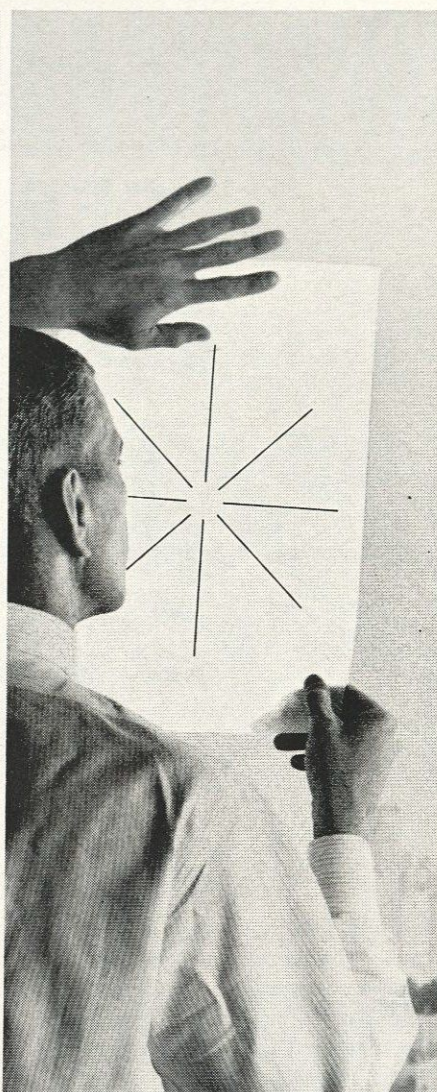
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CERAMIC UNDER IMPACT

STALEY F. ADAMS

The impact failure of the tile tested was caused by a combination of several stresses which will be discussed individually. All of these stresses will then be analyzed in a cross section to show how the tile should fail theoretically. By embedding the tile securely to obtain as uniform a supporting force as possible, it will have two primary types of stresses; one due to bending and the other due to the shearing forces. First consider the shearing stresses, next the bending stresses, and then a combination of the two.

There will be shearing stresses on the section through the tile around the impact area when an impact force strikes a tile. The maximum stress will be adjacent to the impact load as shown in Figure 1. The stress would vary over the entire tile but we are only interested in the maximum value.

This shearing unit stress is due to the difference of the forces on the top and bottom of a small section which will tend to force the area out of the tile creating a shearing unit stress on the particles around the affected section. This is shown in Figure 1. There are failures due to this which are called "shear failures" but which are actually diagonal tensile failures

due to the shearing unit stresses. Any point that has a shearing unit stress in one direction always has an equal shearing unit stress at an angle of 90° to the first stress as shown in Figure 2a. At any angle θ to these shearing unit stresses, there will be a normal and a shearing unit stress which are equal to $S_n = S_s \sin 2\theta$ and $S'_s = S_s \cos 2\theta$ where S_s is the shearing unit stress developed and S_n and S'_s are the stresses acting on an area, at an angle θ to S_s as shown in Figure 2b. In this case, the maximum stress will occur when $\theta = 45^\circ$ where $S_n = S_s$ and $S'_s = 0$. In tile, it probably has the approximate ratio of stresses as most brittle materials such as cast

iron with the weakest value in tension, somewhat stronger in shear and strongest in compression.

The tests indicate the above assumptions are true, and the tile could be expected to crack along diagonal lines which have an approximate slope of 45° at the center of the tile and near the edges of the contact area of the impact load. The tile would react similar to a beam with the maximum shearing unit stresses located at the neutral axis which is near the center of the tile. In Figure 3, a section through the center of the tile is represented showing the loads, reactions, and the diagonal tension due to the shearing forces.

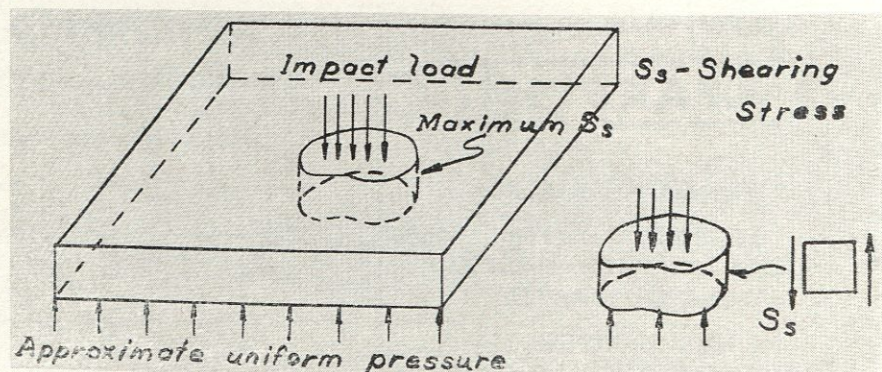


FIGURE 1

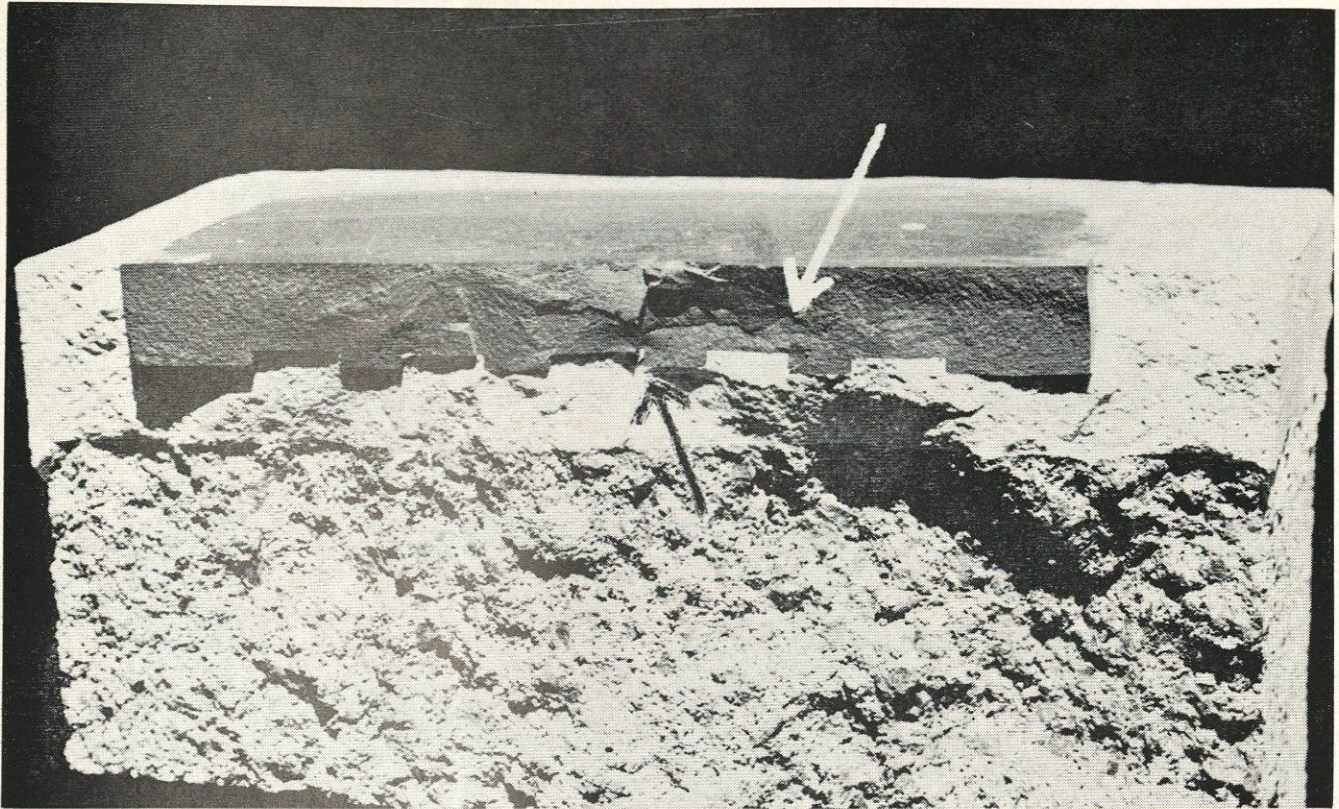


ILLUSTRATION 1

This is further illustrated in the photograph in Illustration No. 1 which shows an initial crack in the center pointed out by the top arrow in the illustration.

By embedding the tile securely, the stresses due to bending have been reduced, but they will still have an important part in the failure of the tile. The uniform support would reduce the bending moment to approximately $\frac{1}{2}$ that of a simply supported tile. The bending stresses will vary from zero at the neutral axis and increase towards the surface. The maximum bending stress in tension will be on the outside fibers on the bottom of the tile and normal to a vertical sec-

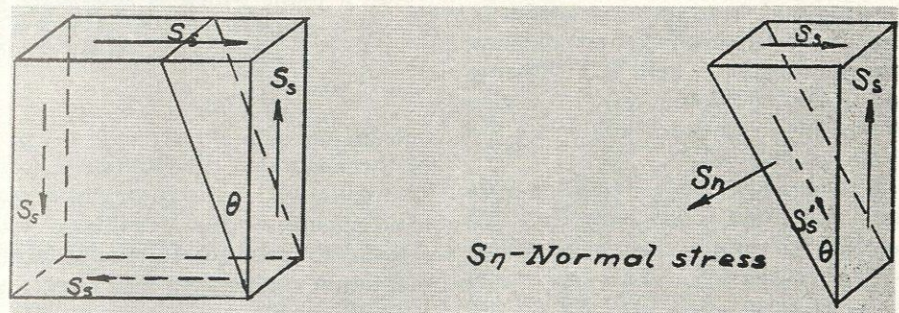


FIGURE 2

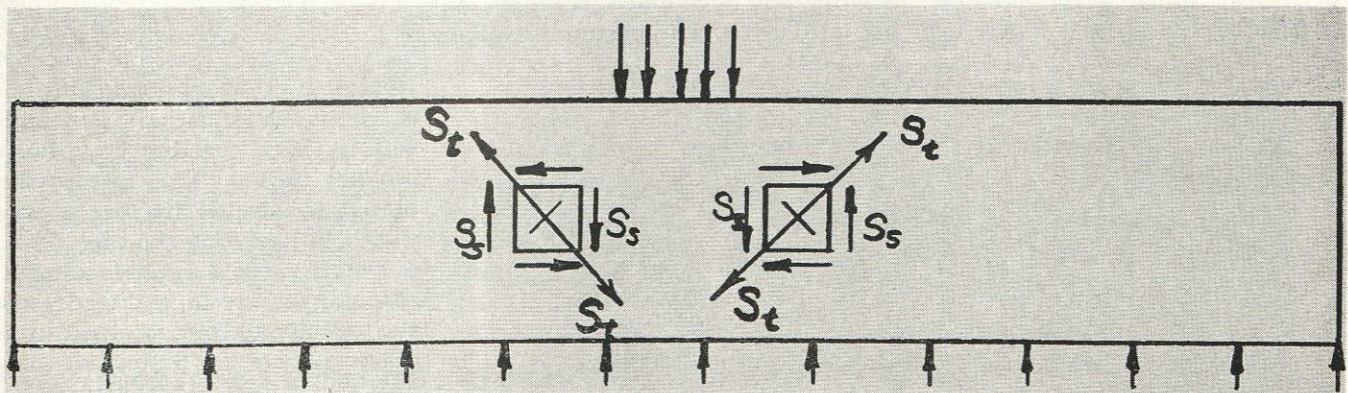


FIGURE 3

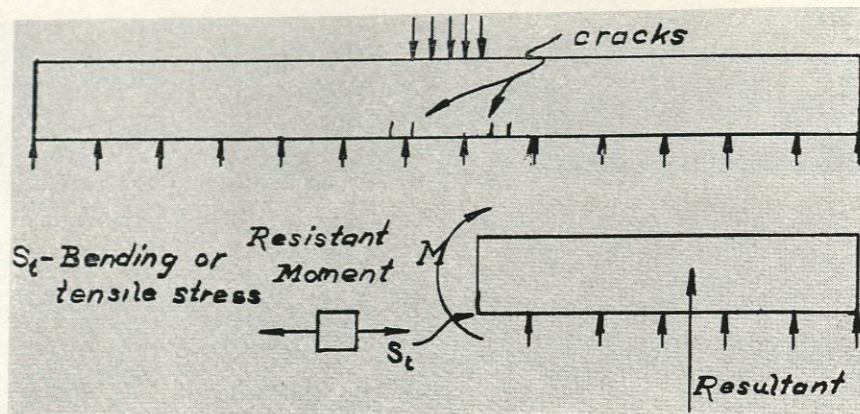


FIGURE 4

tion through the tile. A vertical crack should form at the bottom of the tile as shown in Figure 4 and also as pointed out by the bottom arrow in Illustration No. 1.

The shearing unit stress here is zero; therefore, the maximum tensile stress at the bottom will be this tensile stress which would start vertical cracks as shown in Figure 4 and also as pointed out by the bottom arrow in Illustration No. 1. There is a compressive stress due to bending above the neutral axis, but this stress will not affect the tile except when combined with the shearing stresses.

There will be a combination of the shearing and bending unit stresses in a section between the center and bottom of the tile. There is a shearing and a tensile normal unit stress due to bending on a point at this section as shown in Figure 5.

Although S_s and S_t are reduced from their maximum values here, they will combine to produce stress S_t' which is greater than S_t . This maximum value of S_t' is equal to

$$\frac{S_t}{2} + \sqrt{\frac{S_t^2}{4} + S_s^2}$$

which would occur at the angle whose tangent is $2S_s/S_t$ and the shearing stress on this area is zero. This would cause a crack which would progress away from a vertical as it moves up

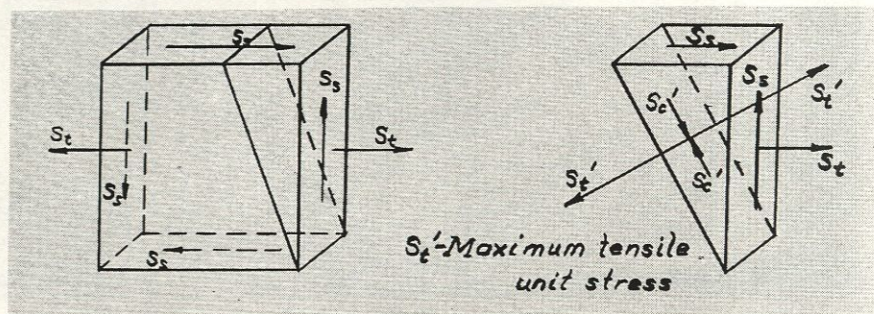


FIGURE 5

from the bottom of the tile as shown in Figure 6.

There is a compressive unit stress S_c on a plane which is at 90° to S_t' which is equal to

$$\sqrt{\frac{S_t^2}{4} + S_s^2} - \frac{S_t}{2}$$

but this stress should not have any part in the failure in the bottom section. Above the neutral axis a compressive bending unit stress combines with the shearing unit stress to produce a maximum compressive unit stress and a small tensile unit stress at 90° to this compression as shown in Figure 7. This S_t' can be calculated from

$$\sqrt{\frac{S_c^2}{4} + S_s^2} - \frac{S_c}{2}$$

where S_c is the bending unit stress and S_s is the shearing unit stress. The maximum value

S_t' is on a plane whose tangent is $2S_s/S_c$. A crack should form on a very flat slope next to the edge of the impact load. By combining all of these into one predicted crack we would have a break along the line indicated in Figure 8. With the stresses produced as follows: $S_{t1} + S_{t2}$ combination of bending S_c and shearing S_s , S_{t3} due to S_s at the neutral axis; S_{t4} due to bending S_t and S_s ; and S_{t5} due to the bending stresses. These are constantly changing values but they are all acting and reach their maximum value at the same time. This has been brought out in most of the tests made and is clearly shown in Illustration No. 2 which is a photograph of a test specimen which was broken by an impact load.

