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WHAT IS MATHEMATICS?
How cold is up? We know that outer space can never be colder than minus 459.72 ° Fahrenheit—that's absolute zero, the point at which all molecular motion ceases. We don't know what coldness like this will do to materials, but we're finding out. Scientists are using a heat exchanger to produce temperatures as low as minus 443 ° Fahrenheit. They test materials in this extreme cold and see how they perform. Out of such testing have already come special grades of USS steels that retain much of their strength and toughness at −50 ° or below; steels like USS “T-1” Constructional Alloy Steel, TRI-TEN High Strength Steel, and our new 9% Nickel Steel for Cryogenics applications. And the heat exchanger to produce the −443 ° Fahrenheit is Stainless Steel! No other material could do the job as well. Look around. You'll see steel in a lot of places—getting ready for the future. ■ For information about the many career opportunities, including financial analysis or sales, write U. S. Steel Personnel Division, Room 6085, 525 William Penn Place, Pittsburgh 30, Pa. U. S. Steel is an Equal Opportunity Employer. USS, “T-1” and TRI-TEN are registered trademarks.
Some straight talk about a career at American Oil

by Roger Fisher

"This Company recognizes the value of varied experience, and encourages you to broaden your knowledge."

Roger Fisher, B.Ch.E. from Cornell and Ph.D. candidate from Princeton is one of many young scientists and engineers at American Oil shaping the future for himself, his Company and the industry. At 26, he has earned a Fulbright Scholarship and will take a year's leave of absence to continue his graduate research on solids mixing at the University of Osaka, Japan.

"American Oil is looking for broad-gauge research people," Roger adds. "In the long run, the Company benefits as well as the professional who continues to grow in his own or in several fields of research."

Roger's present assignment at American Oil involves applied research—to plan, design, build and operate bench scale lab equipment, to study the kinetics of catalytic cracking. His is one of many diversified projects at American Oil Company. Chemists, chemical engineers, physicists, mathematicians and metallurgists can find interesting and important work in their own fields.

The ability of American Oil to attract bright young scientists and engineers like Roger Fisher might have special meaning to you. For complete information concerning career opportunities in the Research and Development Department of American Oil, write D. G. Schroeter, American Oil Company, P. O. Box 431, Whiting, Indiana.

IN ADDITION TO FAR-REACHING PROGRAMS INVOLVING FUELS, LUBRICANTS AND PETROCHEMICALS, AMERICAN OIL AND ITS ASSOCIATE COMPANY, AMOCO CHEMICALS, ARE ENGAGED IN SUCH DIVERSIFIED RESEARCH AND DEVELOPMENT PROJECTS AS:

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- Combustion phenomena
- Solid propellants for use with missiles
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Cover Note

Many new and strange optical materials are being pressed into service by the pioneering infrared designers of today. This month’s cover shows three: A hemispherical dome carved from a single 6-in. silicon crystal to cap the nose of a heat-seeking missile; a crimson arsenic-trisulfide lens for an IR surveillance system; and a sphere of special lead silicate glass destined to become a diminutive IR dome. Our thanks to ASTRONAUTICS, a publication of the American Rocket Society, for making this cover available.
ROSE POLYTECHNIC INSTITUTE
Terre Haute, Indiana

HIGH SCHOOL GRADUATES OF 1962

You are cordially invited to visit Rose Polytechnic Institute where you can earn a degree in:

- CHEMICAL ENGINEERING
- ELECTRICAL ENGINEERING
- MECHANICAL ENGINEERING
- CIVIL ENGINEERING
- MATHEMATICS
- PHYSICS
- CHEMISTRY

ROSE POLYTECHNIC INSTITUTE
TERRE HAUTE, INDIANA

Page 4
What will you be doing tomorrow?

A challenging tomorrow depends on choosing the right company today...one that develops your ability by encouraging you to use it...one that "turns you loose" with early responsibility. A company that's diversified enough, guides you enough to help you determine and do the things you like best.

Allis-Chalmers is that kind of company. Here, you develop professionally...as you create advanced equipment and systems for the world's basic industries: cement, chemicals, construction, agriculture, electric power, paper, petroleum and steel. You thrive on the challenge of opportunity, yet enjoy the stability a sound, growing concern can offer.

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... Designing advanced construction equipment that breaks traditional load and speed barriers?

... Applying electronic computers and data processing equipment to automate entire plants?

... Developing new processes for basic industries, such as systems that make low-grade ore usable?

... Probing new methods of energy conversion, such as magneto-hydrodynamics?
What does Olin do for a living?

Olin conceives new products at a rate of no less than one a week. Some appear under our own name. Others bring fame to our customers.

Did you know that Olin pioneered liquid chlorine and synthetic ammonia in the U.S.? Is a leader in agricultural chemicals and synthetic detergent builders? Makes the hydrazine derivatives used as missile fuels? Some of the work of our CHEMICALS DIVISION

Common clay is now anything but "common." In the lab, we recently developed an economical process to convert clay into — of all things — alumina. Stronger metals, new alloys, and metal sources that would have made alchemists scoff in disbelief, are now being pioneered by our METALS DIVISION

Our organic intermediates — those polysyllabic tongue twisters only chemists can pronounce easily — are used in the manufacture of many new "wonder" plastics. We recently developed smokeless Ball Powder® with many immediate uses, and many more astonishing potentials. New and better explosives, detonators and blasting caps are challenges in Olin's ORGANICS DIVISION

Our research teams are probing for new films to keep foods fresh longer. We work with packaging materials from cellophane to kraft paper, corrugated boxes to lumber. The seemingly incongruous quests for crisper potato chips, lighter weight printing papers and more effective cigarette filters are all part of Olin's PACKAGING DIVISION

In the very research center where penicillin was first crystallized, scientists now probe for a B₁₂ antagonist to arrest cancer. On any given day, 150 of our drugs or new dosages may be undergoing clinical tests throughout the world. From Olin's SQUIBB DIVISION

Olin even works on your leisure, with sporting arms and ammunition. We discovered a new way to make a shotgun barrel by winding 500 miles of Fiberglas® around a thin steel liner. It is superior to all-steel barrels on many counts. Ammunition research led to development of powder-actuated tools for faster, stronger fastenings in construction. At our WINCHESTER-WESTERN DIVISION

Olin products are sold in virtually every free country in the world. Sales, service and manufacturing for overseas markets are the responsibilities of our INTERNATIONAL DIVISION

Olin Mathieson Chemical Corporation. 460 Park Avenue, New York 22, N. Y.
Rose men for many years have taken deep pride in a campus tradition which receives less publicity than it deserves. It does not appear in the student "Bible" nor in the Gilbert Plan. Yet it forms the indispensable foundation for a true professional career.

This fine tradition is honesty. Honesty seems at first glance like such a simple attribute that we can categorize all of our fellow human beings into one or the other of two classifications, honest or dishonest. Actually, the concept of honesty is much more subtle and pervasive. It becomes the cornerstone for a whole way of looking at life, an inner structure that guides one's thoughts as well as actions.

On the Rose campus honesty begins with a genuine respect for the property of others in the classroom, laboratory and dormitory. Freshmen soon learn that their fellow students in the higher classes on the campus take a special pride in being able to leave books, slide rules and clothing in any convenient spot with the assurance that when they return later the same day or even days later their property will be undisturbed. This practice may not be conducive to the best housekeeping but it is a source of deep satisfaction to the Rose man who feels that he belongs to a family all the members of which are trustworthy.

But this respect for the property rights of others goes beyond the simple illustration above. Each of us owes to those who will come after us the obligation to maintain the facilities of the Institute at the highest possible level of utility. Because Rose men, to an unusual degree, feel that they “own” their college, they are genuinely concerned that all of the instructional apparatus and laboratory gear be returned. Every item deserves to be put back where it belongs in good shape, preferably in even better shape than when it was received for any particular project or experiment. Since he knows that handy, small tools and test instruments are especially vulnerable, the thoughtful student who borrows them is scrupulous about getting them back where they belong. Thus, this broadened concept of honesty becomes the basis for pride in the completeness and appearance of laboratories, buildings and the entire campus.

In the classroom and examination room the Rose code of honesty and honor imposes a rigid self-discipline on every student. The distinguished careers of Rose alumni in engineering, business and industry embellish the fine heritage which every student may acquire in his college education. He knows that in his professional career he must stand on his own feet. He has only contempt for the rare man in our midst who attempts to take advantage of those around him by cheating and trickery. The climate on the campus is not healthy for those who try to make their way by dishonest practices.

