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1959

The Wisconsin

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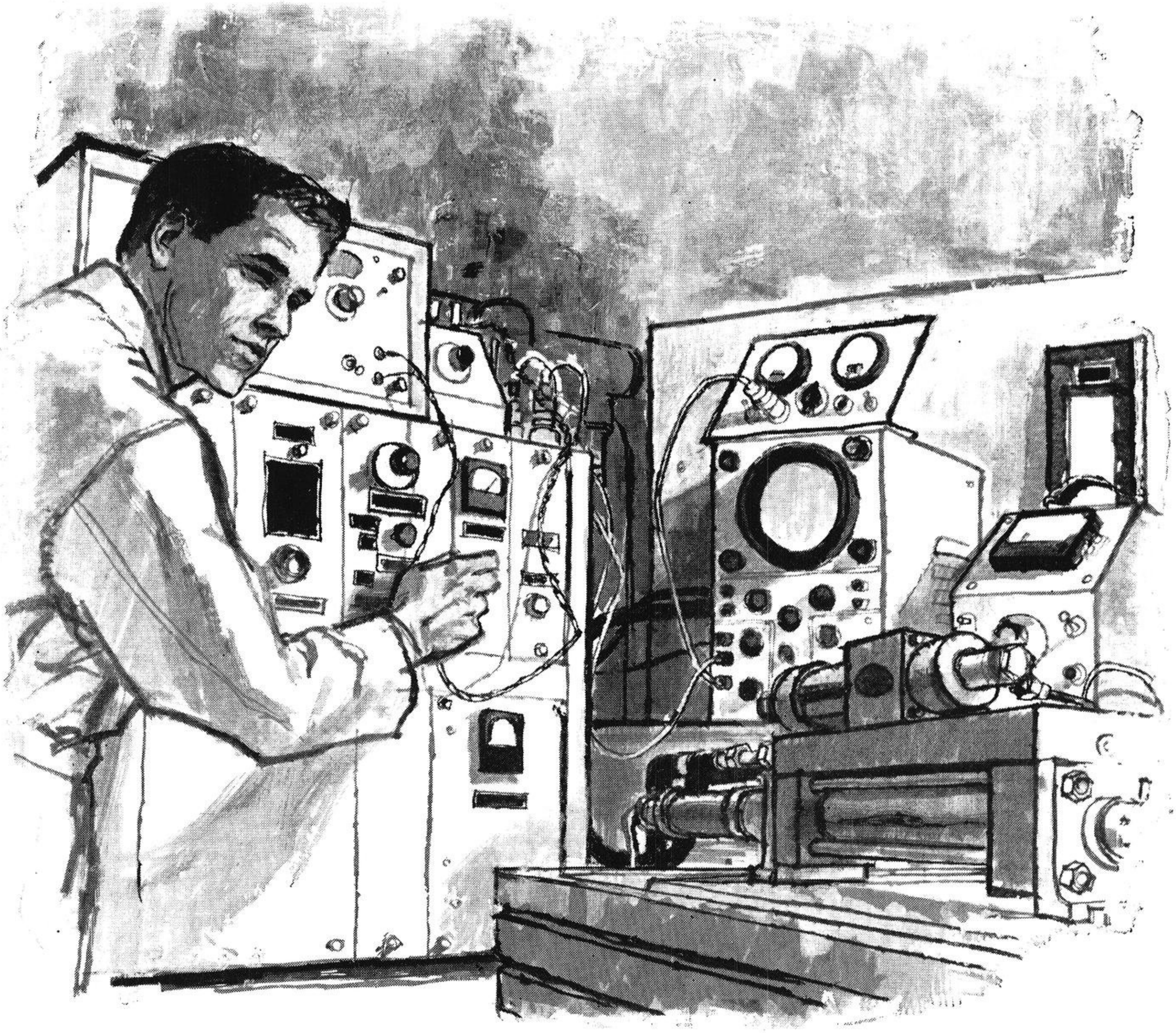
IN THIS ISSUE

Operations Research

Subsurface Exploration

M. E. Curriculum



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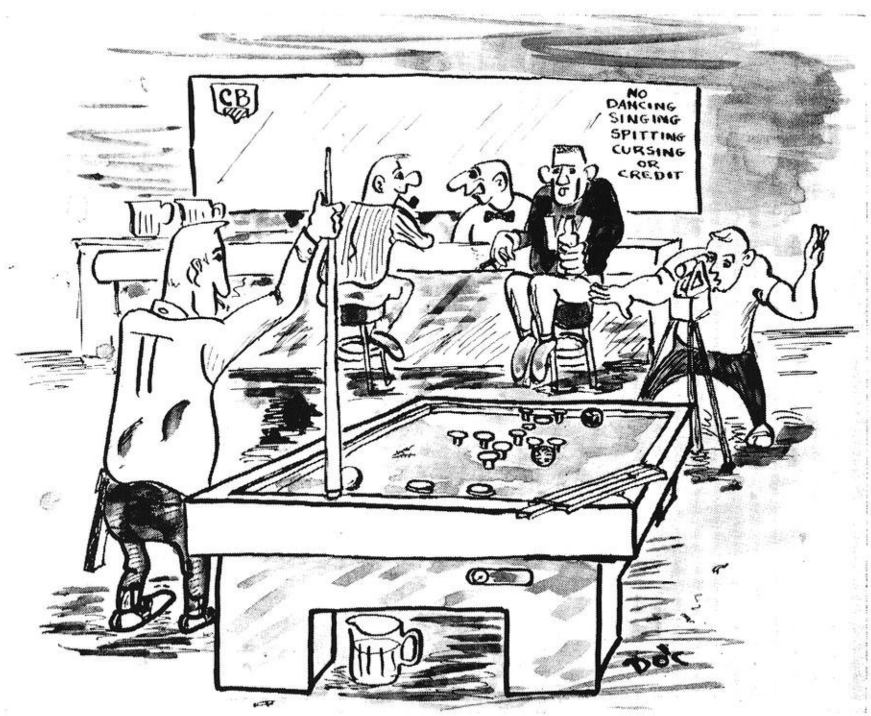
THE WISCONSIN ENGINEER??



Neither of those guys has lost a game in weeks!

Volume 63 MAY 1959 Number 8

WISCONSIN ENGINEER

The Student Engineer's Magazine

FOUNDED 1896

Features

Departments

Cover

A Hill student's view of an engineering student as drawn by Cal Kreunen.

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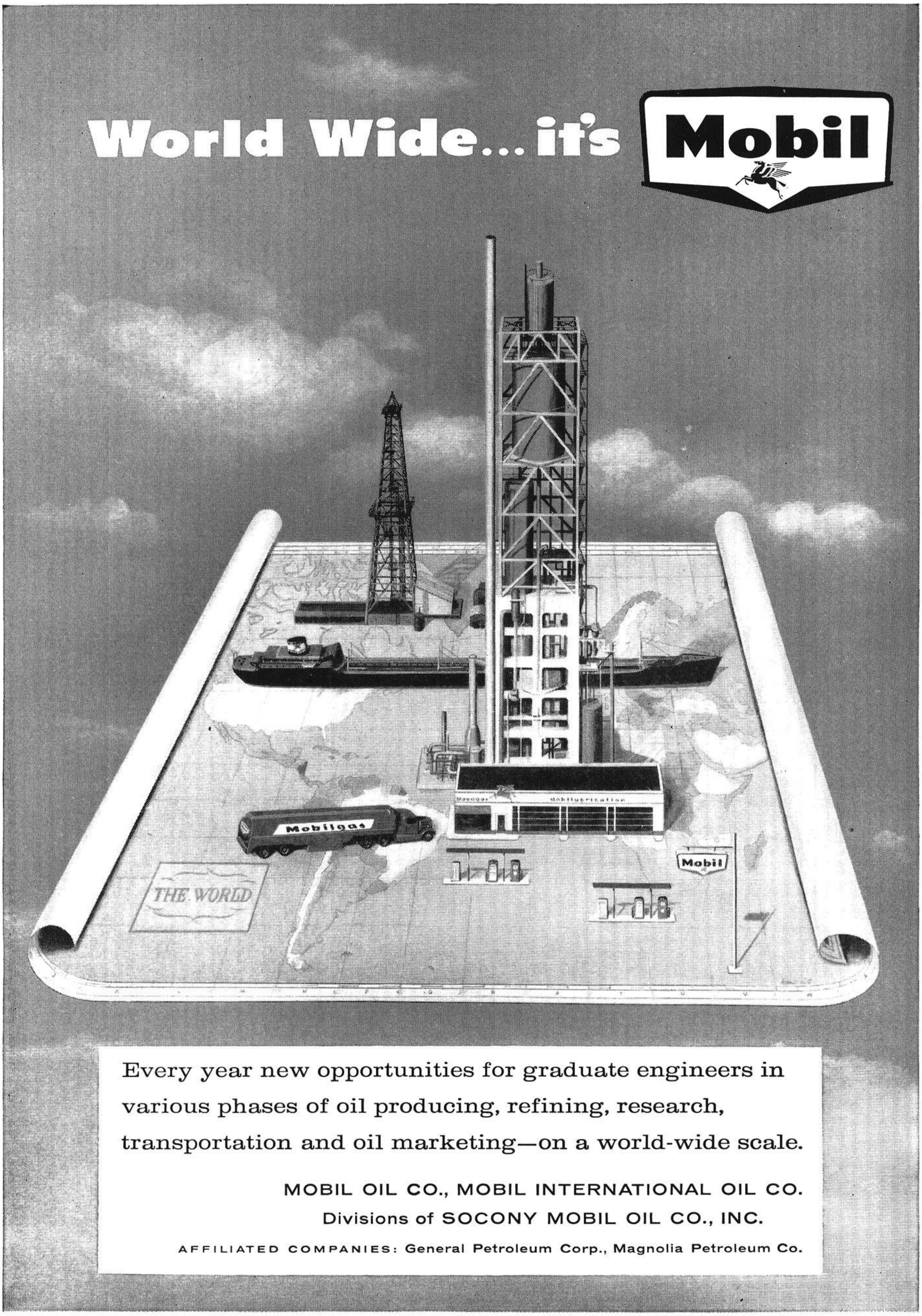
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Space vehicle development, including basic planning, development, contract coordination, and operational programming and planning for manned and unmanned satellites. Systems studies for auxiliary power supplies, air regenerative systems, instruments, guidance and communication equipment for space vehicles.

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Beltsville

SPACE MECHANICS

Experimental and analytical study of orbital mechanics including parameters of preliminary and refined orbits, ephemerides, lifetimes, equator crossings and perturbations.

Beltsville; Langley; Ames

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Developmental studies of boosters, launchers, multi-stage engines, guidance and attitude control systems for space vehicles.

Basic research on the interrelationships between electrical, magnetic and thermodynamic energy, and application of such knowledge to space propulsion.

Magneto hydrodynamics: Research on plasma and ion accelerators for space propulsion and auxiliary power systems.

Research on reactors and reactor shielding for aeronautical and space propulsion systems.

Beltsville; Lewis

AERODYNAMICS AND FLUID MECHANICS

Investigation of the thermodynamics and transport properties of gases at high temperatures as encountered in entry into planetary atmosphere.

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Langley; Ames; Lewis; High-Speed Flight Station

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All Facilities

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Studies of fields and particles in space, investigations of the composition of planetary atmospheres, and development of instrumentation and experimental techniques for these investigations.

Beltsville

STRUCTURES AND MATERIALS

Investigation of the characteristics of high temperature structures and materials. Study of fatigue, structural stability, and other problems of structural dynamics.

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Langley; Ames; Lewis

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NASA National Aeronautics and Space Administration


N.Boyle

Rambling WITH THE EDITOR

As you read this column, Rambling With The Editor, you have perhaps wondered, Who gets to be the editor? How did he get the job? I would like to answer these questions and perhaps remove the false impression that this is a position out of reach of most students. By relating my experience on the "Engineer" staff, I believe these questions can be answered.

Prior to enrollment in the University School of Engineering, I worked on my high school newspaper staff. After my first semester at the University was successfully behind me, I went looking for more extracurricular activities. One of my fraternity brothers at Triangle Fraternity who was copy editor of the Engineer suggested that I apply for a staff position. I did and I was given a job as editor of Wisconsin Society of Professional Engineers news during my sophomore year.

The work was routine, but in helping to lay out articles, I learned what makes a magazine tick. As the year ended, I was given a choice of jobs for the junior year. I began work on Campus News and then upon the transfer of the articles editor to another school, I stepped into the task of finding and selecting articles for print.

By expending a little extra effort to do a good job and to learn more about the magazine, I found this spring that I was considered the most qualified staff member for the editorship. A vote from the Board of Directors of the Wisconsin Engineer Journal Association, and here I am writing my first editorial.

What I have tried to emphasize is that the job of editor is attainable in the years to come to someone reading these very words. All one needs is interest, perseverance, time, and the "sweat of thy brow". Staff positions are still open. We hope you will avail yourselves of the opportunity to gain valuable experience in editing a publication.

Wayne Rogers, editor this past year, deserves credit for the fine job he has done. Many long hours of his time were spent in making the Engineer the fine magazine it has been in 1958–59. The editorial and business staffs, too, have worked long and hard in an effort to make the deadline, read copy, layout articles, and track down advertising plates. Sally Trieloff, Business Manager, this past year and for next year has worked to maintain the magazine as one of the very few campus publications that makes money.

In the coming year, we have a serious problem to cope with in obtaining adequate circulation to warrant advertisements from industry. Since the Professional Engineers have discontinued their news column in our magazine to publish their own newsletter, we find our subscriptions cut by approximately 1500. An enlarged circulation staff will try to increase student subscriptions from about 300 to 1000 or 1500.

The opportunity for training on either the business or editorial staff is here for interested student engineers. We all realize that of the myriad of campus activities, an engineering student has time for only a select few. I am sure you would find work on *The Wisconsin Engineer* staff regarding enough to merit your time and efforts.

Powerful Thor rocket engine shown here provides first stage thrust for early series of Discoverer I satellite launchings.

Geophysical Subsurface Exploration

Determining the underground features of proposed construction site and the difficulties they may present is a problem often encountered in civil engineering. Geophysical methods of exploring the earth's crust can provide a fast and economical way of solving these problems.

by Gerald Wallin CE '60

GEOPHYSICAL methods of exploring the earth were developed mainly in the fields of oil and mineral prospecting, where they have been used widely and profitably during the past twenty years. They were first employed by civil engineers about twenty-five years ago, but their use has not been developed as fully as possible and has not been as widespread as it could be.

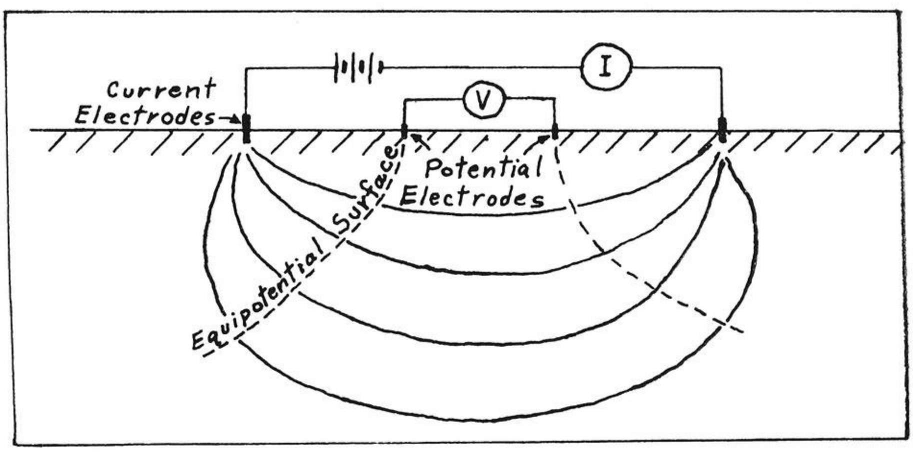
Geophysics is the division of geology concerned with the physical properties of the earth such as magnetism, density, electrical conductivity, and elasticity. Variations in the sub-surface geology cause variations in one or more of these properties which can be measured accurately. The seismic refraction method and the electrical resistivity method each use the variations in one of these properties to determine the geologic structure. The seismic refraction method uses the elasticity of the earth's crust. The electrical resistivity method uses the ability of the ground to conduct electricity.

The difficult part of the geophysicist's job is to interpret the data he collects from the two methods correctly. To do this, he must correlate his observations with all other information he can obtain. A geologic survey of the area and a program of test drillings are particuarly helpful.

The first step in a complete site investigation should be a geologic survey, by air photos and personal observation, to determine the possible sub-surface conditions which could be expected. This should be followed by the proper geophysical survey. Then a program of test drillings can be used, if necessary, as a control or a check on the interpretation of the geophysical data. The results of the geophysical survey can also be used to determine the best spacing of drill-holes to get more detailed information where it is needed most. Such a program may be used as a whole, or any parts may be used as needed to suit the requirements of the particular job. Both the seismic refraction and electrical resistivity methods are flexible enough to fit into any such program.

ELECTRICAL RESISTIVITY METHOD

The earth's crust is a conductor of electricity of varying effectiveness, depending on its composition. The electrical resistivity method uses this principle to determine the



Lines of flow of electric current.

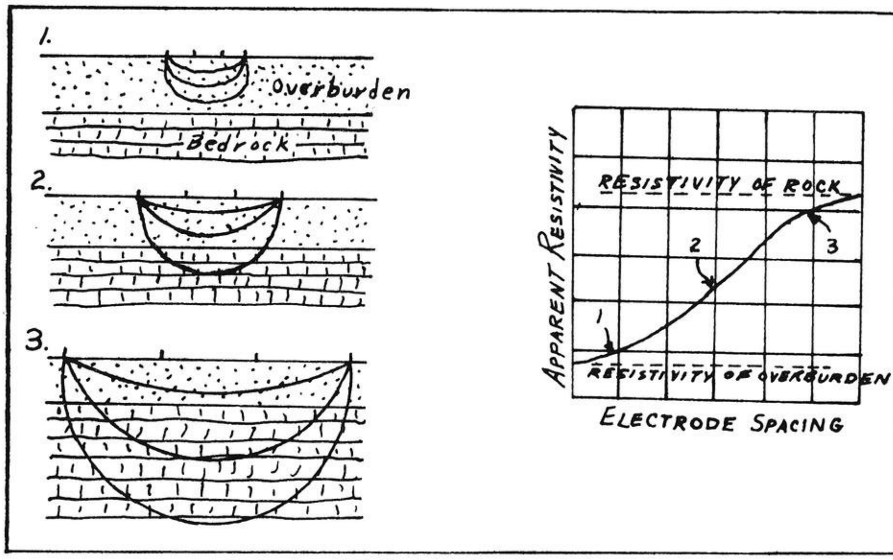
structural features which cause this variation.

The resistivity of a rock is defined as the resistance offered by a unit cube of the rock to the flow of an electric current perpendicular to one of its faces. The minerals in a rock, except certain metallic minerals, are all insulators of varying effectiveness, so the resistivity of the rock depends almost entirely on the amount and salinity of the moisture in it. The more porous or the more jointed and fissured the rock is, the lower the resistivity. The success of a survey depends a great deal on the extent of variation in the resistivity of the different rocks in the area.

To measure the resistivity of the ground, an electric current is introduced into the ground through two metal spikes, called current electrodes. The current flows through the ground, the lines of flow following a pattern much like the lines of magnetic force around a bar magnet. Theoretically, the current flow extends to an infinite depth, but actually its intensity decreases rapidly with depth. For practical purposes, it is limited to a depth equal to one-third of the distance between the current electrodes.

To measure the resistivity, another pair of metal spikes, called potential electrodes, are placed equidistant between the current electrodes in a straight line. These potential electrodes are connected to a voltmeter, and the voltage drop between the potential electrodes is measured. The resistivity of the ground is proportional to the voltage drop divided by the current put in at the current electrodes multiplied by the electrode spacing.

In ground, which has uniform resistivity, the lines of flow have a definite shape independent of the resistivity of the substance or the distance between the electrodes. The depth of current penetration can therefore be varied by changing the electrode separation. Actually, the ground is seldom a single homogeneous material and the resistivity measured is the apparent resistivity of the ground, not of a specific layer of rock. It is the variation in the apparent resistivity with either the electrode spacing or position which makes it possible to determine facts about the ground.



Lateral resistivity in a two layer structure.

One way the electrode spacing can be varied, and the apparent resistivity still kept equal is by expanding the electrode system about a central point. Since the depth of penetration depends on the distance between electrodes, this will increase the depth of penetration. If the ground is homogeneous, the resistivity will be constant for all electrode spacings and equal to the actual resistivity of the material. The graph of resistivity against the electrode spacing would then be constant.

Another type of ideal situation will help to explain the method more clearly. If there is a single, homogeneous layer of uniform thickness lying on bedrock of infinite depth, an ideal curve can be graphed. For this example, it is assumed that the upper layer will have the lower resistivity. When the electrode separation is small compared to the thickness of the upper layer, most of the current will flow through the upper layer. The apparent resistivity will be very close to the actual resistivity of that layer. As the electrode spacing is increased, the current penetrates deeper, and the apparent resistivity increases. When the electrode spacing becomes large compared with the thickness of the upper layer, most of the current will pass through the lower layer. The apparent resistivity will then come very close to the actual resistivity of the bedrock.

This would produce a resistivity curve. The thinner the upper layer, the steeper the curve and vice versa. To determine the depth to the bedrock, the resistivity curve is compared with a series of theoretical curves computed for different values of depth and resistivity ratio. The depth is determined from the theoretical curve which is closest to the field curve.

In practice, ideal conditions such as these are rare. However, by using certain refinements of this method, many types of more complicated problems can be solved. For instance, a three-layer site, which is commonly found if there is a water-table in the ground, can be determined by using only the last part of the curve obtained in the field.

The electrical resistivity method can be used in many cases to give the civil engineer all the information he needs. One of the biggest problems, the depth to bedrock on a site, can be solved with this method. It has been used often to profile rock at shallow depths along proposed sites for pipelines and highways. It can also be used to determine the size and depth of unconsolidated layers such as sand and gravel when they are needed for construction work. A typical example of such a survey is given later in the article.

The resistivity method is more limited than the seismic method in its applications for several reasons. Lateral variations in the nature or the thickness of any layer may cause similar variations in the measurements. Small variations of this type near the surface can affect the apparent resistivity as much as larger variations at greater depths.

(Continued on next page)

Finally, the resistivity curve itself does not give any evidence of its quality or reliability, nor any indication of the identity of the geology investigated.

SEISMIC METHODS

The seismic methods are used mainly for determining the depth of formation boundaries. They are much better for this than any other geophysical method.

Seismic methods are the most widely used of the geophysical methods for oil exploration. Their use at the shallow depths encountered in civil engineering is comparatively new and very successful. The two seismic methods, reflection and refraction, differ from each other in only one respect, but this difference makes one method suitable and the other unsuitable for use in engineering.

Seismic Reflection Method

The seismic reflection method uses the reflection of elastic waves from the surfaces of underground layers to determine their depth. It is best suited for exploration at great depths because there is less interference with refracted waves. It has been used very successfully to depths of 20,000 feet, but it is not suitable for the shallow depths desired in civil engineering.

Seismic Refraction Method

The seismic refraction method uses the refraction of elastic waves from boundaries of different layers to find their depths. It can be used very successfully for investigating civil engineering sites, and it is well suited to finding the depth to bedrock.

A sudden elastic disturbance is set up in the ground by exploding a small charge of dynamite. The resulting seismic waves, transmitted through the ground, are picked up by a number of vibration detectors (seismometers) on the ground surface. The seismometers change the ground vibrations to electrical impulses. These are transmitted to a recording device where they are amplified and recorded on photographic paper moving at high speed. The instant of explosion and time intervals of 0.01 seconds are also recorded on this paper. This gives the time interval between the instant of explosion and the arrival of the vibrations at each seismometer.

The interval of time between the instant of explosion and arrival of the wave-front at each seismometer is recorded and plotted on a graph against the distance of the seismometer from the shot point. The resulting time/distance graph consists of two straight lines intersecting at the critical point. The slope of the first line of this time/distance graph will give the reciprocal of the wave velocity through the upper layer, and the slope of the second line will give the reciprocal of the wave velocity through the bedrock.

In the interpretation of the seismic data, it is convenient to represent the travel of the seismic waves with wave rays. By definition, a wave ray is a wave path which is normal to the progressing wave-front at every instant. It is, therefore, the quickest path between the shot point and a point on the wave-front, but it is not necessarily the shortest path.

Three quantities are required in order to construct a wave ray diagram; the critical distance, x, the critical angle of incidence, i, and the depth of the rock surface, D. According to Snell's law, the critical angle of incidence may be obtained from the expression:

$$\sin i = \frac{V_1}{V_2}$$

where V_1 = the velocity through the overburden

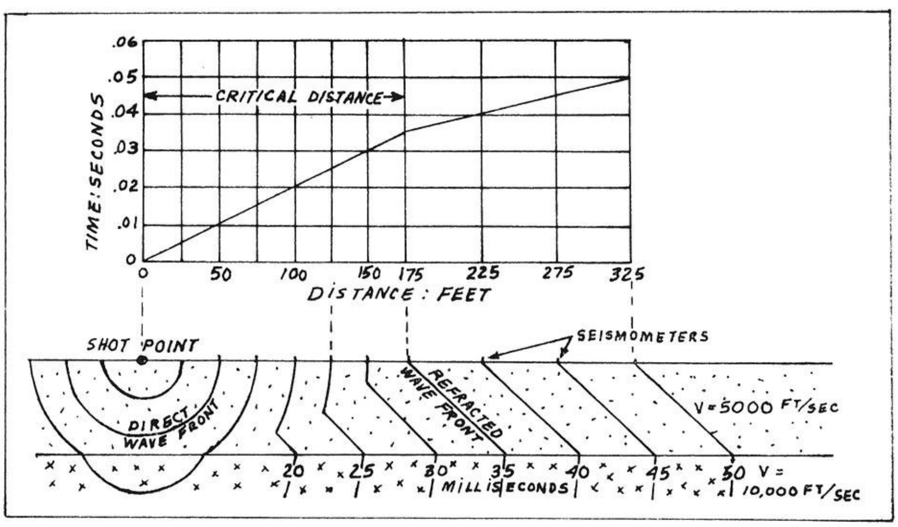
V_2 = the velocity through the bedrock.