It can also be observed in illustration No. 2 that the normal stress has been exceeded, therefore causing a separation of the material. This break is without deformation as the pieces will fit back together to form the original object. This further shows that it is a brittle fracture as we assumed in analyzing the tile.

There is always a certain amount of chipping or crushing directly under the load due to large localized stresses. These stresses are a function of the area of contact with an impact load. They could alter or change the angle

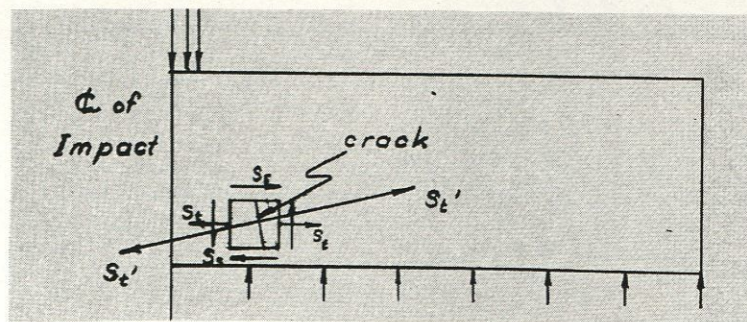


FIGURE 6

of fracture a small amount during the breaking process. An example of this chipping is shown in Illustration No. 3.

The angles may vary since the tile is not a perfectly homogeneous body. Due to these slight variations of the material in manufacture and the ridges on the bottom, the break may vary several degrees from the predicted direction.

The results of a large number of tests indicate the assumption as to the distribution of forces and stresses are reasonably accurate. The conclusion of the investigation adds emphasis to the age old difficulty of producing a tile with greater tensile strength and more ductility. These two problems are still to be solved by the ceramics industry for the manufacture of tile by the stiff mud process.

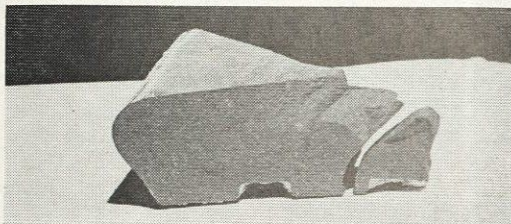


ILLUSTRATION 2

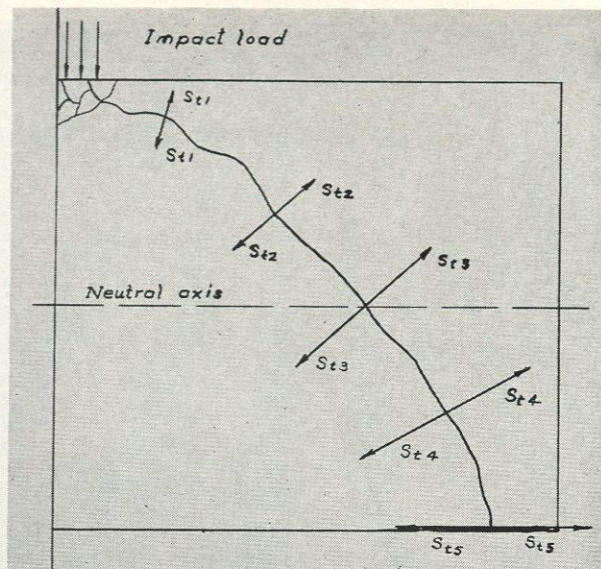


FIGURE 7

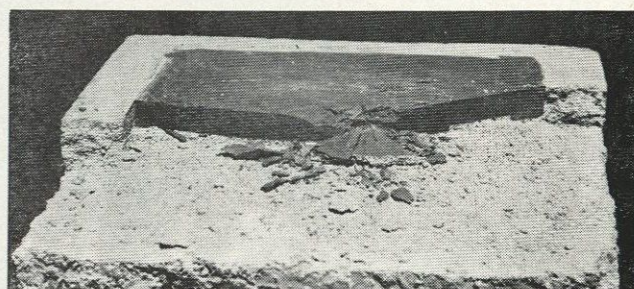


ILLUSTRATION 3

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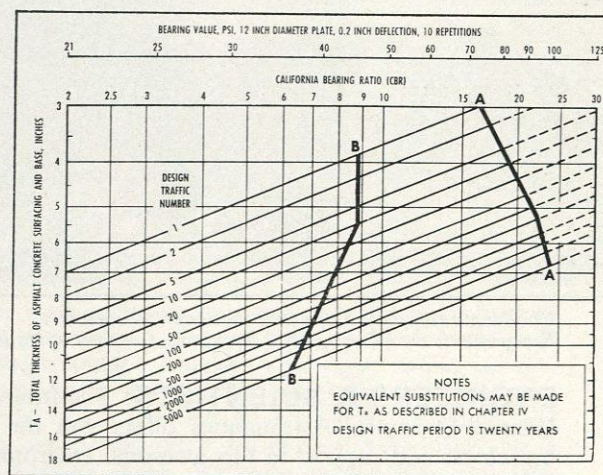
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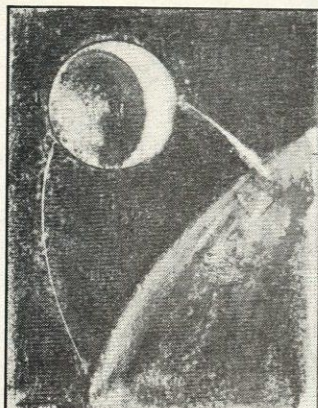
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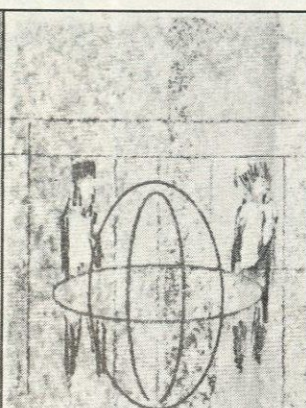
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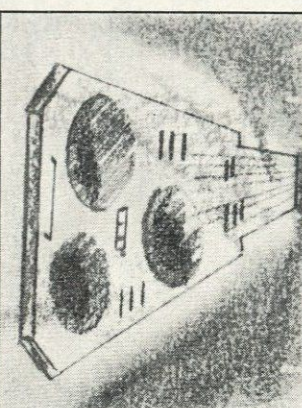
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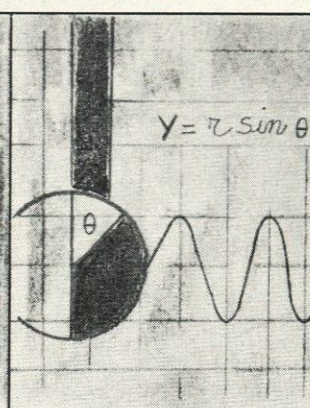
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A RANGER TO THE MOON

JOHN SUNKEL

On July 31, 1964, the spacecraft Ranger 7 hit the moon. In the few minutes before it crashed on the lunar surface, it recorded and sent back to earth photographs, many of which showed detail never before seen. In this way, America advanced another step in her quest to land men on the moon. Before this important step could be taken in the manned space flight program, however, it was necessary to get Ranger 7 close enough to the moon to hit it. This was probably the toughest problem that faced the Ranger 7 flight. The following is a running account of the different phases of the successful flight of Ranger 7. It illustrates the problems which NASA engineers faced and which all scientists, engineers, and technicians face in the field of Astronautics.

Ranger Trajectory

To launch a Ranger spacecraft on a trajectory from Earth that will put the craft on an acceptable course to the Moon requires threading the vehicle through a 10 mile diameter target 120 statute miles above the Earth's surface at a velocity within 16 mph of 24,470 miles per hour. If these accuracies are achieved, then a midcourse maneuver is capable of adjusting the trajectory to yield an impact on the Moon in the desired area.

This circular target (injection point) remains relatively fixed in space each day of the firing period. The Cape Kennedy launch site, however, is continually moving eastward as the Earth rotates. Therefore, the firing angle (azimuth angle) from the

launch site, and the length of time spent in a parking orbit, must change minute by minute to compensate for the Earth's rotation. Actually the trajectory engineer computes a set of lunar trajectories for each day of a launch period.

In calculating a trajectory for a Moon flight, the trajectory engineer must include the influence on the path angle (azimuth angle) from the launch site, and the length of time spent in a parking orbit, must change minute by minute to compensate for the Earth's rotation. Actually the trajectory engineer computes a set of lunar trajectories for each day of a launch period.

In calculating a trajectory for a Moon flight, the trajectory engineer must include the influence on the path of the spacecraft of the gravitation pull of the Earth, Moon, Sun, Venus, Mars and the giant planet Jupiter. At the same time he must satisfy numerous constraints imposed by mechanical limitations of the spacecraft, a moving launch site, photographic requirements and tracking and communication considerations.

For example, Ranger can only be launched during a portion of the Moon's third quarter. For photographic purposes the Ranger must impact the Moon on the sunlit side visible from Earth and within 10 to 40 degrees of the terminator or shadow line for lighting angles that will provide good contrast and shadow detail in the pictures.

The new Moon and full Moon phases are not acceptable because of

attitude control requirements for the spacecraft. The spacecraft locks onto the Sun and Earth for orientation and in these periods the orientation is insufficiently accurate to provide mid-course or terminal maneuvers.

In the first quarter of the Moon the sunlit side is the trailing half and, there are technical limitations on target areas and satisfactory lighting angles.

This leaves the third quarter as the only acceptable lunar phase for launching.

Knowing the days of the month in which he can launch, the trajectory engineer must now determine which portion of each day is acceptable. The answer is that only a few hours of each day are useable. The fact that his launch site is moving eastward, and his launch angles are limited, means he can only fire at certain times and reach the injection area above the surface of the Earth.

Other constraints imposed include the requirement that the Moon be visible to the Goldstone tracking station in the Mojave desert at impact. The transit time to the Moon, controlled by the injection velocity, must conform to this requirement. The injection velocity changes, from day to day, from 24,459 mph to 24,486 mph as the Moon's distance and declination relative to Earth changes.

Further, the trajectory selected must not place the spacecraft in the Earth's shadow beyond specified amounts of time. Too much time in the Earth's shadow would chill spacecraft components and then subject them to too

rapid heating when the spacecraft emerged into the glare of the Sun.

Assume that a set of trajectories for the launch period have now been computed that satisfy all the myriad constraints that are imposed. The launch vehicles will then impose errors in the flight trajectories due to inherent limitations in the accuracy of the guidance system. Guidance errors, within design limits, can be corrected by the small rocket engine carried by Ranger. This midcourse correction will be commanded at about 16 hours after launch. Prior tracking of the spacecraft will have revealed the extent of the correction required.

Additional tracking of the spacecraft after the midcourse maneuver will verify and/or determine the final portion of the trajectory and the resulting impact location. This will allow accurate calculation of the terminal maneuver (changing of attitude of spacecraft to yield desired pointing direction of camera) to be performed prior to impact.

The spacecraft will be accelerated as it nears the Moon by the lunar gravitational pull. This will slightly alter the trajectory from the original elliptical path about the Earth and yield a lunar impact. The spacecraft will impact the Moon at about 5800 miles per hour.

The location of the impact can only be predetermined within a circle approximately 24 miles in diameter. This circle is defined by the effects of the uncertainties of: location of the Moon in respect to Earth, evaluation of tracking data, influence of Sun, Moon and planets on the trajectory, location of tracking stations, precise shape of Earth and Moon and other factors. Analysis of tracking data after the flight will considerably reduce this uncertainty of the impact location.

Mission Description

The Atlas-Agena launch vehicle will boost Ranger to an altitude of 115 miles and on orbital speed of about 17,500 miles an hour using the parking orbit technique pioneered in the first Ranger flights. Orbital speed will be achieved by the first burn of Agena after Atlas has separated.

Some 23 minutes after launch, Ranger's Central Computer and Sequencer (CC&S) will give its first command, ordering the Ranger trans-

mitter to full three-watt power. Until this time, the transmitter had been kept at reduced power—about 1.1 watts. This is required during the time the launch vehicle passes through a critical region between 150,000 and 250,000 feet altitude where arcing can occur in high voltage devices and cause damage to components.

Agena and Ranger now coast in the parking orbit over the Atlantic Ocean until they reach a point where the second firing of the Agena will aim the spacecraft at the target in space where the Moon will be approximately 68 hours later. The second firing of the Agena engine will accelerate the spacecraft to about 24,470 miles an hour and inject Ranger on a lunar trajectory.

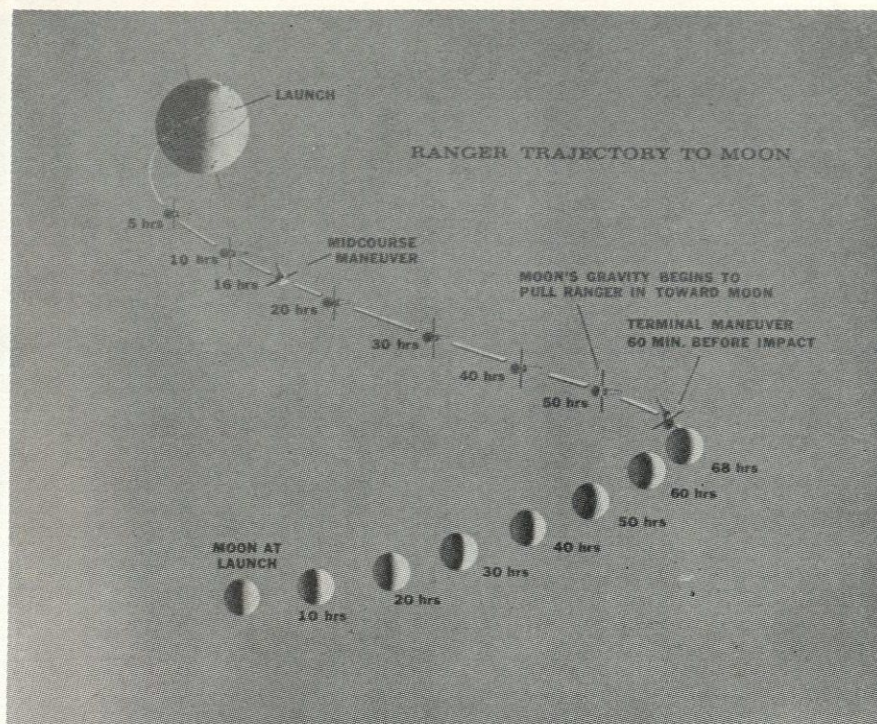
The length of the coast period is determined by the time of day and day of the month of launch, i.e., the changing distance between launch site, which is moving with the rotation of the Earth, and the point in space where Ranger must be injected.