Still another aspect of honesty develops in the mind of the true scholar as he proceeds with his education in a college of science and engineering. As we learn more and more about the immutable laws which govern the physical universe all around us we are able to discard all pretense and sham as trivial. As we learn to reason quantitatively, the beauty and logic of genuine analytical thinking give exciting glimpses into possible future structures and concepts. Thus, the simpler idea of honesty regarding property and ideas becomes transmuted into intellectual honesty, an indispensable element for every decision. Young men now in college will be called upon to provide intelligent leadership as our country faces economic and social problems of extreme complexity. They will need disciplined thinking and intellectual honesty, the ability to face facts squarely, to analyze them objectively and to act vigorously on their conclusions.

All of us on the Rose campus, students and faculty alike, cherish deeply our fine tradition of honesty.

HERMAN A. MOENCH
Acting President

October, 1961
SEE DISPLAYS IN ALL DEPARTMENTS . . .

Attend our annual

ENGINEERS’ DAY

TO BE HELD SAT. NOV. 4TH ON THE CAMPUS

“FROSH START THEIR ENGINEERING CAREER”
Beginning next month, the TECHN:IC will feature a series of articles entitled "DEPARTMENTAL REVIEW" written by members of the faculty at Rose. Each month a different department will describe for you the nature of their curriculum, some history of their profession, and what a student in their department might expect after graduation.

The first article will place the Civil Engineering Department in the spotlight, to be followed by the Mechanical, Electrical, and Chemical Engineering Departments, and then the Mathematics, Physics, and Chemistry Departments.

Because satisfaction during years of undergraduate study is so highly dependent on the proper choice of a curriculum, this series is designed to differentiate between the various fields of study at Rose and help the present and prospective student make his choice. Therefore it would be wise to consider the facts presented by these authors before making your selection of an undergraduate field of study.
EXPERIMENT IN INSTRUCTION

Prof. A. R. Schmidt reports on new methods in use at Rose for teaching mathematics . . .

“A teacher should not attempt to cover the subject of study, but should attempt to uncover it for the student” . . . Unkown.

Evolution of Education

Should teaching-machines be used at Rose? Should classes be conducted on the lecture-system or as small semi-private-tutor groups? Should an instructor be willing to explain as often as asked how to work a problem? Should students be expected to “dig things out” for themselves? Should instructors use true-false, multiple-choice, and completion type tests? Should students be permitted to ask questions in class or be required to listen and take notes? Etc., etc., . . . . These are but examples of questions, each of which could, no doubt; give rise to long and heated discussion among either students or faculty members. Indeed, much has been written on all sides of these and other questions.

Before getting ready to do battle to uphold one or the other of any of these questions, perhaps we should pause a moment to consider a more basic question, namely “why is anyone interested in any of these questions?” Is it possible that proponents of such completely opposite methods as teaching-machines and small, individually-handled classes are really trying to accomplish the same ends? Is it possible that a person who firmly believes in the “get-it-or-get-out” philosophy has anything at all in common with the instructor who prefers to tutor his students almost privately?

If these questions seem hopeless, then try to write a clear, concise statement as to the purpose of an undergraduate education. The literature of various professional organizations and the writings of sages of all decades are full of attempts to define an undergraduate education. So far, apparently nobody has formulated a statement that is universally acceptable (even if the “universe” is limited to this country).

For the purpose of this article then, we adopt the following hypotheses: 1) whatever the purpose or content of an undergraduate education, the curriculum consists of some courses which a student is expected to master to some degree; and 2) regardless of his view of the quality of present-day high school education, the college instructor must accept the raw-material as it comes to him and attempt to turn out the degree of mastery that is expected in his particular course(s).

If we accept these hypotheses, then it becomes the responsibility of the instructor to find the means to accomplish his particular assignment of processing the given “raw material” into the desired “finished product”. This much can probably be agreed to by the majority of instructors and administrators.

The questions posed in the opening paragraph result from many different attempts by various teachers to fulfill this responsibility. Therefore, it may be of value to ponder how teachers throughout the centuries have gone about this task.

In early centuries, teaching was largely a matter of private tutoring. As the number of students increased significantly beyond the number of available private tutors, the educational process evolved into classroom instruction; and, as the number of students continued to increase faster than the number of available teachers, large lecture-classes became more-or-less common. Today, as still another step in the attempt to cope with ever-growing student population but with a still greater shortage of faculty, many educators and psychologists are investigating the possibility of accomplishing the same desired end as did the private tutor, but by introducing new methods and even devices as means to these ends.

Traditional Devices of Education

Traditionally, the devices used by a conscientious teacher include: lectures, recitation periods, problem-solving sessions, term-papers, personal consultation, additional study for either remedial or advanced learning, and tests.

Perhaps the most misunderstood of these devices is the “test”. A good test has three purposes: 1) the obvious value as a means for getting a grade distribution—i.e., showing how much each student has learned.
and which has learned more; 2) a means of emphasizing the important parts of the course; and 3) a means of determining the effectiveness of the instruction. A test which is concocted on the spur of the moment may or may not be of any value for any of these three purposes. Indeed, the careful formulation of a test is just as important as the careful preparation of a lecture or the careful correction of a term-paper or a laboratory report. A poorly-constructed test on which the students do poorly is no measure of anything whatsoever and might even permit the possibility that the students are not at all failing to understand the course.

The Teacher

The role of the teacher is to use all these devices and any others which he has found effective together with an understanding of the similarities and differences between various students in his class. Certainly anyone who has had any experience in the capacity of supervisor of two or more persons knows that no one attitude or approach will produce similar responses from all persons. It is exactly for this reason that once an instructor assumes the responsibility of accepting the available "raw material" and of attempting to turn out the desired "end product", he either remains just an instructor (regardless of his academic rank or degrees) or else becomes a teacher, depending on his ability and willingness to use all the available devices to accomplish this end.

There is still more included in the role of a teacher. Students of all ages are indeed human beings who are, just as are all others, every day undergoing changes in outlook and sense of values. If it is true that the sense of values, the goals, and the sense of responsibility we have as individuals is influenced by everyone around us, every experience, and every idea we encounter, then considering the number of hours a student is within the influence of a given instructor it becomes very important for that instructor to try diligently to present an influence which could add to and not detract from the building of a fine character. It is in this regard that a teacher must practice self-discipline (whether this teacher is a member of the academic teaching profession, a member of the clergy, a Boy Scouts leader, or whatever).

At this point, then, the distinction between an "instructor" and a "teacher" as made in this discussion should be quite apparent.

Returning again to the questions of devices traditionally used by a good teacher, we may add to the previously-stated list the intangible devices called 'enthusiasm', 'inspiration', 'patience', 'understanding', 'discipline' of various types when needed, and 'individual counselling'. Notice especially that the last two syllables of the word "counselling" describe one of the main tasks of any instructor—selling his subject to the student. A given instructor may be the authority in his field, may be of long years of tenure in a classroom, and may possess degrees of various sorts and still be a poor teacher. (It is strange that much fuss is made about the necessity for training-courses for potential salesmen, about the type of personality necessary for success in the sales profession, and about the psychology of sales, and yet year after year there is a great and appalling silence when it comes to the fact that salesmanship is one indispensable ingredient in effective teaching).

New Devices

Many new devices or teaching-aids have been exploited during and since the Second World War, including movies, film-strips, and other audio-visual aids. All of these aids are attempts to automate various functions of a teacher. The most widely-known of the new devices are closed-circuit television and the so-called "programmed learning" materials including "teaching machines" and "scrambled textbooks". Each of these devices has been tested in numerous experiments and found to be quite valuable for its intended purpose. (A general discussion of the nature of teaching-machines and scrambled textbooks can be found in an article by Mr. Robert Valle in the April, 1961 issue of the Technic."

The advantages of closed-circuit television include the instruction of numbers of students limited only by the number of TV sets available, the elimination of interruptions which are disturbing to the quick student, and the ability to use the best experienced lecturers to present the material.

The advantages of programmed learning include the adaptation to different rates of learning which vary from one student to another, the encouragement of independent thinking and action on the part of the student, and the reduction or elimination of the tremendous amount of time an instructor spends in work which uses not even the level of a B.S. degree, to say nothing of higher degrees.

Objectives and Description of the Rose Project

The principal objection to the use of teaching-machines held by the Mathematics Department of Rose is that since so much of a student's technical education must come from textbooks and library references, a student will be delayed in learning to read the prevalent format of technical material if he is taught by use of the bit-by-bit questioning format of teaching-machine material. Another objection, though perhaps less serious than the first, is that automated teaching tends to divorce the student from the instructor and hence from whatever influence and inspiration the instructor may pass on to the student.