It has already been shown that velocities V_1 and V_2, and the critical distance, x, can be obtained from the time/distance curve. The only quantity remaining to be determined is the depth to the rock surface. Bearing in mind that the direct and refracted wave-fronts arrive at the critical point simultaneously, equating the travel times gives the following equation for D in terms of V_1, V_2 and x:

$$D = \frac{x}{2}\sqrt{\frac{V_2 - V_1}{V_2 + V_2 + V_1}}.$$

Special features of the sub-surface formations may also be determined seismically, such as a sloping or an irregular bedrock surface. The slope of the second portion of the time/distance curve will give the actual velocity of wave transmission through the bedrock only if the two surfaces are parallel. If the rock surface is dipping relative to the ground surface, the slope of the time/distance curve will be a function of both the velocity through the rock and the angle of dip of the rock. In practice, a shot is fired from each end of the seismometer spread in turn, so that two time/distance curves for the same seismometer spread can be made. This is equivalent to obtaining two equations from which the two unknowns, the angle of dip and the velocity in the rock, can be found. Once these are found, the depth to the rock can be determined as before.

Profiling an irregular rock surface is simple if three unknowns can be determined. First, the wave velocity through the upper layer must be found. This can be done from the time/distance curves as before. Second, the wave velocity



Travel of seismic waves through a two-layer structure.

through the rock must be found. This can be determined from the curve of a place where the rock is straight, or between two outcrops of the rock, or between two drill-holes. Third, the depth to the rock at one point must be known. This can be obtained from a previous profile, a drill-hole, or by profiling to the desired point from an outcrop of the rock. When these three quantities have been found, the rock profile can be constructed graphically from the time/distance curve by plotting the wave rays from the shot point to each seismometer.

Essentially, all units of seismic equipment contain a device for creating elastic disturbances in the earth, seismometers to pick up the vibrations at different points on the ground and transform them to electrical currents, and a recording oscillograph to record the jump in current on photographic paper along with the time of the disturbance and certain time intervals.

Seismic refraction equipment is available in varying complexities and sensitivities to suit the needs of the job. For explorations no deeper than 50 feet, instruments completely adjusted at the time of manufacture can be used to pick up the blows of a sledge hammer instead of dynamite with all the accuracy of the most complicated equipment. On the other hand, for more difficult explorations, equipment with up to 24 seismometers, each individually adjustable to compensate for natural ground noises is available.

The field procedure is adapted to the needs of the job and the equipment needed. In some cases, the seismometers can just be laid on the ground, and in others they should be buried in small holes to protect them from the wind. The recording equipment can be mounted in a vehicle, or it can be packed on a man's back and set up in a small tent to keep out light.

There are two generally used techniques of profiling an area. In the lateral traversing technique, a series of overlapping seismometer spreads is shot. The length of the seismometer spread is determined by the depth to be explored and the amount of detail desired. A spread of five to eight times the depth is usually required.

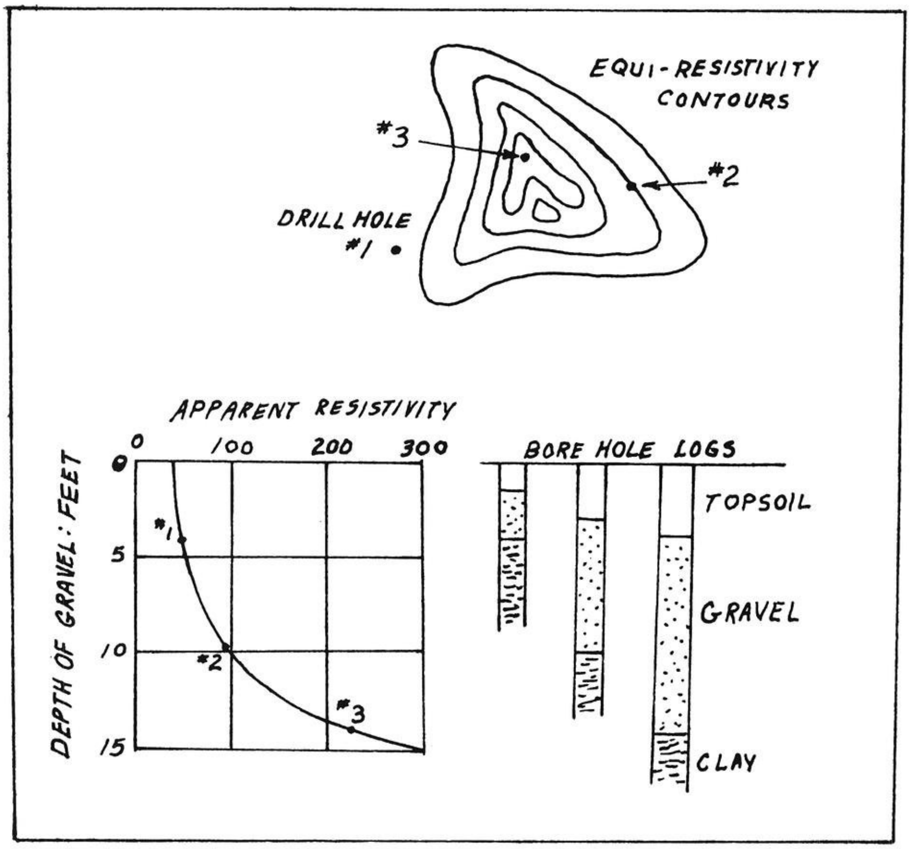
The second method is called arc shooting. It is most often used to follow a certain feature in the profile of the rock, such as a buried river channel. The seismometers are spread in an arc equidistant from the shot point so the varying times of arrival will show the variations of the subsurface feature aid will not be directly related to time as in a line spread. It is necessary, then, that the radius of the arc be large enough that the first arrival is that of the refracted wave, not the direct wave.

The accuracy of a seismic survey is limited by several factors. First, the travel times can usually be determined to an accuracy of one millisecond. But an error of one millisecond can cause an error of from one to three feet in the determination of the depth, depending on the velocities in the rock. This amount of error is significant only at very shallow depths.

The second source of error is in the geologic structure itself. If there is a thin layer of intermediate wave velocity between two layers of high and low velocity, the waves refracted from the high velocity layer may overtake and mask the waves refracted from the intermediate layer. This will make the calculated depth less than the actual depth.

If the upper layer has a higher transmission velocity than the middle layer, the waves will be refracted downward, and no indication of the lower velocity material would show on the time/distance curve.

Both of these cases are rare, however, and they can be detected and corrected for by careful control and checking.



Resistivity contour map of a gravel deposit.

EXAMPLES OF THE GEOPHYSICAL METHODS

1. A typical resistivity survey was used to find the shape and thickness of a gravel deposit. A geological reconnaisance had shown that there was a bed of alluvial gravel overlying a clay formation, and the problem was to determine the amount of gravel that would be available for the construction of a road diversion embankment.

A series of resistivity traverses was run across the site with a constant electrode separation of 20 feet, and a map showing lines of equal resistivity was constructed from the measurements obtained.

(Continued on page 51)

A Student's View of the Mechanical Engineering Curriculum

by John Groeneweg

A report discussing some cogent arguments for changes in the ME curriculum is offered by a student at the University of Wisconsin.

INTRODUCTION TO A STUDENT'S CRITICISM

The Problem

IDEALLY, undergraduate engineering curricula should anticipate future trends and furnish educated men who are prepared to meet or make them. Realistically, a policy of keeping abreast of developments in science and society is a requirement for an educational program. The members of Wisconsin's Mechnical Engineering Curriculum Committee now find themselves in the difficult and demanding position of trying to plan a course of study that will once again meet this criterion. A constellation of Sputniks more than anything else has both pointed out the need and provided the incentive for educational re-evaluation.

The choices made now are most important because they can make Wisconsin a leader in fundamental engineering education or a follower of the school of specialization. With the committee as the fulcrum, the force of one of these ideas must dominate. To find the "balance point" at the undergraduate level where the number of course "weights" is limited is not to be desired or expected.

Objectives of the Analysis

The first and most important objective in writing this article is to present a senior student's view of the academic sequence which he has nearly completed. Just as the committee has a more intimate knowledge of the administration and departmental organization, the graduating student has a more complete understanding of the arrangement and content of the courses as a whole. Certainly a faculty member knows very well how his own particular course is run, but does he know what a student thinks of the course or, more important, if he thinks at all? To say that the views presented here are universal among the students would be incorrect. Many of the ideas, however, are held by other students and by engineering educators. Judge them on their particular merits in view of the result desired: educated men.

The basic thesis is: The engineering curriculum at Wisconsin should be oriented toward basic science and engineering science with opportunity and encouragement for study of the humanities. Suggestions are offered that might otherwise be shut out by pressing duties, established practices, or limited time for consideration.

Finally, in the light of the views and in agreement with the thesis, a suggested curriculum is offered. It is not an absolute, inflexible listing of courses with a detailed syllabus for each subject. Its general pattern is a step toward making Wisconsin a leader in basic, undergraduate mechanical engineering education.

PHILOSOPHY AND GOALS

The Core of Education

Rather than to say, "Education *is* this: . . ."; let us say, "Education *does* this: . . .". Namely, education stimulates and challenges the student *to think* with the goal that he may acquire the ability to judge soundly.

> "It is indeed by no means impossible that much of the kind of knowledge acquired by a student at a university or college will not be the knowledge he needs in after life. The virtue of his training may well be therefore, not solely in its content but in its effect upon his mind."

Thus thought is the core of all education formal or informal. Thought, itself, cannot be taught. Patterns, methods, and logic of thinking may be imparted but the actual process of thinking takes place in the individual as the result of a stimulus or challenge. Too often the student's only stimulus is to score on an exam, and his only challenge is to find a more expedient way of completing the required work.

Why differentiate between stimulating and challenging? Certainly a challenge is a stimulus. The purpose of the separate term, challenge, is to emphasize the part of education which presents an unusual problem or an unattained goal to those students who might solve or accomplish them.

The Supporting Facets

Education aids the student in thinking by offering him a variety of knowledge, methods, and skills by which thinking becomes ordered and productive.

Knowledge: Laws and principles are the guides to correct and useful thought. Knowledge of facts, themselves, is convenient; but knowing where to obtain needed facts and how to interpret the findings is more important. In spite of what psychologists tell us about the enormous capacity of the human brain, we are inclined to agree with those who prefer to remember basic things from which other relations may be obtained.

Methods: Patterns for applying laws and principles to particular problems are valuable aids to thought. Often an established method offers a systematic and effective way to begin solving a complex problem. If the recipe is followed faithfully, results are thorough and accurate.

These same procedures may be detrimental, however, if they are slavishly followed or taught as ends in themselves. What happens when the ingredients of a problem are new and the old methods are ineffective? The chef must then write his own cookbook. Devotion to old recipes may make this very difficult.

The problem and the method must also be compatible. For example, mathematical analysis and value judgement involve two different methods of thinking. The cold logic of the first is not applicable to human relations just as the moral considerations of the second are useless in strict material concerns. This points out the need for varying methods of thinking to meet diverse situations.

Skills: A differentiation must be made between the mechanics used in thinking and physical skills used to carry out the thoughts of others. Mechanics such as grammar and arithmetic are necessary; but they should be looked on as skills to be mastered early so that later time is free for productive efforts.

Special physical skills should be appreciated and understood, but time is often wasted in trying to learn them. A writer need not be a proficient Linotype operator. Why should a designer be a practiced welder? Arthur Bromwell, answers this question by saying:

> ". . . these attempts have taken an inordinate amount of student's time without providing the compensating advantage of intellectual development."

ENGINEERING ORIENTATION OF THIS PHILOSOPHY

Now, before applying this philosophy directly to Wisconsin's curriculum, let us test it in light of what is desired in an engineering graduate. To do this, think of an engineer in these three capacities: Industrial thinker, professional man, and educated citizen.

Demands of Industry

Industry being the engineer's workshop, first consideration must be given to just what his job entails. The engineer can be a link between the ivory tower and the workbench. Through technical thought he applies the scientist's abstract theories to concrete situations. The man in the shop takes his ideas from paper and adds a third dimension in concrete, plastic, and steel.

Controversy continues as to how close to the ivory tower the engineer should approach, on one hand; and conversely, just how greasy he should be expected to get on the other hand. Industry often wavers between these two extremes depending on which of them best suits its needs at a particular time. Therefore, industry's current wishes should be examined in view of recent needs.

In the final analysis industry demands results in the form of good solutions to technical problems. As for prevailing practice, let industrial training programs cover this. What prevails today may be entirely changed tomorrow, but the principles behind the practice are much more stable. Classroom time should be spent on the more lasting subjects. These are the scientific laws and concepts which are, in turn, the bases for productive thought.

Responsibilities of the Profession

The engineer's status as a professional man must begin with his education. His responsibility to society must always be emphasized. This obligation is fulfilled through careful thought which gives accurate results. Blind application of a formula or method might cost lives as well as dollars. Yet narrow specialization without the broad basic picture could cause just that.

Specialization can also undermine his very status as a professional man. As Arthur Bromwell points out:

> "The value of conceptual understanding should not be underestimated. It is the essential difference between the technician and the engineer."

The specialist who knows only the "how" but not the "why" of everything he does is probably well suited to become technician but he is unsuited for the title: Professional Engineer.

Dean Wendt has pointed out that another essential quality of a professional man is dedication. Dedication to what? Money? Certainly not! Yet many appeals to men considering engineering are made on that basis alone. The strict technical curriculum deals not at all with value judgments and dedication to the ideals of service. This points out the need for a varied curriculum which includes the humanities.

The Educated Man

Now we must consider the engineer not as an engineer at all but simply as an educated man in a democratic society. As N. W. Dougherty has said:

> "Somehow the education of the engineer must introduce him to the art of living along with his ability to make a living."

When the slide rule is in its case and the man steps in the door of

(Continued on next page)

his home, does that mean that the value of his education was left behind at the plant drafting board? It can mean just that if he never had anything but a technical education.

At home, in the community with its social, political, and moral problems, the educated man must also find solutions. By his very title as a professional man he has a place of leadership. How can he lead in types of thought which he knows little about or has never practiced? It is this situation that may cause engineers to scoff at Shakespeare or to be indifferent to Marx.

If an engineer is to call himself an educated man he should have been given the opportunity and encouragement to enlarge his philosophy by examining what great men outside the field of science have done in history.

CONFLICTS OF THESE PRINCIPLES AND PRESENT PRACTICE

Now that the goals we work toward and the general methods which we will use to reach them have been discussed, let us begin to analyze and criticize the curriculum, itself. This analysis will cover those specific points which I feel are definite problem areas from the view of a student.

Curricular Arrangement and Administration

One of the biggest problems in these areas at Wisconsin is integration of subject material. Much stronger ties between the humanities and engineering and between the basic sciences and engineering are needed. At present, different courses sometimes contain only different nomenclature. This is not integration but just duplication. The other extreme of complete divorcement of courses also exists.

In a university of this size which contains so many separate departments, the problem of tying courses together logically and usefully is very difficult. The solution must begin with liaison between both colleges and departments. When communication is poor or nonexistent, the present conditions of "departmental rights" attitudes within Colleges and the "College Sovereignty" attitude within the University exist. The student sometimes gets the impression that professors from different Colleges or Departments are saying in effect: "I'll teach this as it should be taught and not the way College X teaches it;" or "Those other courses may be all right, but in the final analysis this is the important thing to know." Pride in your own field is good, but not at the expense of the student. If faculty committees, especially from different Colleges, got together more often, a much better attitude toward the engineer's over-all education would result. Better integration would accompany better understanding.

One example of lack of integration is illustrated by the way mathematics is taught in North Hall and the way it is used in the Mechanical Engineering Building. Much of the math is taught in theory only without a mention of how the class of engineering students will apply what they have learned to the physical world.

Down on the engineering end of Campus, math is often treated trivially in engineering courses. Sometimes it is only mentioned that a certain principle is derived from a differential equation. In other cases, a derivation is arrived at by questionable manipulations.

The medium somewhere between these two extremes, where mathematics is taught as a method of translating physical relationships into equations, seems to be missing in most courses. Understanding of the problems on both sides could do much to remedy this.

A second example, that of physics, shows how poor integration results in time-wasting repetition. To begin, the present physics course repeats much of high school physics. More important, a great deal of time is spent on mechanics which is covered more thoroughly and in somewhat different terms in the Mechanics Department. Coordination in this case could leave more time in the physics course to cover subjects such as atomic physics which the students probably won't be taught in other courses.

An area which shows a complete lack of communication let alone integration is the humanities. To be sure, the so-called "practical" courses such as freshman English, Speech, and economics are included; but only because, it is reasoned, everyone has to be able to write, speak, and understand money matters. As for art, psychology, literature, music, and philosophy the curriculum allows ten elective credits.

This amount of time might even be adequate if it were not for the attitudes of the two faculties toward each other. In many cases, the professor in Bascom Hall still considers the engineer to be an uneducated, insensitive dolt. Likewise, the engineering professor often brands the liberal arts man as an impractical, and therefore useless scholar. Of course these ideas are reflected in the students.

> ". . . the key to the Humanistic-Social situation *anywhere* is the top Engineering administration. If this administration wants progress, it will take the steps (sometimes painful) necessary to produce it; if the administration is satisfied with the *status quo*, nothing is going to happen."

A joint committee from the engineering and arts faculties would be a starting point for better relations. Certainly both fields of study are a vital part of education.

Course Content

Theory and/or Practice: A science-oriented curriculum implies theory-oriented course content. More than that, it should denote a "thinking" curriculum. Where does engineering practice fit into the program? In their "Report of the Committee on Evaluation of Engineering Education" the ASEE says:

> "After facing many questions regarding the future of engineering practice, one is likely to conclude that the teaching of practice, as it exists today, will always be of limited use because the graduate is certain to find practice changing from year to year. And as a matter of fact, the engineering art taught in colleges will normally reflect practice that is already obsolete in part, . . .
>
> But fortunately, some things do not change. Reactions, stresses, . . . (A detailed listing of these things occurs in the text). These studies encompass the solid, unshifting foundation of engineering science upon which the engineering curriculum can be built with assurance and conviction."

This is not to say that the courses should be all theory and no practice. It does say that we must recognize the lesser value of teaching engineering art and place the emphasis on principles and thought exercises using these principles.

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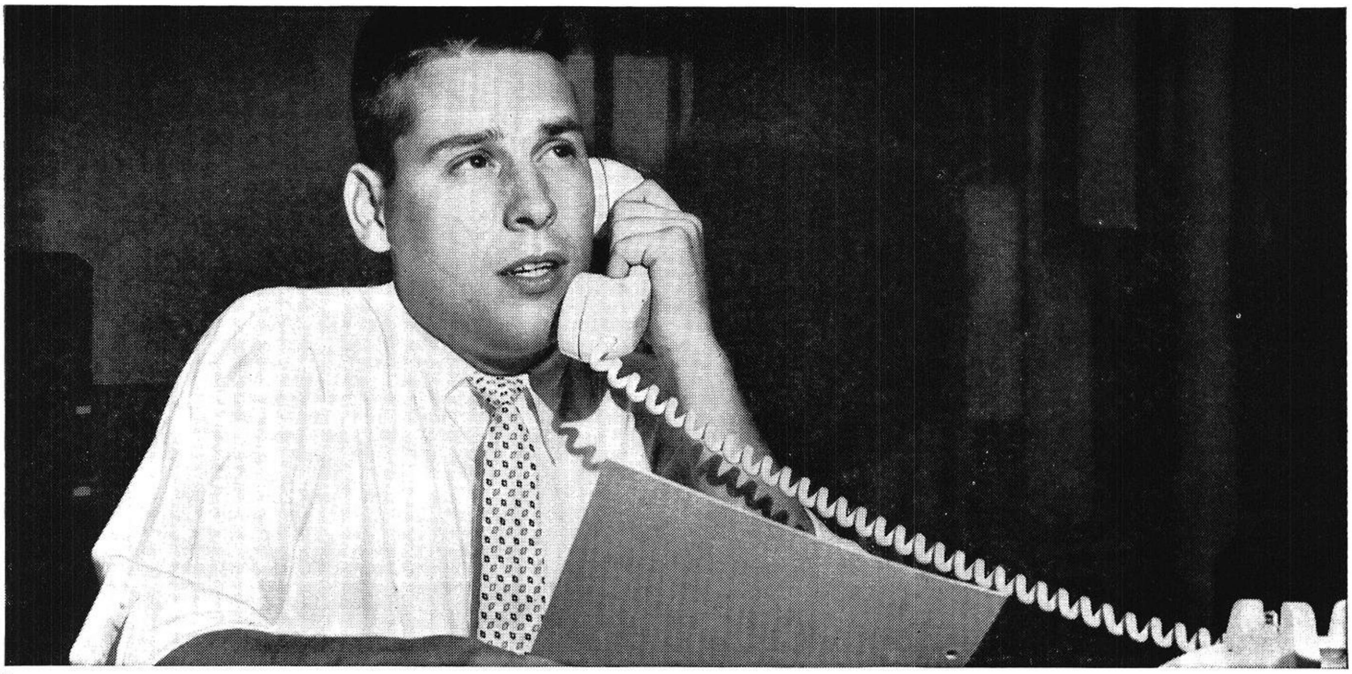


He's been on his way up from the day he started work

James C. Bishop got his B.S. in Electrical Engineering from the University of Illinois on June 23, 1953. On July 1, he went to work as a lineman in the Illinois Bell Telephone Company management training program. On July 2, he was "shinnying" up telephone poles.

And he's been "climbing" ever since. A planned rotational training program, interrupted by a stint in the Army, took Jim through virtually every phase of plant operations.

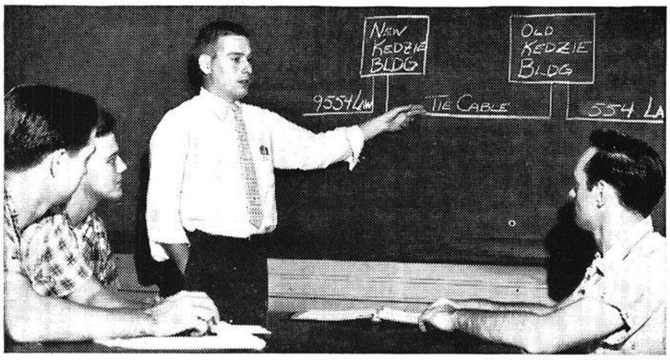
He was promoted to Station Installation Foreman in July, 1957. Then came more training at company expense—in human relations and other supervisory subjects—at Knox College.

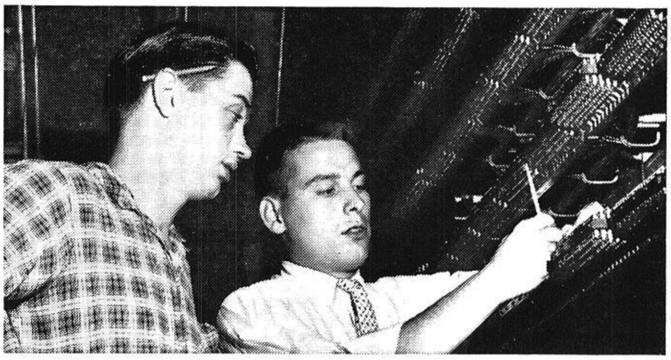
Since early 1958, Jim has been Central Office Foreman in the Kedzie District of Chicago, which embraces about 51,000 telephone stations. He has 19 men reporting to him.

"I was hired as 'a candidate for management,'" he says. "I know I'll get the training and opportunity to keep moving ahead. How far I go is up to me. I can't ask for more than that."

* * *

Find out about career opportunities for *you* in the Bell Telephone Companies. Talk with the Bell interviewer when he visits your campus. And, meanwhile, read the Bell Telephone booklet on file in your Placement Office.





Jim Bishop holds training sessions regularly with his men. At left, he discusses cable routes in connection with the "cutover" of his office to dial service. At right, he and a frameman check a block connection on the main frame.

BELL TELEPHONE COMPANIES

"Teflon" a Solution to Your Bearing Problem

by Robert A. Brauns me'3 me'60

"Teflon" tetrafluoroethylene resins have a combination of electrical, chemical, and thermal properties unmatched by any other single material. These properties have established "Teflon" tetrafluoroethylene resins as outstanding materials for use in electrical insulation at high frequencies and high temperatures; as a gasket and packing material in the chemical processing industries; and in many other applications.

METALLIC bearing materials of the "self-lubricating" variety are known to have very limiting characteristics. Their frictional properties are known to become very erratic with a rise or fall in temperature or a change in load. Metallic bearing materials are susceptible to chemical action, and their strength varies considerably with application.