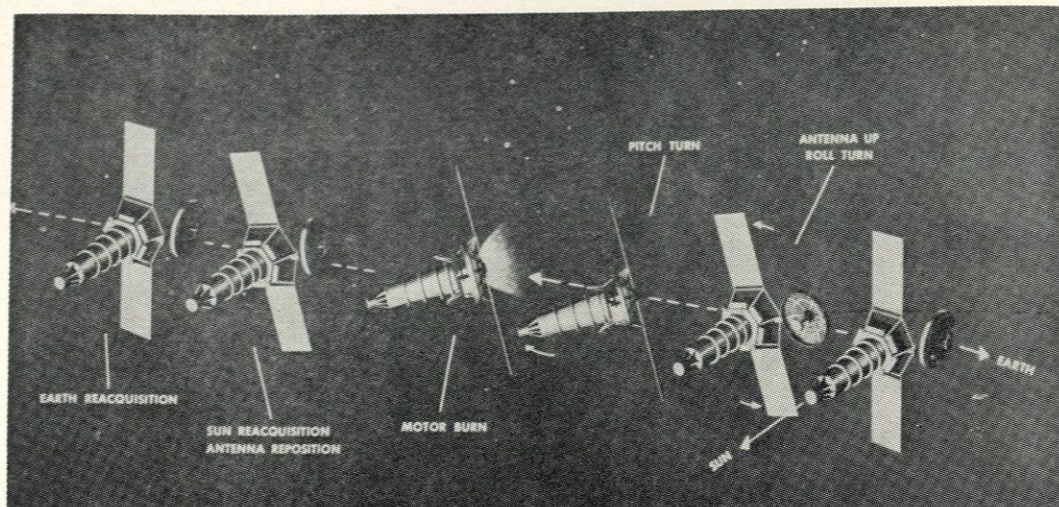
Spring-loaded explosive bolts then separate the Ranger from the Agena. The Agena will perform a 180-degree turn and a retro maneuver to remove it from the spacecraft trajectory. Propulsion for the retro maneuver is provided by a small solid fuel rocket motor. The retro maneuver insures that the Agena will not impact the Moon and that it will not be in a

position to reflect light that could confuse the Ranger's optical sensors and cause them to mistake the Agena for the Earth.

Separation from the Agena will cause the Ranger to begin a slow tumbling motion. The tumbling continues until cancelled out by the attitude control system during Sun acquisition. The yaw, pitch and roll gyros will generate signals to fire the cold gas jets to counteract the tumbling motion. Separation of the Agena will start the mechanical back-up timer, the TV back-up clock, and release the CC&S for issuance of flight commands. During launch the CC&S will be partially inhibited to insure that flight commands will not be given inadvertently.

The mechanical back-up timer will remove an inhibit on the TV system at separation plus 30 minutes. Until this time the TV system has been inhibited from being turned on. However, the television back-up clock which is mechanized to turn on the TV at lunar encounter is still inhibited and remains so until launch plus 32 hours. About one hour after launch the CC&S will order deployment of the solar panels. Explosive pin pullers holding the solar panels in their launch position will be detonated to allow the spring-loaded solar panels to open and assume their cruise position.





SEQUENCE
OF THE
MID-COURSE
MANEUVER.

Opening of the solar panels will trip a switch to release the inhibit on the TV system as a back-up to the back-up timer.

Acquisition Modes

With the solar panels deployed, the CC&S will activate the Sun sensor system, gas jet system and command the attitude control system to seek the Sun. At the same time that the CC&S orders Sun acquisition, it will order the high-gain directional antenna extended. The drive motor will then extend the antenna to a preset hinge angle that was determined before launch and stored in the antenna control module.

In the Sun acquisition mode, the Sun sensors will provide signals to the gas jet system that maneuvers the spacecraft about until its long axis is pointed at the Sun, thus aligning the solar panels with the Sun. A back-up command for Sun acquisition will also be given by the mechanical timer. Both the Sun sensors and the gyros can activate the gas jet values.

In order to conserve gas, the attitude control system permits a pointing error toward the Sun of one degree, or a half-a-degree limit in each direction. It is calculated that the gas jets will fire one-fiftieth of a second each 60 minutes to keep the spacecraft's solar panels pointed at the Sun.

The Sun acquisition process is expected to take a maximum of 30 minutes. As soon as the solar panels are locked on the Sun, the power system will begin drawing electric power from the panels. The batteries will now only supply power in the event

of a peak demand which the panels cannot handle and during midcourse maneuver and terminal sequence.

The next event initiated by CC&S is the acquisition of Earth by the Earth sensor. This will occur at about three and one-half hours after launch. The CC&S will activate the Earth sensor (turning off the secondary Sun sensors at this point) and order a roll search. The gas jets will fire to initiate the roll. A radio command capability is provided to back up the initiation of this event.

During Earth acquisition, the spacecraft will maintain its lock on the Sun, but with its high-gain directional antenna pointed at a preset angle, it rolls about its long axis and starts to look for the Earth. It does this by means of the three-section, photomultiplier tube operated Earth sensor mounted on and aligned with the high-gain antenna. During the roll, the Earth sensor will see the Earth and inform the gas jets. The jets will fire to keep the Earth in view of the sensor and thus lock onto the Earth. Earth acquisition requires a maximum of one-half hour.

The spacecraft now is stabilized on all three axes. There is some possibility that the Earth sensor, during its search for the Earth, may see the Moon and lock onto it, but the Deep Space Network stations have the capability to send an override command to the attitude control system to tell it to look again for the Earth. If this is not sufficient, the stations can send a hinge override command to change the hinge angle and then order another roll search. When the Earth is acquired, the transmitter is

switched from the omni-antenna to the high-gain antenna by a command from Earth.

A rise in signal strength will be an indication that Earth acquisition has been achieved by the high-gain antenna.

With Sun and Earth acquisition achieved, Ranger now is in its cruise mode.

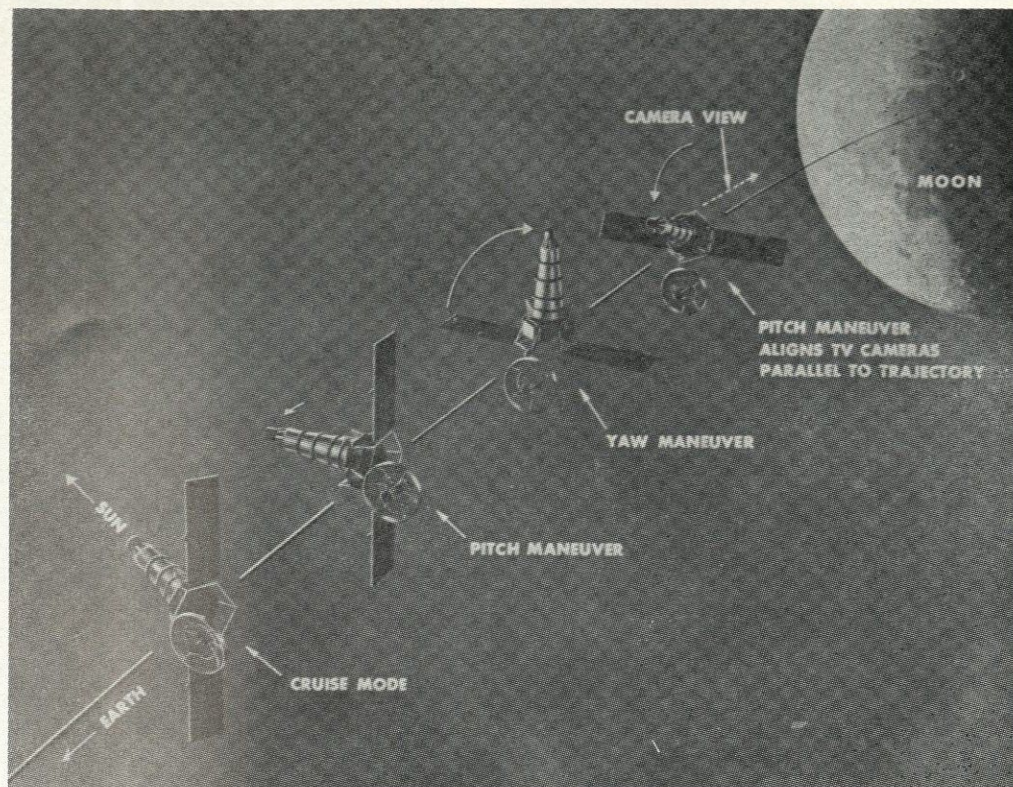
Midcourse Maneuver

The cruise mode will continue until time for the midcourse trajectory correction maneuver. After launch, most of the activity on the lunar mission will be centered at the DSN stations and at the Space Flight Operations Facility at JPL.

Tracking data collected by the DSN stations will be sent to JPL and fed into a large scale computer system. The computer will compare the actual trajectory of Ranger with the course required to yield the desired impact on the Moon. If guidance errors before injection have put Ranger off the optimum trajectory, the computer will provide the necessary figures to command the spacecraft to alter its trajectory. This involves commands for roll, pitch and motor burn. Roll and pitch orient the spacecraft and motor burn controls the velocity increment required to alter the flight path and time of flight.

The first command from Goldstone will give the direction and amount of roll required, the second will give the direction and amount of pitch needed, and the third will give the velocity change needed. This data is stored in the CC&S until Goldstone transmits a "go" command.

SEQUENCE
OF THE
TERMINAL
MANEUVER.



Prior to the "go" command, Goldstone will have ordered the Ranger transmitter to switch from the dish-shaped directional antenna at the base of the craft, to the omni-directional antenna mounted at the peak of the superstructure. The directional antenna will not remain Earth-oriented during the maneuver.

Commands pre-programmed in the CC&S for the midcourse sequence initiate the following: the Earth sensor, mounted in the dish-shaped antenna, is turned off; the hinge-mounted directional antenna itself is moved out of the path of the midcourse motor's exhaust; the autopilot and accelerometer are powered and pitch and roll turns are initiated. During the maneuver the CC&S will inform the attitude control subsystem of the pitch and roll turns as they occur, for reference against the orders from Earth. An accelerometer will provide acceleration rates to the CC&S during motor burn. Each pulse from the accelerometer represents a velocity increment of 0.03 meters per second.

The roll maneuver requires a maximum of 9.5 minutes of time, including two minutes of settling time, and the pitch maneuver requires a maximum of 17 minutes including two minutes of settling time. When these are completed, the midcourse motor

will be turned on and burned for the required time. As the attitude control gas jets are not powerful enough to maintain the stability of the spacecraft during the propulsion phase of the midcourse maneuver, movable jet vanes extending into the exhaust of the midcourse motor control the attitude of the spacecraft in this period.

The jet vanes are controlled by an autopilot in the attitude control subsystem that functions only during the midcourse maneuver. The autopilot accepts information from the gyros to direct the thrust of the motor through the spacecraft's center of gravity to stabilize the craft.

After the midcourse maneuver has put Ranger on the desired trajectory, the spacecraft will again go through the Sun and Earth acquisition modes.

During midcourse, Ranger had been transmitting through the omni antenna. When Earth is acquired, the transmitter is switched to the high-gain directional antenna. This antenna will be used for the duration of the flight.

Ranger is again in the cruise mode. This will continue until time for the terminal maneuver.

A "go" command will be sent to Ranger from the DSN Goldstone station at one hour from impact, and the CC&S will switch the attitude control system from the primary Sun

sensors to the gyros and command the first pitch turn. The spacecraft's solar panels may now be turned partly away from the Sun and, in that event, electrical power for the bus is supplied by one of the two spacecraft batteries.

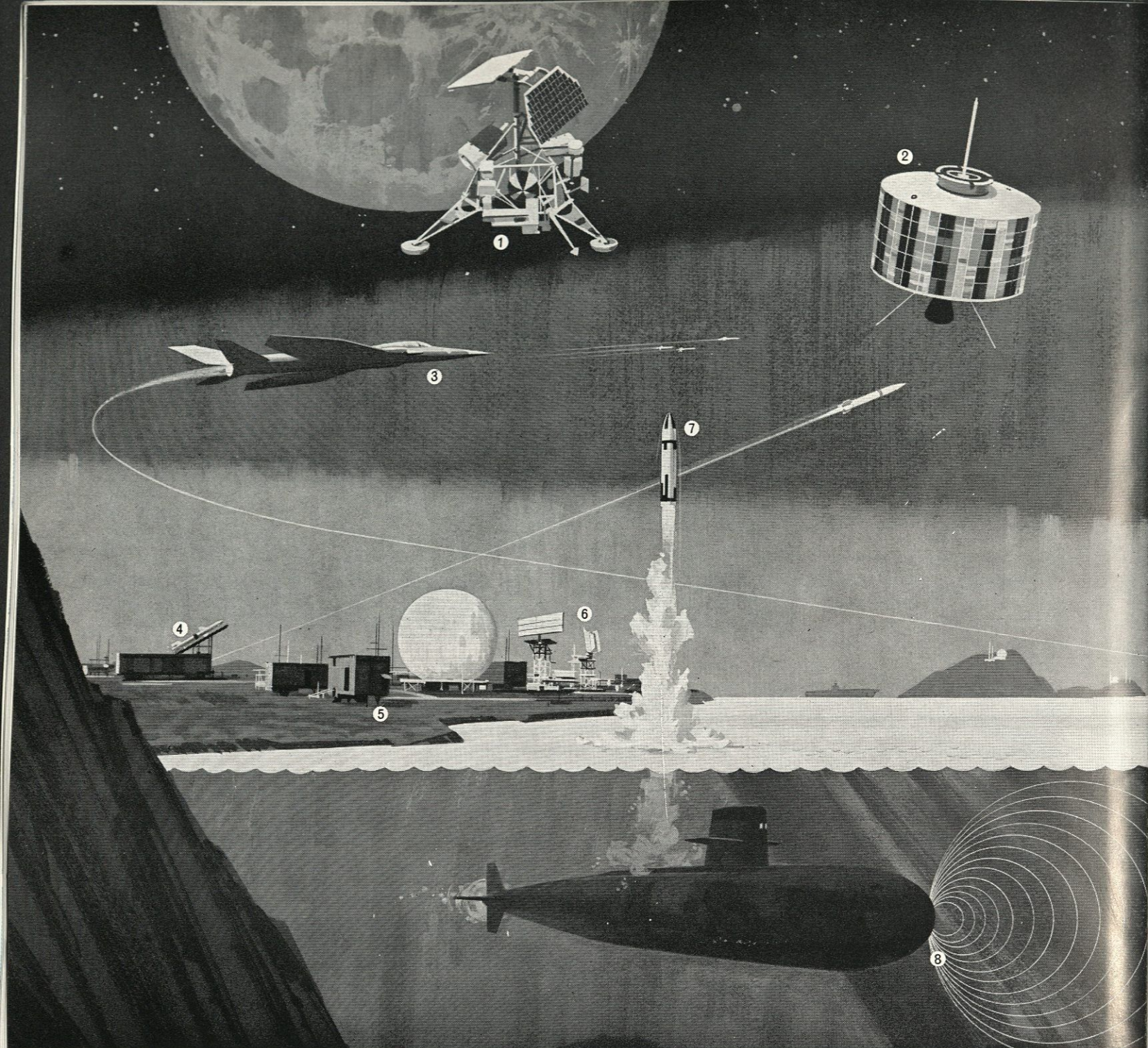
The terminal maneuver, if performed, will require about 34 minutes. It will begin when the spacecraft is approximately 3940 miles from the Moon traveling at about 3400 miles an hour.

At impact minus approximately 15 minutes, the CC&S will send a command to turn on the television system to allow it to warm-up. A radioed command for this event can be sent as a back-up. The F chain can also be commanded into warm-up by the TV back-up clock if the latter has not been inhibited.

The spacecraft will be approximately 1100 miles from the Moon and, its velocity will have increased to about 4400 miles an hour due to the increasing effect of lunar gravity.

About a minute later, the camera sequencers turn the television system on to full power. This command will be backed up by another command from the CC&S if necessary.

At this time, the cameras will start pictures and transmitting them to Earth by the two 60-watt transmitters.



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SCANDINAVIA'S CONTRIBUTION TO GOOD DRINKING

JAN WENNESLAND

Scandinavia has made two major contributions to good drinking by introducing the word *skoal* and the drink *Aquavit*. To my great sorrow I have noticed that Americans do not really appreciate either of the two. This article will, therefore, serve as an introduction to the ceremonies surrounding the word *skoal* (which is really spelled *skal*), how *Aquavit* is produced, and how and why it is enjoyed in the Scandinavian countries.