The desire of the Rose Mathematics Department is to retain the advantages of live instruction and yet increase the effectiveness of the live teacher by freeing him of much busy-work such as routine drill. In this way, he may work with exceptional students, counsel students, and keep up-to-date in his field. Generally, we would like to use instructor time more fully in those areas which cannot be automated (Continued on Page 26)
Ever since Wilbur and Orville Wright built their first aircraft, man has had the problem of how to control them. At first, and for quite a few years afterwards, the stick and control cables were sufficient for all aircraft. Over the years as the speed of aircraft increased, pilots found that they were getting harder and harder to fly at combat speeds. One of the universally accepted solutions was the use of hydraulic boosted controls. This system had some drawbacks including the almost complete loss of control if power was lost. Yet this is a small price to pay for its many advantages.

As a result of this almost all flight control systems employed today in high-speed aircraft and missiles utilize the response of electrohydraulic mechanisms. In the past the responses of this system have proved to be more than adequate for the demands placed upon them. However, today's advancements in aircraft and missiles have introduced a new element that threatens to impair the operational response of all presently existing control systems and mechanisms. This element is the excessive heat that is encountered both in atmospheric re-entry and in high speed flights within the confines of the atmosphere.

While it is expected that the future control systems and mechanisms of aircraft and missiles must withstand temperatures of about 1000° F, present hydraulic systems and hydraulic fluids are incapable of operation at temperatures in excess of 275° F. Beyond this temperature such vital properties as viscosity and lubricity decline rapidly, often changing by a factor of several thousand before the expected operating temperature of 1000° F is reached. There have been some recent developments in the area of organic fluids that have brought about some that are capable of withstanding an operational temperature of 700° F, but they suffer the same disastrous decline in properties beyond this temperature. These high temperature fluids are also very difficult to handle and store, thus placing a limit on their applications in practical devices.

With hydraulic boosted control systems there is also associated some type of electronic activation. Not only does the hydraulic mechanism deteriorate, but the electronic components also begin to fail in a high temperature environment. The dielectric strength and resistivity of electrical insulating material are also subject to high temperature deterioration. Also the presently available electromagnetic control components are relatively useless at high temperatures because of the loss of magnetic properties in these components when such temperatures are reached.

In view of this high temperature failure of existing electronic-hydraulic control systems, the perfection of a control system which does not limit the performance of advanced aircraft and missiles would appear to hinge either on the vast improvement of existing control mechanisms or on the development of non-electronic-hydraulic systems. While much work is being done on the development of improved hydraulic fluids, their high temperature deterioration is making it increasingly
evident that the high speed flight control systems of the future will rely primarily upon nonhydraulic devices. Foremost among such devices is the pneumatic control mechanism.

At present the high compressibility of pneumatic fluids has limited the use of pneumatic control mechanisms to low performance applications in which reliability and maintenance considerations are more important than response speed. Examples of such applications are to be found in windshield wipers and air conditioning systems. The marked inferiority of pneumatic systems to hydraulic systems at low pressures and temperatures explains this limitation of pneumatic devices to low performance applications. However there is no need to operate pneumatic systems exclusively at low pressures. Rather it would seem that the working pressure of a pneumatic system should be tailored to fit the uses for which the system is going to be put. Thus if the compressibility of a low pressure gas gives rise to objectionable response characteristics, it is only necessary to raise the working pressure of the gas, thereby raising the response characteristics by decreasing the compressibility of the gas.

While the designer of future flight control systems has had some range in the choice of the pressure at which his working fluid will operate, he is more limited in the choice of a working temperature. As has been said before, this choice is taken out of his hands by the high temperatures that occur in high speed atmospheric flights.

The necessity of using pneumatic control mechanisms in high temperature applications is best shown by a comparison of the high temperature characteristics of pneumatic and hydraulic systems. Although at low temperatures and pressures the lubricity and viscosity of the worst hydraulic system are far superior to those of the best pneumatic system, at high temperatures and pressures the opposite is true. While the above characteristics drop rapidly with increasing temperatures in a hydraulic system, the characteristics of a pneumatic system remain essentially constant throughout the entire range of operation. Actually certain of these critical properties in gases actually improve slightly with increasing temperatures. For example, at high temperatures the viscosity of air, which determines the pressure drop through small openings and greatly affects leakage, increases until it is far superior to that of high temperature hydraulic fluids. Furthermore the undesirable low lubricity of air, which determines its ability to resist galling and seizure, is at least on par with that of hydraulic fluids in high temperature applications.

In addition to its thermal stability over any practical operating range, high pressure gas has several other advantages as a working fluid in high temperature flight control systems. The availability of air as a power medium can hardly be questioned. In contrast with most high temperature hydraulic fluids it is nontoxic and poses few handling and storage problems. Furthermore the low density of gases lends itself to relatively easy filtration. Finally, the possibility of using available rocket exhaust gases to operate the system should not be overlooked. Such operation would be ideal for jet vane control and other low inertial applications.

At the present time the prime source of dissatisfaction with pneumatic controls has centered on the fact that the compressibility of the working fluid has been so high as to render it useless in the rapid positioning of high inertial loads. However as stated before, the compressibility of the working medium is significantly lowered by the high pressure operation of the device. The response time of pneumatic actuators may also be improved by overdesigning the system, but such techniques take their toll in reliability and overall weight. Another less serious disadvantage involving the use of pneumatic controls is the leakage problem, which necessitates constant care in the installation and maintenance of hoses and fittings.

In spite of the rapid hardware advancements being made in the field of high temperature control systems, one basic hardware problem remains unsolved. This problem involves the high temperature failure of the electromagnetic devices being used as input and control mechanisms in most existing control systems. Not even the most advanced insulating techniques have proved capable of guaranteeing reliable electromagnetic operation at high temperatures for more than limited periods of time. Dissatisfaction with this high temperature failure of electronic control components has led control engineers to search for non-electronic signal input and control devices.

Recently much work has been done in this area of pneumatic control. One of the most promising devices is the pure fluid amplifier. It was developed by the Diamond Ordnance Fuze Laboratories. Although the principle of the pure fluid amplifier is relatively simple, sophistication of this basic device by feedback paths has made possible not only amplification but also analog and digital computation, normal mathematics operations, memory devices, and the regulation of time intervals. On top of all of this the inherent simplicity of the pure fluid amplifier evident in its complete lack of moving parts greatly enhances its reliability and ruggedness. The prime limitation of a control system that employs a pure fluid amplifier is that which plagues practically all high performance pneumatic devices.

This limitation is the speed of response. The speed of response of such a system compares with the response speed of an electronic system in about the same ratio as the speed of sound compares with the speed of light. The exact effect of this relatively slow speed of response upon high performance aircraft and missile control has not yet been determined. Although the response speed of a pure fluid amplifier may leave something to be desired, there is certainly no question as to the capability of this device to withstand the extreme temperatures at which it will have to function.
Mr. Benson, will you tell us a little about the highway you're working on now, please.

Federal Aid Route 17 is six miles of dual lane pavement running from the Charleston city limit westerly to two miles east of Mattoon. There are also four bridges, two twin structures over a creek and two over a railroad. Almost two miles of city section through Charleston, running past Eastern Illinois University, was completed last year.

Is this a big job, as highways go? It's a fairly big job. A section is considered the size of a normal construction season for paving and drainage structures. This paving job was let in two sections to two different contractors, who are working the job together as one section. The bridges were let earlier as a separate section.

How much will all this cost the state?

All three sections will cost the state about $2,300,000. The city section was another million.

You, of course, are resident engineer for the state of Illinois. Just what does that mean?
The term is somewhat self-explanatory. The resident engineer spends all his working hours on the job as the head field engineer. He interprets the specifications, plans, and any questions arising on the job. His job is to see that the contractor fulfills his contract with the state.

**How many state employees work under you?**
Most of the time there have been about twelve engineers, engineering technicians, and engineering aids concerned directly with the construction.

**Supervising a dozen men and millions of dollars worth of work seems like a lot of responsibility for a man out of college only five years.**

Well, it's largely supply and demand. When I came to work for the state in '56, the big federal aid highways were just starting, and there was a shortage of engineers. Engineers moved up the ladder of responsibility faster than they did ten years before. I think my advance has been normal for the length of time.

**How do you keep your responsibility from giving you ulcers?**
If the responsibility of your job keeps you awake nights you should be doing something else. If you liked the job it wouldn't bother you. In a job you like, you strive to get responsibility. It gives you a good feeling, not a feeling of "I don't want to go out on the job today because I might make a mistake."