The Du Pont Company of Wilmington, Delaware, has introduced plastics as an answer to these bearing problems. One of these new plastic materials is Tetrafluoroethylene resin, more commonly called Teflon. Not only does this material solve the aforementioned problems, but it possesses better embeddability features and affords better wear.

The basic application for self-lubricating bearings is in journal, or sleeve, bearings. A journal bearing is a shell of some suitable bearing material which is placed in a bearing hole to aid it in guiding and confining the moving parts of a machine. In a modern six-cylinder gasoline engine, journal bearings are used in more than 20 different locations, all of these applications being critical.

This article will compare the characteristics of the babbitt metals, bronzes, copper-lead alloys, and aluminum alloys with the relatively new material, Teflon. Self-lubricating materials were chosen for comparsion because Teflon and these materials are employed in similar situations. The article will cover the control of properties in manufacture, specific engineering properties, design and production aspects, and finally, a cost analysis.

FLEXIBILITY IN MANUFACTURE

A manufacturing process has to be flexible to be of any value. If a certain characteristic is desired in preference to another the best time to obtain it is during the production cycle. For instance: If a designer wishes to obtain a high yield strength, without sacrificing fatigue strength, he should be able to accomplish this during the production cycle. Manufacture should not be a "hit-or-miss" proposition. It should be a "positive" type of procedure.

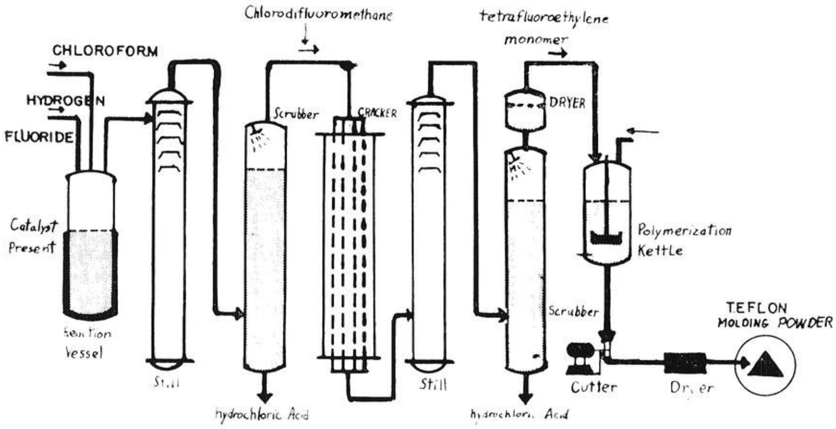
Metallic Materials

Self-lubricating bearings are bearings of high oil content produced from metal powders. The first step in their manufacture is a thorough mixing of the required powders. Next, the bearings are briquetted, or compressed, under high pressures to form the desired shapes. These shapes are then baked, or sintered, to form a strong unit. Finally, the baked cores are immersed in oil to obtain the self-lubricating feature. Oil content is sometimes upwards of 20 per cent.

Self-lubrication occurs as follows. Heat is generated as a shaft rotates in a bearing. This heat expands the impregnated oil and it flows outward to the bearing surface, thus providing the desired lubrication. Upon cooling, the oil contracts and is drawn back into the bearing material.

Teflon

Teflon is produced by a number of methods, all of which have the following common steps, which are very similar to those for metallic materials. The first step is cold



Some of the important steps in the manufacture of "Teflon" molding powder are illustrated above.

A constant, or nearly constant, coefficient of friction is just as desirable as a low coefficient. If friction were not relatively constant, a designer could design only for a small area of application. A machine designed to operate in Florida would not give good results when operating in Iceland if the coefficient of friction changed markedly with temperature.

Variation with Temperature

This variation of the coefficient of friction with temperature is a constant problem with the self-

(Continued on next page)

pressing. This is another term which means to densify the material; in this case, tetrafluoroethylene resin, under pressure. This step is followed by sintering, or bonding adjacent surfaces by heating. The final step is cooling, which changes the crystalline structure.

Variations in the manufacturing cycle affect three basic parameters. These parameters, in turn, affect the final properties of this material. They are crystallinity, molecular weight, and void content.

Crystallinity describes the transparency and structure of Teflon as related to a true crystal. It is determined by the rate of cooling and by sintering conditions. The cooling rate can change the crystallinity by as much as 30 per cent. Crystallinity increases markedly at high temperatures and, thus, is also affected by the sintering cycle. The influence of crystallinity on various engineering properties is illustrated in Table 1.

Molecular weight is relatively fixed by the initial molecular weight of the resin. However, if the temperature during sintering is raised above 734°F for a certain period of time, noticeable molecular weight changes occur. These changes can be advantageous, as illustrated in Table 1.

Void content, a measure of the density of an object, is primarily influenced by the condition of the original resin. However, sintering conditions are also important. At too high a temperature, void content can increase. The influence of void content on various properties is also indicated in Table 1.

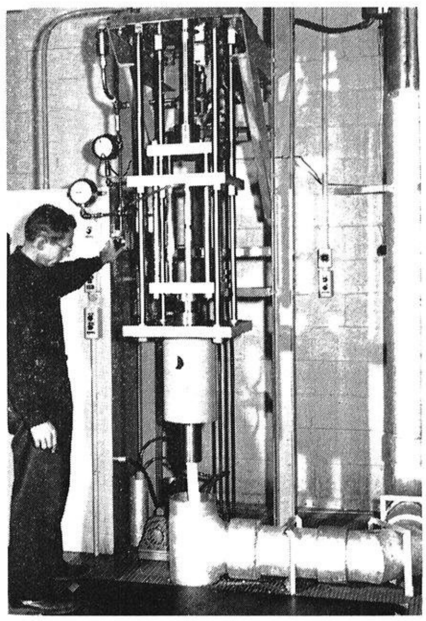
The above table shows that important engineering properties can be closely controlled during manufacture by varying the sintering temperature or the cooling rate. This element of control makes Teflon an excellent material for modern design. In comparison, phosphor bronze, a commonly-used metallic bearing material, exists in only four common grades, each of which has very set properties.

TABLE 1.—EFFECT OF MOLECULAR WEIGHT, CRYSTALLINITY, AND VOID CONTENT ON PROPERTIES

Property	Maximum Change Due to Increase in		
	Molecular Weight	Crystallinity	Void Content
Flex Fatigue Life	100 fold	100 fold	1000 fold
Compressive Stress at 1% Deformation	0	50%	0
Hardness—Durometer	0	20%	No data
—Rockwell	0	20%	30%
—Scleroscope	0	70%	10%
Tensile Impact Strength	0	15 fold	80%
Proportional limit	0	80%	20%
Yield Stress	0	15%	20%
Yield Strain	0	15 fold	0
Tensile Strength	25%	50%	50%
Ultimate Strength	50%	70%	50%
Ultimate Elongation	20%	100%	80%

ENGINEERING PROPERTIES

Possibly no other property is more important to a bearing material than the coefficient of friction. In most journal-bearing applications a low starting friction is extremely important. This friction, which is directly proportional to the coefficient of friction, may control the efficiency of the equipment or the power requirements necessary. The internal combustion engine illustrates this point. It always takes more power to get things moving than to maintain this movement afterwards. This high power requirement at the start is almost entirely due to high frictional losses.



—All Photos Courtesy Du Pont

Extrusion equipment for fabricating tubing of "Teflon" TFE-fluorocarbon resins. This technique for tubing is similar to that for flat sheet, tape, or wire coating.

Two rods of plastic are brought out of hot sulfuric acid. The Teflon rod on the right is not affected at all by the highly corrosive hot acid.

lubricating bearing materials in use today. At high operating temperatures all oils will vaporize to a certain extent. If the temperature becomes too high, the bearing will lose its "oil-pack" altogether and the shaft which it should guide and lubricate will seize. When the operating temperature becomes too low, the expansion of the lubricant will not take place and no lubrication will result.

This problem of variation of friction with temperature does not occur in Teflon applications. Under standard conditions the coefficient of friction is 25 to 70 per cent less than that of a metallic material. The temperature may vary from —320°F to 500°F without any ill effects.

Variation with Load

The coefficient of friction also varies with applied load. This is extremely important where bearings are pressed into their housings. Suppose the shaft is fairly tight running and the temperature of the surroundings increases, causing the housing material and bearing material to expand ever so slightly. If the housing material has a lower coefficient of expansion than the bearing material, a high pressure would exist between bearing and housing.

Metallic bearing materials do not exhibit good coefficients of friction with change in load. When this load gets large, the impregnated oil tends to be squeezed out of the bearing, causing the bearing to lose its lubricating qualities. Naturally, with no lubrication, the coefficient of friction would again increase and the shaft would seize.

Teflon again eliminates this problem. It can withstand higher loads for much longer duration than other materials. In fact, the coefficient of friction decreases as the load increases. Since the lubrication principle of Teflon is inherent in its molecular form, the lubricant cannot be "squeezed out" like that of metallic bearings.

CHEMICAL CONSIDERATIONS

Most materials will react chemically with many substances. This consideration is especially applicable in the food processing industry. Here the danger of contamination due to chemical action is always present. While bearings probably would not be in direct contact with the product being manufactured, the danger is always present due to leakage on other unforeseen occurrences. High humidity is also present in most applications, and this tends to increase corrosion.

Metallic bearing materials react chemically as do all metals. The oil-impregnated types are detrimental in the food processing industry due to the seeming ability of oil to saturate everything which comes in contact with it. High humidity results in corrosion which progresses from the inside outward in these materials.

Teflon is chemically inert to all substances except metallic sodium compounds, flourine and related elements, and other uncommon compounds at elevated temperatures and pressures. It is an ideal material to use in applications where contact with foodstuffs, textiles, paper, and drugs is inevitable. Teflon will also resist strong acids and alkalies. It possesses negligible moisture absorption properties and therefore can be utilized in outdoor applications which are exposed to weather.

STRENGTH CONSIDERATIONS

Fatigue strength is a factor to be considered in every design. A fatigue failure is one which results from a constant reversal of stress. The relationship of the number of cycles to fail versus the applied stress is a measure of a material's fatigue strength.

Strength in compression and in tension is probably one of the most important considerations when designing for any crucial application, as a bearing could very well be. Metallic materials and Teflon both possess satisfactory strength. One possible advantage of Teflon is its ability to deform and reform a substantial amount under excessive load. This redistributes the applied stress, and the Teflon bearing then returns to its original shape when the load is reduced.

MISCELLANEOUS PROPERTIES

Embeddability of a bearing is that ability which enables it to embed small abrasive particles in its bearing surface without endangering its own properties nor scoring the shaft. Both metallic materials and Teflon possess good embeddability features. Teflon, however, seems able to embed these hard particles without any apparent effect on bearing life. After a period of time, metals will show the effects of embeddability.

Bearing wear is dependent on many factors, including: load, velocity, friction, lubrication, and shaft finish. Since these are all variable quantities it is impossible to make a definite statement concerning bearing life. It can be assumed, however, since Teflon ex-

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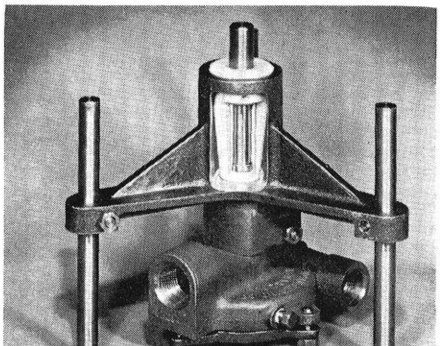


Teflon bearings used in this submersible pump possess resistance to a wide range of chemicals, strength, impact resistance and a low coefficient of friction.

Operations Research

by Charles J. Strauss ee'59

This article illustrates the application of operations research methods to modern industrial management problems

THE early years of World War II witnessed the birth of a new science, Operations Research. This new science was developed because of the nature of certain problems that faced military men which did not lend themselves to existing solutions. This type of problem is typified by: spacing of bombers to achieve an optimum bombing pattern, distance between ships to maximize chances of submarine detection and determining the proper depth at which to have depth charges explode in order to maximize the kill. The men who were selected by the Navy and Air Force were not necessarily familiar with military problems, but all had a background in the sciences. It was felt that these men would be more valuable to the Operations Research team (commonly known as OR) because they could view the problems more objectively without the preconceived ideas of solutions more experienced military men would be likely to have. At the end of the war, many of these men returned to civilian life and applied the same methods of solution to industrial problems.

The entry of these specialists into industry marked the beginning of a further division of labor. Just as the industrial revolution marked the division of the workingman's labor, so this was the division of management's labor. Many problems that the modern business manager faces are so complex that a solution is not readily available. In these cases, the OR man can analyze the problem and present to the manager a set of different solutions from which he can choose the one which is in best agreement with his company's objectives.

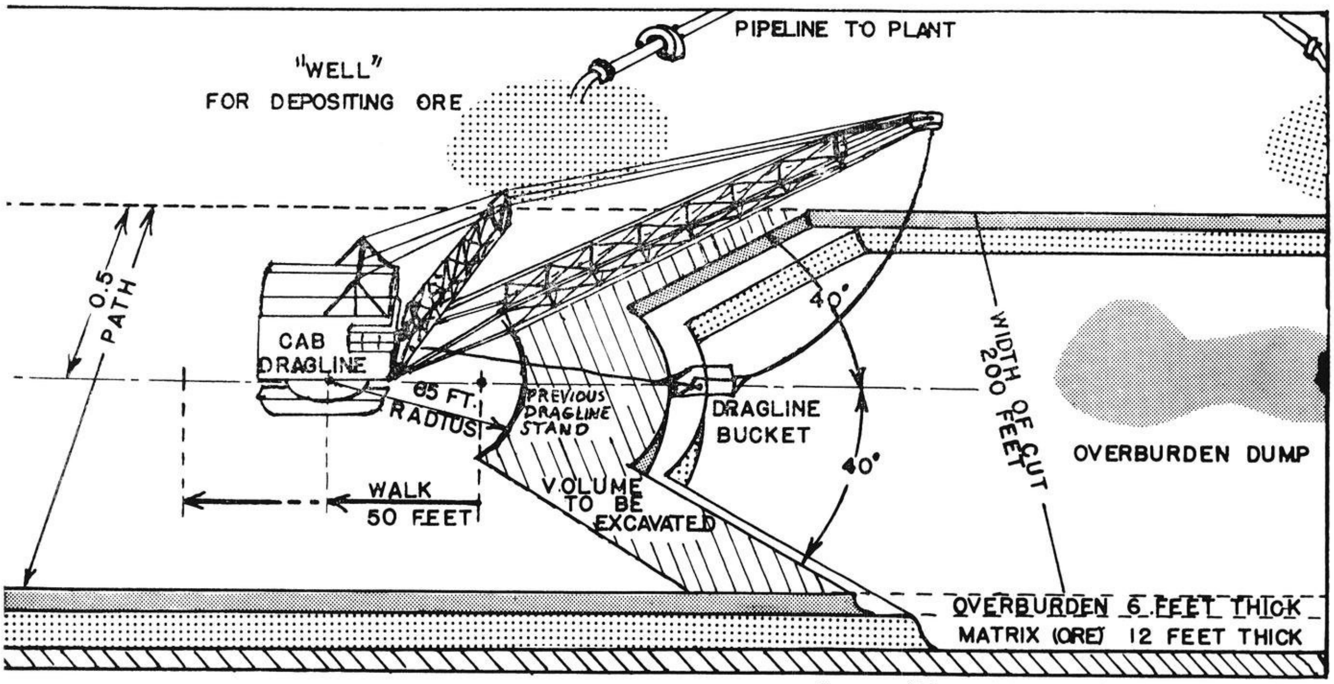
A given company seldom has a single objective and when more than one exist, it is unlikely that a high level managerial solution will advance each objective to its maximum. Therefore, an optimum solution is seldom possible and for this reason the OR man can not determine the best solution to the problem. This is still the job for the manager. The objectives may be to improve the quality of the product, or to increase the company's share of the market or short-run profits. The solutions presented by the OR team enable the manager to see the consequences of any of the many possible solutions and to choose one which is compatible with the objectives.

Operations Research has been defined as, ". . . scientific research methods, . . . as used in the physical sciences. . ., applied to the solution of practical operating problems in industry and business. It is also used in military, governmental, and other activities." Some of the tools used by OR are: matrix algebra, probability theory, applied statistics, sampling theory differential and integral calculus, symbolic logic, linear programming, servo theory, waiting line theory, game theory, and Monte Carlo procedures. It follows, then, that OR is distinguished, not by methods used, but rather by the type of problem to which the methods are applied. This type of problem does not lend itself to laboratory solution.

A more practical approach is to follow a procedure as outlined below:

1. **Define problem and state purpose of study.** The OR team and executives must agree as to what the problem is. Management frequently recognizes that a problem exists but is not able to define it. Even if management can precisely define the problem, they may be unable to state what they hope to achieve through OR.

2. **Observe operation and determine variables.** There will be many variables involved, sometimes as many as several hundred, and it is important to recognize them and determine which are controllable and which are uncontrollable. The uncontrollable factors may be wage rates, customer demands, raw material costs, machine tolerances, or any other factors over which management has no control. Controllable factors may be inventory levels,



—Courtesy of Fortune Magazine—Copyright 1956 by Time, Inc.—Artist Max Gschwind

The Problem. The ten variables in the Surface Mining Problem that the OR team had to consider are indicated in the above figure.

sales commissions, production levels or any factors over which management has control.

3. **Set up a mathematical model.** A mathematical model is a set of equations which describe the operation under consideration. These equations are composed of the variables—both controllable and uncontrollable.

4. **Vary the uncontrollable variables over a reasonable range.** This simulates all possible conditions which may prevail in actual business for the particular problem.

5. **Test the solution by some measure of effectiveness.** This measure of effectiveness must be compatible with the objectives of the company and the purpose of the study.

6. **Develop a method of control.** This must be built into the solution so that change in the uncontrollable variables can be detected and corrections can be made which will bring the operation back to optimum performance. This control, utilizing the measure of effectiveness to determine when sub-optimum conditions prevail, will be determined from servo theory and can be designed to indicate when the model no longer applies.

A few examples will illustrate the type of problems that are suited to solution by these methods.

Surface Mining Problem

A mining company is using a dragline for surface mining of ore. The dragline cost $1,250,000 and the company estimates that the machine's time is worth $20 per minute or $1200 per hour. They wish to obtain maximum efficiency from the machine. The OR team observes the operation of the machine and notes the variables involved. Some of these variables are: the thickness of overburden, thickness of ore layer, the width of the strip being excavated, distance the boom is extended, height the boom is extended, the angle of the boom to left and right, distance the dragline moves before beginning next excavation.

The OR team divides these variables into two categories; controllable and uncontrollable; and from the mathematical model, the optimum values for the controllable variables can be determined for any given set of uncontrollable variables, such as ore layer thickness, overburden thickness, etc. Thus, the most efficient operation can be obtained. The overall improvement in efficiency in this case was seventy per cent.

Waiting Line Problem

A plant which produces small fabricated assemblies has a conveyor carrying the finished pieces from the assembly tables to the paint shop. The pieces are to be sprayed at the paint shop but since the pieces are of several different sizes and thus require different periods of time to have the paint applied, and since the different size parts arrive at the paint shop at different rates per minute, it is not readily apparent just how many paint booths are needed in the paint shop. Each booth consists of an enclosure with a ventilating fan, spray gun with compressor, and automatic fire extinguishing equipment. Also, a more involved conveyor system is required for each additional booth. The cost per booth is $7000. The company frequently handles orders that are urgently needed by another company and swift completion of an order is important. One obvious solution would be to install as many booths as are necessary to handle the heaviest loads. This would eliminate any pile-up of assembled pieces waiting to be painted, but it would be prohibitively expensive. A second possible solution would be to install a small number of booths to save the cost of the additional booths but then pile-ups may occur, overtime may have to be paid to finish painting after the assembly line stopped,

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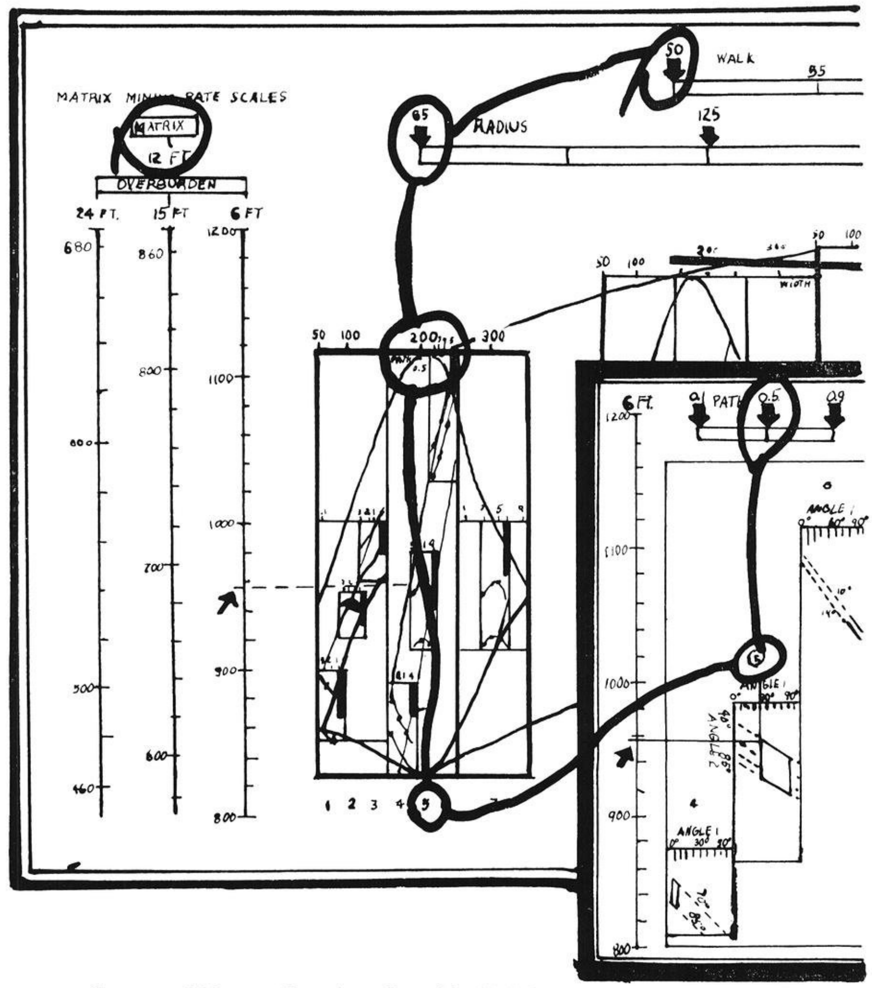
and business might be lost due to the slower service in filling orders. The OR team will present the management with a compilation showing the consequences of any decisions they make about the number of booths to install. On the basis of this report, a sound decision can be made.

Linear Programming Problem

A manufacturing company has plants in New York, Chicago, and Los Angeles and fifteen warehouses around the country. They produce one hundred items, each of which can be produced at all three plants. Labor rates vary at each plant, storage costs differ at each warehouse, and transportation costs per mile vary throughout the country. An inventory problem exists because of shortages of certain items at some warehouses and surpluses at others. The management of this company would like to establish inventory levels for each item at each warehouse and establish production levels for each item at each of the three factories. From a profit standpoint, each dollar saved on inventory is equal to $20 of sales, since the company nets five per cent of its gross sales. This particular problem involved 300 variables and solution was possible only with the aid of a high speed computer. After setting up a mathematical model of the problem, all possible combinations of uncontrollable variables were tested and a solution was obtained which provided the necessary inventory levels at each warehouse and which showed the proper production of each item at each factory.

The preceding examples have illustrated a few of the types of problems which lend themselves to solution by OR methods. No attempt was made to show the details of solution because of the complexity involved.

Some solutions which are easily obtained today were impossible to obtain a few years ago before the development of the high speed computer. This is particularly true of problems involving waiting-line theory since several years may be required to collect data by observational methods. Today, with the aid of a computer, tables of random numbers, and Monte Carlo methods, this data can be simulated and



—Courtesy of Fortune Magazine—Copyright 1956 by Time, Inc., Artist Max Gechwind

The Solution. This figure illustrates the form in which information was made available to the dragline operator and how optimum valves for controllable variables are determined.

recorded in a day. In problems involving linear programming, a mathematical model can be set up and uncontrollable variables can be varied over appropriate ranges. The correct values for the controllable variables can then be determined. In other words, the computer can show the manager how his decisions will be reflected in the performance of the operation. From the results, tables can be set up which will show the correct decisions for a particular situation.

An important point to emphasize here is that while the . . . term, OR, has not been used for many years, the tools and their method of application are not new. The recognition of the value of OR and the specialization of the OR man, in addition to the clear definition of methods has enabled OR to be used in widely diverse problems. By virtue of having methods defined, it it possible to teach the applications to men who otherwise would need many years of actual experience to learn them. In many problems the only way to find an optimum solution is by finding it through OR, however the danger of managers being replaced by computers is remote. Decisions must still be made by men of good judgment and experience. The manager must still choose the solution which is consistent with the company's objectives. OR is merely a guide to decision-making which shows the consequences of selecting any one of several alternatives.

The wide acceptance by industry proves the value of OR. Large companies in almost every field have OR departments. In general, only large companies can afford the expense of an OR project since it may not show results for a long time. The expense of OR should fall within one-tenth to one-half of one percent of gross sales. Since even a small OR team may require a budget of $100,000, OR has been restricted to larger corporations.