American visitors to any of the many fine Scandinavian restaurants often witness the following fascinating scene:

Two middle-aged couples, obviously Scandinavians and obviously married, are shown to a nearby table. As soon

as they are seated, the women start chatting. The men say little or nothing; they sit stiffly in their chairs, looking uncomfortable. It should here be mentioned that even though the Scandinavians are supposed to be very friendly (according to the travel agencies and travel guides) they are really very reserved toward people whom they do not know very well.

A waiter approaches the two Scandinavian, middle-aged, married and slightly uncomfortable couples. One of the men gives a brief order. The waiter disappears to appear a few minutes later with a tray laden with several bottles of beer and another bottle solidly encased in ice.

From the ice-coated bottle, the waiter deftly fills four small glasses

He then pours the beer and leaves.

The two men look at one another, nod, smile; the women stop talking. All four exchange glances and, as if on signal, all lift the small glasses to the height of their second chins. Holding them there, all look from one to another in turn. Then they say in unison, "*Skoal!*" They nod, all lift their glasses to their lips and down the contents in one gulp. All smack their lips and say, "Aaahhhh!" Then all lower the empty glasses to their hearts, look deeply into one another's eyes, and nod as if in greeting or salute before they finally set their glasses down. Without further ceremony, all enjoy a long, cooling draft of beer.

At this point the waiter reappears

with the ice-encrusted bottle, refills the little glasses, and disappears.

The two men no longer seem ill at ease; they beam—even at their wives, who have resumed their chattering.

The fascinated Americans have witnessed a traditional Scandinavian drinking ceremony. It is ceremony repeated whenever Scandinavians drink together, whether they drink Aquavit, beer, Scotch, wine or champagne. It does not matter whether you are in a restaurant or a small cabin, in your own home or in an old sailboat. At all gatherings, it is a ceremony repeated at least as many times as there are guests or drinkers, as everyone *skoals* everyone present, and some forgetful ones might *skoal* the same person twice.

This is probably what has led many to believe that the Scandinavians are heavy drinkers, but while the custom is to down Aquavit in one gulp, all other alcoholic drinks are sipped. However, the ceremony explains, in part, why Scandinavian dinners and get-togethers may last for hours, and why the guests are able to leave the

table sober. An American on rye for an equal length of time would be wanting to fight every man in the house. Also aquavit is mostly served along with very heavy food. As a matter of fact, Aquavit prevents indigestion much better than any of the thousands of pills the Americans swear by. It is also well known that without a glass within his immediate reach, a Scandinavian has a very hard time finding a way to end his speech. Even a small, informal Scandinavian dinner party will have at least two speeches—one by the host welcoming his guests, and one by the man seated with the hostess, thanking her for the meal. The host will end his speech by saying, "Skoal, and welcome to the table!", while the guest will end his speech and the meal with the following words "Skoal, and thank you for the meal!" After each of these toasts, of course everybody will raise his glass and go through the Ceremony.

An English drinking song begins, "Cold water is the best of drinks," and ends, "but even beer is good enough for me." The Scandinavians

make some excellent beers, but beer was not good enough or strong enough for them, so they invented Aquavit, distilling it from an over supply of potatoes into a potent liquid of some 86 proof. Apparently this was not strong enough to satisfy the Scandinavians' taste for firewater, so they spiked it by adding spices that add fire to its taste. Then it was discovered that only a good Scandinavian beer would quench the fire. This explains why aquavit is never served or drunk without a beer chaser. The invention of aquavit proves the ingenuity of the Scandinavians. It helped not only to dispose of a surplus of a surplus potato crop, but it also increased the domestic beer sales.

I shall end this little introduction to Scandinavian drinking habits with a word of warning to all Americans. It seems to me that one of the great American hobbies is the mixing and drinking of Martinis:

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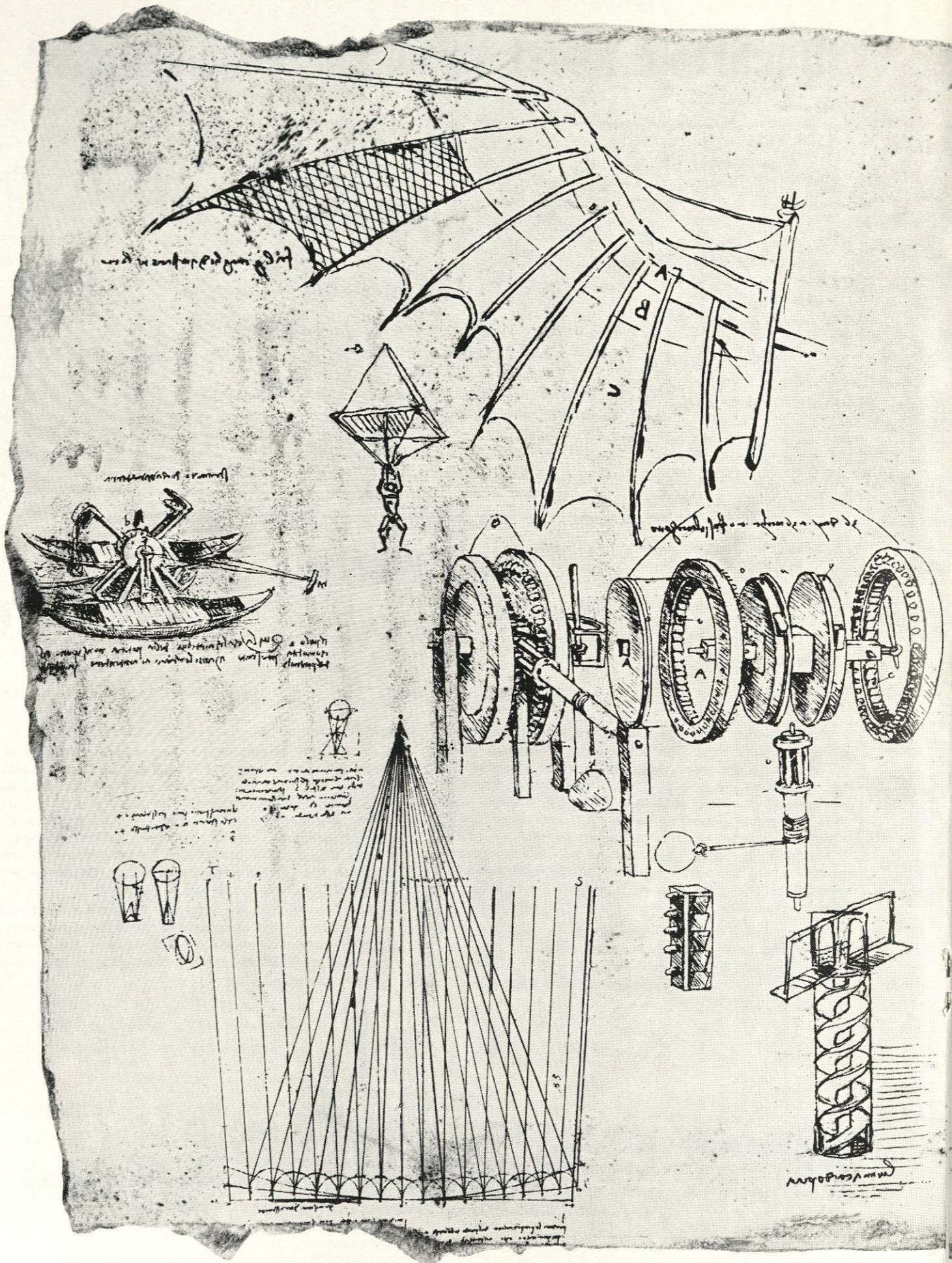
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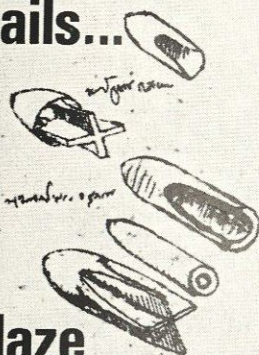
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BALLS OF FIRE

ART ROSCOE

Lightning, to the average person is simply a brilliant flash of light which seems to splinter the sky in long jagged traces. The great quantities of energy that are contained in these flashes is evidenced by the destruction which often accompanies their contact with the ground. This energy builds up as a static charge resulting from friction between rapidly moving air currents inside thunderstorms. The release of this charge to an object at a lower potential (another cloud, an aircraft, or the ground) is the lightning flash which we see. The tremendous quantity of energy which is generated within the clouds sometimes manifests itself in other strange and often spectacular ways. One of these manifestations is ball lightning.

Ball lightning is a strange, often frightening, but little understood phenomenon of nature which has impressed men for thousands of years. Ball lightning almost always occurs in conjunction with St. Elmo's Fire which is commonly referred to now as corona effect. St. Elmo's Fire or corona effect normally manifests itself as a blue-white glow and is most often seen around high voltage power lines. It occurs less frequently along fence lines or even on automobiles or houses during severe electrical storms.

Most of the recorded observations of ball lightning have also occurred

during electrical storms when St. Elmo's Fire was present. The "Balls of Fire" have been reported as shooting out of the mouthpieces of old fashioned upright telephones, hovering over fence lines, or rolling along the ground. These reports have characteristically been greeted by a great deal of skepticism and many authorities in this country have stoutly denied the very existence of ball lightning. On the other hand, researchers in the Soviet Union have compiled a great deal of data on its observed characteristics.

Personal Experiences

My first experience with ball lightning occurred in 1958 when I was flying as a pilot with the Military Air Transport Service (MATS). The aircraft (a C-124) was flying through a thunderstorm over the North Atlantic at an altitude of 8000 feet when a small, blue-white ball appeared briefly almost directly in front of the cockpit. I was watching it wide-eyed when it discharged with an extremely bright flash and blinded me for about 30 seconds. This experience was repeated several times during the next five years in all parts of the world.

My experiences with ball lightning and those of my colleagues on other flights are remarkable in their simi-

larity. They all occurred while flying at altitudes between 6000 and 12000 feet above sea level inside thunderstorms. In every case of which I am aware, the aircraft was enveloped in St. Elmo's fire and was giving off a relatively bright blue-white glow from the leading edges of the wings and tail and from the propellers, just prior to the formation of the ball lightning. The ball would then appear, usually on the radome directly in front of the cockpit, and would begin to roll or slide back and forth across the radome at a rather leisurely rate. This would normally continue until the aircraft left the thunderstorm at which time the ball would discharge with a brilliant flash and violent explosion. Though the explosion would shake the entire aircraft, I know of only two cases in which physical damage of any consequence was done to the aircraft. In one instance the radome was separated from the rest of the aircraft, and in the other an eight inch hole was blown in the sheet metal of the upper part of the rudder—from the inside out.

My own opinion as to the cause of the damage in both cases is that a great deal of heat was generated by the rapid decay of the lightning ball. This heat caused very rapid expansion of the air in the radome and in the tail and because both of these

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areas are relatively confined, the release was found by blowing out at weak points. This, of course, is pure speculation on my part.

The balls which I observed ranged from about 6 to 14 inches in diameter and glowed with a pale blue-white light. Though they normally seemed restricted to their position on the radome or directly in front of the wingtips, they would, on rare occasions, actually come inside the aircraft. At these times, they moved freely inside the aircraft, and I have actually seen one pass completely through a metal bulkhead. To my knowledge, no physical damage was ever done to the inside of the aircraft by one of the balls.

After several of these episodes, I set out to determine the nature of ball lightning, but soon became frustrated in my efforts. When I approached people who I thought should know about such things (meteorologists, engineers, etc.) I was generally greeted with conjectures, skepticism or disbelief, but never any facts. The only papers on the subject which were available at that time were done by Russians and had not yet been translated. I had reached an impasse until last month when Professor Hanna of the C. U. Electrical Engineering Department brought to my attention a recent translation of seven Russian papers on ball lightning. The remainder of this paper will be essentially a summary of the Russians' findings.

Russian Work in the Field

In summarizing the Russian work, it may in general be said that ball lightning occurs most frequently near the end of a severe electrical storm when the air is highly ionized (electromagnetic disturbances caused by streak lightning are also usually present). The diameter of the balls may range from a few inches to several feet and the colors vary all through the spectrum from red to blue-white. They appear to move by rolling or sliding along conductors, but may also hang motionless in the air or travel up or down rough waveguides such

as chimneys. The reports suggest that the lightning balls usually occur as a result of lightning discharge, but may originate randomly in space and are frequently airborne or partially so. They usually decay quite suddenly (often explosively) but on occasion will just fade away without a sound.

Estimates based on color and light intensity indicate that the surface temperature may be as high as 9000°F and that a great deal of energy is released during decay. D. L. Ritchie of the Consultants Bureau in New York suggests that for a ball 100 cm in diameter, the stored energy may be up to 1,250,000 joules. This is about the equivalent of 60 pounds of TNT.

The Plasmoid Theory

Lately, with the emergence of the disciplines of plasma physics and magnetohydrodynamics, the hypothesis that ball lightning is a ball of plasma or plasmoid has grown in popularity. Recent Russian efforts have been made to explain ball lightning as a ball of plasma in resonance with an external radio frequency electric field. P. L. Kapista postulates that electromagnetic disturbances caused by thunderstorms serve to feed energy into the ball of plasma. This would seem to require electromagnetic waves of a single frequency to nurture a ball of specific diameter. However, Y. Yankov has demonstrated theoretically that a stable plasma configuration is compatible with multiple frequencies.

According to Kapista, it is assumed that the absorption frequency corresponds to that of the characteristic oscillations of a sphere. This then fixes the wave length at approximately four times the diameter of the sphere, or about 35 to 100 cm for the majority of the balls observed.

Sites most favorable for the production of lightning balls are regions where the intensity of the required radio frequencies is greatest, and because the balls depend on the *rf* source for their existence, their mo-

tion is independent of winds and convection currents.

As a result of interference effects in front of a reflective surface, standing waves are set up with antinodes at $.25\lambda$, $.75\lambda$, 1.25λ , etc. These antinodes are points of maximum electric field intensity and as such are favorable locations for the production of ball lightning. In fact, several balls may be formed in a line at half wave length intervals. This no doubt explains the presence of the balls in front of reflective surfaces of an aircraft.

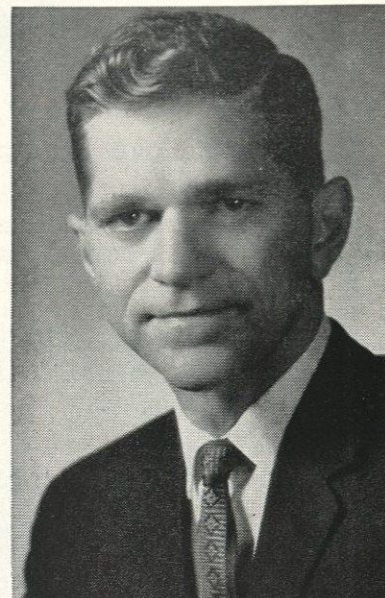
Kapista speculates that the ball lightning penetrates into buildings or aircraft by following the path of short wave electromagnetic oscillations which can propagate through apertures or along a chimney conductor as a waveguide. However, at the time his paper was written (1957) he had not definitely proved the existence in nature of the electromagnetic oscillations necessary for ball lightning production.

One of the Russian papers dealt with the experiences of Soviet aircrews with ball lightning, and it is interesting to note that their encounters were, for the most part, quite similar to my own and those of my colleagues in MATS. One notable exception was that the Russians, on a number of occasions, observed the balls floating freely through electrical storms. In one instance, an aircraft struck one of these free floating balls. The ball immediately discharged with its characteristic flash and explosion, but again no physical damage was done to the aircraft structure.

I regret that I must end with no firm conclusions of my own concerning the nature of ball lightning. This is due in part to my limited ability to understand the advanced field theory and mathematics used by the Russians to justify their own conclusions. However, this may be a subject worthy of serious consideration by researchers in this country in the areas of plasmas, electro-magnetic fields and magnetohydrodynamics.