**Do you feel that state engineers' salaries are adequate considering the large amount of responsibility?**
Well, nobody ever thinks he makes enough money, but the State of Illinois pays much higher salaries to engineers than any other state I know of. Salaries have increased considerably since I came to work.

**What, in your opinion, are the advantages and disadvantages of working for the state?**
The disadvantage is that as an employee of an agency of the government advancement often depends more on longevity than merit.

Of course, I think the advantages outweigh the disadvantages. The retirement system is better than in a private organization. Also, you're sure of your job as long as you're good at it, which gives you more time to think about doing your job instead of keeping it. The professional attitude is better. In private organizations you compete with your fellow employees. One doctor doesn't compete with another—he just does the best job he can. Engineers should do the same thing. In a state organization you don't have to compete against your fellow employees. You just do your best for the good of the profession.

**What about highway engineering gives you the most satisfaction?**
Seeing a job that you've worked on from the very first being changed from a wilderness into a new modern highway to travel on. Either that or watching a steel beam being set between piers or abutments that you've laid out and seeing that they fit, that they're not too short or too long. That's sometimes quite a thrill.

**How good are a highway engineer's chances for advancement?**
An engineer's chances for advancement in any field are good if he's good at his job.

**Did you gain anything by going to Rose that you would have missed at another college?**
Well, that's hard to say, since I didn't attend any other college; but from my experience it seems that graduates of Rose, or any small college, have a better "common sense" engineering knowledge. At Rose, each student is a person, not just a number, and he knows he is always free to ask questions of his professors. I think small college students get a more practical engineering knowledge, and when you get out of college nobody wants an idea unless it's practical.

(Continued on Page 30)
Fun is the watchword for October, and what could be more fun than an Autumn day on the farm with Miss Bonnie Townsend, our Farmer’s Daughter for this month. Bonnie is a junior at the old reliable, Indiana State College, and she calls “Nap Town” her home.

When Bonnie is not being photographed by The Technic, she somehow finds time to study to be a kindergarten teacher (kindergarten must have changed a mite since I was there), and to participate in many social and extracurricular activities at State. A member of Sigma Kappa sorority, she is their homecoming queen candidate this year. She is a member of the Sparkettes, who perform at most of State’s football and basketball games, and is president of State’s chapter of the Student Education Association.

Brown hair and eyes and a sparkling smile identify Miss Townsend. Vital statistics are: 5 feet 3½ inches tall, 3.28 slugs in mass, 10.8 in. — 1.83 feet — 86.4 cm.

Bonnie is constantly present at Rose dances and social functions, and is always ready with a quick smile for Rose men.
In recent years the word refractory has undergone a change in meaning. Previously, when one said refractory one thought of temperature resistant ceramics, as only ceramics were used when high temperatures were involved in an industrial situation. Now a refractory is any material with the ability to withstand high temperatures and still retain a high percentage of its strength. The refractory material must not change its composition by reaction with oxygen or lose its structural strength through some intermolecular action due to extreme temperature.

For centuries ceramic refractories have been used in furnaces or ovens for making pottery, tile, bricks, processing metals and various other materials which require high heat for their production. The materials in these ceramic refractories are carefully blended to produce the correct mixture of alumina and silica-bearing clays for the specific use. Ceramic refractories are available in a myriad of shapes and sizes. Fire bricks are usually made to order for each use as each industry has special conditions which must be met. Great skill is required to determine the proper mixtures for the use. As long as we process materials with heat, we will have need for fire brick and other ceramic refractories.

With the dawn of the jet age came requirements for lightweight materials which retained their strength at high temperatures and were sufficiently inert not to react with the fuels used in the jet engines. Ceramic materials were too heavy, or, in the terms of the industry, had a strength-to-weight ratio which was too low. Ceramic refractories were used for making jet engines. Comparison of ceramics with metals shows that the high porosity cuts down the load capacity enormously. For example, a ten percent porosity produces a fifty percent decrease in strength. Consequently the field of refractory metals began. With the dawn of the space age, not only are these refractory metals a necessity in the rocket engines, but also on the surface of the rockets. The skin or outer surface of a rocket must be lightweight, not porous, strong, and resistent to the high temperatures caused by air resistance. In addition, the skin should have an insulating effect if possible. Even the structure of the space craft must be temperature resistant.

The space problem facing our scientists today is whether to shield the structure of the space craft with insulation and cooling techniques, or make it from high temperature resistant metals. The first alternative presents a terrific weight problem, while the second is plagued by a monster of a temperature problem.

Three solutions to this dilemma have been proposed:

1. Ablation cooling which requires superalloys.
2. Insulation and water cooling. Superalloys would be used for structure and heat resistive metal for shielding. This is six hundred forty pounds lighter than the first.
3. Radiation cooling using only refractory metals. This is eight hundred sixty pounds lighter than the first.

One small item is in the scientist’s favor in the space travel problem—the prime structure is lightly loaded when the maximum temperature is reached.

In today’s nuclear reactors which are used to produce power, it is essential to conduct the heat produced in the pile or reactor to the point at which power is produced from the heat energy. This is accomplished in such ways as steam or liquid sodium acting as the medium. In any case, highly inert, strong, temperature resistive, and radioactivity resistant materials are needed to transfer the heat exchange medium.

In future thermionic power plants, more refractory metals will be needed. A great need now exists for lightweight protective coatings of high temperature sensitivity. The present maximum for these protective coatings is...

(Continued on Page 27)
Quality is the key to success at Western Electric

Admittedly, our standards are high at Western Electric. But engineering graduates who can meet them, and who decide to join us, will begin their careers at one of the best times in the history of the company. For plentiful opportunities await them in both engineering and management.

As we enter a new era of communications, Western Electric engineers are carrying forward assignments that affect the whole art of telephony from electronic devices to high-speed sound transmission. And, in the management category alone, several thousand supervisory jobs will be available to W.E. people within the next 10 years. Many of these new managers will come from the class of '62.

Now’s the time for you to start thinking seriously about the general work area that interests you at Western Electric, the manufacturing and supply unit of the Bell Telephone System. Then when our representative comes to your campus, you’ll be prepared to discuss career directions that will help make the interview profitable.

After a man joins Western Electric, he will find many programs that will aid him in exploring the exciting course of his career — while advancing just as fast as his abilities allow. And he’ll be secure in the knowledge that he is growing with a company dedicated to helping America set the pace in improving communications for a rapidly growing world.

Challenging opportunities exist now at Western Electric for electrical, mechanical, industrial, and chemical engineers, as well as physical science, liberal arts, and business majors. All qualified applicants will receive careful consideration for employment without regard to race, creed, color or national origin. For more information about Western Electric, write College Relations, Western Electric Company, Room 6105, 222 Broadway, New York 38, New York. And be sure to arrange for a Western Electric interview when our college representatives visit your campus.
"If we can first know where we are and whither we are tending, we can better judge what to do, and how to do it."

. . . Abraham Lincoln

The library wishes to extend its annual welcome to all students to come in and use its resources. We are proud of our collection and are happy to be of service.

The library has had a busy start, as it was included in the orientation program for freshmen this year. Mr. Bennett had an active part in acquainting all the 176 "new" students to our library.

We also wish to announce the revision of our Guide for Readers which is in its third revision and now available. We have a good supply and you are very welcome to a copy.

* * * *

Want to use your study-time more effectively? May we suggest these from our collection:

Armstrong, W. H.
Study is Hard Work.
Brown, H. E.
This is the Way to Study.
Crawford, C. C.
Methods of Study, and
The Technique of Study.
Headly, L. A.
How to Study in College.
Jones, E. S.
Improvement of Study Habits.
Robinson, F. P.
Effective Study. (most recent addition)
Smith, S.
Best Methods of Study.
Staton, T. F.
How to Study.

FROM THE NEW BOOK SHELF
In Place of Folly,
by Norman Cousins
The following is an excerpt from "Education and the World Scene," by Reinhold Niebuhr, contained in the book entitled Education in the Age of Science, edited by Brand Blanshard.

"The task of education is to help the coming generation to measure the significance of these three aspects and to adopt creative and responsible attitudes rather than irresponsible evasions into the asylums of hysteria or complacency.

"The most obvious new aspect is . . . we emerged from the Second World War incomparably the strongest nation in the Western community. We have adjusted ourselves to this new situation of power and responsibility with some degree of grace and wisdom but of the problems that the new generation must face are derived from the fact that it is difficult for a nation to adjust itself to the precarious eminence of world hegemony with only scant apprenticeship as we have had.