(Continued on page 50)

Running Scared

by Everett P. Partridge

The advantages of the insecurity in the engineering profession are summed up by Everett Partridge, Hagan Chemicals & Control, Inc., in this speech given at the Students Night Program of the American Institute of Chemical Engineers

As YOU go about prospecting for a job, many interviewers will inquire, "What are you?" What they mean of course, is, "Have you completed certain prescribed courses in a formal curriculum which will lead people to think of you as a chemical engineer, a mechanical or an electrical engineer, a chemist, or a nuclear physicist?"

A much more significant question is, "What are you trying to become?" This is important, because all your life you will keep on becoming.

In doing this, you of the present generation will have to struggle against a particularly serious handicap. I don't mean a recession in business, for the economists' graphs for the future all zoom upward. By 1965, we shall have 25 million more people, $100 million more gross national product, 115 million more kilowatts than we had in 1955.

Any one of you can have your choice of at least ten jobs now and for some years to come.

Your *real* income will be slightly more than twice mine when I got out of college in 1925.

You can expect your wife to work, too, so that your combined income will allow you to have two cars, even if no babies.

You need take no thought for the future, for you will be protected by:

1. medical, surgical and hospitalization insurance
2. unemployment insurance
3. severance pay
4. profit-sharing
5. pension
6. Social Security

You have it made. Why worry about anything?

This is a truly serious handicap. I think you go farther and have more fun if you run scared.

By running scared I don't mean a state of panic. I do mean a state of mind which keeps saying to others of your own performance, "I should have thought of that," instead of "Well, you didn't tell me to."

If you do accept responsibility, inevitably you will feel the weight of it on your mind. You will worry about making the right decision, you will wonder afterwards if you did. You will feel uncomfortable.

Nobody likes to be uncomfortable. So the majority of men, including, unfortunately, some who call themselves engineers, seek security rather than responsibility. Their ideal job is one where everything that goes well is obviously a result of their good work, but everything that goes wrong is the fault of someone else, an incompetent boss or a stupid assistant.

Perhaps you have seen the early stages of this mental disease already in some classmate or even, perish the thought, in yourself. Whose responsibility was it that you didn't get much out of that course in English or differential equations or heat transfer? Was it actually the fault of that lousy instruction . . . or of the classmate who wouldn't lend you his notebook the night before the exam? Or, could it just possibly have been your own shying away from the responsibility of disciplining your own mind to work at the problem day after day?

When I was a student chemical engineer at Syracuse University, one of the courses required in the senior year was economics. It was taught by a professor from the College of Business Administration who came over to the College of Applied Science on Monday, Wednesday, and Friday at 10 a.m. for an hour that he must have dreaded.

As engineers we were proud of our carefully nurtured cult of uncouthness. We also looked down on Business Administration because that was where all the boys who flunked out of engineering went.

So we had the usual unthinking undergraduate fun with this utterly humorless professor of economics.

One item was the fictitious student we registered under a name I wish I could remember. Anyway, every time the solemn professor called the roll, there was laughter. After some five weeks during which we used all the usual ruses to report our imaginary classmate present, in the infirmary with sleeping sickness, or on his honeymoon, the professor realized that he had been taken. He stormed down to the Dean, shouted that he had never been so insulted in his life and refused ever to teach that course in economics again.

We barely cared. What did economics have to do with engineering anyway We rather congratulated ourselves on having eliminated a dusty nuisance from our solid 8 a.m. to 5 p.m. schedule. I suspect, however, that my classmates have had to study economics quite a bit over the thirty years since.

I have a responsibility right here that I want to fulfill. If I fail, I could say, "Well, after all what can you expect of young folks today? They have been spoiled by lack of discipline at home and in school. They just don't give a damn." What I actually should say to myself would be something like this "Partridge, why didn't you get across to those students? Perhaps you weren't using their language. Perhaps you couldn't get inside their minds."

That attitude might well be considered by some instructors who take their own responsibilities too lightly.

Because I feared I might not be tuned to the proper wave length for reception by you, I asked the last three recruits to our training course for field engineering services to sit down with me one afternoon some weeks ago. They suggested several little messages I might transmit. They say that out on the job:

1. You can't just "cut classes" when you like it.
2. You can't depend on your room-mate to carry you through some problem on which you are stuck.
3. Everything isn't in the books.
4. Don't expect things to happen overnight.
5. A training program isn't just a necessary evil to be gotten over as quickly and painlessly as possible.
6. You don't have to compensate for your inferiority complex by telling the boss the first week what to do and how to do it.
7. The shortage of engineers doesn't guarantee a good, continuing job with a future.
8. You have to assume responsibility.

How much can be expected of an engineer is illustrated by the experience of a man, now retired, who worked for many years for one of the large steel mills in the Pittsburgh area. As a young engineer in the utilities department, he was made responsibile for all plant water. Full of vim, he checked the entire complicated distribution system, discovering, to his horror, that if one pump taking water from the river went out of service, the entire plant operation must inevitably be shut down. He convinced his boss and his boss's boss and so on all the way up the line to the president of the company that a second big pump should be purchased. But the president took a long look at the cost and said, "No." Not many months later the pump failed. The mill shut down.

The young engineer was promptly called to the president's office to explain why the water supply had failed. As tactfully as he could, he pointed out that he had warned against the precarious dependence on one pump, had even argued with the president himself for the purchase of a spare, and could therefore scarcely be blamed for the catastrophe. "Yes," roared the president, "But if we needed that extra pump, it was your job to convince me!"

When I stated my thesis that you go farther and have more fun if you run scared than if you feel secure, I meant both points. Let's consider why you go farther.

Here is an equation attributed to Dan McQuaid, who calls himself the cowboy engineer:

$$V = A - S$$

In words this reads: "The value of any position is equal to the ability of the individual to produce, minus supervision."

Strangely enough, industry is always looking for men to whom it can pay more money. Such men must have a value for A — S that causes them to stand out from their fellows. Sometimes an individual who does not have exceptional ability to produce goes ahead of an inherently more able man simply because the average fellow is a self-starter who runs scared, while the more able fellow requires so much supervision that he is actually less valuable.

Do you know what happens then, even in some cases after the supervisor or manager has carefully explained the whole situation? The inherently more able man who has been bypassed goes around muttering under his breath about eager beavers who spend all their time trying to make themselves look good to the boss!

My second point was that it is more fun to run scared than to feel secure. Let's not interpret that as a plea that you develop ulcers at thirty. But if you feel responsible, you will feel that you really count for something. That is a way that most of us human beings need to feel.

If you feel responsible, it helps to fix your thoughts on the thing for which you are responsible, which makes for mental health. The man who shuns responsibility easily gets to thinking about himself more and more, so that he enjoys life less and less.

It has always seemed to me that there was an impressive psychological truth behind the Biblical statement that, "He who loses his life shall gain it." I would paraphrase this as: "He who loses himself so completely in living that he identifies himself with what he is trying to accomplish, really lives."

Long before this, you have realized that my title was obviously created to stir your curiosity. Long before this you may have begun to wonder when I would quit beating to death this idea of reaching out for responsibility. The answer is: in about four seconds. But first let me urge that you never utter the famous phrase, "Let George do it," unless your name is George.

THE END

Bonding Rubber to Metal

by Melvin Sook M.E.3

Introduction

PRIOR to 1939 little had been accomplished in the field of metal-rubber bonding. The Second World War brought about a need for metal-rubber bonding and since then the knowledge in this field has expanded.

The principle problem involved in bonding rubber to metal is that of achieving a permanent bond. In this article some of the methods of achieving this bond will be presented, along with the processes involved. Brass to rubber bonding has been found to give the best results and is the method most used, therefore it will be given the most attention.

Methods other than brass to rubber bonding are used and these will also be presented.

Discussion of Rubber-Bonding

The need for bonded, rubber-metal units is most evident in the engineering industry. They are used to dampen mechanical vibrations, to absorb shock loads, and to suppress noise. Suitable units of this type have added a new construction unit to those already available to the designer and engineer. Rubber has inherent properties which no other material has, but to make full use of these properties it has to be applied in a suitable manner. The presence of the metal component enables the designer to use a bonded unit at nearly any point he wishes in his layout, without having to worry about how to hold the rubber part in place.

Early methods of uniting soft rubber with metal were by mechanical means such as bolting or encasing rubber in a housing, or by using a layer of hard rubber called "ebonite" between the metal and the soft rubber. The ebonite formed an attachment to the metal on one side and united with the rubber on the other. This formed a bond, but the unit did not have all the necessary and desired characteristics. This method is still used for manufacturing solid tires and lining pipes and tanks.

With the development of modified rubbers by the use of synthetic rubber, qualities have been produced in the rubber which cause it to develop a good bond when it is vulcanized while in contact with brass. Brass is the metal which is used to form the rubber-metal bond.

Parts that are to be bonded to rubber do not have to be brass themselves. The parts may be made of any metal onto which brass can be plated. All that is necessary is that a thin layer of brass be present for the rubber to bond with.

Preparing the Metal Surfaces

Metal surfaces of parts to be used in making a metal-rubber bonded unit must first be prepared before they will be ready to be brass plated. This preparation includes cleaning, degreasing, and removing surface scale.

Cleaning: Probably this first operation of cleaning metal parts is the most important of all. To produce a good bond the part must be plated and, to be consistently well plated, the part must be well cleaned. Parts which are not well cleaned will show signs of the brass deposit peeling off or blistering. Parts which are poorly cleaned may not even develop a bond with rubber, and if a bond is obtained it will be of poor strength. The cleaning operation consists of degreasing and removing oxides and scale.

Degreasing: Most metal parts to be bonded will arrive at the plant with an oil or grease coating on them. This coating may have been purposely applied to retard rusting and oxidation of the surface during storage or it may be the result of cutting oils used in machining the parts to size. This grease and oil is first removed. The best method of doing this is by passing them through a solvent bath or a vapor degreaser. This bath usually consists of a hot alkaline solution connected to a low voltage direct current. The solution is kept near its boiling point which greatly aids in reducing the viscosity and surface tension of the oil, thus enabling cleaning to take place in a short period of time. The current produces gas at the cathode and anode. The gas bubbles cause agitation which helps remove surface impurities on the metal.

Removing Oxides: When metal parts have been heat treated, they are covered with a scale. This scale is usually loosened by sand- or shot-blasting before the parts are processed through the regular cleaning baths. However, if the scale or oxide is not heavy enough to warrant this type of treatment, the parts are passed into an acid solution after they have been degreased. Hydrochloric or sulphuric acid is usually used. This is referred to as pickling. The metal part emerges from this solution with a black deposit consisting mainly of iron oxide, iron carbide, carbon, and sulphates. These deposits are then removed by brushing or buffing with wire brushes.

The parts now have clean surfaces free from oil and scale and are ready to be plated.

Brass Plating

It has been found that brass bonds to rubber the best of any metal, so nearly all metal objects are first brass plated and then the rubber is applied. Metals other than brass develop bonds with rubber, but they are not very strong. Therefore, brass is the mostly used base for bonding.

Brass is generally applied to other metal surfaces by an electroplating process. The deposit must be uniform in composition and physical structure. It has been found that the plating containing 70 to 80 per cent copper and the rest zinc gives the best bonds.

The brass plate is deposited in production by plating zinc and copper simultaneously from a solution of their salts. The salts are placed in a carefully prepared solution and an electric current is passed through it. The part to be plated is made the cathode of the electric circuit.

The simple salts of zinc and copper cannot be used for electroplating because each has different potentials. Therefore, complex radicals are formed by preparing solutions with cyanides. These radicals have the same potential and are therefore satisfactory for electroplating. The chemistry of the electro-plating is quite complex and many variables affect the quality of the deposit. Variables include current density, temperature, salt concentration, age of solution, and impurities present.

The deposited plating does not have to be thick. Thicknesses as low as 0.00001 inch will produce a satisfactory bond. Generally, a good plate can be produced in 5 to 10 minutes. Care must be taken to balance the variables at all times to obtain a uniform plate. Uniform plating is essential for consistently good bonds.

Methods of Bonding

The next step in the process is the bonding itself. Rubber is first ground. The ground rubber is then introduced into molds which contain the metal parts that are to be bonded to it. The process is similar to casting iron.

The rubber that is used may be pure natural rubber. Generally, it is a mixture containing a synthetic rubber. The exact composition of the rubber will depend on the qualities desired in the finished product and the service to which it will be put.

When parts are to be compression molded, the rubber is applied directly to the metal part. The mold is then closed under pressure. Parts of the metal that are not to be bonded are painted with an anti-bond solution such as cellulose acetate in acetone.

After the mold is closed, it is kept under sufficient pressure to keep it closed. This is necessary because the rubber tends to expand and run when heated. The mold is then heated to about 120 to 175° Centigrade which is sufficient to cause the rubber to vulcanize. This temperature is held for a period of time which is called the "curing time." During this time, the bond is formed. Table I gives a number of curing times.

Molds: The molds are made of steel and range from simple to complicated structures.

Various types of molds are used, the most advanced being the injection mold, into which the rubber is injected directly into the mold in a hot condition. The curing time is reduced in this method because the rubber is hot when injected. Higher output and reduced costs are the results. The exact type of mold used depends on the nature of the parts to bonded and the capital available for the operation.

Nature of Different Bonds

There are two mechanisms of bonding rubber to metal—chemical and mechanical.

Brass Bond: The brass rubber bond is essentially a chemical bond. The sulphur in the rubber reacts forming a union with copper in the brass. The chemical reaction during the vulcanizing period is primarily concerned with the sulphur contained in the rubber. The copper in the brass reacts with the sulfur and forms cuprous sulphide. The sulphide then unites with a free sulphur atom in the rubber or it can attach itself directly to the rubber.

Mechanical Bonds: The mechanical bond is formed by cements or other adhesives attaching themselves to the metal and to the rubber. The metal parts have rough surfaces to which the cement attaches itself, thus bonding the rubber and metal together.

The mechanical bonds give the greatest variety of bonding. They are much easier to use but do not give the ultimate bonding strength as do rubber-brass bonds. There is no single adhesive for all purposes. Rather, there are special adhesives for bonding various rubber-metal combinations. An advantage of cements is that they can be used on vulcanized rubber, whereas the brass bond uses unvulcanized rubber.

Some Bonding Cements

Ebonite: As previously mentioned, ebonite is one of the bonding cements. However, the ebonite bond fails rapidly at temperatures over 100° Centigrade, because ebonite is a thermoplastic. At normal temperatures ebonite forms a bond strength of about 475 to 550 pounds per square inch. This type of bonding is presently used to make solid rubber tires.

Thermoprenes: Thermoprenes are synthetic rubber adhesives which are used for bonding rubber to resins, wood, ceramics, glass and ebonite, and metals including steel,

(Continued on page 49)

SCIENCE HIGHLIGHTS

Bill Timmler ee'60

INCLUDED in the potpourri of this month's "Highlights" are some very unusual items. Worth mentioning are a "transmission" for surveying transits, an exceptionally large piece of "sagging" glass, and a transistorized electronic circuit equivalent of a nerve cell. Dispersed in between are items on a "total electric home," a system which doubles the capacities of submarine telephone cables and many other items illustrating the tremendous developments being made daily in science.

A crew of four men hoisted a huge piece of glass onto a lift truck. The jagged-edged chunk weighed 2796 pounds. It was removed from a pile of glass which an unknowing passerby would have shrugged off as a "scrap heap." But this was no ordinary piece of glass. It was destined to become the primary ingredient in a huge new telescope mirror to be used for astronomical research being made by Corning Glass Works. With a diameter of 84 inches, the new disk was to become the largest telescope mirror cast since the famed 200-inch disk, world's largest, was completed 25 years ago this year.

Beyond this, the new blank would set a few records of its own. If all went well, it would be the first large-size glass disk of ribbed construction made by sagging and the largest piece of glass ever fabricated by this method. In the process, the mammoth chunk, scrubbed clean by sandblasting, was placed atop a circular mold of insulating brick. Around it were placed smaller pieces of glass, all carefully selected on the basis of weight and shape. They were moved into a melting furnace. Here at temperatures reaching approximately 2300 degrees Fahrenheit the glass was to be melted down to shape.

The 200-inch mirror, made for the Hale Observatory at Palomar Mountain, had been formed by ladling molten glass into the mold. The sagging method was being used on the new disk to reduce bubble inclusions, and because this method would be less complicated, less costly.

Sagging had been used successfully in making disks up to 72 inches in size, but these had been solid pieces, produced without the complications of carefully engineered cores, set in the mold to provide the honeycombed pattern on the back face. Would the sagging work on a ribbed disk so large in size? Calculations by Corning engineers indicated the job could be done. Yet, the final answer lay in the doing. Through the days of the melt-down, the engineers anxiously waited. The wait was not without its points of drama.

Shortly after the furnace began heating up, inspection showed the big piece of glass, sitting squarely in the center of the mold, was cracking. An early drop-off of any sections of the glass would prove damaging to the delicate cores. The melt-down was halted. The mold was removed from the furnace. The loosening pieces were "sliced off" and placed in new positions around the mold.

Orders were issued to resume the melting operation. The watchful waiting began again. Another inspection showed that melting had occurred smoothly; the separate chunks of glass had fused into a single cylindrical shape. But the big disk, now glowing orange with heat, was slightly marred by bubbles. Another 48 hours of soaking in the intense heat was ordered to remove the bubbles.

The disk was rapidly moved from the oven to an anealing kiln where for seven months it would be slowly and scientifically cooled to prevent breakage and to limit stress in the glass. This cooling operation is currently underway in Corning, New York. It is anticipated that sometime during the summer the disk will be ready for shipment. This will be no small problem. The great piece of glass must be transported cross-country to Tucson, Ariz. There it will be ground and polished and then hauled to the top of 6,785-foot Kitt Peak, 40 miles southwest of Tucson.

The mirror will become the primary reflective piece in one of two telescopes being constructed as part of a new national observatory. Operated by the Association of Universities for Research in Astronomy, Inc. (AURA), the observatory is being constructed under sponsorship of the National Science Foundation. The observatory will offer any qualified astronomer the use of the latest in astronomical facilities.

Six months of planning and engineering went into the production of the 84-inch disk. One of the major tasks was building the mold. Corning engineers relied heavily on the work done on the 200-inch disk by Dr. George V. McCauley, the man who supervised construction of the biggest piece of glass ever cast. They followed his calculations and design for providing a ribbed pattern in so large a piece of glass.

Each core, made of ceramic brick, was precisely placed by predetermined pattern to provide the greatest strength and rigidity, while keeping the weight of the disk to a workable minimum. Cores were both cemented and bolted to the floor of the mold. A unique cooling system was installed on the underside of the mold to prevent the steel rods, anchoring the cores in place, from melting under the furnace heat.

Into the center of the mold went a core which would form the 26-inch central hole of the mirror. Cylindrical cores were set to form the points where the mirror would be held to position in the telescope. Triangular and kidney-shaped cores were placed in a pattern designed to give the greatest support. Then the huge pieces of glass were lifted to positions on the mold, resting on the cores. The 2,796 pound piece was lowered onto the center core, reinforced beneath by steel.

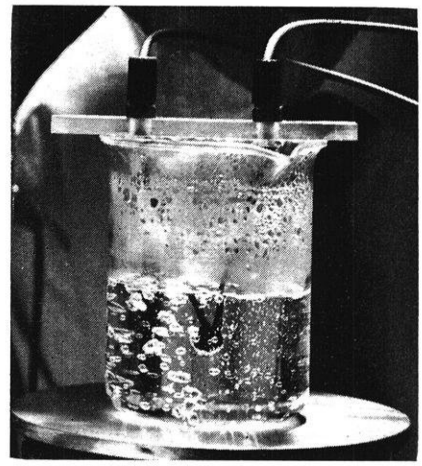
Like the 200-inch disk, the new blank is made of hard, borosilicate glass, selected because of its low expansion, thermal resistance, and mechanical strength. The glass must retain its shape through time, temperature change and mechanical stresses, if the astronomers are to obtain an undistorted image of the stars.

Melt-down of the huge chunks occurred in a specially-built furnace, just as the annealing is currently underway in a kiln built especially to house the big disk. Part of the special equipment included a huge table on which the mold rests. It was moved along two rails into the dome-shaped furnace and from the furnace to annealer. Sitting on this table, the mold actually formed the bottom part of the furnace and annealer. The table was raised to shut tight these enclosures.

Melting was accomplished by use of gas heat, jetted into the top of the furnace, and electrical heat, supplied through elements which lined the underside of the mold. The annealer is heated by electricity, with elements lining the interior of the circular kiln. In the annealer, the disk will be held at a constant temperature for two months and then slowly cooled at about one degree (Centigrade) per day. With cooling completed, it will be ready for the long trip to Tucson.

POSITIVE TEMPERATURE COEFFICIENT THERMISTORS FOR ELECTRIC MOTOR PROTECTION

Engineers in the Materials Engineering Laboratories of the Westinghouse Electric Corporation have developed a significant new family of solid-state devices that serve as tiny contactless thermal switches. They are thermistors, of a new type, whose resistance increases abruptly when a specified desired temperature is attained. In their first major industrial application, they meet the long standing need for a practical, reliable, and precise system for over-temperature protection of hermetic motors in large air conditioning and refrigerating systems.



The silvery disc in the photograph is a ceramic wafer to which a metallic surface has been applied. Complete thermistors result when discs are fitted with leads, insulated, and encapsulated for proper mechanical, electrical, and thermal properties.

Initial quantities of these new switching thermistors are going to the motor department in Buffalo, N. Y., where Westinghouse motor engineers have developed a new system for protection of motors against over-temperature conditions. Termed Guardistor motor protection by Westinghouse, the system will be applicable to motors of any type, but is particularly applicable to totally enclosed motors such as those used in hermetically sealed units for air conditioning and refrigeration units.

In this system, the first new approach to motor over-temperature protection in many years, thermistors installed directly in the motor windings will operate a small external relay which de-energizes the motor or gives a signal when overheating occurs. This is the only protective system so far developed that is inherently failsafe.

Such applications of the new thermistors are made possible by their unique ability to display an abrupt and substantial increase in resistance when their temperature rises to a specified point and their ability to return to nominal resistance value when cooled below that point or level. Thus, when their temperature reaches the critical point, they become high resistance circuit elements and, with no moving parts, perform the function of a switch by effectively opening the circuit. When their temperature falls below the critical point, their

(Continued on next page)

resistance returns to a quite low value, so that they act as a conductor to close the switch.

The new devices are termed Positive Temperature Coefficient Thermistors to indicate that their resistance increases with temperature in contrast with conventional thermistors whose temperature coefficient of resistance is negative. Other contrasts include: within their respective operating ranges, the sensitivity of Positive Temperature Coefficient Thermistors is many times that of conventional thermistors and temperature ranges in which switching occurs are very sharply defined and are controllable.

Positive Temperature Coefficient Thermistors now being produced are small ceramic discs, roughly the size of aspirin tablets, that are surfaced on opposite faces with a metallic coating. Before use they are fitted with leads and encapsulated in an epoxy resin having proper thermal, electrical, and mechanical characteristics. The process by which they are made involves typical ceramic and powder metallurgy operations.

SIMPLE ELECTRONIC CIRCUIT SIMULATES LIVING NERVE CELL

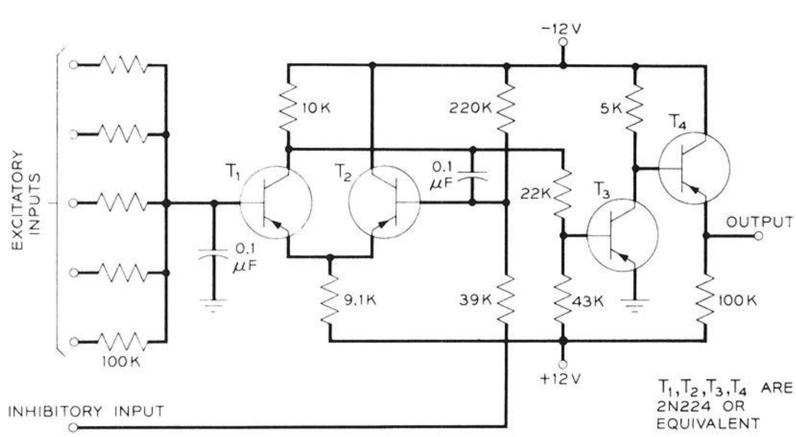
A simple electronic circuit that simulates some functions of the individual biological nerve cell, or neuron, has been developed. Numbers of these artificial cells are being combined into experimental networks that are roughly analogous to the nerve systems of the eye and ear.

Scientists are especially interested in discovering how visual and auditory nerves function and how their signals are interpreted by the brain. Knowledge derived from such basic research may lead, as it has in the past, to better and more economical communication.

The gross function of the nerve cell; transmission of electrical pulses in response to stimuli, and only to those stimuli that meet certain conditions has been simulated by a simple circuit. The cells have been combined into groups that simulate simple functions of the eye. Similar experiments with ear models are being started.

The neuron circuit fires electrical pulses of standard amplitude and duration, just as a biological cell usually does. If the circuit is driven by a constant stimulus, simulating receptor cells as in the eye or ear, trains of pulses are emitted. A higher intensity of excitation increases the frequency of pulsating and when the neuron is exicted continuously, the frequency of pulses can be made to decrease with time, exhibiting accommodation as a living nerve cell does.

Input excitation must, as in a biological cell, surpass a threshold value, and the cell will integrate two or more input pulses below threshold value to cause firing. A particular input connection can also, while energized, inhibit firing of the neuron by other inputs. Similarly, immediately after firing, the electronic neuron's threshold rises to infinity and for a few milliseconds no input signal can fire the neuron again.