DEAN'S COLUMN

DEAN PETERS



Another major step in the development of University-industry liaison and scientific industrial activities in the State of Colorado was achieved through the recently announced Boulder Research and Industrial Campus (BRIC). A major research and industrial campus of this type is an essential ingredient for the future economic development of the entire State. For the past two years, representatives from the University and the local Boulder area have been working together closely to have such a campus initiated under conditions of controlled planning to permit a quality type of development. The new research-industrial campus will not have any direct financial connections with the University, but it will be supported strongly by the University and also, we hope, by the other appropriate groups in the State of Colorado.

The site to be developed is only ten minutes by a main highway from the University of Colorado campus and five minutes more to the National Bureau of Standards and the National Center for Atmospheric Research. As originally announced, the size of the research-industrial campus was 340 acres. Through recent additional land acquisitions, the size may increase to 567 acres. The site adjoins to the east, across a four-lane highway, the Boulder recreational area with water sports and fishing. To the north is the 640-acre site purchased by IBM a few

years ago, and to the east is the new Gun Barrel Green residential area surrounded by the new Boulder Country Club with its twenty-seven hole golf course. Detailed plans for the campus, including the architectural concept, are being prepared. In early 1965, a conceptual and a preliminary master plan will be presented. Plans will be formulated for building on sites under sale or lease arrangements with all service requirements furnished. Also, high-quality land-use standards will have been established and will be maintained through covenants as part of any sale or lease arrangement.

I, personally, am delighted with the plans under way for the research-industrial campus. I feel that our advantages are such that this campus will be unique in the nation with a definite possibility of equaling or surpassing those areas found presently at Stanford Industrial Park and the Route 128 installation at Boston. The key importance of this campus to the scientific and industrial development of Colorado is obvious.

Other significant aspects related to University-industry liaison are developing rapidly in our College of Engineering. We are providing a monthly Industrial Newsletter which invites personnel to attend our engineering-oriented seminars and colloquia. Approximately 200 industries in the State are currently receiving this Newsletter. Another exciting de-

velopment relative to our educational function and University-industry liaison is the recently announced Cragmor Center in Colorado Springs. We are now completing plans for initiating a graduate engineering program at the Colorado Springs Center with our first efforts being devoted toward a program leading to a Master's degree in Electrical Engineering, with strong emphasis on Applied Mathematics. In addition, our engineering program continues to develop and expand at the Denver Center.

We feel that the engineering educational services we are providing through our Denver Center, the Colorado Springs Center, and the Boulder Campus are of great importance to the future economic development of our State, with particular importance relative to increasing the industrial attractiveness of the State. We are currently making plans for a continuation education type of program related to the engineering education needs on an advanced level for industrial personnel.

The faculty of our College of Engineering feels that University-industry liaison is essential to the future development of our State. We are making every effort to cooperate in and give leadership to the further development of this liaison.

Max S. Peters
Dean

ABOUT THE AUTHORS

CERAMIC UNDER IMPACT

STALEY F. ADAMS

Staley F. Adams is a graduate student in the Civil Engineering Department on a National Science Faculty Fellowship from the University of Kentucky. He is an associate professor of engineering mechanics at the University of Kentucky.

A RANGER TO THE MOON

JOHN SUNKEL

John Sunkel is a graduate student in the Department of Aerospace Engineering Sciences. He is working under a NSF Assistantship on High Reynolds Number Wind Tunnel Experiments under the direction of Dr. L. Garby. He will graduate in August with the M. S. degree.

Reference

This article was written with the aid of NASA news releases and the National Geographic Magazine.

BALLS OF FIRE

ARTHUR ROSCOE

Arthur Roscoe is a senior majoring in electrical engineering. He is a captain in the Air Force attending the University of Colorado under the Air Force Institute of Technology program. He has been in the Air Force for 8½ years, five of which were spent as a pilot in the Military Air Transport Service. He has accrued a total of 4,500 flying hours, most of them in the C-124 Globemaster. He is married and has four children.

"Ball Lightning," Donald J. Ritchie, Consultants Bureau, New York, 1961.

THE REAL CRISIS IN EDUCATION

CARL G. BAILEY

Carl Bailey is a Captain in the Air Force and is attending CU under the

Air Force Institute of Technology program. Carl plans to graduate in June with a B.S. degree in Aeronautical Engineering.

Captain Bailey, as he is popularly known, is a member of Tau Beta Pi, Sigma Tau, and A.I.A.A. Much of his spare time is spent at home with his wife and two children.

SCANDINAVIA'S CONTRIBUTION TO GOOD DRINKING

JAN WENNESLAND

Jan Wennesland is a senior majoring in civil engineering and plans to graduate in January. He is a member of Tau Beta Pi, Chi Epsilon and the American Society of Civil Engineers. He is also president of the Norwegian Club. Jan is married and he hails from Kristiansand, Norway.

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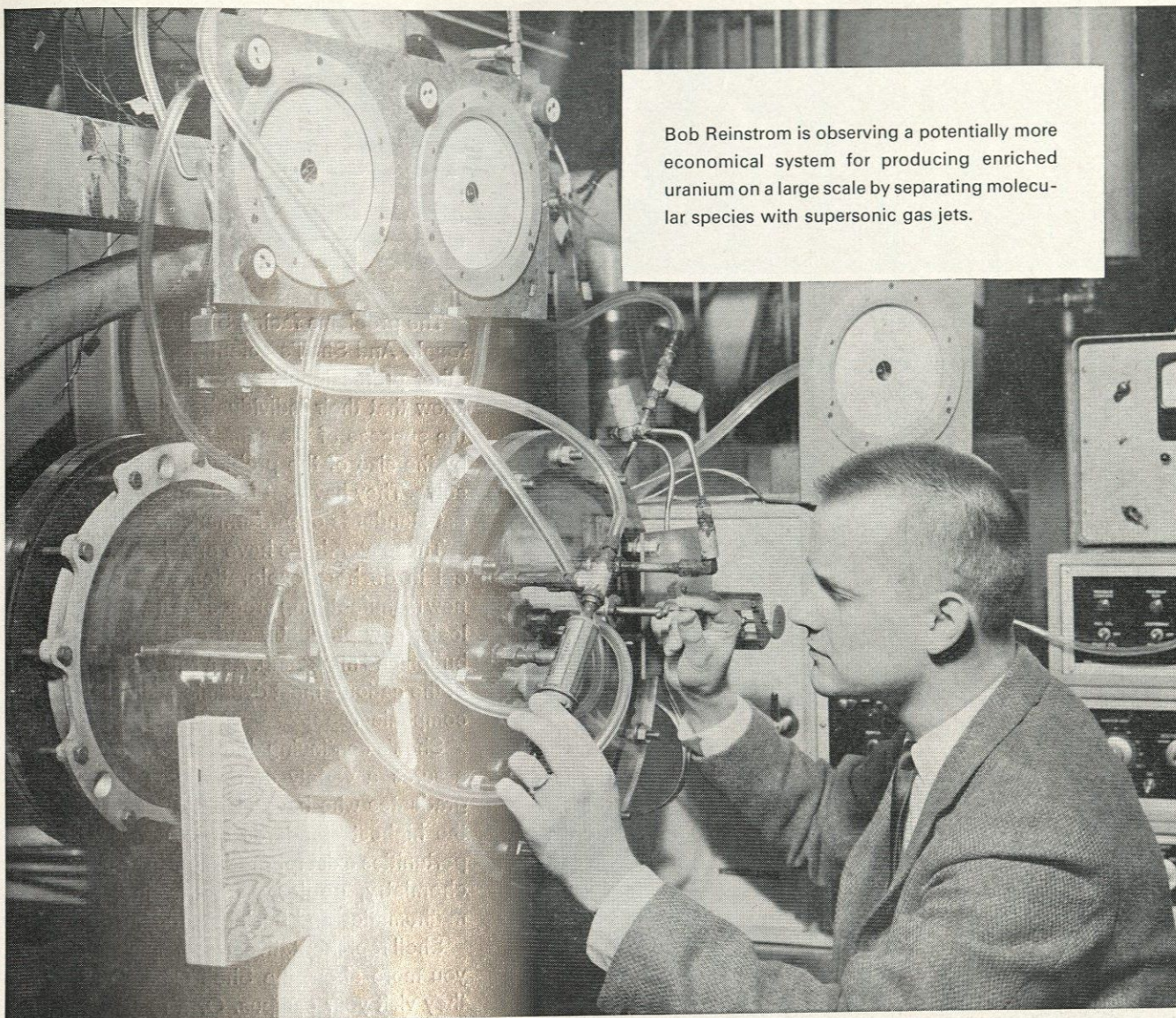
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Bob Reinstrom is observing a potentially more economical system for producing enriched uranium on a large scale by separating molecular species with supersonic gas jets.

Young Engineers Find Opportunity at Allison

■ Bob Reinstrom came to Allison Division, General Motors, early in 1962 following his graduation from the University of Minnesota with a BS degree in Mechanical Engineering.

As a research engineer at Allison, he has been associated with the Nuclear Liquid Metal Cell Program, the MCR (Military Compact Reactor) Project, and the Energy Depot Project. In these assignments, he has contributed to these studies:

- 1—Analysis and design of heat transfer equipment to investigate boiling, condensing, and thermal cycling in closed liquid metal systems.
- 2—The steady-state parametric optimization and transient behavior analysis of nuclear reactor systems.
- 3—Thermodynamic analysis of open chemical processes.

Presently, Bob is doing graduate work in engineering at Purdue University-Indianapolis campus . . . one of

the many advantages of a job with Allison.

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justable between 1- and 4-millisecond duration, at the rate of up to 1200 pulses per hour.

Harry E. Rockefeller, manager of Linde's Electric Welding Department, said, "Unlike the few prototype laser welders currently being tested by other manufacturers, the Linde laser welder is one of the first such systems to be offered commercially as standard equipment."

Mr. Rockefeller reported that the laser welder is manufactured by Korad Corporation, a subsidiary of Union Carbide, and is marketed exclusively by Linde's Electric Welding Department. Korad's president, Dr. Theodore Maiman, invented the first laser — a pulsed ruby crystal system similar to that employed in the new welding unit.

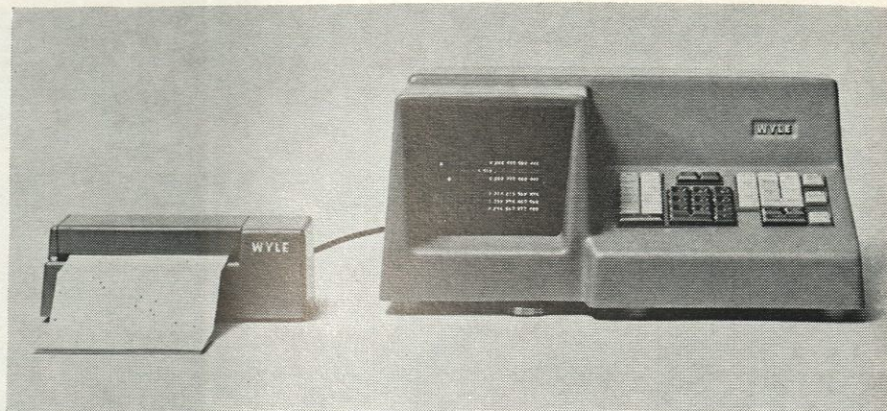
The laser welder head contains a Linde ruby crystal rod, xenon flash lamp, and reflector. This unit is thermally insulated to prevent condensation on the reflecting surfaces of the ruby laser crystal, and is water-cooled to dissipate the heat generated by laser operation. The laser output beam is essentially made up of light waves at a wave length of 6943 Angstroms. An optical lens system focuses the beam onto a 0.010-inch diameter spot approximately two inches in front of the welding head.

Union Carbide's laser welder has produced high-quality spot welds in joining fine wires (0.015- to 0.030-in.) and in welding fine wires to foil. Weld strength approaching the tensile strength of the wire itself was achieved consistently; for example, joint strength for 0.015-inch wire was at least 90 per cent of wire tensile strength. It is anticipated that the laser welder will find a ready market in the electronic manufacturing industry which currently scraps an estimated \$150-million worth of parts annually because of joining faults or failures.

DESK COMPUTER

The first electronic desk calculator that can be programmed automatically has been developed by Wyle Laboratories.

The calculator, the Wyle Scientific, becomes automatic with the addition of a specially engineered punched-card input unit. With such a unit, the scientist or engineer can solve frequently-used equations simply by inserting cards into the reader and



WYLE'S NEW ELECTRONIC DESK CALCULATOR

then entering the number variables manually on the calculator keyboard. No special card punching equipment or programming knowledge is necessary. The scientist or engineer simply duplicates the problem-solving steps of the calculator on the cards with a stylus. The entire operation can be performed right at his desk and the prepared cards can be stored in a convenient file for future use.

Capable of performing eight problem-solving operations a second, the Wyle Scientific with its unique card reader is considerably faster than calculators without the automatic input feature. Since the equation-solving steps are automatic, the possibility of error in manipulating the machine is eliminated. In addition, each step of the problem is visible in one of the six registers on the calculator's cathode ray tube display.

AIR WAVE DETECTOR

P. G. Davey, of the Lawrence Radiation Laboratory, and Walter C. Marion of the University of California, have developed a system so sensitive that it is capable of detecting the drop in atmospheric pressure of less than a one-quarter inch rise in elevation. It recorded both the ground wave and the air wave of the Alaska earthquake which occurred 1960 miles away.

Made from two large wine bottles, open to the outside air, and a thermistor bridge located in a tube leading to the bottles, the system records the effect of the air which passes in and out of the empty bottles. Current is only applied to the center thermistor of the bridge. As air moves in and out of the bottles, the thermistor is cooled off, the resistance changes, and the bridge is thrown out of balance. Surge tanks prevent slight breezes from affecting the air flow. It will

be used at the University of California Seismographic Station.

NUCLEAR CONVEYOR

O. E. Gooding and Company of Ypsilanti, Michigan, is using a nuclear scale to measure the fill dirt being used in a road-building job near Jackson. The scale automatically weighs the fill as it moves over a conveyor while being loaded into trucks and thus informs the operator when the load is complete.

In operation, radioactive cesium-137 isotope contained in a tube beneath the conveyor belt directs gamma radiation through the moving belt with its load of fill dirt to measuring cells in another tube above the belt. The radiation waves vary with the changes in the thickness or density of the material. The density of the material plus the speed of the conveyor belt is computed into quantity of material delivered on a totalizer which reads in pounds.

LASER SATELLITE TRACKER

Scientists at NASA and General Electric are working on a system of tracking satellites with a laser device. The experiments were carried out at the NASA Goddard Space Flight Center, Greenbelt, Md.

A satellite, Explorer XXII, was launched on October 9 with an array of corner reflectors on it. The ruby laser was mounted on a telescope, and the telescope was aimed at the predicted path. The laser was then flashed on and off as the satellite passed overhead, and the returning signal was displayed on an oscilloscope. The system was first successful on October 11, and has worked nine other times since. The accuracy is expected to be within 10 feet, but much work still remains to be done before the system is perfected.

MICROFILM CATALOG FILE

Design engineers in Original Equipment Manufacturing industries will soon have access to the world's largest single source of definitively indexed product data ever published. The availability of such data will become an engineering tool for product improvement.

The unique product information and catalog distribution system developed for defense products industries, and currently being used by over 200 aerospace, military, electronics, and government organizations, will be expanded and made available to non-defense products manufacturing industries and their suppliers. The new OEM design edition will initially contain over 100,000 catalog pages from 3,000 suppliers to the OEM market, and will be distributed beginning in December of this year.