"The second aspect of the world scene to which we must adjust ourselves is the contest with a Communist bloc of nations which under Russian leadership, has managed to build an empire of tremendous strength . . .

"The third new aspect of the world scene is the nuclear stalemate, arising from the fact that both of the great powers have enough nuclear weapons to destroy the foe, but no defense against being destroyed in the process."

Herein lies the subject treated by Norman Cousins in his recent book entitled In Place of Folly.

Peace with Justice, selected addresses of Dwight D. Eisenhower
Of all the men who spoke out for peace and freedom during that crucial decade 1950-60, Dwight D. Eisenhower commanded the widest international attention. General Eisenhower achieved this distinctive position even before he became the President of the United States. These thirty addresses contain a record of the basic principles which are the heart of liberal thought.

Music of the Spheres,
by Guy Murchie
From an imaginary space station
(Continued on Page 28)
WHAT IS MATHEMATICS?

by Jerry Badger
Senior Math.

Few people except mathematicians know what mathematics really is. Most outsiders regard mathematics as a tool for their particular field. For this reason they learn only a small part of mathematics, the part that is immediately useful and practical and also indispensable for engineering and elementary science.

There are probably as many answers to the question “What is mathematics?” as there are people qualified to answer this question. To fully appreciate mathematics one must have studied it and have an understanding of the underlying concepts. My purpose is to set forth in words which some one who has not studied mathematics can understand what the word “mathematics” means to me.

Several hundred years ago mathematics problems were stated almost entirely in words and were solved in words. To write what we now symbolize in one line might have taken a long paragraph, and the understanding of this paragraph required a very intelligent man. Mathematics as we know it today is a group of symbols along with some rules for manipulating these symbols. The rules are designed to do all the work and difficult thinking which was formerly written out; i.e.—the notation or symbolism does the work of manipulation and the individual’s mind is left free for more important considerations. Symbolism is one important ingredient of mathematics.

René Descartes, an eighteenth century mathematician and philosopher, is usually considered to be the inventor or originator of analytic geometry. The idea of assigning coordinates to points on a graph was an old idea, but no one had gone any farther than this. Descartes was the first to carry this idea farther in a systematic manner. He was interested not only in the results of his method of attack on geometric problems, but the method itself. This emphasis on method is one of the key differences between mathematics and the other sciences.

Since all branches of engineering can be considered as applied physics, I shall pick on the physicist. Suppose that a mathematician and a physicist read a derivation which should predict the outcome of an experiment. When the physicist reaches the grand result of the derivation, he is more interested in this result than in the derivation; and he gets his assurance that this result is “good” from agreement with the experimental results. On the other hand, the mathematician may call the result “good” even if it does not agree with the results of the experiment; he is more interested in the derivation than in the result.

What does the word “good” mean to each of these hypothetical men? To the physicist, the result is good if it agrees with the experiment. To the mathematician, the result is good if every step in the derivation is valid as determined by the original assumptions and rules for manipulation of symbols.

In physics and engineering, the starting point or the original assumptions are usually glossed over as though things could not be otherwise; the emphasis is placed on the results gotten from these assumptions. Often other assumptions are made tacitly. Not only is the fact that some assumptions are made partially hidden, but the rules for manipulating or applying these assumptions are left unwritten as intuitively obvious. To the physicist or engineer this treatment is all right; to the mathematician this is heresy.

(Continued on Page 29)
What is fiber optics?
Fiber optics is the use of very thin glass fibers or "light pipes" to conduct light from one point to another. A bundle of these light pipes, resembling a rope, can be used to conduct an image.

These fiber bundles can be bent around curves or tied in knots and still conduct the light or image impinging on the end of the bundle. Although bending of light rays is one of the more spectacular applications of fiber optics it is not their only advantage. Because of their ability to accept a wide cone of entering light, they can increase the effective brightness of faint or fleeting objects.

How does fiber optics work?
The basic concept upon which fiber optics operates is known as total internal reflection. Figure 1 is a diagram of these reflections. A ray impinging upon a surface is totally reflected as it is passing from a medium of low density to a medium of higher density at greater than the critical angle. The critical angle is defined as, \( \sin \phi_c = n'/n \) where \( n' \) is the index of refraction of the lower density medium, \( n \) is the index of refraction of the higher density medium, \( n' = c'/v' \), \( n = c/v \) and \( \phi_c \) is the critical angle. \( c \) is the speed of light in a vacuum, \( v' \) is the speed of light in the higher density medium, and \( v \) is the speed of light in the lower density medium.

If each individual fiber picks up a certain amount of light on a particular part of the image, the image will be reflected along the fiber. Then if the fibers are in the same relative positions on both ends of the rope an image will be formed in much the same manner as the newspaper picture. This is illustrated in Figure 2.

Applications
Work with fiber optics is largely still in the research and development stage. However, some applications are now in use.

The foremost application, and probably the one which has been given the most attention, is the gastroscope. This device is used by doctors to inspect the inside of the stomach of a human being. The periscope type instrument now used has blind spots, is uncomfortable for the patient since it is very stiff, and lacks a good light source. All these drawbacks can be eliminated by the use of the fiberscope. The fiberscope is completely flexible since it is made of fine fibers. It causes the patient no discomfort. The light problem is also solved, since the outside fibers in the rope can be used to conduct the light into the stomach and inside fibers can be used to transmit the image back out.

If the fibers in a bundle are not aligned, but rather are interwoven at random, the emerging image will be scrambled. Nevertheless the image will contain just as many units of information as the pattern at the other end. If it could be sent backward through the bundle, or transmitted through a second identical bundle, it would be reconverted to the original form. This suggests that

(Continued on Page 28)
Monorail "Airtrain"—a compact, high-speed transportation system that will be automatic and practically noiseless. Construction is now being planned by leading U.S. cities to provide efficient, low-cost urban transit. Lightweight Monorail design demands strong, weight-saving metals. Logical choice: Nickel-containing materials such as nickel steels for the basic structure, nickel steel castings for underframes, trucks, other load-bearing assemblies.

And Nickel Stainless Steel is a natural for skin and trim on cars—its excellent strength-to-weight ratio permits thinner gauge body shells for dead-weight reduction, its handsome finish stays virtually maintenance-free.

How Inco Nickel helps engineers make new designs possible and practical

When engineers design a transit system, a nuclear ocean liner, or a gas-turbine car, chances are Nickel, or one of its alloys can help the equipment perform better. Nickel-containing metals can provide valuable combinations of corrosion resistance, ductility, workability, and strength at extreme high and low temperatures. Over the years, Inco has developed new alloys and gathered data on the performance of materials under demanding service conditions. This data is available to help solve future metal problems.

Write to Inco Educational Services—ask for List "A". You’ll find descriptions of 200 Inco publications covering applications and properties of Nickel and its alloys.

The International Nickel Company, Inc. 67 Wall Street, New York 5, N. Y.

38 billion light years — that’s how far this 66-story telescope can “see” into space. Nickel in steel gave engineers a material tough enough to maintain precision in the rotating mechanism even with anticipated 20,000 ton load. Nickel used in steel members provided high strength at minimum weight to support the giant reflector.

Magnetic memory. This tiny part takes advantage of the unusual magnetic behavior of a twisted high-nickel alloy wire. Interswoven wire can store thousands of “bits” of information magnetically, ready to answer the computer’s call. When twisted, this high-nickel alloy shifts magnetization direction from longitudinal to a helical path.
**Greek Briefs**

**Alpha Tau Omega**

With the exception of a few the ATO’s are again assembled; bright (?) and cheerful, ready for another year. The comrades of old friends produced the spirit and energy which quickly put the house in full swing and tip-top shape.

The year started off with a bang as our National Chapter Service Secretary, Eric Larson visited us. He came with the intent of providing us with information as to how to improve the chapter, but he could find few faults (not more than two or three, anyway).

Sunday, September 24, one of the days that he was here, we had an initiation. Filled with an excellent chicken dinner prepared by Mom Srofe and the Mother’s Club, we gained our two newest actives, Del Ellis and Dr. J. N. Reeds. Dr. Reeds, head of the Chemical Engineering department, had been pledged the Tuesday before along with Dave Cripe, a Junior.

Earlier in the year elections were held to fill some vacancies. Brother Fred Wright was elected Vice-President, Brother Hannum is the Worthy Sentinel, and Brother Snyder is now the Worthy Scribe.