SCHEMATIC DIAGRAM OF ELECTRONIC NERVE CELL

The circuit includes four transistors, thirteen resistors, and two capacitors, mounted on a three-by-four inch printed-circuit card for ease of handling. The pulse length it delivers, about six milliseconds, is considerably longer than that of a biological nerve, but it can be shortened if desired. The cell has an integrating time-constant of two milliseconds and a refractory time-constant of about ten milliseconds, approximating time-constants of the biological neuron. Because the electronic inputs and outputs are compatible, the cells can be assembled into chains and networks.

Electronic neurons can be combined with photo-resistive cells to simulate simple functions of nerves in the retina. Some receptors, known as "on" receptors, fire only when the light intensity they receive is increasing; "off" receptors fire only when the light is decreasing; and "during" receptors fire while they receive a steady light. Flicker-fusion phenomena have also been produced. In the human eye, these can cause a sequence of flashes to be seen as continuous illumination; this property of vision is exploited in motion pictures and television.

The mutual inhibition of cells in an array has been demonstrated experimentally. Some animals have been observed to possess this arrangement, in which a cell receiving a greater light intensity inhibits the firing of nearby cells that receive less light. This results in local sharpening of image boundary detail.

It is hoped that further imitation of nerve functions, so far as they are known, and other experiments may lead to better understanding and prediction of neurological behavior.

NEW TANGENT SCREW IMPROVES TRANSIT EFFICIENCY

A two-speed tangent screw for surveying transits that makes possible faster and more accurate vernier settings and telescope aiming has been developed.

According to the announcement of the development, there are two gears in the new tangent screw. The first, called "high gear," enables the transit operator to secure a

(Continued on page 52)

ENGINE EARS

by Bob Helm ce'61

A. S. M. E.

The American Society of Mechanical Engineers society exhibit for the 1959 Engineering Exposition, "The Rube Goldberg Machine," triumphantly took first place in their classification of exhibits. The exhibit, more aptly titled "Shades of Rube Goldberg" utilized the three basic machines in a simple transfer of motion. These three machines; the wheel and axle, the lever, and the inclined plane; along with variations of these machines, cams, wedges, pulleys, and friction wheels combined to transfer the motion from one to another until at the end, a "surprise box" was utilized, much to the pleasure of the younger generation. Much credit must be given to Jim Hill and Dave Lynch who spearheaded the committee building the exhibit.

Besides winning first place in their society class, the M.E.'s took first place in three out of the other four classifications. In the Craftsmanship Class, Frank Kottler copped the coveted award with his home-made telescope. In the Student Group Class, Bucky Goodrich, and Dave Evens took the honors with their 25 horsepower gas turbine engine. In the Graduate Student Class, John Johnson took top laurels with an exhibit portraying end-gas temperature measurement in a spark ignition engine.

The Promotions Committee of A.S.M.E. must be given due credit for the success of the St. Pat's Banquet and for much incidental work done for the Exposition. This committee functioning under the leadership of Bob Olson carried on much of the behind-the-scenes work of the society for the year.

The Special Projects Committee, under the chairmanship of John Lillesand is in the final planning stages for a field trip. Along with this field trip, a picnic is being planned jointly with S.A.E. and Pi Tau Sigma. This committee also did much work in planning many M.E. demonstrations for the Exposition.

A special meeting held earlier this semester, originated by the President, was held for the Freshmen and Sophomore Mechanical Engineers. It consisted of a panel of Engineering Students talking on the various phases of the campus life that the undergraduate engineer will be exposed to at some time. The program was moderated by Prof. E. P. Mikol of the Mechanical Engineering faculty. The following students, with their respective topics, are listed below:

1. Lalit Sarin—"Engineering Societies & Fraternities" (Honorary and Professional)
2. Dick Mann—"Campus Activities" (Polygon Board and Student Senate)
3. Bob Olson—"Summer Job Opportunities In Industry" (For the Undergraduate Engineer)
4. Tom Pitterle—"The 1959 Engineering Exposition"

Prof. B. G. Elliott, chairman of the M.E. Department, also gave a short presentation on "The Benefits of A.S.M.E. to the Undergraduate M.E."

The new officers for the 1959–1960 year were elected at the April 22 meeting This was a joint meeting with the Civil Engineers Student Society.

The annual A.S.M.E. Regional Conference is to be held in Brookings, South Dakota from April 30 to May 2. Approximately twelve members of the local society will make the trip to Brookings for the Conference. Wisconsin's winner in the speech contest, and our representative in the competition at the conference is Charles H. Veen, a Junior in M.E. from Milwaukee. The title of his presentation is "Combined Ion Fluid Propulsion System" and is illustrated with self-made slides. The $25.00 cash award for winning the local contest was made to Charles at the society's April 22 meeting.

The last meeting of the society for this year will be held on Wednesday, May 13, 1959 in Tripp Commons in the Memorial Union at 8:00 P.M. The speaker will be from Boeing and will speak on the new 707. This will be the close of business for the year and will include an evaluation of the year's activities. The newly elected officers will be installed in a special ceremony. The award for the outstanding member of the society for the current year will also be awarded. He has, not as yet, been named.

The Membership Chairman for the year, Dave Minshall, has an-

(Continued on page 36)

MEET JOAN

SUBJECT:
: Joan Beechen

ORIGIN:
: Cedar Rapids, Iowa

DESCRIPTION:
: Class—Freshman
: College—B.A.
: Age—18
: Dimensions—Curvilinear

PROCEDURE:
: AL 5-9621

OBJECTIVES:
: Men (Engineers?)
: Swimming
: Reading

nounced that the total membership for the year has hit a record breaking high of over 250 members. This, in itself, is a credit to the excellent work that Dave has done for the society this year.

The Executive Council of the society for the current year was as follows:

President—Bob Olson
Vice-President—Sally Trieloff
Recording Secretary—Fred Lowe
Corresponding Secretary—Lalit Sarin
Treasurer—Dick Dahnke
Polygon Representative—Bill Fagerstrom
Polygon Representative—Dave Gantenbein
Membership Chairman—Dave Minshall
Faculty Advisor—Prof. D. F. Livermore

ALPHA CHI SIGMA

Alpha Chi Sigma, a professional fraternity for chemists and chemical engineers recently initiated nine new members including three engineers: Paul Cehauvich, John Stuoffacher, and Sam Louiello.

The AXE softball team won its first game this year 12–0 behind the one-hit pitching of Gary Blue. They're hoping to have as successful a season as last year when they went all the way to the finals before being nosed out by the Betas for the fraternity championship.

Highlights of the AXE spring social calendar were a pledge party April 19, a formal at the Cuba Club April 25, and a May 9 picnic at Devils Lake.

AXE engineers who will be initiated into honorary fraternities this spring are:

Pi Lambda Upsilon: Ron Smith, Lee Raymond, Bernie Jepson, Gerald Tice and Doug Olson.

Tau Beta Pi: Gerald Tice, Ron Smith and Lee Raymond.

WISCONSIN MEN CITED

Seven men widely known in engineering and industry, three of them natives of Wisconsin and five of them graduates of the University of Wisconsin, were cited for outstanding accomplishments in their fields at the 11th annual Wisconsin Engineers' Day celebration on the UW campus May 1.

The seven leaders were recommended for distinguished service citations by the UW College of Engineering faculty and Pres. Conrad Elvehjem, and the recommendations were approved by the University's Board of Regents.

They are:

Erwin C. Brenner, vice-president of the Milwaukee Gas Light Co.;
Theron A. Brown, president of the Madison Gas and Electric Co.;
Ralph E. Davis, president of Ralph E. Davis Associates, Houston, Tex., consulting petroleum engineers and geologists;
Walther C. Fischer, manager of engineering of Fairbanks-Morse and Co., Beloit;
Hugh L. Rusch, vice president of Opinion Research Corp., Princeton, N. J.;
Martin W. Torkelson, executive officer of the Wisconsin State Planning Board, Madison; and
Charles S. Whitney, consulting engineer of New York and Milwaukee.

The citations will be presented at the Engineer's Day dinner in Great Hall of Wisconsin's Memorial Union at 6:30 p.m. Friday, May 1. More than 400 engineers and industrialists from all parts of the state and nation attended.

MOTOR COMPANY ADVANCES KLATT

Mr. Wesley Klatt, Waukesha, has been named Manager of Engineering Records at the Waukesha Motor Company. In his new position, Mr. Klatt will direct the operations of the Specification Department, the preparation and release of new parts and components directives, standardization and interchangeability records, power curve data, and engineering specifications and records in general.

Harvey Klatt

After his graduation with a Mechanical Engineering degree from the University of Wisconsin, Mr. Klatt joined the Waukesha Motor Company Engineering Department in 1929. In 1950, he was named Installation Engineer. He has a background of wide experience with internal combustion engines, having been intimately associated with their design and development in connection with his duties at the Motor Company and his activities on technical committees of the Society of Automotive Engineers. Recently, he was honored by the SAE with a Certificate of Appreciation of the Technical Board for his work in the development of standards used in the automotive industry.

RECLAMATION BUREAU NEEDS ENGINEERS

Engineers who are interested in beginning a career in the development of water resources in the West are being sought for employment with the Bureau of Reclamation, the U. S. Civil Service Commission has announced. The Bureau of Reclamation, which plans, designs, and builds engineering works to supply irrigation water to farms in the 17 western-most states, offers young engineers an opportunity to take part in some of the greatest engineering works in the world. Many huge irrigation projects have been authorized by Congress and are now underway.

The jobs to be filled pay starting salaries of \$4,490, \$5,430, and \$6,285 a year. Practically every type of civil engineering, as well as most types of electrical and mechanical engineering is encountered in the Bureau's design and construction work.

Civil service announcements and application forms are available from many post offices throughout the country or from the United States Civil Service Commission, Washington 25, D. C.

For further information write: The Bureau of Reclamation, Denver Federal Center, Denver, Colorado.

Engineering Institutes

Purpose—Engineering Institutes are meetings of two to five days presenting current information to technical personnel from industry.

Most of the programs deal with industrial operations, and the speakers are recognized authorities in their fields. Material is presented by informal talks, panel discussions, films, slides, and demonstrations.

The institutes are held on the Madison campus in the Wisconsin Center located on the N.W. corner of Langdon and Lake Streets.

Coming Institutes

Specification Writing, May 14–15—A clearer understanding of what a specification consists of, how it is developed, and what the specification writer should know is the objective of this institute.

Wood Utility Poles, May 18–22—The determination of whether a wood pole in service may safely remain as is, must be replaced, or may be relied on for additional years of service after special treatment, affects many thousands of dollars for every power or communication utility. Ways of combating this waste will be discussed.

Legal Problems in Engineering Practice, May 19–20—The intent of this two-day meeting is to explain some of the legal implications concerning engineering practice, so that the engineer will recognize them and know when to consult an attorney for advice and action.

Engineering Organization, May 21–22 — Effective communications will be the highlight of this institute for chief or administrative engineers. Other important topics to be discussed are: selection and training of engineering personnel, efficient organization structures of engineering departments, scheduling of work for smooth flow through the department, and cost control of engineering projects. Selected speakers from industry, consulting firms, and universities will staff this important institute.

New Opportunities With Plastics, May 26–27—Improved technology lends new economy to plastics on cutting processing costs and speeding production. Authoritative speakers at this Ninth Plastics Institute will emphasize these considerations as they discuss new plastics materials.

Consulting Engineers, Problems and Practices, June 4–5—Most consulting engineers find an ever increasing need for more knowledge of the nontechnical aspects of their business. Even the best managed firms recognize the need for improvements which can increase profits. This institute will offer presentations by authoritative speakers on subjects such as: fees and costs, promotion and advertising, cost accounting, financial statement analysis, and quality of engineering versus cost.

STUDENT WINS AWARD

Curtiss Druckery, M.E. student, is the recipient of the $700 American Society of Tool Engineers' award. Ten such awards are given throughout the country each year by A.S.T.E. The award is given on the basis of scholarship, need, and outside activities.

Meet the President

Harvey C. Sargent, President
Lake Superior Chapter

Harvey C. Sargent, President of the Lake Superior Chapter of W.S.P.E was born on December 25, 1905, in Oshkosh, Wisconsin. He attended grade schools in Oshkosh and Green Bay, where he graduated from High School in 1924. He was employed as an electric meter tester by the Wisconsin Public Service Corporation of Green Bay until 1927 when he decided on an engineering career and entered the University of Wisconsin Engineering School. While in attendance at the University he was employed on a part-time basis as a student assistant in the University of Wisconsin Standards Laboratory.

After graduating from the University of Wisconsin with a B.S. in Electrical Engineering, in 1931, he entered the employment of the Superior Water, Light and Power Company of Superior, Wisconsin, as Electric Meter Foreman until 1940 when he was advanced to Electrical Superintendent. In 1945, he was made Engineer and Electrical Superintendent until 1952 when he was advanced to General Superintendent, in charge of Water, Gas and Electric Departments of that Company.

Mr. Sargent is a member of the American Institute of Electrical Engineers and is a past chairman of the Arrowhead Section of Duluth, Minnesota. He is also a member of the Duluth Engineers Club, the North Central Electric Association, the Northwest Gas Association, and is a Registered Professional Engineer in Minnesota, as well as in Wisconsin. Mr. Sargent is a charter member of the Lake Superior Chapter of W.S.P.E. He served as Vice President during 1957–58 and was elected President for 1958–59.

Mr. Sargent is a Past Exalted Ruler of the Superior Elks Lodge, Past President of the Superior Kiwanis Club, Past President of the Douglas County T.B. and Health Association, served on the Board of Directors of Superior and Douglas County Association for the Disabled, and is presently a Director of the Superior Association of Commerce.

Married to Gertrude Leyda on June 24, 1932, both he and his wife enjoy fishing and hunting and they take particular pleasure in river canoe trips in Northern Wisconsin and they spend much of their free time at their summer cottage near Gordon, Wisconsin.

Wisconsin Society of Professional Engineers

by Darell Meyer ee'61

ENGINEERS SEE SELVES IN A MIRROR

What kind of a man is an engineer?

Members of the Harnischfeger Corp. Engineers' club asked that question in a period of self-examination, and in some cases, self-criticism.

They submitted to analysis of a college professor, an engineer in training, a representative of management and a professional engineer.

Their thoughts and expressions created a composite of an "ideal engineer"—one that many of them indicated they wanted to be, and were not.

He's Like Others

E. C. Koerper, of Koerper Engineering Associates, summed up that a successful engineer is just about like any other professional man who gets ahead.

The group agreed that he is creative, hard working, has a pleasing personality, strives for self-improvement, participates to some extent in community affairs, has a native intelligence and curiosity and is interested in benefitting mankind.

The panel members outlined some weaknesses of the profession. The panel consisted of Richard Falk, secretary and assistant to the president of the Falk Corp.; Dr. A. Bernard Drought, dean of the college of engineering, Marquette university; Gordon F. Leitner, vice-president of the special products division, Cleaver-Brooks Co., and Noel Biesnik, an engineer in training at Allis-Chalmers Manufacturing Co.

For More Experience

Drought: There should be increased co-operation between the engineering schools and industry in programs to give engineering students practical experience. Engineering students often leave college "well heeled in the scientific approach," but knowing little about the "practical business of engineering."

Leitner: The engineer has no obligation to improve his professional standing by continuing his schooling, attending technical meetings and seeking a registered status.

Falk: Management has a great deal of responsibility for stimulating engineers to their best efforts. Supervisors should create an atmosphere of looking for new ideas; the "bright ones" will then come forward.

Biesik: Engineering schools offer a good basic background in basic technical subjects, but there is more need for study of the social sciences. Indusry should provide more financial assistance to engineering students and more summer jobs.

Some Leave Field

Of particular interest to the engineers was the evaluation of their status by a representative of management. One asked Falk whether training for engineering, as contrasted with education in business, was an asset in an employe's chances to become an executive.

Falk said that engineering training would be an asset. But he warned that engineering students shouldn't stress professional subjects to the exclusion of all others, because they might not retain engineering as their final professional field. He said he had known engineers who had shifted to law or sales after beginning an engineering career.

"Every day," Falk said, "more and more engineers are being used in a sales capacity. More and more, they are being sent into the field to see the customer at work.

"There is no better way to salve a customer than to walk in on him with an engineer who can solve many, many problems. He becomes a part of a sales-engineering team."

Drought, described an engineer as a "citizen of the United States, a child of God and an engineer." He said an engineering degree was "not a whole answer."

(Continued on next page)

W.S.P.E.

(Continued from page 39)

"He must be a hard worker," Drought said. "A man who works 40 hours a week, then is through, won't get very far in engineering."

A member of the audience responded: "Without company recognition of professional status, an engineer will not put in more than 40 hours."

To which a supervisor replied: "The recognition an engineer gets depends entirely on what he produces."—From THE MILWAUKEE JOURNAL.

CAREER OPPORTUNITIES FOR ENGINEERS WITH THE BUREAU OF RECLAMATION

Yearly Salaries: GS-5 $4490, GS-7 $5430, GS-9 $6285.

Apply to: Executive Secretary, Central Board of U.S. Civil Service Examiners, Bureau of Reclamation, Denver Federal Center, Denver, Colorado.

EXCERPTS FROM WSPE BOARD MEETING
March 14, 1959

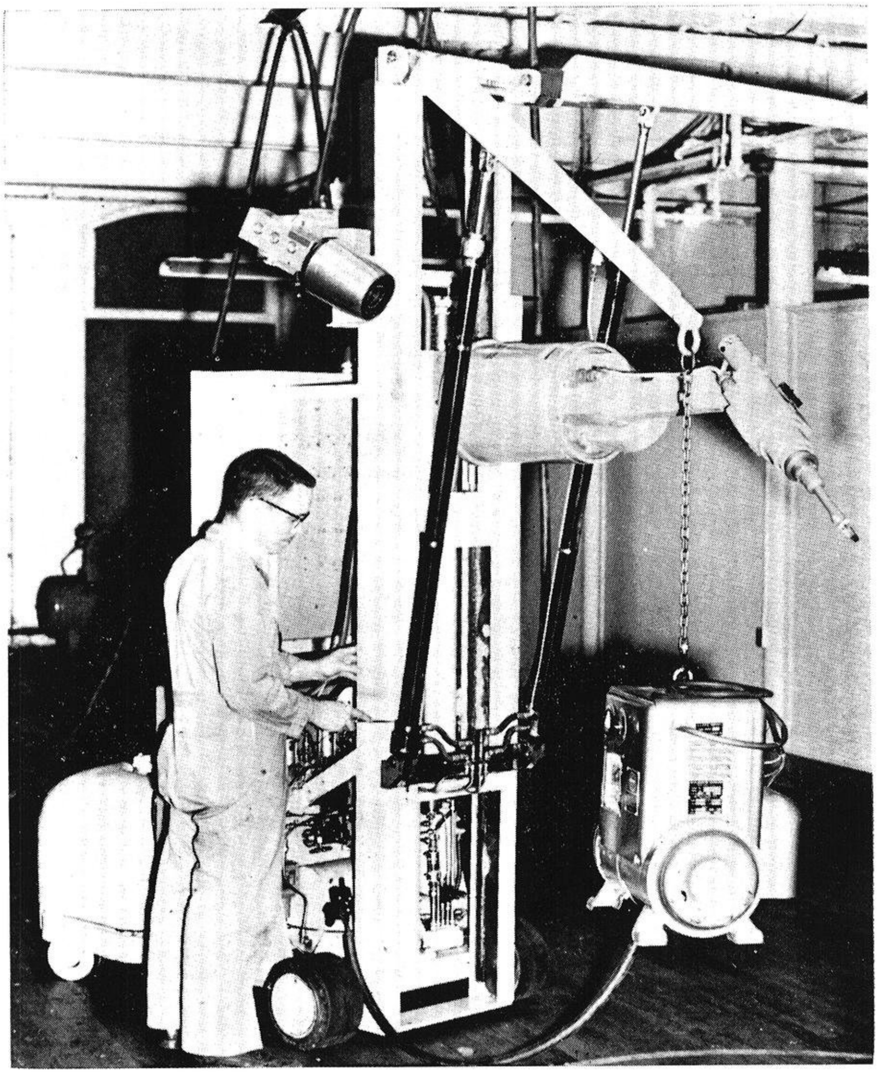
Books of P. E. Examinations questions can be ordered from: William Glendinning, 5123 Bell Blv., Bayside 64, New York. There is a charge for these books. The Army Corps of Engineers has a P. E. Examination Correspondence Course available to Reservists.

WSPE has been invited to hold its 1960 Annual Meeting in Green Bay and in Madison by the Chamber of Commerce of each city. The site of the 1960 Annual Meeting will be open for discussion at the 1959 Annual Meeting. The Board will make the final decision.

The Waukesha Chapter plans to increase next year's special engineering section published by the Waukesha Daily Freeman to 64 pages. This year's commemoration of National Engineers' Week contained 32 pages and is being mailed throughout the country.

S.E. Chapter Officers for '59–60 are:

President—Vitas T. Thomas
Vice-President—Anthony W. DeBlaise
Secretary-Treasurer—Norval C. Johnson
Director—A. Allan Jankus
Director—James H. Larsen
Past President—Benjamin C. Seal



An engineer of The Babcock & Wilcox Company's Atomic Energy division is shown making a minor adjustment on the largest of a six-man robot "team" being developed to do maintenance and repair work in radioactive areas. The three-armed, three-ton mechanical monster stands eight feet tall, and can thread pipe and lift heavy loads. At upper left is a television camera which will provide the robot's human master with a clear view of the task it will perform. When completed the robot team will include a pipe cutter, a pipe welder, a tow truck, and a 50-ton capacity crane, in addition to the unit shown here, all ultrasonically controlled from a shielded "master brain" control console.

Science Highlights

REDS CLAIM NEW TRICK

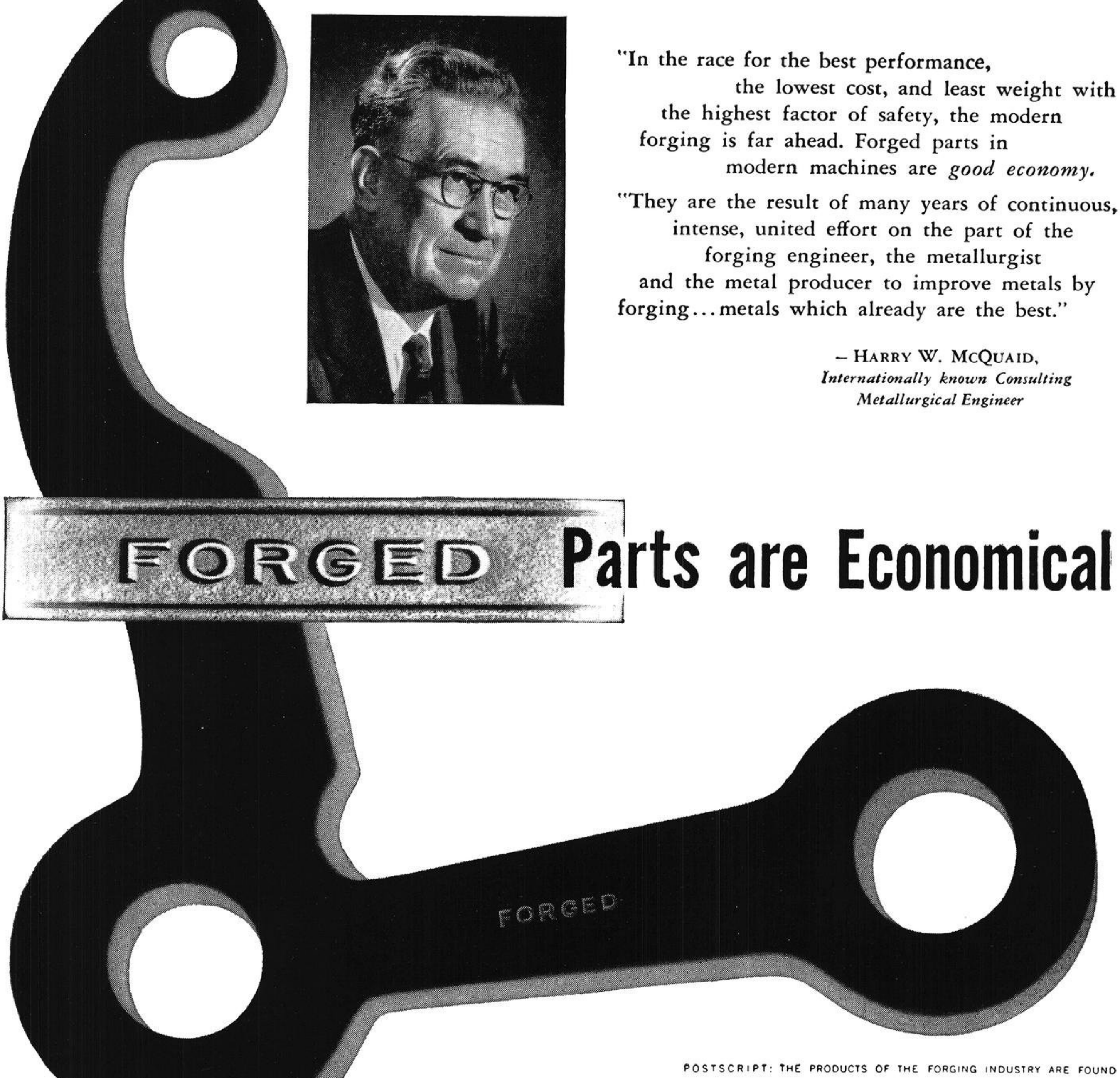
A new Russian claim may get the award as the neatest trick of the year. Without giving any details, USSR scientists have boasted of a process by which electricity and cement can be produced simultaneously by burning shale in power plants.