In announcing expansion of the VSMF system, Thomas E. Falvey, General Sales Manager of the OEM

edition for Information Handling Services, stated, "Recent studies with design engineers in the commercial and industrial fields convinced us that the need for VSMF was as great in those fields as it was in the defense industries. VSMF enables the design engineer to select from a wide variety and vast number of sources the best part or material for each design application."

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VSMF (Defense Design Edition), is currently being used by 54,000 engineers who, last year, made more than 720,000 reproduction copies of catalog pages from the VSMF files.

VSMF has been used by the air-

craft/missile industry since 1961 and has saved the government and its suppliers an estimated \$25 million a year.

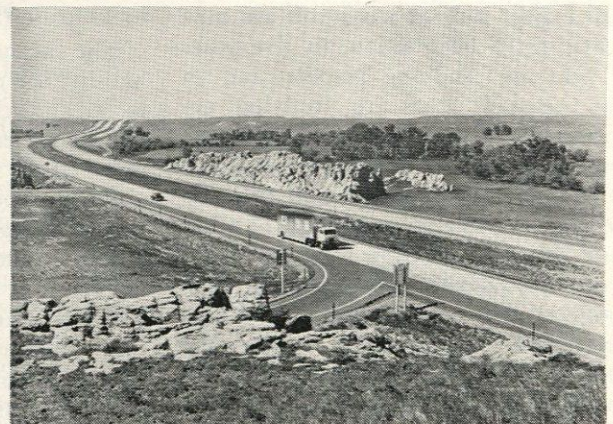
MINIATURIZED FLAW DETECTOR

All the big-time hot-rodders and racing boat enthusiasts will be pleased to hear of the release of a revolutionary new type of magnetic particle crack and flaw detector. Developed by the Testing Systems Division of U.S. Casting Repair Corp., Philadelphia, Pa., the system is called a "Magnetic Flaw Finder." It weighs less than 4 pounds, is easily operated by one man, and is capable of finding even the most minute surface cracks in any ferro-magnetic material. Requiring no special training to operate, the Magnetic Flaw Finder is ideally suited for finding stress cracks, fatigue cracks, heat and grinding cracks, and even welding defects in ferrous parts of any size.

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BOOK

REVIEWS

JOANN CRAM

Did you all read in the November 30, 1964, "Colorado Daily" that "you can expect half of what you are now learning to be obsolete in five years if you are studying physics, and in ten years if you are studying engineering"? The article (which was on page nine if you happen to save old Dailies) also states that in some of the physical sciences, half of what you will need to know in the next ten years hasn't been discovered yet. One look at the mushrooming technical literature substantiates these comments. Evidently, a good engineer needs to maintain and *read* a personal library of technical journals and books. General information material should be included for variety though, and a book of famous mathematical puzzles might be fun to have.

Probability and Its Engineering Uses

by Thornton C. Fry, D. Van Nostrand Company, Inc., Princeton, New Jersey, 450 pages, 1964, \$12.00.

Dr. Fry, who, by the way, is a Consultant to the Director of the University Corporation for Atmospheric Research here at Boulder, has revised the first edition of this book which was published in 1928. The point of view of the first edition has been re-

tained in the revision although it is now more postulational than was fashionable in 1928.

The author recognizes that probability is a concept rich in economic, social, and scientific connotations, and he has selected and presented his material in such a way as to bring out these connotations without sacrificing logical and mathematical integrity. The revision includes new material on Random Walks, Markov Processes, and the Foundations of Statistics; much of the material has been completely rewritten. The book contains lots of examples, and presents a well-graduated introduction to the mathematical theory of probability, followed by a treatment in greater depth of topics of special interest to physical and social scientists. It presupposes a knowledge of college mathematics through calculus. Some of the chapter headings are the following:

Permutations and Combinations
Elementary Principles of the Theory of Probability
Probability and Experiment; Bernoulli's Theorem
Probability and Experiment; Bayes' Theorem
Averages
The Distribution Functions most frequently used in Engineering

Matrix Methods and Markov Processes

The Foundations of Statistics

The Theory of Probability as Applied to Problems of Congestion

Life: Its Nature, Origin, and Development

by A. I. Oparin as translated from the Russian by Ann Synge, Academic Press, September, 1964, paperback, 207 pages, \$2.45.

This is stuff to capture the interest of any engineer. Scientists the world over argue the opinions of Russia's A. I. Oparin. His claims in this book that life and its origin are parts of a single process, that organized systems are requisite to the synthesis of ordered protein molecules, and that artificial synthesis of living matter is a "naive" expectation, are typical of many of his theories which have brought dissent and approval from leading men of science.

The book is divided into five parts, the first being "The Nature of Life". Oparin discusses such things as the extent of life; the conflict between idealism and materialism as to the essential nature of life; attempts to formulate definitions of life; attempts to treat the organism as a machine; cybernetics. He concludes that it is

only possible to understand life by studying its origin and development. "The Origin of Life" concerns contemporary cosmogonic theories such as the origin of the solar system and the formation of the crust of the Earth. The formation of hydrocarbons and their nearest derivatives is followed through an evolution process to the origin of the first organisms. "The Earliest Period of the Development of Life" discusses more terrestrial history and develops life up to the formation of cells. Photochemical reactions, photosynthesis, and the origin of respiration are included here. Nutrition, growth and development, movement, irritability and nervous activity are the subject of "The Further Evolution of Life." A Conclusion chapter terminates the book. And it's all in a paperback edition!

The Making, Shaping, and Treating of Steel 8th edition

Published by the United States Steel Corporation, 1964, 1198 pages, \$10.00, or \$5.00 student price.

The Making, Shaping, and Treating of Steel is a complete one-volume reference work relating to the iron and steel industry. Completely revised since its seventh edition was issued in 1957, the new column offers user and makers of steel a comprehensive summary of present-day theory and practice covering all phases of iron and steel production from raw materials to finished products.

Recent developments in steel making and processing that are reviewed include basic oxygen steelmaking processes, vacuum degassing and continuous casting methods. Four new chapters cover the manufacture of tonnage oxygen for steel plant use, direct-reduction processes, manufacture of heavy press forgings, and water requirements for steelmaking. A fifth new chapter presents the fundamental principles for the physical chemistry of iron and steelmaking.

In addition to the subjects mentioned above, extensive discussions are devoted to the manufacture and properties of carbon and alloy steels, and the products made from them. These include blooms, slabs and billets; heavy forgings; rails and structural sections; plates, merchant bars, and hot strip mill products; cold reduction mill products; galvanized products; tinplate and terne plates; cir-

cular shapes; axles; shafts; wire; tubular products; electrical sheets; and corrosion-resistant and heat-resistant products.

Copies of the volume, priced at \$10.00 each, may be obtained from United States Steel, Office Service-Stores, 1509 Murriel Street, Pittsburgh, Pa. (15203) Students, however, may obtain the book for \$5.00 per copy, providing each order is counter-signed by a faculty member.

Famous Problems, and Other Monographs

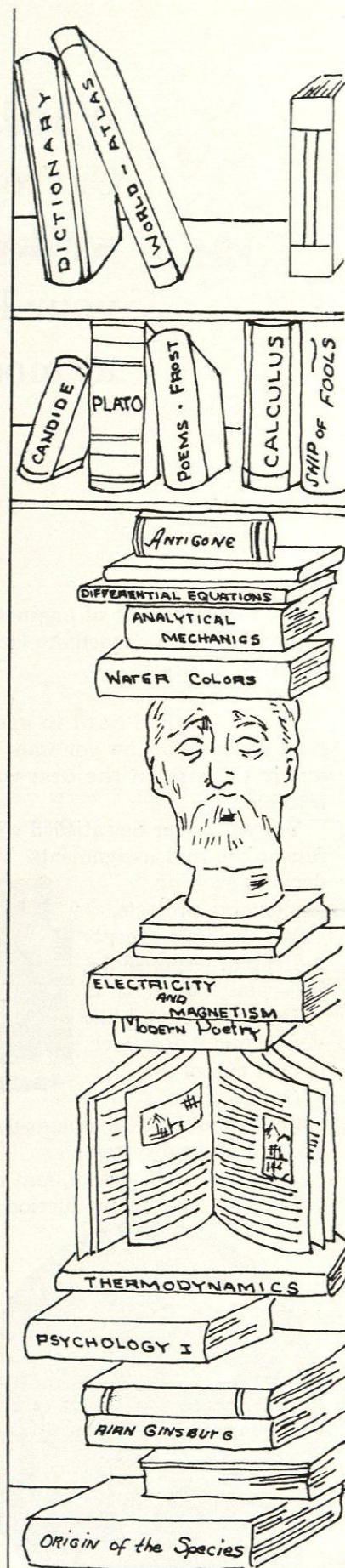
By Klein, Sheppard, MacMahon, and Mordell, Chelsea Publishing Company, 1962, 350 pp., Cloth \$3.95, Paperbound \$1.95.

"Famous Problems of Elementary Geometry," by Klein. A simple, easily understandable, account of the famous problems of Geometry — The Duplication of the Cube, Trisection of the Angle, Squaring of the Circle — and the proofs that these cannot be solved by ruler and compass. Also, the modern problems about transcendental numbers, the existence of such numbers, and proofs of the transcendence of e .

"From Determinant to Tensor," by Sheppard. This monograph is written simply and in nine parts: I. Origin of Determinants; II. Properties of Determinants; III. Solution of Simultaneous Equations; IV. Properties; V. Tensor Notation; VI. Sets; VII. Cogredience, etc.; VIII. Examples from Statistics; IX. Tensors in Theory of Relativity.

"Introduction to Combinatory Analysis," by MacMahon. A concise introduction written as an introduction to the author's two-volume work on the field.

"Three Lectures on Fermat's Last Theorem," by Mordell. This famous problem is so easy that a high-school student might not unreasonably hope to solve it; it is so difficult that tens of thousands of amateur and professional mathematicians, Euler and Gauss among them, have failed to find a complete solution. Mordell's very small book begins with an impartial investigation of whether Fermat himself had a solution (as he said he did) and explains what has been accomplished. This is one of "the masterpieces of mathematical exposition."



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The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information

and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems.

In the Phoenix Division there are gas turbines for propulsion and secondary power, valves and control systems, air turbine starters and motors, solar and nuclear power systems.

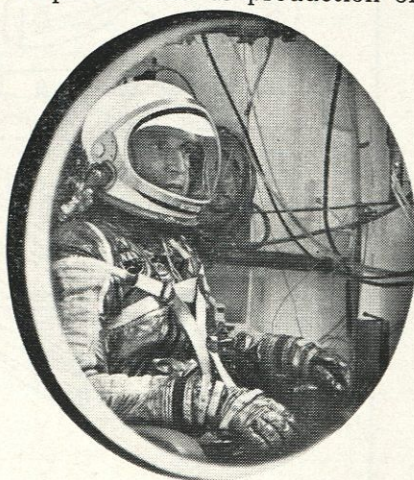
In each category AiResearch employs three kinds of engineers.

Preliminary design engineers do the analytical and theoretical work, then write proposals.

Design engineers do the layouts; turn an idea into a product.

Developmental engineers are responsible for making hardware out of concepts.

Whichever field fits you best, we can guarantee you this: you can go as far and fast as your talents



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PUZZLE PAGE

BRUCE DUNN

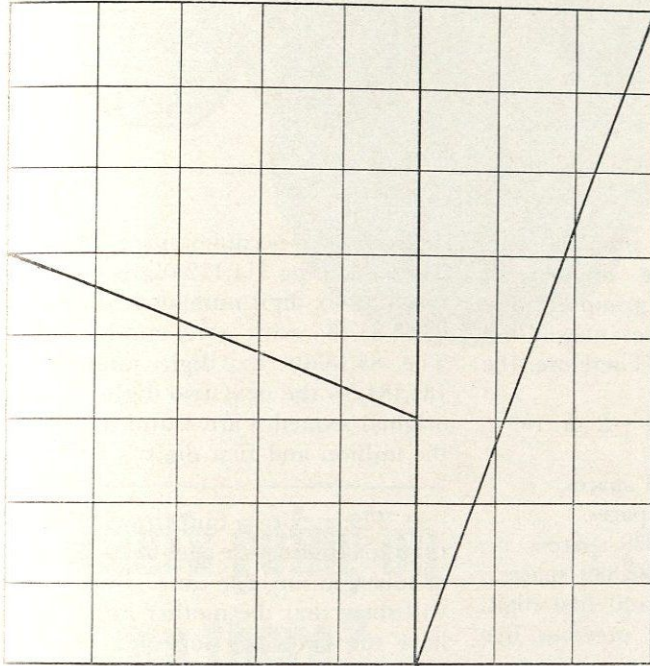


FIGURE 1

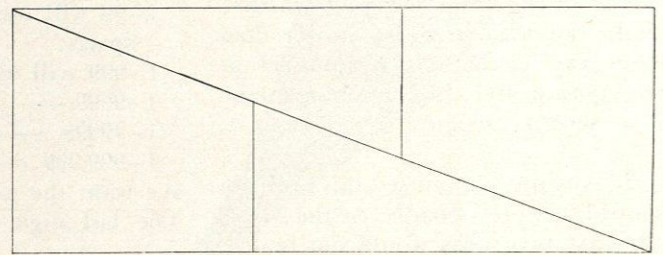


FIGURE 2

1) The first puzzle this month is a very simple problem in algebra. We define an arbitrary A, B and C such that:

$$\begin{aligned} A &< B \\ C &= A+B \end{aligned}$$

Then, from the second equation:

$$\begin{aligned} 2C &= A+B \\ 2C(A-B) &= (A+B)(A-B) \\ 2AC-2BC &= A^2-B^2 \\ A^2-2AC+C^2 &= B^2-2BC+C^2 \\ (A-C)^2 &= (B-C)^2 \\ A-C &= B-C \\ A &= B \\ \text{but } A &< B \end{aligned}$$

Find the fallacy.

2) Next we look at the world of plane geometry. If you take a square paper and section it into 64 squares you can divide it as shown in figure 1, and form it as shown in figure 2. However, the rectangle in figure two has an area of 65 units, not 64. Where did the extra unit come from?

3) Mrs. Davis, Mrs. Jones, and Mrs. Smith, whose first names are Dorothy, Helen, and Mary not necessarily re-

spectively) went shopping together. While they were deflating their husbands' bank accounts, Mary spent twice as much as Helen, and Helen spent three times as much as Dorothy. If Mrs. Davis spent \$3.85 more than Mrs. Smith, what is each woman's full name?

4) Another problem for the algebra expert is the problem in which a cube, measuring one yard on a side, is placed exactly against a perpendicular wall. Now a nine foot ladder is placed such that it touches the wall, the ground, and the cube. How high up the wall can the ladder reach under these conditions? (Figure 3)

References

- 2) Irving Adler; *MAGIC HOUSE OF NUMBERS*, pp 57-58
- 3) C. R. Wylie Jr; *101 PUZZLES IN THOUGHT AND LOGIC*, Prob 68
- 4) *DREXEL TECHNICAL JOURNAL* Dec, 1961

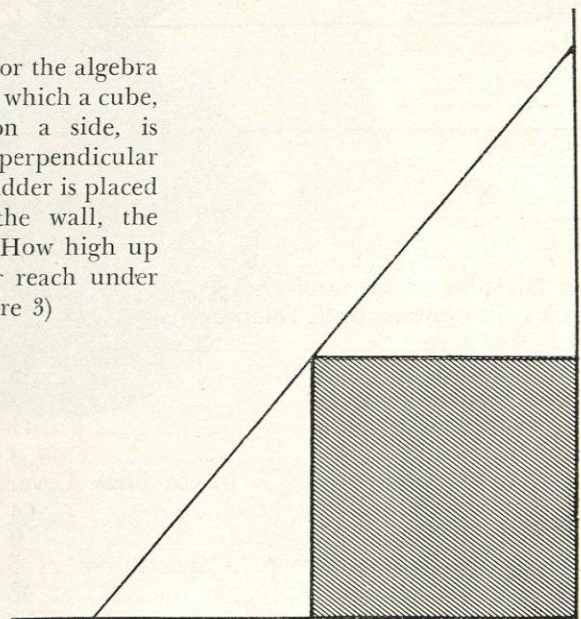


FIGURE 3

Answers To November's Puzzles

PUZZLES

1) The first puzzle was answered by only six people in one week's time. I did get one answer that was wrong, but Jeff Kohr, Bob Eckland, Paul Voillequé, Gary Tufly, Bill Long, and Michael Herzig all came in with the right answer, in that order. The answer was:

$$\begin{array}{r} 80809 \\ 124 \overline{) 10020316} \\ \underline{992} \\ 1003 \\ \underline{992} \\ 1116 \\ \underline{1116} \\ 0000 \end{array}$$

Also, Mr. R. B. Egan of the graphics department came in with the answer to the puzzle from last year which I could not answer. The answer does yield two circles which intersect at two places, and the sectioning plane is as shown in figure 4.