Summer proved enjoyable for most of us. Several of the neophytes found that their pins were the key to new and invigorating activities. Brothers Ward, Finney, and Allard were all pinned. Summer was particularly happy for Brothers Mitton and Ellis, who became husbands.

Looking forward in the semester, while books and extracurricular activities will keep us busy, we are looking at a hopefully successful football season now that the team has been bolstered by the addition of our talented neophytes.

This year promises more of the fun, work, and friendship which make life worth living.

Bronis de Supinski

**Lambda Chi Alpha**

Another year has seen its beginning and Lambda Chi Alpha has seen fifty-two brothers and eight pledges return for another year of academic endeavor.

With bookwork apparently nearby, some of the brothers actively engaged themselves in the advancement of their social status during the summer interim. Brother Don Bonness availed himself of the summer romance season to pin Miss Susan Chapman, an ISC sophomore. Hal Reilly surrendered his pin to Miss Janet Zakryk, a sophomore at Bucknell University. Carl Moffett bestowed his pin upon his worthy mate, Miss Sarah Bohley, who is presently a career girl. Brother Fred Terry relinquished his pin to an ISC sophomore, Miss Sara Fisher. Last, but not least, Mike Hayes awarded his pin to Miss Jane McQueen, a freshman at I.U. The brothers would like to extend their congratulations to these pin-mates.

Lambda Chi Alpha also wishes to congratulate two brothers who have entered into the holy bonds of matrimony. Ron Klinect has wed the former Miss Lorey Tieber and Ed Blahut has taken the former Miss Bonnie Jean Vanata to be his wife.

Participating in varsity football are brothers Andel, Blahut, Fred Terry, and Kovacs, along with pledge Grafe.

The Lambda Chi Alpha interfraternity football team this season is under the chairmanship of brother Andel. Past practices have indicated that a successful season will be enjoyed by the Lambda Chi Alpha entrant.

During the past summer, brothers Ban, Hobbs, and Hrezo attended the Lambda Chi Alpha Management Training Seminar at DePauw University. Our chapter ranked highly in the awarding of trophies for scholarship. This year the brothers of Theta Kappa brought home the second place award to sit along side the first place trophy won last year. The brothers are proud of these trophies, which are won in the keen competition of more than 150 chapters in the nation.

Page 24 THE ROSE TECHNIC
To open the social season, Lambda Chi Alpha entertained the young ladies from St. Mary-of-the-Woods College at a mixer on Friday evening, September 29.

The brothers of Lambda Chi Alpha wish all faculty and students a successful year.

Bob Valle
John Stockton

Sigma Nu

Fall is here once again and it's good to be back from summer experiences in the cold, cruel world to the old Sigma Nu homestead. With the new semester well under way and six-week exams staring us in the face the brothers at 831 South Center have been fervently working to live up to their resolutions of more study, higher grades, and a schedule permitting more time devoted to further relations with this year's female population.

Brother Bob Lovell, honorable House Manager, was among the first back from his "summer vacation" and by registration day had things organized so that twenty-five men could move into the house. Among the outstanding changes made over the summer months was our acquiring a cook, Aretta DeBow, who immediately won the hearts and increased the waistlines of the Brothers with her old-fashioned good meals.

Since spring is a time of hard work and no play for Rose Men, it seems that "A Young Man's Fancy . . . "'time has been shifted to the summer months. Among those giving up their pins to the fair sex is Brother Jim Brown who pinned Miss Linda Hass. Sharin Brayfield received a pin from Brother Paul Sabia, and Brother Larry Bond and Miss Judy Riggs were pinned this summer. Brother Gary Valbert and Miss Marcia Radcliffe have been pinned since last April, an event which somehow escaped mention in this column until now.

Congratulations go to Dave Larue who has just pledged Sigma Nu. Welcome to the fold, Dave.

The fall football season is upon us and nine Sigma Nus are on the varsity squad. Brothers Hall, Goss, Charleston, Johnson, O'Neil, Petrovsky, Zangelin, Hollobough, and Hoffman are prepared to contribute their share in a winning season. The inter-fraternity squad is fighting for its third championship in a row under the guidance of Brother Dick Landenburger.

Brother Dave Herrington is back among our folds after a year's absence (devoted to hard work, diligent study, and getting married). Thanks to a brand new spirit this year is shaping up to be the best yet for Sigma Nu.

Joe Grumme

Theta Xi

Keep your eyes open this year for some revolutionary action around the vicinity of 902 South 6th Street. It's just an inconspicuous yellow brick building, but what outsider knows what kind of revolution brews within.

If a roar from the basement is per- chance heard in the wee hours of the morning, to avoid malicious rumors, we would like to release the info that the sound comes not from a rocket blastoff, or a midnight bombing (pun intended), but from action packed games of bumper pool and Kickit. These games involve a keen eye and steady nerves, and as the games progress, the tension dv/dt's to the point where the stress reaches a dy/dx equal O, where all emotion is released with great zealor upon which the cycle begins.

A brand new trend has been started to escape the fate of Brothers Cunningham, Pitt, Clayton, and McGivern (huh?). It seems these beloved brothers have fallen by the way side and become maritally involved. It sure was nice knowing them. It seems Brother Cunningham was snared by the wits of Miss Dana Lou Anderson. Brother Pitt was shutdown by Miss Janet Newland. It looks like he will be taking orders from other places than the pentagon. Mike Clayton appears to have wasted his time in Chem E, because his freedom was put into solution by Miss Mary Jane Detrick. So for Bill McGivern, it took him a year and a half to confess his crime. Anyway, back to the trend of escaping the fate of the prementioned. It seems the new trend is to grab your pin and run, or just run and have your pin thrown after you. There will always be a few individuals like "Jorje" McLeLellan and Ralph Wardle, who got engaged to Miss Kitty Doyle and Miss Joanne Nero, respectively (not together).

Another phase of the revolution is the acquirement of some new living room furniture, compliments of Brother Pat Hauert. Also a new roll-away bed was purchased. Funds have also been started for the purchase of our firetruck, a 1921 Stutz. Any persons wishing to contribute to this worthy cause, call C-6294.

Due to extenuating circumstances, we got caught, the "Cowardly Nine" will not appear on the gridiron this year for their annual reign of terror. I seem to hear a cheer from the insurance company, but boos from the plaster cast company. I wonder why?

This year, there will be a gala festival held at one of the local restaurants for Homecoming Brothers. There is a rumor that there may be entertainment by the "ponies".

I guess you're wondering the cause behind this major revolution. Well, the reason is the fall of "Mafia" Malone, now ex-dictator. His regime has been replaced by George McLeLellan, President; Lynn Roberts, Vice President; Steve Kern, Treasurer; Jerry Oxley, Senior House Manager; Jim McClure, Junior House Manager; Curt Yee, Corresponding Secretary; and Joseph (Bud) Weiser, Scholarship Officer. We are keeping a wary eye on the carry-over members of "Mafia's" rule.

Castro had July 26 revolution, so keep your eyes open for the January 1.

Curt Yee
and allow him to fulfill more effectively the non-technical role described previously.

In formulating the project begun this semester with the present Freshman Class in mathematics, the first considerations were to find a method which would reduce the mortality-rate among those who, by all measures available, are capable, and which would also aid in learning how to study technical material. One prevalent factor among the reasons for failure is the lack of morale resulting from getting “lost” and hence getting behind. Generally, it does little good for an instructor to admonish a class to “read the book” when too often one of the difficulties is that students have nothing in their background experience to enable them to understand what is involved in “reading the book”. Often the student is not aware of the questions that should occur to him as he reads technical material and he may or may not be aware that the present-day emphasis on reading-speed has little or no connection with technical material. Indeed, the rate of an hour per page may be an undreamed-of snail’s pace in his mind until he learns that every word and every symbol must be seen and understood. Osmosis has proved to be an all-too-costly and dangerous method of acquiring the ability to read technical material.

Along with these considerations, the Rose project in mathematics seeks to devise a method which can be used in any technical course to show a student how to study that particular type of material. The only technical materials used are the textbook and a mimeographed supplement to the text. The supplement is written in sections paralleling the text and each section of the supplement consists of 1) comments, questions, examples, cautions, and references, all of which might be the remarks of a private tutor working with a student as he studies the assignment; 2) a practice test covering the section; 3) the answers to questions in the first part and in the practice test. After the student is satisfied with his understanding of the assignment using only the textbook, then he uses the supplement to determine whether the points mentioned in the notes were noticed in his previous study. The purpose of this part is to point out exactly those items the student should have noticed, some questions that should have occurred to him, and any relation that that day’s material may have to earlier assignments. When all this is completed, the student may obtain from the proctor a quiz over the assignment which is graded and recorded.