GERMANS DISCOVERED GREMLINS

Gremlins are not new. Early German prospectors met them first, when they discovered nickel. Since the nickel looked so much like copper when it was in ore form, miners believed it actually was copper. When it didn't react like copper in smelting, it was reasoned that a gremlin or "Nicholas," trapped inside, was being deliberately mischievous.

'BIG BROTHERS' HELP

A U. S. contractor has two elephants on his payroll and claims the "big brothers" outmaneuver tractors in the jungle, handle big logs easily, require little maintenance; and, they work for "peanuts." The elephants are clearing a path through jungle ahead of 300 miles of highway under construction near Bangkok, Thailand.



"In the race for the best performance, the lowest cost, and least weight with the highest factor of safety, the modern forging is far ahead. Forged parts in modern machines are *good economy.*

"They are the result of many years of continuous, intense, united effort on the part of the forging engineer, the metallurgist and the metal producer to improve metals by forging... metals which already are the best."

– HARRY W. MCQUAID,
Internationally known Consulting Metallurgical Engineer

FORGED Parts are Economical

POSTSCRIPT: THE PRODUCTS OF THE FORGING INDUSTRY ARE FOUND AT VITAL POINTS OF MODERN CONVEYANCES AND MACHINES... LEVERS, STRUTS, CRANKSHAFTS, GEARS. THE FORGING PROCESS IS UNLIKE ANY OTHER. *FORGED* PARTS START WITH REFINED METALS—METALS ALREADY TRIED AND PROVED. THESE METALS ARE GIVEN ALMOST ANY DESIRED FORM OR SHAPE BETWEEN IMPRESSION DIES, UNDER ENORMOUS PRESSURE OR BY CONSECUTIVE BLOWS FROM POWERFUL HAMMERS. THE RESULT IS ADDED STRENGTH AND TOUGHNESS... WHICH PERMITS, WEIGHT-SAVING DESIGNS, CUTS SERVICE COSTS, HELPS PROVIDE SAFETY IN A HIGH-SPEED WORLD.

DROP FORGING ASSOCIATION 55 Public Square • Cleveland 13, Ohio

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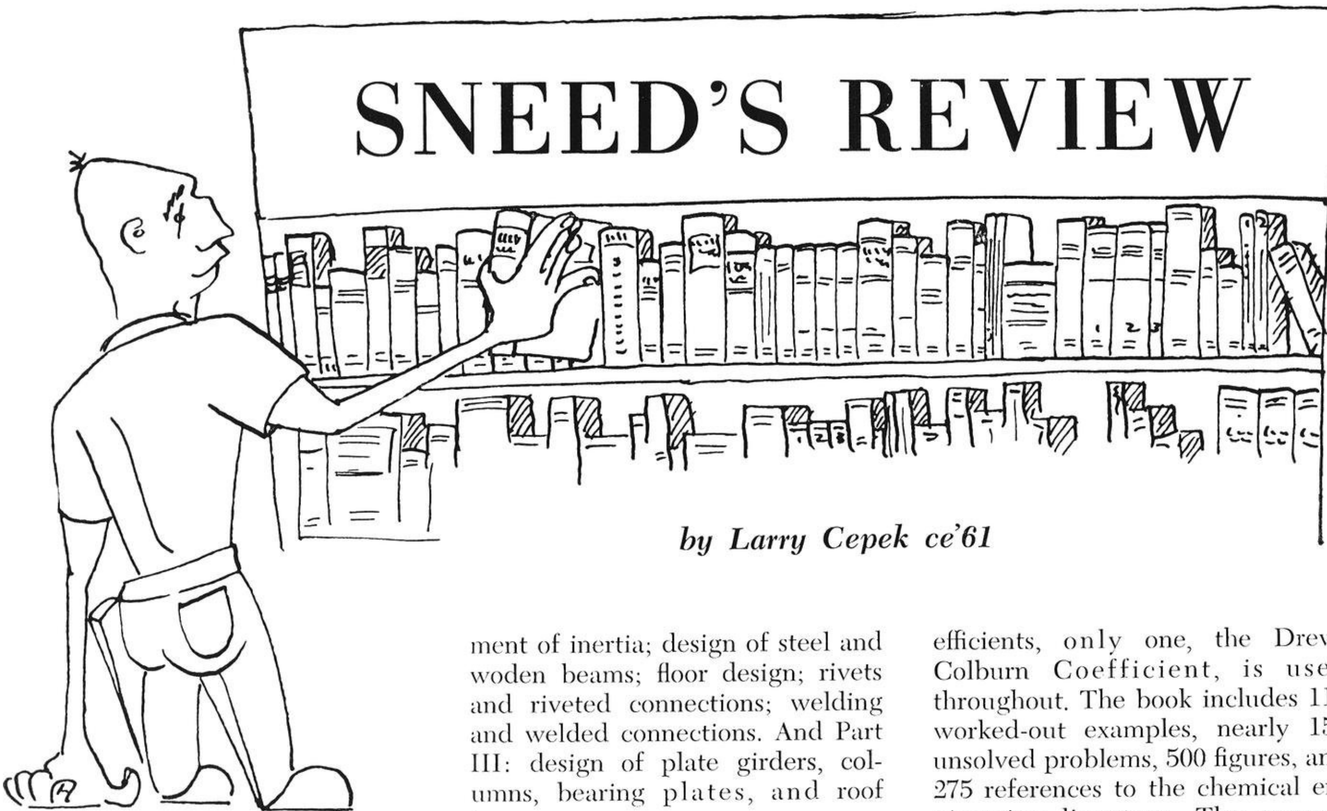
SNEED'S REVIEW



by Larry Cepek ce'61

NEW ENGINEERING HANDBOOK AVAILABLE

636 pages, $5.00

"Simplified Problems in Strength of Materials and Structural Design," by Ephraim Viertels, is an all-problem reference work prepared for the structural engineering field. For use either as a reference work or a refresher, this brand new book is a must for all in the structural field, whether a graduate engineer or an engineering student.

The book is in three parts and has twenty-two subject headings. Questions on each subject are presented, then problems on that subject stated and solved in step-by-step fashion. All questions and problems arranged on a theoretical and practical basis, and answers are provided for each problem solved. There is a total of 735 problems.

Part I covers: simple stresses, graphic statics; center of gravity; reactions of beams, girders, roof trusses, and arches; shear and shear diagrams; bending moment and moment digrams; influence lines; and torsion. Part II includes: elements of theory of bending; moment of inertia; design of steel and woden beams; floor design; rivets and riveted connections; welding and welded connections. And Part III: design of plate girders, columns, bearing plates, and roof trusses.

Because it provides for the easy and simple solution of everyday problems which may arise in structural engineering, the book will be a valuable aid to working engineers. Students, architects, and engineers will find it particularly helpful in preparing for their State license examinations.

UNIT OPERATIONS OF CHEMICAL ENGINEERING

By Warren L. McCabe and Julian C. Smith
945 pages, $10.50

The McGraw-Hill Book Company announces the publication of *Unit Operations of Chemical Engineering* by Warren L. McCabe, Administrative Dean, Polytechnic Institute of Brooklyn, and Julian C. Smith, Professor of Chemical Engineering, Cornell University.

Written at an undergraduate level, this volume covers the unit operations of chemical engineering from both a practical and a theoretical standpoint. Each unit operation is treated separately. General discussions are also included covering fluid mechanics, flow of heat, and mass transfers, each giving scientific and theoretical foundations for several operations. In place of a multiplicity of mass transfer coefficients, only one, the Drew-Colburn Coefficient, is used throughout. The book includes 113 worked-out examples, nearly 150 unsolved problems, 500 figures, and 275 references to the chemical engineering literature. The nomenclature throughout is unified, and tables of symbols are given at the end of each chapter.

The approach to the basic operation of fluid flow differs from conventional chemical engineering treatments. This subject has been renamed "Fluid Mechanics" and represents a new arrangement of old subject matter plus much new material. Specifically, the boundary layer concept is introduced early and used throughout the chapter as a basic idea tying together fluid flow through pipes and fluid flow around single solids, through orifices, past sudden contractions and enlargements, and through beds of solids. In this general picture, boundary layer separation, wake formation, and form drag are integrated.

The treatments of important measuring instruments, such as orifice meters and rotameters, are modern and complete.

Mass transfer is dealt with in a simplified fashion.

The theory of diffusion is basic and up to date. It is based on the relative velocity method, and the problem of direction of diffusion and number of diffusing components is handled in a simplified and general manner.

HI-FI GUIDE

By Don Hoefler
$2.00 144 pages

As opposed to people who play records on their high fidelity sets as background music to discuss the merits or imperfections of their equipment, there are those hi-fi "experts" who dedicate themselves to the installation of equipment upon which they play blank phonograph records, in order that they may sit back and bask in the fact that the apparatus itself makes no noise. For those of us who fall, or listen, rather between these two extremes, Hi-Fi GUIDE, a new book just announced by the Arco Publishing Company, is just right, because it tells us simply how to install and maintain the best equipment necessary for the enjoyment of music.

Don Hoefler, in clear, everyday language, easily understood by the average Hi-Fi fan, deals with every phase of this fascinating hobby. Eliminating the mysteries which surround this field, Mr. Hoefler, with the elaboration of 300 illustrations, explains the early beginnings of sound reproduction to the latest developments in stereophonic sound, telling in detail the intricacies of compensators, preamps, cross-over networks, AM and FM tuners, tape recorders, speakers, enclosures and amplifiers, to mention a few of the topics he touches upon.

Available from the Arco Publishing Company, 480 Lexington Avenue, New York 17, N. Y., this Hi-Fi Guide is priced at $2.00 and if you are a "do-it-yourselfer," Mr. Hoefler explains how to assemble components economically from kits, so that this 144 page book may save you a great deal of expense both in installation and maintenance.

Closely associated with the sound reproduction field since the early nineteen-thirties, both as an audio engineer and writer, Mr. Hoefler's is a voice of authority. Whether you are a hi-fi initiate or a full fledged "bug," this book will aid you in choosing the correct equipment, enable you to make your own repairs and help you to get the most out of your "sound" investment.

FLUID METERS—THEIR THEORY AND APPLICATION—FIFTH EDITION

ASME Publication. $8.00

The Fifth Edition includes information on a number of new types of fluid meters and metering procedures that have been developed in recent years. It is divided into three sections with the first giving the classification and nomenclature of fluid meters, together with definitions of special terms and other general information. The theory of fluid measurement and the steps taken to develop practical working equations from the theoretical relations are set forth in the second section. Figures and tables for use in solving practical fluid measurement problems, along with examples illustrating their proper use are contained in the third section.

The arrangement of this Edition is similar to that of the Fourth. Also, the method of presenting the material is the same wtih two exceptions: First, to conform with the universal teaching practice of engineering schools in the United States, the gravitational system of units has been used in the development of equations and the presentation of physical data. Second, the coefficients of differential head meters are presented on the basis of the pipe Reynolds number in the belief that this is of greater convenience to the user.

1957 REPORT ON OIL AND GAS ENGINE POWER COST

ASME Publication. $3.00

This 28th Annual Report contains data for 1956 and previous years. It has been prepared by practical diesel men of long experience from information supplied by 104 oil and gas engine generating plants, the total net output from which amounted to 1,028,689,887 kw-hr. For each plant the Report gives details on costs of fuel and lubrication, attendance and supervision, maintenance and repair; facts on type of engine, kind of fuel, installed capacity, type of load, with information on major repairs and the number and duration of enforced shut-downs; the costs by years for the plants reporting for two or more successive years; the fuel oil economies of the three types of engines shown graphically.

SPORTS CARS OF THE WORLD

By Robert Halmi
$2.75 128 pages

Clear and concise, yet filled with invaluable information, Robert Halmi's new handbook *Sports Cars of the World*, fills the long-felt need for a handy, reliable summary of sports car types and characteristics. It thoroughly covers all true sports cars currently in production here and abroad, with special attention to the most recent models.

On the other hand, no space is wasted on shelved or "unavailable" styles, nor on cars which purport to be "sports" vehicles but which in fact lack the high performance to justify such a claim. *Sports Cars of the World*, then, is truly an up-to-the-minute encyclopedia of elite sporting automobiles. As such, it is essential to every enthusiast.

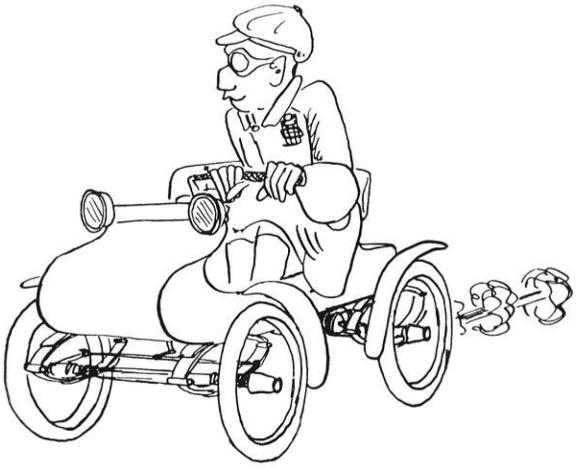
The text gives today's prices, as well as the addresses of distributors and manufacturers. It presents the latest photographs of models now available. It lists the specifications of each car, along with complete performance data, in a handy chart for comparison purposes. In addition, with each car listing is included a quick synopsis of pertinent data which at a glance tells dollar price, top speed, engine type, horsepower, torque, and weight-to-power ratio.

Here is everything the enthusiast wants to know about the various active sports marques.

Robert Halmi, the author of various works on photography, is also well known for his stories and photographs that frequently appear in leading magazines. He is perhaps best noted, however, for his authoritative writings on high-performance cars, and he has considerable reputation as a competition driver.

Sports Cars of the World is cloth bound and sells for $2.75. Like all the other volumes in the Modern Sports Car Series it is 5½" x 8½" in size, contains 128 pages, and is fully illustrated. Orders may be sent direct to Arco Publishing Company, 480 Lexington Avenue, New York 17, N. Y.

THE END



THE ENGINEER OF YESTERYEAR

Floyd Gelhaus ee'61

NEW FUEL FOR MOTOR TRUCKS

December, 1926

During the war, those countries having no domestic supplies of gasoline were hard-put to secure fuel for the motor transport service. This, together with the disinclination to purchase such vital necessities abroad, has led French engineers to experiment with materials from a local source. One fuel developed during this year is "Carbonite," which is composed of charcoal and a secret binder. Waste wood, bark, and other forest scrap can be used to produce the charcoal. In a recent test, a Mack truck weighing five tons and carrying a 7-ton load, made 100 miles on a consumption of 84 pounds of "Carbonite." The ordinary gasoline engine is used without alteration and draws in the charge of gas resulting from the distillation of charcoal. The producer is no larger than the average gasoline tank and requires but little attention.

COOLIDGE TUBE

December, 1926

A vacuum tube which produces as many electrons per second as a ton of radium was announced by Dr. W. D. Coolidge of the research laboratories of the General Electric Company. So concentrated are the rays from the tube that many startling experiments have been conducted with the new device. Crystals of mineral calcite apparently become red hot when exposed to the rays for a moment, but they are glowing with a cold light. Ordinary salt is turned brown and considerable time elapses before it again becomes the colorless substance it usually is. Bacteria and small flies are almost instantly killed by exposure to the rays. Ordinarily colorless acetylene gas is transformed into a yellow solid which cannot be dissolved. And, a rabbit's grey hair has been destroyed, to be replaced later by a profuse growth of longer, snow-white hair.

THE EARTH INDUCTOR COMPASS

October, 1927

Lindbergh attributed his success in keeping on his outlined course to his earth inductor compass. Regarding this instrument he wrote: "Laymen have made a great deal of the fact that I sailed without a navigator and without the ordinary stock of navigation instruments, but my real director was my earth inductor compass. I also had a magnetic compass; but it was the inductor compass which guided me so faithfully that I hit the Irish coast only three miles from the theoretic point that I might have hit if I had had a navigator. The inductor compass was so accurate that I really needed no other guide."

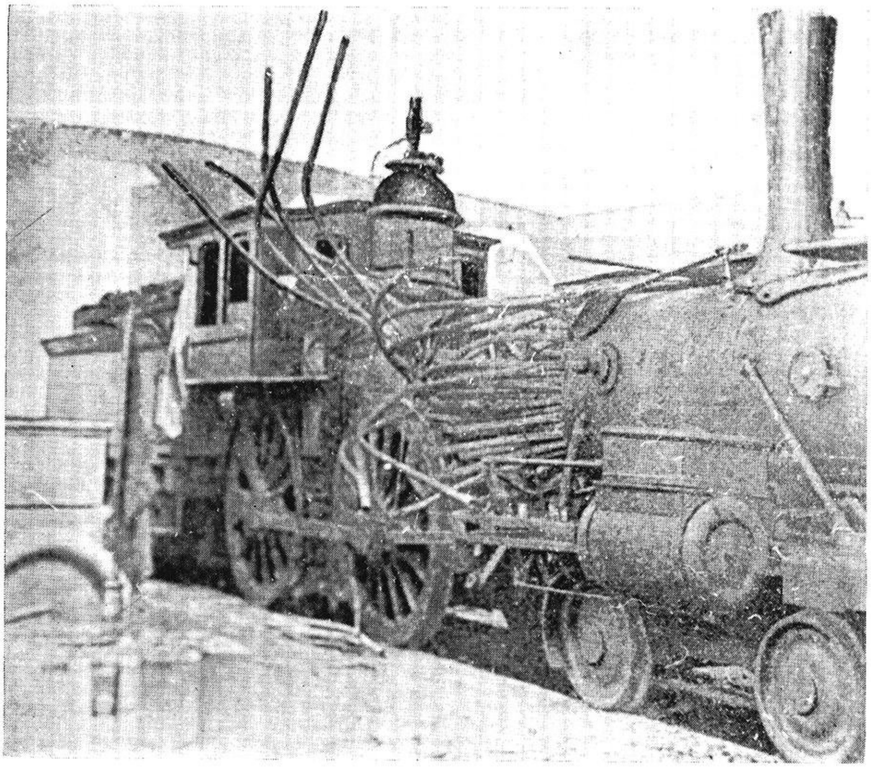
The earth inductor compass, instead of depending upon the interaction of two magnetic fields as does the magnetic compass, depends upon electromagnetic induction. In the case of the earth inductor compass, the electric conductor consists of a rectangular armature which is driven by a windmill; and the magnetic lines of force that are "cut" are those of the earth field. The emf generated by an armature depends upon the position of the brushes in relation to the magnetic field; when the brushes are in a line parallel to the magnetic lines of force the potential is zero and when they are perpendicular the potential is maximum. The compass is a sensitive galvanometer; the brushes are moved by a "controller" on the instrument board so that they can be in any desired position in relation to the plane. The course of flight is maintained by putting the brushes in position and steering so that the galvanometer reads zero.

USE OF NOBLE GASES

November, 1927

In recent years, helium, neon, and argon have been obtained economically enough to make them of commercial importance. It has been found that a beautiful red glow is produced by passing an electric discharge through a glass tube containing a small amount of neon. Hence, neon is now used in a novel type of electric sign in which the letters and designs are made from glass tubing. Helium, as is well known, is used advantageously in balloons because of its lightness and non-inflammability. Argon is used for filling electric light bulbs of high power as it is found to increase their efficiency as compared with vacuum lamps.

had caused the precipitation of metallic copper from the sulphate solution, but the identity for the precipitating agent remained to be determined. After considerable experimentation, certain bacilli were found by means of which it was proved beyond question that the copper was deposited by the action of microbes.



This locomotive exploded while standing in the Chicago & Northwestern Round House in January, 1898. Three persons were killed and several injured.

NEW BOX CAR LOADER

December, 1927

Instead of conveying the material to be loaded into the box car, a new box car loader utilizes centrifugal force to throw the material to the desired position. By the use of the new machine, which can be easily manipulated by one man, a box car can be loaded to capacity in 15 to 30 minutes. The new Sinden Loader consists of a short, high speed, motor driven belt, fed by a hopper. The carrying run of the three foot belt is depressed into a circular curve, and the hopper is so placed that the material to be loaded drops through the bottom of the hopper and meets the belt traveling downward. As the material falls on the concave side of the curve, it is forced against the fast moving belt and attains the same velocity as the belt when it is thrown of tangentially. By virtue of the clinging effect caused by the centrifugal force there is secured attractive force of several times the normal force of gravity. Thus, the material accelerates very rapidly and a very short belt is all that is required to give it sufficient velocity to project it to any part of the car. The material is projected in a steady stream or jet which forms a pile beginning at the far end of the car and working backward toward the car door.

MICROBES PRODUCE COPPER

December, 1927

Copper is ordinarily thought of as one of our most valuable metals which is found in the earth in deposits caused by some geological action of the rocks; but according to a recent report of the Department of the Interior, it now appears that metallic copper may be deposited, in relatively small quantities, through the action of bacteria. During a survey of the region near Cooke, Montana, by the Geological Survey, spongy masses of native copper were found in the black muck of a bog. About half a mile above this is an outcrop of pyritic copper ore; this weathers rapidly, and the copper is removed from it in solution as cupric sulphate. Redeposition of the copper as native metal only in the black muck and in none of the gravels and sands in the vicinity was ample proof that something in the muck

FRENCH ARMY WILL TRAVEL IN AUTOS RUN WITH CHARCOAL

January, 1928

The French army is gradually converting its automobiles into wood burning vehicles.

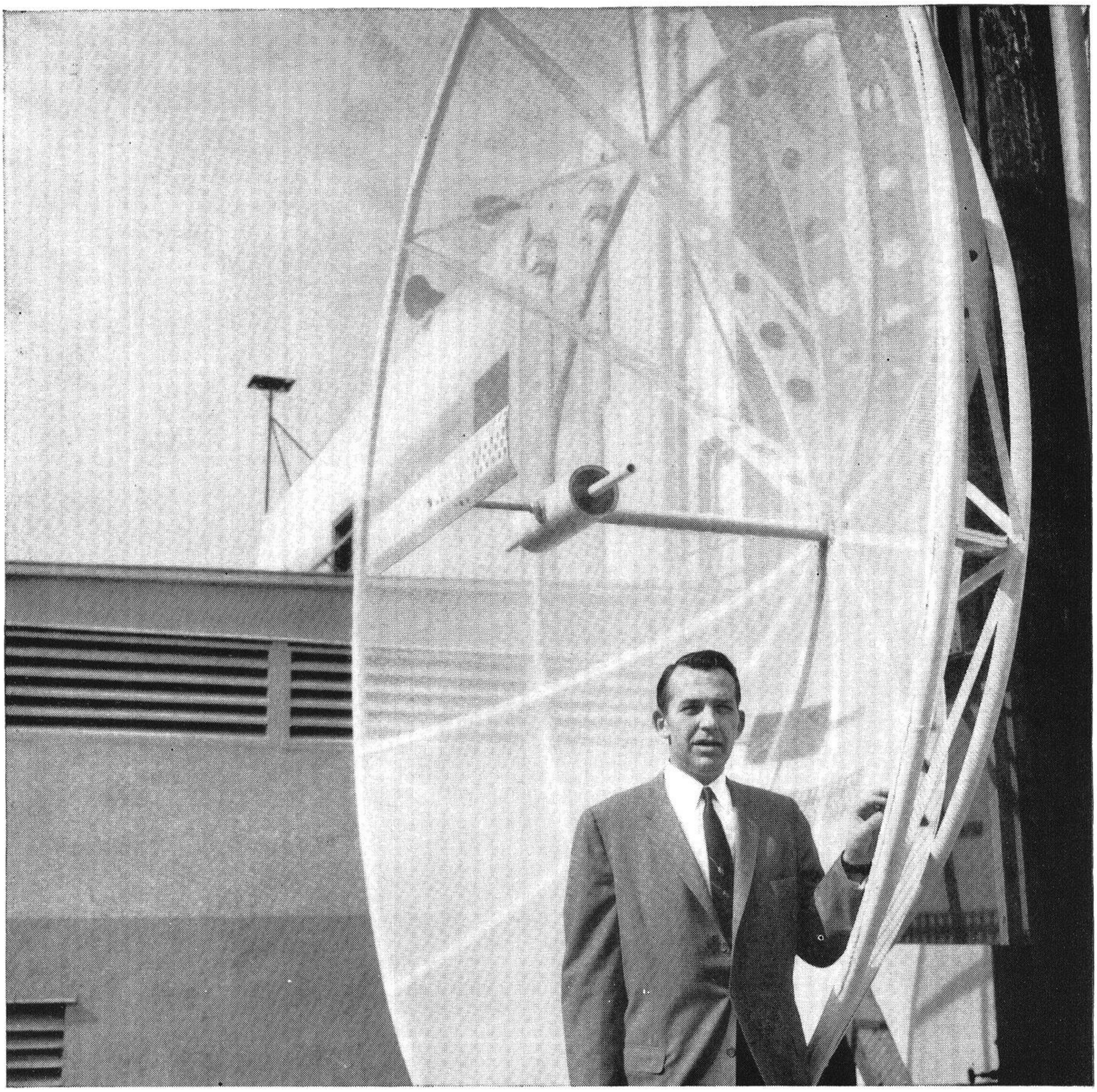
The cannon, gun tractors, ammunition carriers, and ambulances of the future French army divisions will travel on "green coal."