2) Anyone who missed this problem should feel pretty badly. At the worst, the first two socks would not match, but the third sock would have to match one of them.

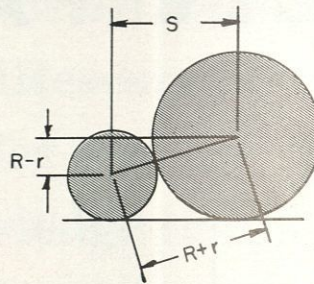
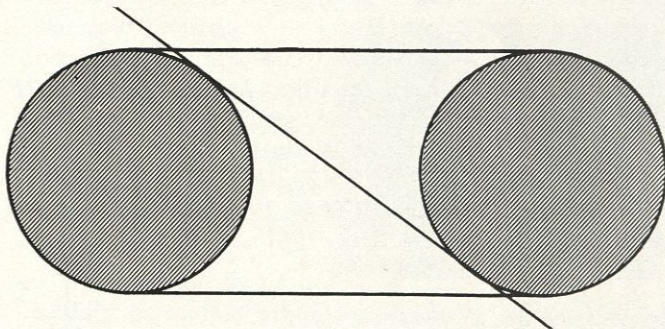


FIGURE 5

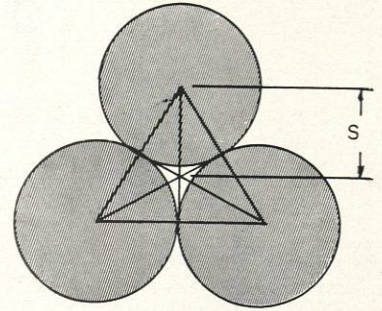


FIGURE 6

3) To solve this problem you simply must find the number of digits occupied by any group of numbers. For example, the integers 1-9 will occupy 9 spaces. Therefore, the ninth digit is 9.

1-99 will use $9+90 \cdot 2$ or 189 spaces.

1-999 will use 2889 spaces.

1-9999 — 38889 spaces.

1-99999 — 488,889 spaces.

1-999,999 — 5,888,889 spaces.

We want the million and first digit, The last digit in the previous five

digit number occupies space 488,889. The remaining 511,112 digits must be taken by six digit numbers. $511,112 \div 6 = 85,185$ with a remainder of 2. The 85,185th six digit number is 185,184, so the next two digits in our original sequence are 1 and 8. Thus, the million and first digit is 8.

4) There exists a multitude of equations for finding the ages of the family members at any one time. Doing this will show that the mother and father have the same fraction of a year in their ages and thus had to be born on the same day of the year.

5) The key to this problem was knowing that it involved solid geometry. The center of the orange was at the geometric center of the equilateral triangle, shown in figure 5. As the triangle is six inches on a side, the center distance is $s=4.47$. Looking at figure 6, we see that

$$\begin{aligned} (3-r)^2 + (4.47)^2 &= (r+r)^2 \\ r &= 1.66 \\ D &= 3.33 \end{aligned}$$

FIGURE 4

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FROM FRUIT JARS TO SATELLITES

GARY MAUTH

The Ball Brothers Research Corporation of Boulder, Colorado, was organized in 1957 as a wholly owned subsidiary of Ball Brothers Company, Incorporated. The Boulder facility functions as an independent division of the parent company, undertaking and performing a variety of research, development, fabrication, and testing activities in the fields of aerospace and electronics communications.

The parent company, Ball Brothers Company, was founded in 1882 at Munice, Indiana, as a fruit jar manufacturing firm. Since that time, it has grown to include production of plastic containers, zinc products, industrial rubber products, various plastic products, and space systems.

The Boulder laboratory itself conducts research and development work for the government and the aerospace industry in the fields of satellite systems, instrumentation, rocket systems, and digital communications. At present, approximately eighty percent of the Boulder laboratory's work has been related directly to space systems research, development, and engineer-

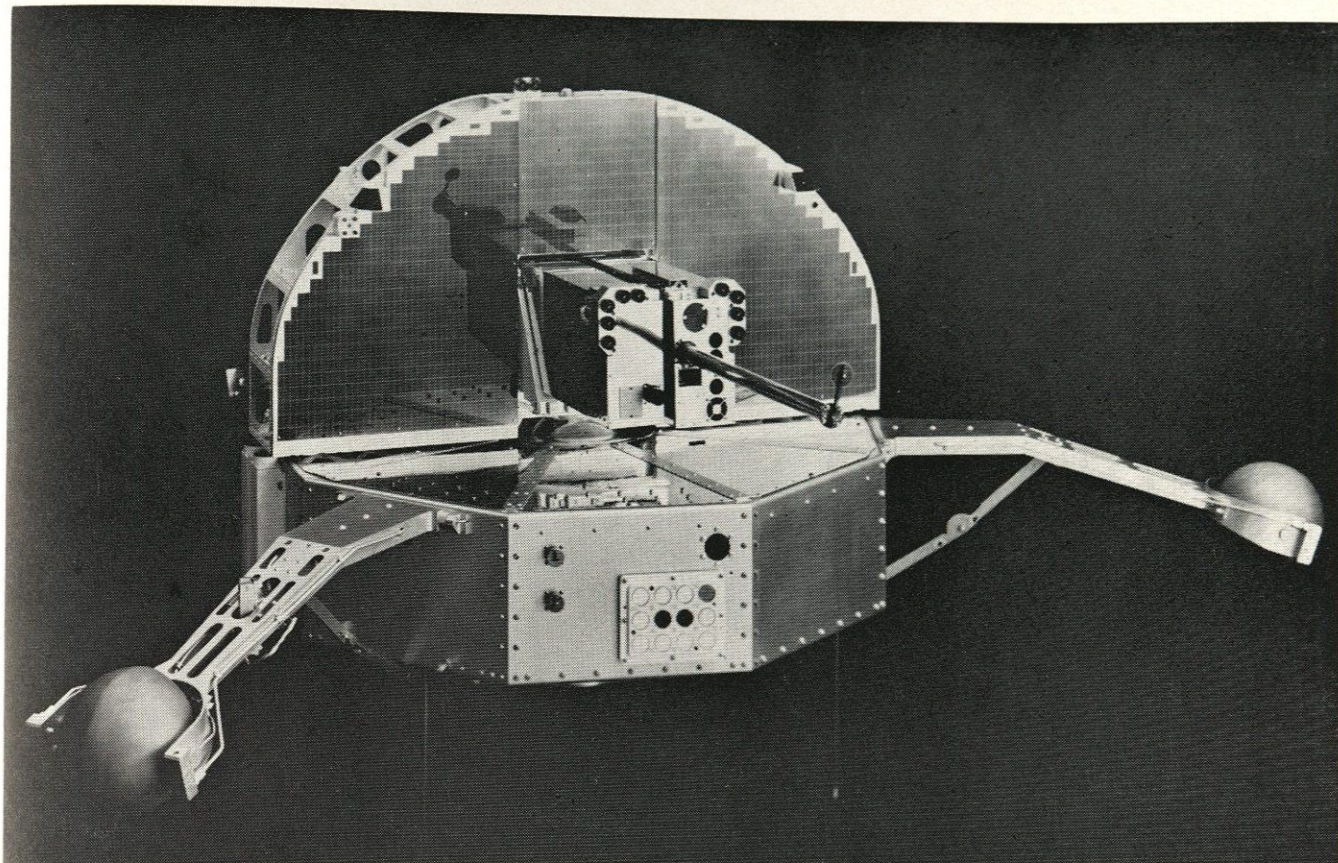
ing. To support this activity, the facility presently employs about 400 people.

The aerospace efforts of B. B. R. C. have already been marked with one very successful satellite, the OSO-1, and are destined to be further enhanced in late 1964 when OSO-B is scheduled to be launched. Hopefully, by the time this article is in print, the OSO-B will be in successful operation. Future plans call for production of OSO-C, D, and E.

The OSO satellites for which B. B. R. C. is prime contractor to NASA are a series of Orbiting Solar Observatories whose function is to gather scientific data about the sun which cannot be obtained by observation from the earth's surface. By staggering the launchings over an eleven year period, information for an entire solar year will be obtained. The OSO satellites can be characterized as "street car" satellites in that they carry a series of experiments aboard as "passengers."

The first OSO, OSO-1 was launched on March 7, 1962 aboard a three-stage

Thor-Delta rocket. It achieved a near perfect orbit and operated successfully over a period of fifteen months, although its design life was only six months. OSO-1 weighed 485 pounds and was designed to operate as a stabilizing platform for solar-oriented experiments. The craft had two main sections (very similar to OSO-B shown in the picture); a wheel-like lower structure which rotated and housed those experiments that scanned the sun, and a fan-shaped top portion which contained solar cells and fixed sun-pointed experiments. The upper fan "locked" on the sun, and its cells provided the satellite with twenty-seven watts of power. Coarse and fine photo-detector sensors located in various positions on the craft served to orient OSO-1 toward the sun. These sensors were developed by B. B. R. C. to maintain OSO's spin axis normal to the solar vector and also to control the sail (upper portion) in azimuth so that it was perpendicular to the solar plane to within a few degrees. Other sensors provided error signals which held the instruments pointed to within two



BALL BROS. RESEARCH CORPORATION'S OSO-B SATELLITE.

minutes of arc to the sun. OSO-I telemetered information to the earth by two independent tape recorders and transmitters.

OSO-B, the second Orbiting Solar Observatory built by B. B. R. C., was originally scheduled for launching in 1963, but the third stage of its delivery rocket exploded on the pad at Cape Kennedy, and the entire satellite was destroyed. However, B. B. R. C. has since built up another OSO-B from their original test model, and it is scheduled to be launched in late 1964. The general physical configuration of OSO-B is similar to OSO-I, but OSO-B will be able to scan the solar disc instead of fixing on one point, and will be able to be focused on any spot on the sun's surface which researchers feel is especially important. Of the total weight of the OSO-B, 40% will be devoted to scientific experiments, which is an unusually high ratio of scientific experiments to total satellite weight.

Future satellite plans call for the construction of more OSO's, and B. B. R. C. has NASA contracts for the OSO-C, now under construction and to be launched in early 1965, the OSO-D and the OSO-E. All will be similar in nature to OSO-B and will

help scientists at B. B. R. C. and elsewhere to learn more about the sun over the eleven year solar cycle.

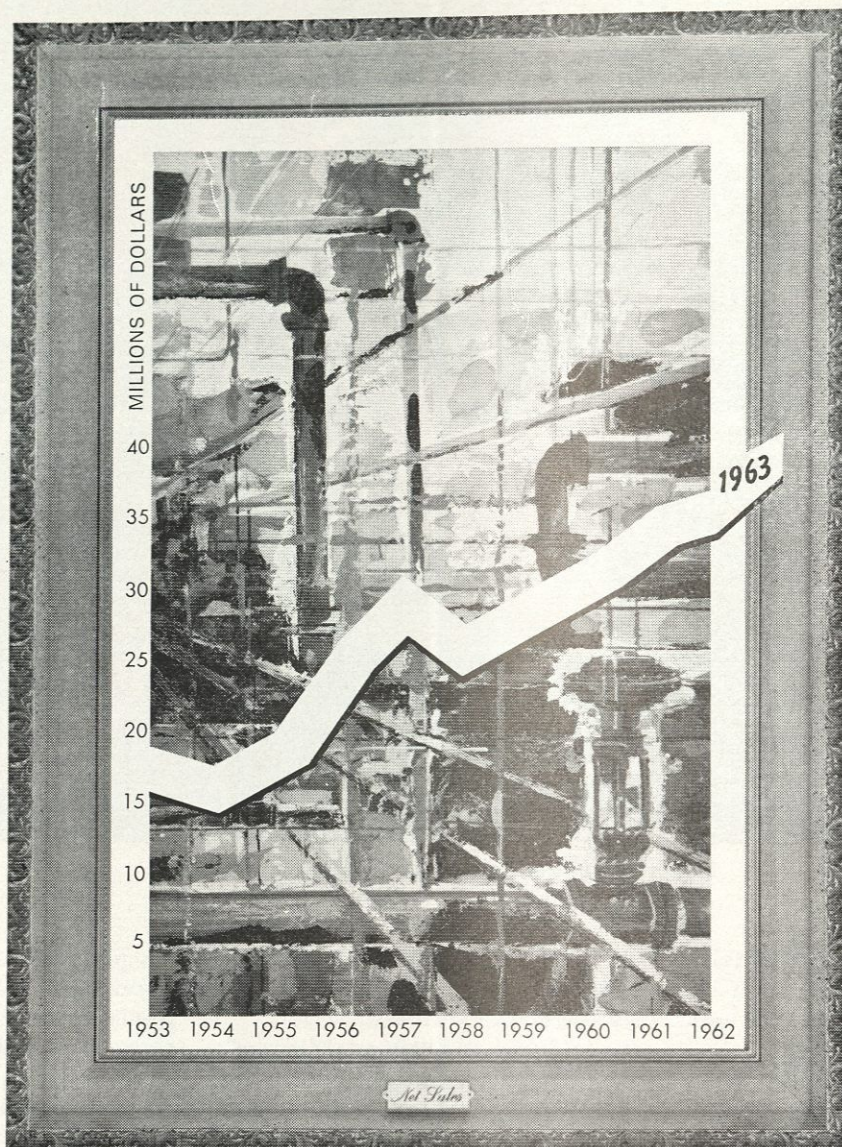
In addition to their satellite work, B. B. R. C. has designed, built, and provided launch support for twenty-nine solar pointing controls and telemetry systems which have been flown on the Aerobee sounding rocket experiments. Out of the twenty-nine packages launched, twenty-six had 100% successful performance records. The standard package includes a servo pointing control system which can orient the experimental package to the center of the solar disc, and a standard telemetry system with intelligent frequencies up to 2,100 cps.

B.B.R.C. has also done considerable research and development of digital television. Digital television differs from conventional TV in that the picture is made up of dots instead of lines and, because of this, pictures transmitted via digital means can be fed directly into computers for analysis. Another advantage lies in the fact that digital signals can also easily be scrambled and unscrambled as a means of coding a transmitted message. These digital transmission systems are capable of operating over a range of from 2400 bits/sec. B.B.R.C.

has programs dealing with slow-scan television, microwave transmission, special cameras, and broadcast studio equipment such as special effects generators. Work has also been done on a visual data transmission system which uses electronic scan conversion techniques to produce a narrow-band video signal suitable for phone line transmissions.

Another interesting project currently under study by B.B.R.C. is called the Mars Microbiological Detection Equipment. This is a micro-organism detector intended to be landed on the surface of Mars by 1971. The experiment measures turbidity due to biological growth in each of five culture cells into which soil dust samples are inducted by vacuum action. A breadboard of this system has been built and tested, and work is far along in eliminating the problem areas.