In order to administer the project in a way that would permit a comparison between use and non-use of the supplement, the entire Freshman Class was divided into two groups consisting of three sections each. The two groups were formed by pairing the students on the basis of 1) size of high school graduating class and rank in that class, 2) both verbal and mathematics scores on the college board exams, 3) the number of years of high school mathematics and the average grade in those courses, and 4) the grade on the orientation-week mathematics test. After this pairing was completed, the two groups were formed by separating the students in each pair. In order to further control the influencing variables, each instructor has one section which uses the printed supplement and one section which does not. Each pair of sections, under the same instructor, receives the same lectures, the same recitation periods, and all students take the same test every third week and at the final examination time. All students are receiving at least as much instruction as did preceding classes. While no comparisons of individual by individual can be expected to be particularly meaningful because of the differences in motivation, goals, self-discipline, outside distractions, etc.; nevertheless, comparisons of paired sections are expected to show whether use of such a supplement may be of value.

One important feature of this project is that regardless of the value or lack of value of this method, every student will have had at least as much instruction and help as he would have had if the project never been undertaken. In short, no student is in the position of having been ruined because of an experiment which did not succeed.

Role of the Student

The role of the student, aside from that of “learner”, in this entire undertaking must not be under-rated. As an aid in improving the supplementary material, each student using it is asked to accept the responsibility of pointing out to the proctor (and writing appropriate suggestions in the supplementary book) those parts which need more explanation, those parts which are not covered at all in the supplement, those parts which seem to cause difficulty in understanding, and those parts of the notes which are vaguely or poorly written. All these aids to the authors will make possible an improved edition to be used with the next Freshman Class, so that such contributions by the students of the present class will be of much value to others as well as themselves.

As with any innovation, there will be bugs to iron out, unfortunate confusion and even disappointment resulting from being or not being in the group using the supplementary material. The Mathematics Department solicits constructive criticism not only from the Freshman Class but also from other students since both faculty and students are primarily interested in but one thing: how to do a more effective job of teaching not only the course material but also the difficult assignment of how to think analytically.

There is apparently no similar investigation being undertaken elsewhere and the appraisal so far by several persons not connected with Rose has been most encouraging. If this project is successful, then much of the credit must go to students; it will be students who will have made the supplementary material understandable to the only people to whom it can be of value—more students.
REFRACTORY MATERIALS
(Continued from Page 18)

tive coatings is in the neighborhood of 3000° F., whereas the need is for coatings resistive to temperatures around 4000° F. Coatings must satisfy the following conditions:

(1.) Exclusion of oxygen from the surface of the metal.

(2.) Applicability to complex configurations by many processes, including plating, cladding, spraying, vapor deposition, etc.

(3.) High resistivity to development of flaws.

(4.) Suitability for use on several alloys.

(5.) Negligible reduction in properties of base metal. Currently, ceramics are being investigated for the purpose of coating other refractories. Glass also is a leading contender in this field. Other possibilities include Inconel, alumina plus glass with Columbium as base, alumina plus chromium with Molybdenum as the base metal.

For today’s aircraft and spacecraft needs, nickel base alloys are used to a large extent. One of the newest of these is Rene 41, which is an age hardenable, austenitic alloy. As it is a typical refractory metal, a description of it, its strengths, its weaknesses, and its problems in development will suffice for the entire field. Rene 41, classed as an intermetallic precipitate of nickel-aluminum-titanium, has a yield strength at 1400° F. of 110,000 pounds per square inch, and at 1200° F is twenty-five percent above all other comparable refractories in strength. There are two types of processing for this alloy depending on whether the requirements demand high tensile strength or high stress-rupture strength. All nickel-base, precipitation-hardening alloys derive their strength from intermetallic compounds dispersed in a solid nickel-rich solution. In Rene 41 Ni₃ (Al, Ti) is prevalent between 1400° F., and 1850° F., which gives the metal its high temperature resistivity.

As in all high temperature metals, welding and brazing is a problem with Rene 41. The following requirements seem to be standard in welding refractory metals:

(1.) Material must be properly annealed before welding.

(2.) Good fit-up is mandatory.

(3.) Gas must cover both sides of joint on all butt joints.

(4.) All burrs on joint must be removed before welding.

(5.) Arc length and current must be controlled to allow only minimum heat input.

(6.) Automatic welding is best. To minimize weakening due to oxidation, the weld must be shielded from the atmosphere. Any working of the metal must be done at or near 1975° F. Silicon and boron, which are used in the brazing operations, violently attack nickel-base alloys. Silver brazing does not have this effect, but its maximum service temperature until recently was only 600° F. New developments have raised this temperature. When brazing high temperature metals, a host of factors must be considered in the realms of processing and service.

Besides the mentioned nickel-base alloys, work is being done on developing Molybdenum, Columbium, Tantalum, Tungsten, and Rhenium as refractory metals for spacecraft. One of the most promising of these is Rhenium, which has a terrific strength-to-weight ratio, is inert at high temperatures, and is light in weight. Another major point in favor of this metal is its high resistivity to a large dose of radiation. In addition, it is easily worked, which is a drawback for many refractory materials.

One of the major problems with all of these refractory metals is the high cost due to scarcity, inaccessibility of natural resources necessary, problems in processing because of the care which must be taken and the temperatures at which the processes must be carried out, and the high cost of brainpower required to create these new metals. Still another cost factor is the high cost of special testing equipment needed to test these materials at their operating temperatures.
coasting along its orbit, Mr. Murchie surveys the heavens and ponders the vastness and complexity of the cosmos. Mr. Murchie inquires into such matters as the best routes for space vehicles to follow, the possibility of being lost out there while in clear view of one’s destination, and the rhythms of the bounded and unbounded universes.

Isaac Asimov says of the book: “One can only stand amazed at the breadth of Mr. Murchie’s understanding and his ability to put the facts and speculations of science into colorful and non-technical language. Reading this book was an experience . . . and a pleasure.

Tiger by the Tail,
by Alan E. Nourse
A collection of nine science fiction stories by Alan E. Nourse. Some of these stories are breathlessly exciting, some are charged with suspense, and some are happily humorous. But all of them are first and foremost good science fiction!

The Five Worlds of Our Lives,
by the Editors of Newsweek
IMPERIALISM . . . IDEALISM and
UPHEAVAL . . . DICTATORS . . .
NATIONALISM . . . SPACE

This is the story of the great forces surging beneath current news, forces set in motion since the turn of the twentieth century and shaping the course of world events today. It ranges from the bold explorations and conquests of the world of Imperialism, to the hopes and struggles of the world of Idealism and Upheaval, the terror of the World of Dictators, the volcanic World of Nationalism, and on to the soaring, breathtaking adventures of the World of Space. You see the relationships between problems and resulting events. More than four hundred photographs, many in color, are integrated into the text, illustrating every key turning point.

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WHAT IS MATHEMATICS?

(Continued from Page 21)

The mathematician requires that all assumptions and manipulative rules be explicitly written out. Then he can justify each step in a derivation by reference to a written assumption or rule; any step which can not be so justified can not be permitted in the derivation. When the mathematician reaches the end of the derivation, he is certain that on the basis of his assumptions and rules the result can not be otherwise.

Unfortunately, the foregoing words probably mean one thing to some one who already knows what I am trying to say and mean something else to some one who does not know what I am trying to say; so I will illustrate with an example.

During freshmen orientation week I was asked to prove an inequality. The inequality was one which every self respecting engineer would call obvious. The problem the freshmen faced was not merely the inequality; it was the word “prove”. What does one do to prove something in mathematics? “Prove this theorem” means: (1) start with an original assumption (called a postulate) or with a previously proven theorem; (2) work with this postulate or theorem according to the manipulative rules until the desired theorem results, i.e.—show that this theorem is a logical result of the original postulates and manipulative rules. (The word “logical” refers to the ordinary ideas of Aristotelian logic.)

The first step in proving this inequality is to find a starting point. If very many theorems have been proved from the postulates, then one of these is probably the starting point. I started with a list the freshmen had of previously proven theorems and proceeded to prove the inequality. When I was done, they accepted the inequality as proven; but they accepted the proof because I said it was a proof and not because they were sure a proof had been given. When a mathematician is through with a proof, he knows that he is through because he can justify every step by a written explicit rule along with the postulates and previously proven theorems. He does not merely think that he is through and correct because he arrives at a desired result or because some one else tells him so. Of course a freshman is not expected to know what constitutes a proof; that is one of the things he might learn at Rose.