So far, only the large trucks have been transformed to wood burners. But the use of wood as a national fuel is being systematically developed in order that France, in case of another war, might be independent of the foreign monopolies which now control the gasoline supply of the world.

MODEL OF A FUELLESS MOTOR PROVES SUCCESSFUL

March, 1929

According to recent press reports, a small sized fuelless motor, invented by Lester J. Henderscat of Pittsburgh, Pa., has been operated successfully. The motor obtains its power from the terrestial magnetism of the rotation of the earth, thus making production of power possible over an indefinite period of time. The exact method of the conversion of energy is not known at the present time as the necessary patents have not as yet been obtained. A corporation, however, has been formed for the purpose of obtaining patents and for the further development of the motor. The motor is still in an experimental stage, but if it proves to be as successful as the tests indicate, it will completely revolutionize all modern industry. At the present time the inventor claims that a 45-horsepower motor can be manufactured at a cost of only $12.50. THE END



STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

I've been asked whether non-aeronautical engineers have good prospects for advancement in the aviation industry.

The answer is *yes, definitely!* At Douglas many of our top supervisory people have moved up from other engineering specialties. The complexity of modern aircraft and missiles requires the greatest variety of engineering skills known to industry.

For example, we now have pressing needs for mechanical, structural, electrical and electronics engineers in addition to aerodynamicists, physicists and mathematicians. Whatever your background in the engineering profession may be, there are prime opportunities in the stimulating aircraft and missiles field.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box P-600
Santa Monica, California

M. E. Curriculum

(Continued from page 16)

At present, we find emphasis on past applications not only in the laboratories at Wisconsin but in many classes as well. Where practice is emphasized there is a tendency to over-emphasize methods, memory work, and physical skills. This, in turn, leads to doing problems by rote, "plugging-into" formulas without regard for principles, and using a standard method as a solve - all - problems - of - this - type recipe.

As an example of practice in the form of skills, let us look at a heat power laboratory course. The author would be the last to say that these labs are not valuable in showing the physical application of textbook theory. On the other hand, he would be the first to say that time is wasted on methods and calculations in relation to their instructive value. A typical experiment involves taking crude measurements on obsolete machinery in order to make repetitive arithmatic calculations. The written report is then graded on technical accuracy while very little attention is given to written expression. There is a separate writing course to teach that. The student gains very little knowledge of how to actually set up and conduct a test to answer a specific question. Instrumentation is given little notice. As a whole original thinking is at a minimum.

Remembering "rules of thumb" or "using your mind as an attic" is a type of practice that is also sometimes taught in the classroom. For example, in thermodynamics, a formula is given for calculating the total head of fluid on which a pump is operating, but no reference is made to the derivation of this equation from the general energy equation. No mention is made of any hydraulic principles involved.

A machine design course offers an example of the "cookbook" method at its best. The two hour "labortory" consisted of working problems. This is accomplished by thumbing through the text until an appropriate formula is found. Some of the formulas have a suspicious complexity to them. Maybe that is because they are partially empirical. A little difficulty is encountered in finding the right order in which to apply the different recipes. Once in a while the problem has the order of the required results reversed. But as soon as the numbers are "plugged-in" an answer is bound to follow after enough slides of the "slipstick." Oh, the answers may have a number of qualifications; but these are usually ignored. Where is creative thought stimulated or judgment challenged? Certainly, these two mental faculties are necessary in a designer.

These examples, offered as constructive criticism, show how skills, knowledge and methods can become ends in themselves. Actually, they should support thought and sound judgment.

Another point is also clear. The curriculum is only a printed outline. Course content makes an effective or ineffective curriculum regardless of course names or numbers. The outline, as always, is only the beginning.

Missing Material: Content cannot be discussed without mentioning obvious omissions. These are most pronounced in the nontechnical portion of the curriculum. Arguments vindicating the humanities are offered in almost every current source of literature dealing with engineering education. It is not necessary to include more in defense of nontechnical material. Two specific steps should be taken as a beginning of a definite program.

First, there should be at least twelve credits of "free" electives in the curriculum which are restricted to courses outside the College of Engineering. These courses should fall mainly in the junior and senior years where the student's thinking is likely to be more mature than in earlier years. Because of the present prejudices toward nontechnical courses, it is felt that the rule about schools is necessary. Here would be a start toward graduating the educated man previously mentioned.

The second measure concerns nontechnical survey course content. At present some of the survey courses, such as the first psychology course, are not designed for students who will never take another course in that field. The courses are designed for majors in the field who take many advanced courses and need all the basic definitions and more uninteresting material as a basis. Why not have different survey courses for nonmajors such as engineers, pharmacists, and commerce students? Agreement with this suggestion does not mean the course standards should be lowered or any subject perverted. Such courses could touch on more advanced topics with the purpose of leaving the student with a layman's knowledge of the subject. A step such as this would require the close cooperation of all the schools involved. More interest and understanding between schools and between students could result.

Precious Time

When maintaining a four year course with its obvious economic and social advantages, time becomes precious indeed. Raising academic standards and dropping so-called deadwood are two ways to put the available time to better use.

Raising Standards: This refers to cutting down on material that could and should be taught in high school so that college level work is not delayed. The college of Engineering has already done this with the mathematics courses. Some other areas where the administration could adapt this procedure of raising entrance requirements include English and the physics. These are not engineering courses, but why shouldn't the College of Engineering be a leader in asking for higher standards.

For example, the practice of spending a large amount of time on grammar, spelling, and simple theme writing in the freshman English course is hard to defend. It is even more unfortunate that junior engineering students spend a large amount of time on these same subject in their technical writing course. These basic skills are certainly not college-level work. Freshmen English should involve methods of argument, explanation, and description and should emphasize the content of themes. The present technical writing course could be combined with laboratory report courses. Fewer, more instructive reports could be required, and the work could be graded from the

(Continued on next page)

standpoint of expression as well as accuracy.

Time spent in physics might also be put to better use than a more detailed repetition of high school material. If the traditional topics such as heat, light, and sound were covered well in high school, college physics could introduce the student to modern concepts such as solid state physics and nuclear physics.

Dropping Deadwood: This second suggestion for saving time means that courses which emphasize very special skills must be examined very carefully in view of their total educational value. Often class hours spent on such courses are greatly out of proportion to the future usefulness of what was learned.

Four required engineering laboratories contain examples of what can be class as "deadwood." They are the machine shop, the foundry, the metallurgy lab, and the welding lab. Large amounts of time are spent in metal casting, specimen polishing, metal machining, mold making, and welding. The important question to answer is: How can a product be made and what material should be used? An unimportant question is: Can I make the product myself? Yet this second question seems to receive a great amount of attention. Much of the shop time could be used for more demonstrations and explanations so that the first question is answered.

Second semester freshman chemistry is another example of "deadwood." Seven hours a week are devoted to qualitative analysis. Some attention to physical chemistry would be of more value to an engineering student.

RECOMMENDATIONS FOR SPECIFIC CURRICULUM CHANGES

Suggested Curriculum

At the end of this article a revised curriculum is to be found. Courses names and the number of credits are indicated to give an idea of proportion. The following comments are given in explanation of the revision:

1. Math courses are the same as those which have been planned for 1959. A definite effort should be made to refer to physical applications throughout the sequence.

2. Physics has been moved to the freshman year with the idea that it is more important for ME's than chemistry. Content should include some modern physics as mention previously.

3. Chemistry during the sophomore year should contain some physical chemistry rather than so much qualitative analysis.

4. The two freshman drawing courses are essentially the same as Drawing 12 and 23. More emphasis should be placed on sketching and spatial visualization.

5. Speech has been cut to a two credit course with the feeling that this is sufficient.

6. English composition should concentrate on content rather than mechanics as indicated. Knowledge of grammar spelling, and the simple theme should be an entrance requirement.

7. Statics and Dynamics are essentially the same as Mechanics 1 and 2. Some thought should be given to the idea of using simple vector notation in these two courses.

8. Strength of Materials has been increased from a four to a five credit course and combined with the materials laboratory (Mechanics 53).

9. Metals and Metal Casting replaces M. & M. E. 8 and 33. Much less shop time is involved and both microscopic and macroscopic properties of metals are studied. Foundry might better be included with Production Processes, but physical facilities make this less practical. This metals course is also good background for the processes course.

10. Production Processes is a combination of M. E. 37 and M. E. 25. Here again, much less shop time is involved and much more emphasis is placed on answering the question: How can the product be made?

11. The economics course remains essentially the same as Economics 1A.

12. Four three credit electives (one each semester beginning with the second semester of the sophomore year) are labeled nonengineering in the hopes that this may be the beginning of the humanities program. If one of the electives was a history course, another nonengineering elective could be substituted for Contemporary Trends. This elective system is one of the most important revisions of the suggested curriculum. The engineering elective system is also important as explained in point 19.

13. Mechanism and Machine Elements covers the present M. E. 41 in somewhat less detail and also includes the part of M. E. 43 which introduces the student to machine elements. Some of the problems and construction work is eliminated with the idea of just introducing the student to machine design. It is felt that both introductory thermodynamics and machine design should be four credit courses.

Machine Stress Analysis follows with more detailed problem work in applying strength of materials and dynamics to machine design. This course would include many of the topics of M. E. 44 and some of the problems of M. E. 43. Particular methods as taught in M. E. 43 are reserved for a more advanced course.

Machine Design Lab continues the sequence with laboratory operations designed to demonstrate stress phenomena. A fewer number of reports are required and they are graded for expression and form as well as technical accuracy. More mention will be made of this system in connection with Heat Power Lab.

14. The two thermodynamics courses essentially M. E. 61 and 62. Emphasis is placed on the Thermodynamic Laws and the way in which the principles are derived from them.

Heat Power Lab demonstrates the physical application of these principles. Similar to the Machine Design Lab, this is a technical report course as well as a laboratory. Experiments also point out general tests used to obtain definite types of data. These two lab courses, Heat Power Lab and Machine Design Lab, also perform the function of M. E. 99.

15. The Electrical Engineering courses remain the same: E. E. 12, 14, 15, and an E. E. elective.

16. The course labeled Transport Phenomena is a new ME course. This subject covers the material of C. E. 71 with some at-

tention also given to mass and momentum transfer. Ch. E. 125 might serve as a model for portions of this course. Here, as in other introductory courses, frequent examples of translating physical circumstances into mathematics should be given.

17. Industrial Management is about the same as M. E. 12. A view of industrial organization is presented.

Engineering cost analysis deals mainly with the accounting of M.E. 13 taught in the form of engineering cost situations.

18. The first semester of the senior year includes both a machine design elective and a heat power elective. These courses take the place of the required courses M. E. 44 and 63. Among the machine design electives would be: Advanced Mechanics of Machinery, Advanced Kinematics of Machinery, and Advanced Dynamics of Machinery. Heat power electives would include: Advanced Thermodynamics, Heat Transfer, and Compressible Fluid Flow. These courses are not necessarily the same in content as present courses with the same names.

19. Eleven M. E. electives are included in the curriculum to give the student a change to concentrate his interests in his senior year. The restriction might be made that these courses must include at least one laboratory and must be chosen from a least two of the three divisions: Industrial Engineering, Heat Power, and Machine Design. Now the particular begins to be considered since a general foundation has been established. The present three groupings of engineering electives offer a starting point for reorganization of courses to form the suggested elective program. Such courses as Statistical Quality Control and Instrumentation should be added.

20. Human Relations and Professional Orientation remain the same.

Deciding Ingredient: Faculty

A curriculum does not stimulate or challenge thought in itself. The critical ingredient is the faculty. Our present curriculum has been a good one where the instructors have tried to induce thought on the part of the students. A new curriculum will be a better one where the teachers increase their efforts.

Revised Mechanical Engineering Curriculum (146 cr.)

Freshman Year	**credits**
English Composition	3
Calculus I	5
Physics I	5
Engr. Drawing	3
Speech	2
Mil. Sci.–Phy. Ed.	0
	18
	credits
English Composition	3
Calculus II	5
Physics II	5
Descriptive Geom.	3
Statics	3
Mil. Sci.–Phy. Ed.	0
	19
Sophomore Year	
Calculus III	5
Chemistry I	4
Dynamics	3
Metals and Metal Casting	3
Economics	4
Mil. Sci.–Phy. Ed.	0
	19
Differential Equations	3
Chemistry II	4
Strength of Materials	5
Production Processes	3
Elective (nonengr.*	3
Mil. Sci.–Phy. Ed.	0
	18
Junior Year	
Thermodynamics I	4
Transport Phenomena	4
Mechanism and Machine Elements	4
Industrial Management	3
Elective (nonengr.)	3
	18
Thermodynamics II	3
Introductory E. E.	3
Machine Stress Analysis	3
Heat Power Lab	3
Engr. Cost Analysis	3
Elective (nonengr.)	3
	18
Senior Year	
Machine Design Lab	3
E. E. Course and Lab	3
Machine Design Elective	3
Heat Power Elective	3
M. E. Elective	3
Elective (nonengr.)	3
	18
E. E. Elective	3
M. E. Electives	8
Contemporary Trends	3
Human Relations	3
Professional Orientation	1
	18

* Indicates nonengineering electives; preferably nontechnical courses in the humanities.

Bonding Rubber

(Continued from page 29)

aluminum, tin, lead, and brass. The strength in tension is approximately 500 pounds per square inch. The bond is good, flexible, withstands shock loads, resists bending, and resistant to water. It is also chemically inert. Its main use is in covering chemical equipment and storage tanks.

Rubber Hydrochlorides: Halogen acids react with rubber and form hydrohalides. Hydrohalides are used to form rubber hydrochloride cement which is used to bond metal and rubber. The cement forms a good bond and has good properties which are similar to thermoprenes except that it does not withstand shock.

Chlorinated Polymers: These cements are formed from various polymers of chlorination polymers of rubber in solution. One of the original adhesives in the field of mechanical bonds was a resin made by chlorinating natural rubber. Chlorinated polymers are adhesives which are used in bonding synthetic rubber to natural rubber. They are extensively used for bonding ferrous and non-ferrous metals to rubber.

Desmodur R: Desmodur R cement is German in origin and gives good bonding properties between metal and rubber. Best results are obtained from rough surfaces. In use, it is spread on the metal part and the rubber valcanized to it. Desmodur R gives bonding strengths of approximately 800 pounds per square inch.

Summary

The processes of metal-rubber bonding are still in a state of improvement and change. At present, there are many adhesives and cements on the market which will glue rubber to almost anything. The strengths and characteristics they give are somewhat different for each particular cement. The chemical means of bonding has not changed much since it was introduced. Brass is the metal most often used as it gives the best bond yet obtained. Generally, the base metal of the part to be bonded to the rubber is not brass. Most often brass is electro-plated to the

(Continued on page 54)

Teflon

(Continued from page 20)

cels metallic materials in almost every property, that Teflon would also wear better.

DESIGN AND PRODUCTION ASPECTS

Possibly the most important design aspect is that of design clearance. Clearance dictates how much noise an assembly will make under running conditions and how much a bearing will wear. When designing with Teflon extra clearance is necessary due to the high thermal expansion of this material.

Even with this large clearance requirement for Teflon bearing, noise is reduced and better wear is obtained because of the superior conformability of this material. Conformability is ability to reform over shaft surface irregularities.

Perhaps the biggest production aspect of a material is its machinability. Metallic bearing materials are easily machined, especially when lead has been added. Teflon can be readily machined with standard metal or wood-working tools. One handicap in the machining of Teflon is its high coefficient of thermal expansion. If a machinist does not make adequate allowances for expansion, the final product will not be dimensionally accurate.

Metallic materials are relatively cheap compared to Teflon. The low initial expense of metallic bearings makes them more popular than Teflon for most standard applications. This low initial cost, however, could be misleading, for if a bearing would fail due to temperature variation increased load, or any other reason, an additional cost would be incurred upon replacing the bearing and repairing the damage the failure had caused. Therefore, when bearing problems are inevitable, Teflon would give a cheapter overall cost because it would not fail, if designed properly. Thus, a high initial cost would result in a lower overall expense. This initial cost can run as high as ten to one for bearings of comparable dimensions.

CONCLUSIONS

Teflon has a definite advantage over standard self-lubricating bearing materials. These materials are comparable due to their similar applications. The advantages of Teflon start with control of certain parameters during manufacture. These parameters control engineering properties. Thus, a designer can design certain features into his product and expect to achieve these features during manufacture.

Teflon excels all other bearing materials in frictional properties. The coefficient of friction is very low and is constant with variation in temperature and with variation in load. This means that a designer does not have to be concerned with detrimental effects of friction due to environmental conditions.

Teflon is a chemically pure material which will react with very few substances. This makes it a safe material to be used in food, textile, paper, or drug processing.

Exceptional fatigue strength, along with good compressive and tensile strength are other properties of Teflon. It will conform to slight irregularities in shaft design, which results in redistribution of stress and quiet operation.

There are some disadvantages to be found in the application of Teflon. Extra clearance must be designed into a Teflon application due to its high thermal expansion. A machinist must take this fact into account to obtain an accurately machined product.

Another disadvantage is its cost. It is extremely expensive as compared to metallic bearing materials. Therefore the need for Teflon must be present before it is economical to apply it.

The design will indicate whether the aforementioned need exists. If it does, it is suggested that a designer contact a representative of the Du Pont Company, rather than try to apply knowledge gained entirely from catalogs and other printed matter. The representative is in the best position to supply information, because Teflon is his product.

BIBLIOGRAPHY

1. E. I. Du Pont de Nemours and Company, Inc., *"Teflon Tetrafluoroethylene Resin,"* Design and Engineering Data Catalog, 1956.
2. Amplex Division, Chrysler Corporation, *"Oilite Engineering Manual E-56,"* 1959.
3. Johnson Bronze Company, *"Johnson Automotive Bearing Manual,"* 1952.
4. E. I. Du Pont de Nemours and Company, Inc., "Engineering Facts About Teflon," 1958.

Operations Research

(Continued from page 24)

OR has not yielded such phenominal results in industry as were realized in the military during World War II mainly because the weapons or systems which were tested were new and were being used far less efficiently than the machines in modern industry. Early OR teams were able to improve efficiencies by several hundred per cent in many cases. If a present day team can realize a five to ten per cent improvement, it is considered good. Even a relatively small percent improvement can represent a savings of thousands of dollars and this has encouraged many companies to investigate the possibilities of using OR.

The large demand for personnel in this field has prompted several schools to offer courses in OR. MIT, Case Institute, John Hopkins, Cornell, and the University of Wisconsin—are among those schools offering OR courses. MIT also offers an advanced degree in OR. Case Institute recently inaugurated a four year undergraduate curriculum.

At present, OR has not developed to the point where ready-made solutions are available. Most problems require creative thinking and some original development work. These requirements have attracted some of the best minds from other sciences. After becoming familiar with OR, most men are enthusiastic,—not only about what OR is today,—but what it is certain to be in the future. All indications point towards Operations Research exerting an increasingly powerful effect on American industry.

BIBLIOGRAPHY

1. R. L. Ackoff, "Opsearch," *Chemical Engineering Progress,* Vol. 53, No. 1, pp. 4–7.
2. Dean, W. Stebbins, "Development of Operations Research," *Journal of Engineering Education,* Vol. 47, No. 10, pp. 836–840.
3. Herbert Solow, "Operations Research is in Business," *Fortune,* Feb. 1956, Vol. 53, p. 128.
4. B. Harris, A. Hauptschein, L. S. Schwartz, "Operations Research in Communications," *AIEE–Communication and Electronics,* No. 39, Nov. 1958, p. 633.
5. Page, Mortensen, "How OR aids the Refiner, *"Petroleum Refiner,* Vol. 35, No. 12, p. 126.
6. Henry Lefer, "Sperry Sharpens New Executive Tool," *Aviation Week,* Vol. 64, No. 8, pp. 49–55.

Geophysical

(Continued from page 13)

The clay was known to extend to a considerable depth, and the only formations occurring within 20 feet of the ground were the gravel and clay. Any variation in the apparent resistivity could therefore be attributed entirely to a variation in the thickness of the gravel. Since the gravel has a much higher resistivity than clay, the high-resistivity zone on the resistivity-contour map indicated the greatest thickness of gravel.

A theoretical calibration curve was constructed correlating apparent resistivity with gravel thickness, and three borings were made to check this curve, and to determine the quality of gravel. Using the calibration curve with the equal resistivity-contour map, another map was drawn showing the lines of equal gravel thickness from which an estimate was made of the quantity of gravel available. This resistivity survey was completed in one day.

2. The seismic investigation of a damsite in Pakistan illustrates the use of seismic surveys over water where exploration by normal drilling methods is usually slow and expensive. This survey was made on the site of a proposed hydroelectric project in Pakistan where the River Kabul passes through a steep-sided gorge about 300 feet wide. Bedrock consisting of metamorphosed granites and schists is exposed in the sides of the gorge, but is covered in the river with a thick deposit of sand, gravel, and boulders. Borings previously drilled in the river indicated a considerable variation in the depth to the rock. The main purpose of the seismic survey was to determine the rock profile at forty sections across the river at intervals of 75 feet along the gorge, in order to select the most favorable sites for the main dam and the coffer dams.

It was intended to make a survey by placing the seismometers on the riverbed along the lines of section across the river, and firing charges at each end of the section on the riverbanks. However, it was found that the disturbance of the seismometers by the fast flowing river was too great, and the procedure was reversed. A seismometer was placed at each end of the sections on the river banks, and charges of about three pounds of gelignite were fired at intervals of 40 feet along the section of the riverbed. The velocity in the overburden was determined by direct measurement along the bank, and the velocity in the rock was determined in outcrops on the side of the gorge. These velocity measurements were used to interpret the time/distance graphs by drawing the wave ray paths. Profiles of the bedrock were then drawn along the sections.

The total length of all sections investigated across the river was 13,000 feet, and the error in depth checked by 20 drill holes was less than six per cent. Each section took one day to complete and the whole survey was made during the time it took one drill to complete four holes in the river.

3. In 1949, with the aid of the Water Board of the City of Detroit, a demonstration was held in order to point out the practical use of seismic investigation in foundation work. A profile 610 feet long was run to a depth of 145 feet. The location of the survey was chosen by an engineer of the Water Board the morning of the demonstration and was along a route previously test-drilled. The logs and their location were withheld until after the survey.

In the short span of two hours, seismic techniques were able to determine that at the south end of the profile the depth to bedrock was 142 feet. An eight foot layer of weathered material rested on top of the clay, and an eight foot stratum of low velocity material (sand) came in under the south end. This stratum was interpreted to be 26 feet below the surface and pinched out about 200 feet from the south end.

The remainder of the cover consisted of clays with a velocity of about 6200 feet per second. At the north end of the profile at point A the depth to bedrock was 123 feet. The weathered layer at this end of the profile was about 18 feet thick, gradually thinning to the south.

Upon completion of the survey, and after the results had been tabulated in the field, the Water Board engineer revealed the location of the test holes and their logs. The rapid seismic survey proved to have less than three per cent error when compared with the logs.

4. The seismic survey of a proposed site for the Connecticut Turnpike shows how this method can be used to profile the bedrock on a proposed site for a highway, and how seismic methods can save time and money. The problem was to determine the quantities of rock to be excavated on the Greenwich-Killingsley section of the turnpike. This section consisted of 5.2 miles of two-lane construction, with provision for the addition of two future lanes.

The location was all new with small exceptions. Terrain was rough and mostly wooded, with many large outcroppings. Soils were boulder-strewn glacial till and bedrock was a schist and gneiss formation.

A geophysical surveying company was called in to make the survey on a contract with the construction firm and the state. Their seismic work was done in 13 days, and the drill-holes used as checks were completed in twenty days. The final report was completed two months after work began.

The information provided gave profiles of the bedrock elevation right and left of centerline, which permitted cross-sections to be drawn up every 50 feet. Included in the report were characteristic velocities of materials encountered in the overburden.

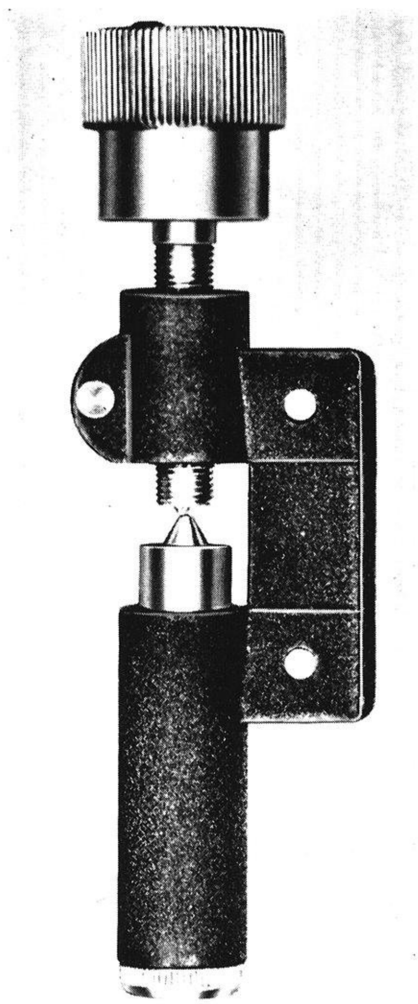
It is estimated that the seismic findings made it possible to expedite planning by two-thirds the normal time. Bedrock profiles were forwarded to the construction firm as fast as the seismic interpretation was completed in each area. Bedrock elevations were then plotted on the cross-sections. It would have taken up to three times as long to have obtained the necessary information by other means and to correlate this information to the points of reference on the sections.