The past successes of B.B.R.C. are indicative of its overall capability and promising future. Being so basically involved in the fastest growing technological field of the age, B. B. R. C. can expect to grow to become even more one of Colorado's truly important industries.



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The REAL Crisis In College Education

CARL G. BAILEY

This article was originally prepared as a Tau Beta Pi Pledge Essay. Due to the timeliness and definite importance of this topic to the College of Engineering, we suggest that students, alumni, and especially faculty seriously consider this problem.

We are told by the news media that colleges and universities face a terrible financial crisis in trying to meet the ever increasing demand for a college education. I believe that the manner in which many of the scientific and engineering departments are attempting to solve the financial problem may lead to an even greater, more tragic crisis for America's youth. The recruiting of research-oriented staff members in an effort to obtain research grants can, unless the faculty administrators are thorough, leave the department without teachers, and its students without a good fundamental education.

With the advance of technology, a college education is becoming more and more essential to a prosperous future. Educational planners, recognizing the growing demands, have set forth requirements for expansion of every facet of our colleges and universities. New facilities must be built and more teachers must be found, all of which requires a great deal of money.

Discounting a continual dunning of the alumni, philanthropies, and grants from various foundations, the single greatest source of revenue is research grants — primarily from Governmental agencies. To obtain these grants, a University must possess, or have plans for, advanced research facilities, and must have staff members who understand the latest theories and techniques, and are capable of original research. These research personnel (Ph.D's almost without exception) must also serve as members

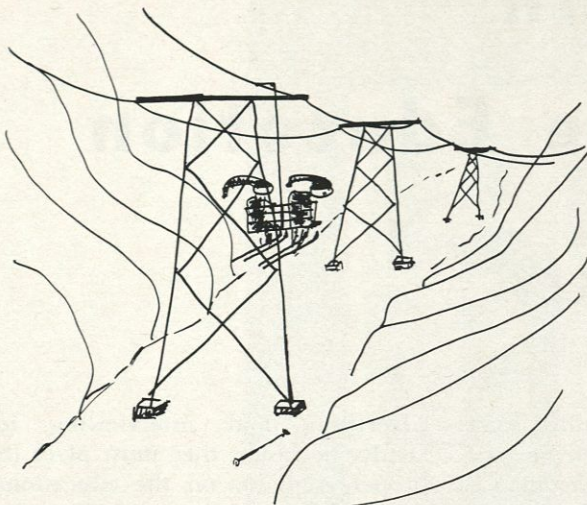
of the educational staff, since some portion of their salaries will be paid from education funds. At first glance, this would seem to be an excellent situation. Research personnel will always be conversant with new theories and techniques, assuring that the scientific posture of the department will not stagnate. These researchers are well qualified academically to teach in their fields but they may *not* possess the ability or the inclination to teach others, and this is the real danger. An instructor who approaches his class with only resignation or perhaps annoyance at his task transmits this feeling to his students. A teacher who is too busy to refresh his memory on the fundamentals which he must present to undergraduates, or who fails to recognize the limitations of the average undergraduate, will have little success. In turn, the student falls deeper into a sea of frustration as he tries to grasp more complex subjects without the necessary fundamental background. Finally, he may resort to rote memorization without comprehension, searching only for a degree, not an education.

A Way Out

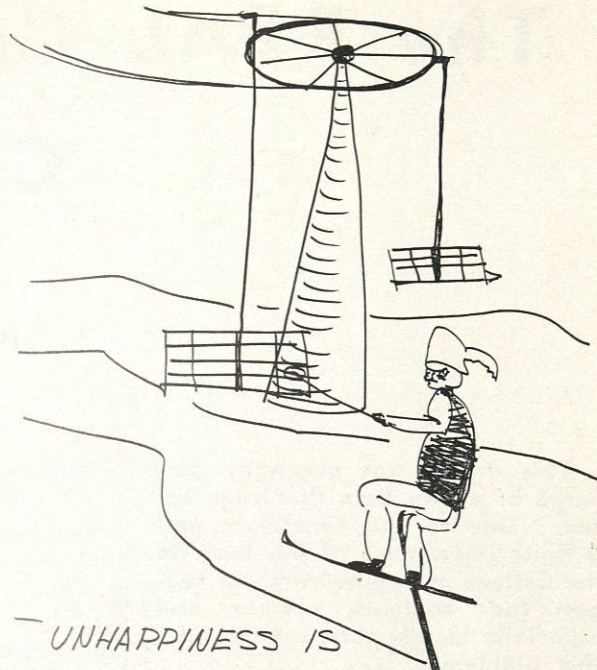
There is an old adage that criticism should not be presented without offering a solution. I do not mean to imply that college students must be "spoon-fed" to succeed, but I do insist that the fundamental educational concepts must be followed if the students are to be successful after graduation. Men simply do not absorb sufficient educational ability by osmosis during their study for the doctorate. They must, at least, understand the fundamentals of education and have more than a passing desire to impart their knowledge to others. What is the solution? I believe that it lies with the administrative faculty of the Universities. When

advertising and interviewing for faculty positions, they must place the proper emphasis on the educational duties of the position and be sure that the applicants have an honest desire to instruct, as well as perform research. Next, Department Heads must emphasize the importance of well-founded educational techniques to the new instructor, and he should not be insulted by critical efforts to help him improve his teaching abilities. Periodic monitoring of his classroom presentation by senior faculty members can be an invaluable aid, and student critiques will also help. The department should have course outlines which detail the minimum material to be covered in each course, and the administrators should be sure that these outlines are current and insist that they be followed. The best instructors should be used for the group of fundamental courses which are the foundation of the department. In many cases, teachers with the least interest in research may be the best-qualified instructors for these fundamental courses, but such courses should not be the "proving ground" for the new teacher.

The challenge facing the faculty administrators is clear, then. It is possible to gain the monetary benefits realized from faculty research and to have a teaching faculty that is both current and communicative. This will probably not be the case unless these administrators have a firm and emphatic policy regarding the educational posture of the department. Effective instruction is the result of preparation, practice, and proper motivation. The college administrators can assure that, as our institutions expand, the students will continue to receive a college education, not merely a college degree. It is my belief, and fervent hope that the real educational crisis can, and will, be averted.



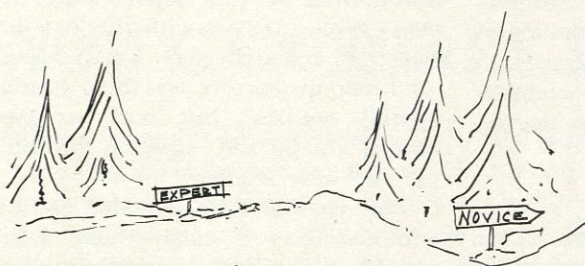
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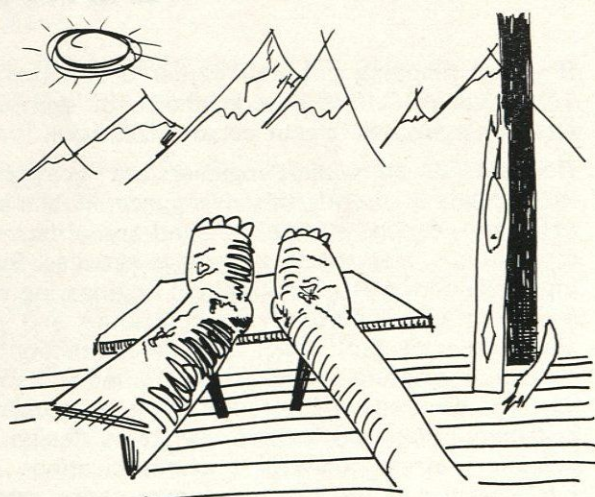
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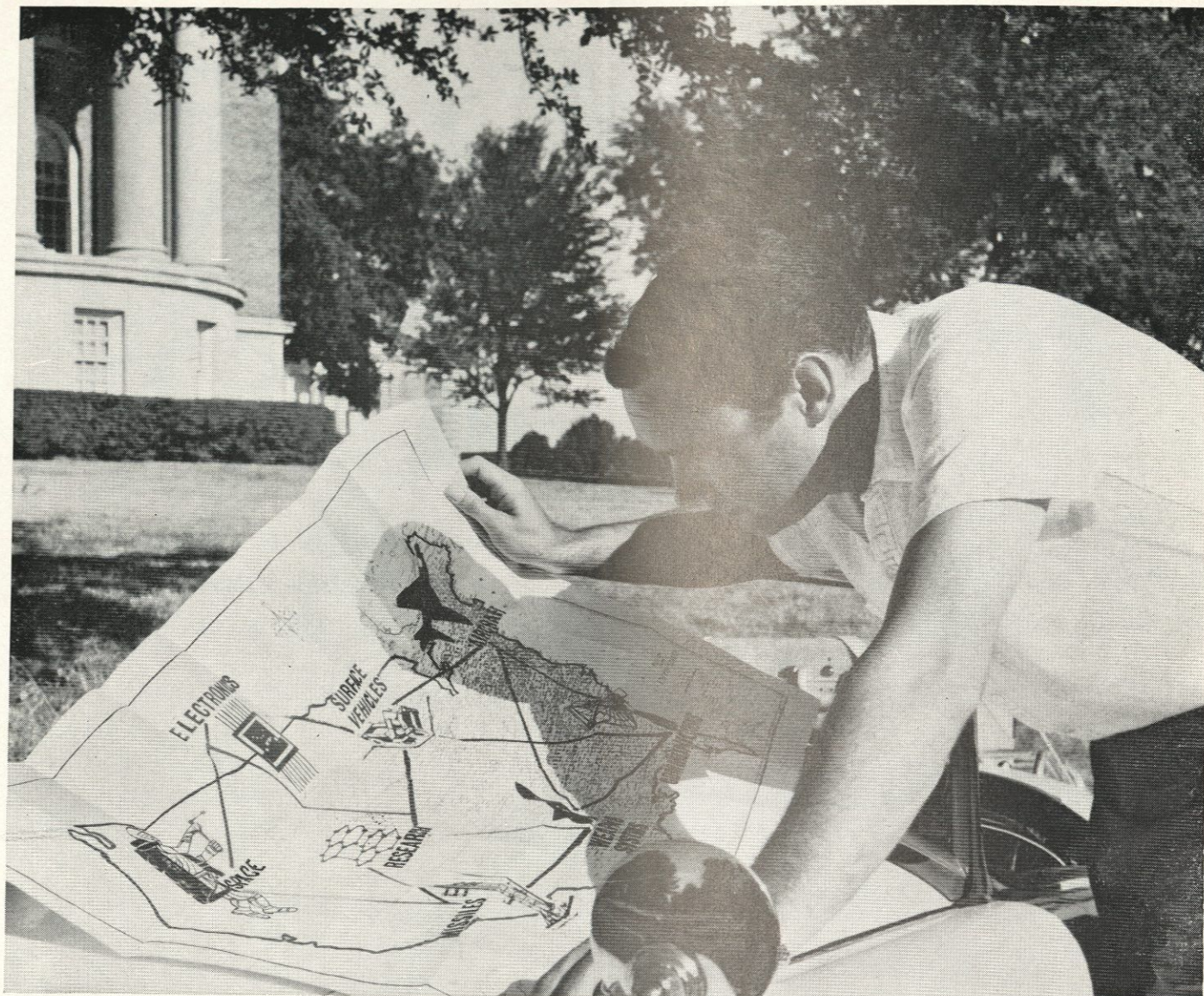
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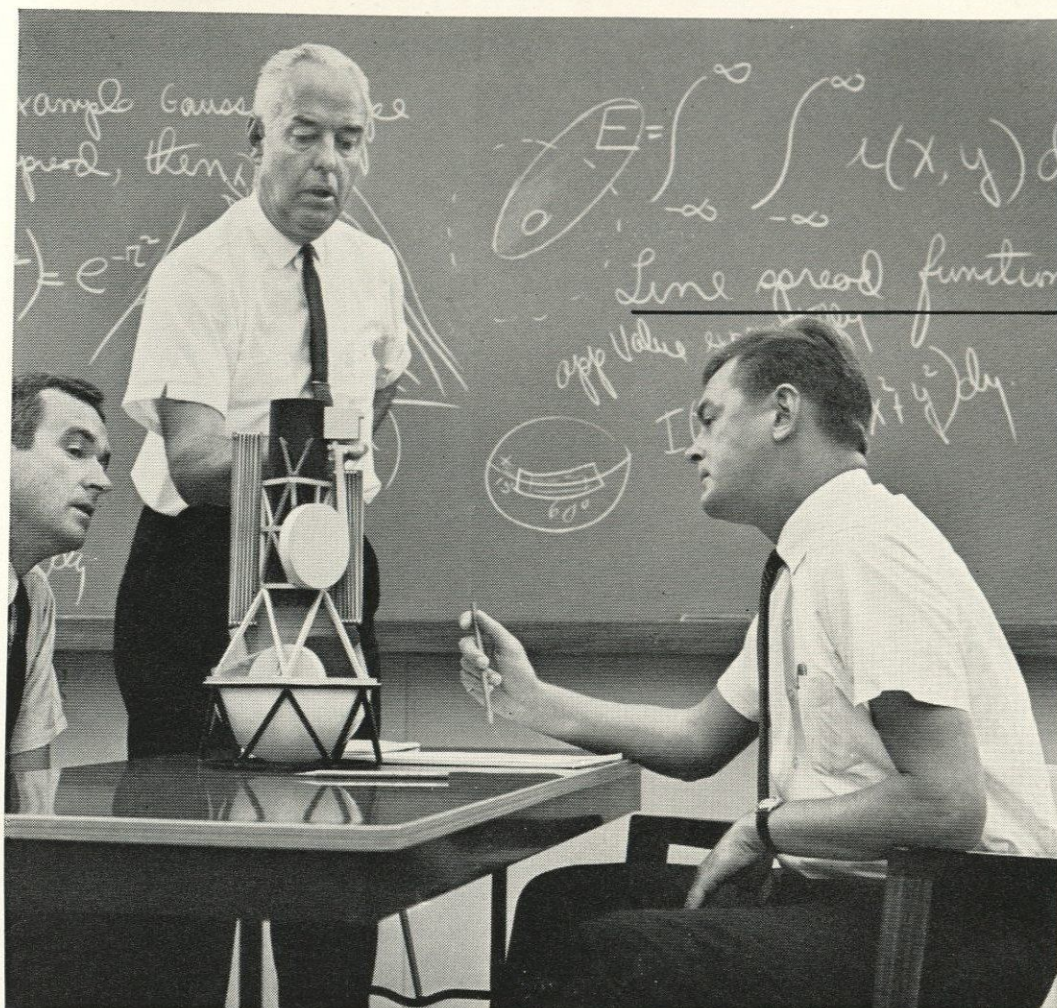
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going
to learn
what
this
means*

The mechanical engineer who decides to join forces with us upon completion of his formal education will discover soon enough that the biggest part of his education is still ahead of him. This cliché can be interpreted two ways.

The literal way—"Line spread function" mathematizes certain aspects of image structure in optical theory. Very few mechanical engineers shelter behind academic ivy long enough to get that deep into other men's games. If, for example, we need mechanical engineers capable of communicating with our optical physicists for a common purpose—and we have such purposes in our little-known but heavy aerospace commitments—we had better provide the right fertilizer for ivy ourselves. So we do. Some of the more sophisticated current ideas on what constitutes

engineering have strong partisans among the men from whose ranks a newcomer can pick his boss here.

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Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group



C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were inde-

pendent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. Can you tell me what the "promotional ladder" is at General Electric?

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. Will my development be confined to whatever department I start in?

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing—adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. Yes, but just how often do these opportunities arise?

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. How does General Electric help me prepare myself for advancement opportunity?

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