While the job could have been done by borings within the sum alloted, sections would have been drawn up with much less information available. It is estimated that to obtain the same information with other methods would have cost about four times as much as the seismic survey. **THE END**

Science Highlights

(Continued from page 32)

"rough" sighting on the object. When reversed, it goes into "low gear" and allows a much finer ratio of adjustment (four to one). By shifting from high to low gear the surveyor maintains complete precision control while making a final pointing.



Two speed tangent screw.

With the two speed tangent screw, accuracy is increased and time saved for the entire field crew. The new arrangement will be especially appreciated by crewmen working with heavy gloves. The new screws can be adapted to transits purchased within the past five years.

TOTAL ELECTRIC HOME

A new idea in American Homes, in which electricity does all the work; including heating, cooling, cooking, cleaning, and entertaining; has been developed.

Electric heating, properly planned and installed, is the finest and most comfortable form of heating to be found anywhere in the world. It is clean, odorless, quiet, and, most important, safe.

Also unveiled is the home's "electrical centers," or portions, of a model Total Electric Home which have been built and will tour the country. The "home" included a "Food Preparation Center," a "Weather Control Center," and an "Entertainment Center."

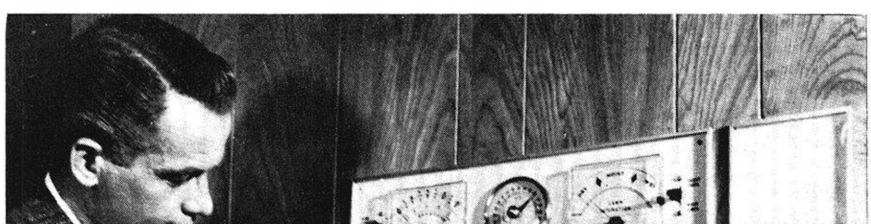
The Centers were not designed as a model home nor to try to sell that home, but just to assure the builder that it was real and practical. The main difference between the Total Electric Home and conventional homes is that electricity does almost everything. It illuminates, heats cools, entertains, prepares and preserves food, does the manual labor, and, above all, saves time so that families can see more of each other and do more things together.

The Entertainment Center is built so that everything for good home entertainment is easily accessible; a television set is built into the wall; next to it, a tape recorder; AM-FM radio, stereo hi-fi, records and tape storage, games, card tables and chairs. A flick of your finger in the Entertainment Center, and a movie screen descends to a position where it is ready for the showing of slides or home movies.

The "Weather Control Center" masterminds the atmosphere in the Total Electric Home. At this Center, it is possible to actuate heating and cooling equipment and to control the Precipitron electronic air cleaner and germicidal lamp which eliminate pollen and airborne health hazards. The Center controls self-adjusting sun shades and draperies. It can de-ice the sidewalk and driveway and, in dry spells, can control the lawn sprinklers. For the amateur weather man, the instrument panel contains wind direction and velocity gauges, a barometer, inside and outside thermometers and relative humidity indicators.

The "Food Preparation Center," is designed for the person who loves to create meals. There are platform ranges, an electronic oven to cook food in minutes, a 24-inch wall oven which can keep a roast rare and hot up to six hours, an infrared food warmer, waste disposers, plenty of refrigerator and freezer space. There is a planned place for everything, including "every conceivable portable appliance with automatic timers."

Stepping onto the patio-like entrance, a visitor notices that outdoor lights automatically go on. A closed circuit TV camera could go into operation as the outside lights come up so that people inside are able to see who is calling. The door lock is controlled electrically from the inside.



The Weather Center has an instrument panel that shows wind velocity and direction, barometric pressure, inside and outside temperatures and relative humidity.

TASI WILL DOUBLE THE CAPACITY OF SUBMARINE TELEPHONE CABLES

A new system which will increase the number of telephone conversations carried by underseas telephone cables perhaps by as much as two times is under development. The system is called TASI, standing for Time Assignment Speech Interpolation.

In a normal two-way telephone conversation, one person on the average will be speaking only half the time, and even while he is speaking, there will be significant gaps and pauses in his speech. Thus, if the two directions of transmission are separated, each transmission path is idle, on the average, more than half the time. If two conversations are interlaced to take advantage of these gaps, greater use can be made of existing transmission facilities. It is this interlacing process which leads to the designation Time Assignment Speech Interpolation.

In practice, the system would not work with only two talkers on one line since they would frequently be speaking at the same time. However, where a larger number of channels is available, such as a submarine telephone cable, an averaging effect occurs so that at any instant there is a greater probability of sufficient "free time" being available to accommodate the larger number of conversations. Increasing the capacity of a 36-channel system to 72 channels is more feasible with TASI than doubling the capacity of a 5-channel system.

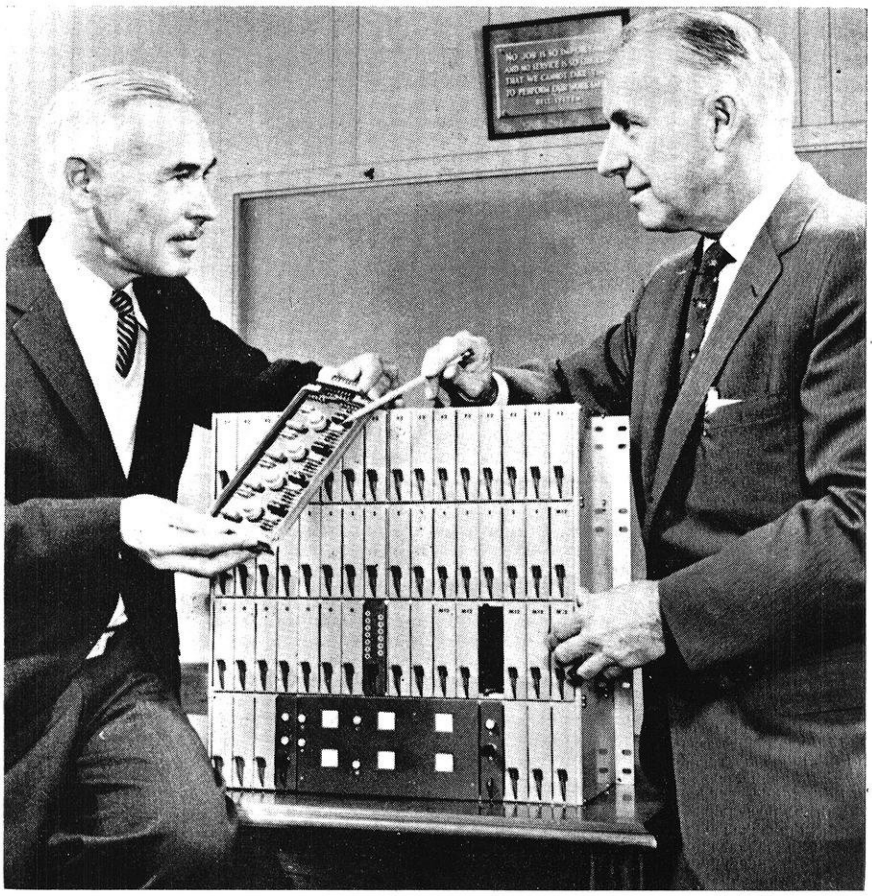
TASI is essentially a group of high-speed switches. If, for example, 36 cable channels were available, 72 talkers could be connected. When there are more talkers than channels, the equipment will connect talkers who become active by disconnecting talkers who are silent at that moment. In turn, this disconnected talker will be assigned another momentarily inactive channel when he starts to speak again. A talker will be disconnected only when he is silent.

When a talker starts talking, his voice actuates a speech detector. The speech detectors are scanned by a control circuit similar to a modern digital computer. When a talker becomes "active" this control circuit initiates a coded tone burst consisting of a group of four audio tones which precedes the voice over an available cable channel. After the tone burst, which lasts only 10 milliseconds, the control circuit connects the talker to the same channel. The coded tones operate switches to connect the talker to the proper line at the receiving end. The tones are not heard since the listener is not connected while they are being transmitted. When a talker is not "active" and his channel is needed, another coded tone burst is transmitted over a separate signaling channel and severs the connection.

Switching of talkspurts from one channel to another is accomplished in a few milliseconds by a time-division switch. Speech is sampled for about two microseconds and the resulting pulses steered to the appropriate idle channel during the sampling by the selective operation of transistor "gates" in each channel. This short interval of sampling makes it possible to sample all active talkers 8000 times a second and then reconstruct the speech from the samples before it is transmitted over the undersea cable.

The signaling system in TASI keeps the receiving end informed of the connections that the transmitting end has established. Four groups of audio tones are employed for signaling purposes; four tones in each of three groups and three in the fourth group. Each signal comprises one and only one tone from each group; if more or less are present, an error is indicated and appropriate steps taken to correct it. "Connect" signals which precede the voice signal at the beginning of the speaker's talkspurt are sent over the same channel as the speech. Disconnect and connection checking signals are sent over a separate channel used only for this purpose.

All of the circuits for TASI are completely transistorized. Terminals for doubling the capacity of the Transatlantic cable will require several thousand transistors of four different types, and tens of thousands of semiconductor diodes and passive components.



Bell representatives examine a part of the TASI components.

(Continued on next page)

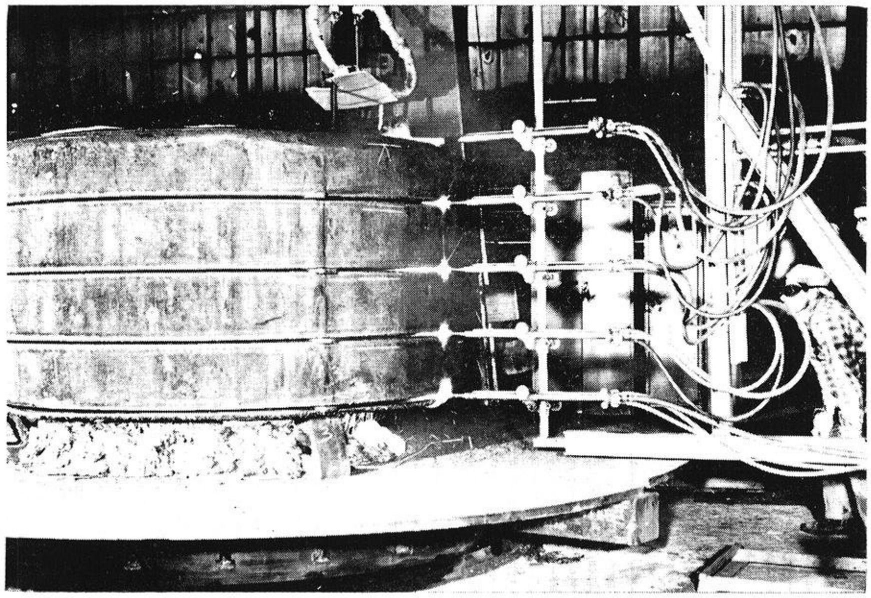
TURNTABLE SLASHES PRODUCTION TIME

A new twist in flame-cutting procedures has made it possible to make a big cut in production costs. In standard flame-cutting operations, cutting torches are moved over a stationary workpiece. But in this ingenious setup the work is positioned on a controlled speed turntable and rotated past stationary cutting torches. On one job huge multiple ring forgings were flame cut into equal sized rings in less than one-tenth the time required for machining.

Engineers of Linde Company helped to set up this unique operation. Five Ox-weld C–43 torches mounted on a vertical rig slice the big forgings horizontally as they rotate past the torches. One man regulates the speed of the electromotive turntable and controls the intensity of the cutting flames. Machining time is drastically reduced. One job on forged rings which formerly took 320 hours is now machined in less than 115 hours using the new method.

Any type of steel from low carbon to high alloy can be cut with this setup which handles work from 36 inches O.D. to more than 200 inches. Turntable speed can be accurately controlled from 0 to 20 turns per hour. Parts up to 120,000 pounds can be carried on the turntable. Torch carriers move on tracks that are radial to the table.

Ox-weld torches mounted on a horizontal arm are also used to make bevels and vertical cuts. Vertical cuts and deep 40-deg. chamfer-cuts on the inside of the rings are made simultaneously. Less than one inch is left on the cut faces for machining. Flame-cutting has cut the total machining time on this operation more than sixty per cent and frees costly machining equipment for use on closer work.



Five Stationary Oxweld C–43 torches make quick accurate cuts in a multiple ring forging. This operation produces four rings of equal thickness.

COLOR PHOTO TECHNIQUES REVEAL ALTERED DOCUMENTS

How color photography aids law enforcement officers in examination of questioned documents was revealed by Harris B. Tuttle, Eastman Kodak Company's consultant on law enforcement photography. Speaking before the questioned documents section of the American Academy of Forensic Sciences meeting at the Drake Hotel in Chicago, Tuttle told of methods for determining whether a ballpoint pen message was written under or on top of a typewritten message. The importance of color photography in presenting evidence in such cases was stressed.

When a ballpoint message is written over a typewritten one, the pressure required to put ink on the paper leaves a groove over the type characters that is visible under specialized viewing conditions. By using oblique lighting and low magnification, the pressure groove can be photographed in color to provide evidence.

Earlier methods of determining a superimposed ballpoint pen message involved study of deposition of ink. Where ink from the typewriter ribbon appears, there are no paper fibers available to absorb the ballpoint ink and none appears over the typewritten characters. However, this test would not work where a weak typewriter key or a worn ribbon leaves unused paper fibers to absorb ink.

The reverse condition, when a message has been typed over ballpoint pen writing, is also detectable through the groove left by a pen. When the typewriter key strikes the page, this groove is flattened out, and the type character leaves an inked impression in the paper that is easily visible under low-angle lighting.

'BEAVER-NAPERS' PLAN ASSAULT

Canadian construction men are planning some mass beaver-naping after losing three battles to a colony of 30 amphibious rodents. Three times, construction men tore down a beaver dam to relieve flooding of a quarry. Each time the beavers repaired the gap in their home. Now the men plan to kidnap the busy beavers and let them do their dambuilding elsewhere.

Bonding Rubber

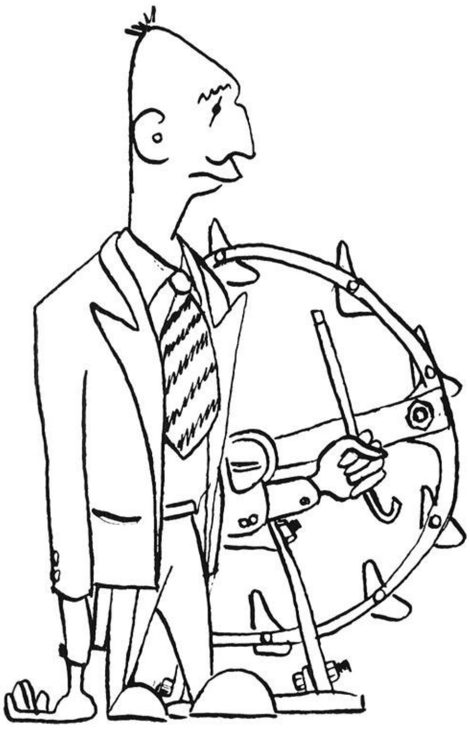
(Continued from page 49)

cleaned and prepared metal surface of the part. Then the rubber is bonded to the brass plated part by placing both metal and rubber in a mold and curing. This causes the rubber to vulcanize and form a chemical bond.

Metal parts which are bonded to rubber either mechanically or chemically are ideal for engineering use where the full benefits of the rubber characteristics are desired. Rubber bonded parts may be the answer to many engineering problems where they will do the job better than any other method.

BIBLIOGRAPHY

1. S. Buchan, *Rubber To Metal Bonding*, London; Crosby, Lockwood, and Son Limited. 1948.
2. J. H. Gerstenmaier, "Bonding Methods For Adhering Rubber To Metal," *Rubber Age*. July 1953.
3. "Bonding Rubber To Metal," *Modern Metals*. July, 1953.



THE FERROUS WHEEL

by Vern Wyers ee'62

The dam burst, and the raging flood quickly forced the town people to flee to the hills.

As they gazed down sadly at their flooded homes they saw a straw hat float gently downstream for about fifty feet. Then it stopped, turned around and plowed slowly upstream against the rushing waters. After fifty feet, it turned and moved downstream again. Then upstream again. "Say," said one of the townfolk, "what makes that hat act so darn funny?"

"Well, I ain't sartin sure," spoke up a youth, "but last night I heard Grampa swear—come hell or high water he was agonna mow the lawn today."

* * *

Do you know what the little stream said as the elephant sat down in it?

"Well, I'll be damned!"

* * *

A divinity student named Tweedle
Refused to accept his degree
He didn't mind the Tweedle
But he hated to be Tweedle, D.D.

* * *

A girl met an old flame, and decided to high-hat him.

"Sorry," she murmured, when the hostess introduced him to her, "I did not get your name," "'I know you didn't," replied the old flame, "but that is not your fault. You tried hard enough."

What They Mean When They Say:

See me after class—(it has slipped my mind).

Pop Quiz—(I forgot my lecture notes).

I will derive—(formula has slipped my mind).

Closed book quiz—(Memorize everything including the footnotes).

Open book quiz—(Oil your slide rules and wind your watch).

Honor system—(alternate seats).

Do odd numbered problems—(the even numbered problems will be on test).

Briefly explain—(not less than 1000 words).

* * *

Neither side will ever win the battle of the sexes—mainly because there's too much fraternizing with the enemy.

* * *

A clergyman and a truck driver found themselves in an automobile smashup. The truck driver told the minister what he thought of him in profane terms. When he paused for breath, it was the clergyman's turn.

"You know, my good man, that I cannot indulge in your kind of language, but this much I will tell you; I hope when you go home tonight, your mother runs out from under the porch and bites you."

Two rabbits were being chased by a pack of wolves when one turned to the other and said:

"What are we running for, let's stop and out-number them."

The other rabbit said:

"Keep running, bud, keep running . . . we're brothers."

* * *

A Texas oil man was visiting New York. His city friend showed him all of the sights including the Empire State building.

"Isn't that a magnificent structure?" asked his friend.

"Nothin'," said the Texan. "I got an outhouse bigger'n that."

The New Yorker looked him over. "You need it!" he retorted.

* * *

Instructor: "Before we start this final exam, are there any questions?"

E.E.: "What's the name of this course?"

* * *

As the couple on their honeymoon stood on a cliff overlooking the ocean, she grew very romantic.

"Darling," he murmured, "when did you first know that you loved me?"

"Well," replied the groom tenderly, "when I first began to get mad when people said you were brainless and unattractive."

STORY INDEX

Volume 63—October 1958 Through May 1959

OCTOBER

NOVEMBER

DECEMBER

JANUARY

FEBRUARY

MARCH

APRIL

MAY

Ferrous Wheel

(Continued from page 55)

Last night I held a little hand,
So dainty and so sweet.
I thought my heart would surely break,
So wildly did it beat.
No other hand in all this world,
Can greater solace bring,
Than that sweet hand I held last night.
Four aces and a king.

* * *

One day a little baby stork was very perturbed because his mother was gone all night and he asked his father about it. "Why, your mother has been making people very happy," the father stork replied. The next night the father stork was gone and the baby stork asked his mother where he was. "Your father is out making people very happy," the mother stork replied. The next night the baby stork was gone till the wee hours. When he came in, mother stork and father stork asked where he had been. "Oh, out scaring the hell out of college kids," baby stork replied.

What is so cheap as the Scot who tells his children ghost stories instead of buying Exlax.

* * *

A beautiful girl was walking along the sidewalk one evening on her way to the movie. She noticed a small bird lying at the side of the walk with a broken wing. Instead of going to the movie she took the bird home, bandaged its wing, and fed it. In a few weeks the bird was well enough to fly away.

Now let's see you guys find anything dirty in that.

* * *

Boss: "I suppose you know when quitting time is—"

Secretary: "Oh, certainly. Whenever somebody knocks on the door."

* * *

The guy was walking down the street dressed only in a barrel when a cop stopped him.

"Are you a poker player?" asked the law.

"Not me," replied the character, "but I just left a couple of guys who are."

One of our student engineers who had the pleasure of working down South this summer attended a party in New Orleans and approached a girl wearing a rather daring, low-cut gown.

"That's a gorgeous dress you have on, Sue," he said.

"Sho' enough?" she drawled.

"It sure does!"

* * *

Say it with flowers, say it with sweets,
Say it with kisses, say it with eats,
Say it with jewelry, say it with drink,
But never, oh never, say it with ink.

* * *

A preacher was hearing confession. In the middle of it, he stopped the young sinner, saying, "Young man, you ain't confessin', you's braggin'."

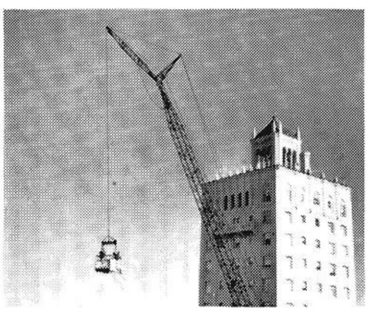
* * *

"What steps would you take in determining the height of a building using an aneroid barometer?" read a question in a C.E. exam.

One student replied: "I would lower the barometer on a string from the roof and then measure the string."

Though the building is not yet built, this is a view from one of the apartments.

How to look out a window before the building is up



With 180 "view" apartments to sell, the developers of The Comstock turned to photography to get a jump on sales

A feature of The Comstock, San Francisco's new co-operative apartments on top of Nob Hill, will be the spectacular panoramic views of the Bay area from their picture windows.

How could these views be spread before prospective buyers—before the building was up? The developers, Albert-Lovett Co., found the answer in photography. From a gondola suspended from a crane, color photos were made from the positions of the future apartments. Now, the sales representative not only points out the location of a possible apartment on a scale model, but shows you the view from your window as well.

Photography rates high as a master salesman. It rates high in other business and industry tasks, too. The research laboratory, the production line, the quality control department and the office all get work done better and faster with photography on the job.

Whatever your field, you will find photography can save you time and cut costs, too.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

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With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Kodak
TRADEMARK

One of a series

General Electric interviews Dr. Richard Folsom, President of Rensselaer Polytechnic Institute, to explore . . .

Teaching— A Career Opportunity For the Engineer

Leading educators, statesmen and industrialists throughout the country are greatly concerned with the current shortage of high-caliber graduates who are seriously considering a career in the field of science or engineering education. Consequently, General Electric has taken this opportunity to explore, with one of America's eminent educators, the opportunities and rewards teaching offers the scientific or engineering student.

Q. Is there in fact a current and continuing need for educators in technical colleges and universities?

A. Colleges and universities providing scientific and engineering educational opportunities are hard pressed at the present moment to obtain the services of a sufficient number of well-qualified teachers to adequately carry out their programs. Projected statistical studies show that this critical need could extend over the next 15 or 20 years.

Q. Why is this need not being met?

A. There are probably three main reasons. These might be classed under conditions of financial return, prestige associated with the position, and lack of knowledge and understanding on the part of the college student of the advantages and rewards teaching as a career can afford.

Q. What steps have been taken to make education a more attractive field to engineering students?

A. Steps are being taken in all areas. For example, we have seen a great deal in the newspapers relating educators' salaries to the importance of the job they are doing. Indications are that these efforts are beginning to bear fruit. Greater professional stature is being achieved as the general public understands that the youth of our nation is the most valuable natural resource that we possess . . . and that those associated with the education of this youth have one of the most important assignments in our country today.

Q. Aside from salary, what rewards can a career in education offer as opposed to careers in government or industry?

A. The principal rewards might be freedom to pursue your own ideas within the general framework of the school, in teaching, research and consulting activities. As colleges and universities are normally organized, a man has three months in the summer time to engage in activities of his own choice. In addition, the educator is in direct contact with students and he has the satisfaction of seeing these students develop under his direction . . . to see them take important positions in local and national affairs.

Q. What preparation should an engineering student undertake for a teaching career?

A. In college, the engineering student should obtain a basic understanding of science, engineering science, humanities and social sciences with some applications in one or more professional engineering areas. He should have frequent career discussions with faculty members and his dean. During graduate work, a desirable activity, the student should have an opportunity to do some teaching.

Q. Must an engineering student obtain advanced degrees before he can teach?

A. It is not absolutely necessary. On the other hand, without advanced degrees, advancement in the academic world would be extremely difficult.

Q. How valuable do you feel industrial experience is to an engineering or scientific educator?

A. Industrial experience for a science educator is desirable; however, with a senior engineering educator, industrial experience is a "must". An ideal engineering educator should have had enough industrial experience so that he understands the problems and responsibilities in carrying a project from its formative stages to successful completion, including not only the technical aspects, but the economic and personal relationships also.

Q. What do you consider to be the optimum method by which an educator can obtain industrial experience?

A. There are many methods. After completion of graduate school, perhaps the most beneficial is a limited but intensive work period in industry. Consulting during an academic year or summer is a helpful activity and is desirable for older members of the staff. Younger educators usually need experience in "living with the job" rather than providing consultant's advice to the responsible individual.

Q. Based on your experience, what personal characteristics are possessed by successful professors?

A. Primarily, successful professors have an excellent and growing knowledge of their subjects, are interested in people, and transmit enthusiasm. They have an ability to explain and impart information with ease. They generate ideas and carry them out because they are devoted to developing their fields of knowledge. They desire personal freedom and action.

For further information on challenging career opportunities in the field of science and engineering education, write to: Mr. W. Leighton Collins, Secretary, American Society for Engineering Education, University of Illinois, Urbana, Ill.

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