By having rules explicitly stated, the mathematician can systematically carry his work forward. Mathematics is an explicit systematic way of thinking.

The foregoing is not meant to say that the mathematician is not interested in results, but rather that his special interest is in being certain that a so called result is really a result of the assumptions and rules. He does not call a result good just because it agrees with his intuition.

Many students have trouble with theory and would rather stick to problems. But theory is just a grouping together of all problems with some particular feature in common. Any specific example or problem has its own particulars which usually cloud the real underlying issue of the problem so that the investigator gets lost in unessential information. But the theory strips away most of the miscellaneous information and underlines the essential part of the problem for the investigators attention so that he gets an unclouded view.

Applied mathematics tends away from the straight assumption and rule approach so that what is taught as a tool for an engineer will be related through the world of pictures to problems the engineer may face. That is, things which will probably be applied directly to the physical world are usually introduced with reference to intuitive concepts of the physical world.

Take the definition of an integral as an example. The definition can be stated and the properties derived with no reference to the concept of area. In fact “area” should probably be defined in terms of the integral. But to keep the engineers happy, the integral usually has the concept of area tied to it.

Although the postulational approach is not always in the spotlight in freshman and sophomore calculus, calculus could be presented in this way.

The much more interesting part of mathematics deals with things which are abstract and not tied to intuitive physical situations. The only way to find out about and appreciate the more interesting part of mathematics is to study mathematics. To go on and try to describe these advanced topics would be like describing freshman calculus to some one who has not yet had algebra. The appreciation of these advanced topics requires a thorough knowledge of them; a description is not enough.

This concludes my opinion on “What is Mathematics?” Again I must emphasize that others may disagree with my opinion, but I hope that this article might serve as a guide to some one who is trying to decide if he would like to study mathematics.
What part of your college education has proved most valuable to you?

In construction you don’t use specific technical information you’ve learned as much as your general engineering background, because the highway is already designed. But you must have the knowledge of why it is designed as it is in order to make sound engineering judgments in the field and make changes if necessary. So your whole college background is important.

You took advanced ROTC at Rose and spent six months in the Army. What is your opinion of ROTC now?

At the time I took advanced ROTC the Korean War was going on, which made a lot of people decide to take it whether they wanted to or not. But I’m glad that I took advanced ROTC. I gained a lot of valuable experience in the Army as an officer. I learned a lot dealing with men. I was in a position of authority and had to make decisions, which an engineer has to do all his life. Also, I think every man should have a working knowledge of our armed forces, and you get much more as an officer.

As an alumnus, do you feel that Rose’s traditions, such as the traditional freshman-sophomore rivalry, are of value?

Since I graduated from Rose, and even while I was there, there has been a trend toward more book knowledge and less horseplay. Of course, the main reason you go to college is to gain knowledge, not to play around, but a college education is no good in life unless you get some of the other things too.

I feel that I gained a lot which has helped me in life from the extra-curricular activities and fellowship between the classes, which is brought about by the traditions more than any other thing. You don’t find that kind of fellowship among any other engineering graduates that I’ve seen anywhere, large school or small. It seems to me that from the graduates I’ve seen in the last few years this element may possibly be lacking somewhat, due to the fact that there is less fellowship between the classes now.

Is there any advice you would give to Rose students?

Well, I could probably get more advice than I could give. I’m still learning every day and hope to as long as I practice engineering.

I think you should strive to become a professional engineer. That takes four years after graduation in most states.

The best advice I can give is not to think you know everything about engineering just because you’re a college graduate, because you probably don’t know anything. You’ll learn just as much from practical experience as from college. If you don’t you’ll be left behind. You have to study continuously.
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Kokomo, Indiana
The lumber camp foreman put a newly hired Rose Tech graduate to work beside a whizzing circular saw. As he started to walk away, he heard an "ouch!" and turned to see the Rose graduate looking puzzledly at the stump of a finger. Rushing back, he asked what happened.

"I dunno," said the boy. "I stuck my hand out like this and... well I'll be damned, there goes another one."

Frosh: "A woman's greatest attraction is her hair."
Soph: "I say it's her eyes."
Jr.: "It's unquestionably her teeth."
Sr.: "What's the use of sitting around lying to each other?"

Don't worry if your grades are low,
And your rewards are few;
Remember that the mighty oak
Was once a nut like you.

Mother (putting Junior to bed): "Shh... the sand man is coming."
Junior: "For fifty cents I won't tell Daddy."

Jack and Jill went up the hill,
Upon a moonlight ride.
When Jack came back, one eye was black
His pal, you see, had lied.

Two producers were watching the star of a Broadway play. "I wonder who made her dress," said one of them admiringly.

"It's hard to say," answered the other, "probably the police."

The younger generation still has great respect for old age—provided it's bottled.

Anyone can play bridge, but it takes a cannibal to throw up a hand.

ROTC Sergeant: "Does your uniform fit satisfactorily?"

Frosh: "Well, the jacket is okay, Sir, but the pants are a bit snug under the armpits."

"Was her father surprised when you wanted to marry his daughter?"

"Was he surprised? Why the gun fell right out of his hands."

A husband answering the phone: "How do I know? Why don't you call the weather bureau?"

"Who was that?" asked his wife.
"Some fool wanted to know if the coast was clear."

For years the bum slept under bridges and in ditches. Then one day switched to culverts and became a man of distinction.

Customer: "Your dog seems very fond of watching you cut hair."
Barber: "Naw, it's just that once in a while I snip off part of the customer's ear."

Polo is golf with fertilizer.

"Use a bottle opener, Granny. You'll ruin your gums."

Mary had a little skirt,
And it was very tight,
Who gives a damn for Mary's lamb,
With Mary's calves in sight.

Atheist: a football fan who doesn't care who wins the Notre Dame - Southern Methodist game!

A German was the guest of a Frenchman who asked him how they distinguish between an optimist and a pessimist in Germany.

"It's very simple," replied the German. "The optimists are learning English and the pessimists are learning Russian."

When a man has no education he has to use his brains.
The engineer designing and constructing vessels finds photography one of his valuable tools. Motion-picture studies of models in tanks help in hull design. Electron microscope plates contribute to the proper metallurgy for propellers and other parts. And radiography checks welded seams of hull plate and piping as well as heavy castings for internal imperfections.

The same is true in virtually every field of engineering effort you may pursue. Whether in research, production, sales or administration, the use of photography will work with you to simplify work and routine, to save time and costs.

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If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N.Y.
Dr. Hollomon, what characterizes the new needs and wants of society?

A. There are four significant changes in recent times that characterize these needs and wants:

1. The increases in the number of people who live in cities: the accompanying need is for adequate control of air pollution, elimination of transportation bottlenecks, slum clearance, and adequate water resources.

2. The shift in our economy from agriculture and manufacturing to "services": today less than half our working population produces the food and goods for the remainder. Education, health, and recreation are new needs. They require a new information technology to eliminate the drudgery of routine mental tasks as our electrical technology eliminated routine physical drudgery.

3. The continued need for national defense and for arms reduction: the majority of our technical resources is concerned with research and development for military purposes. But increasingly, we must look to new technical means for detection and control.

4. The arising expectations of the peoples of the newly developing nations: here the "haves" of our society must provide the industry and the tools for the "have-nots" of the new countries if they are to share the advantages of modern technology. It is now clearly recognized by all that Western technology is capable of furnishing the material goods of modern life to the billions of people of the world rather than only to the millions in the West.

We see in these new wants, prospects for General Electric's future growth and contribution.

Q. Could you give us some examples?

A. We are investigating techniques for the control and measurement of air and water pollution which will be applicable not only to cities, but to individual households. We have developed, for example, new methods of purifying salt water and specific techniques for determining impurities in polluted air. General Electric is increasing its international business by furnishing power generating and transportation equipment for Africa, South America, and Southern Asia.

We are looking for other products that would be helpful to these areas to develop their economy and to improve their way of life. We can develop new information systems, new ways of storing and retrieving information, or handling it in computers. We can design new devices that do some of the thinking functions of men, that will make education more effective and perhaps contribute substantially to reducing the cost of medical treatment. We can design new devices for more efficient "paper handling" in the service industries.

Q. If I want to be a part of this new activity, how should I plan my career?

A. First of all, recognize that the meeting of needs and wants of society with products and services is most important and satisfying work. Today this activity requires not only knowledge of science and technology but also an understanding of economics, sociology and the best of the past as learned from the liberal arts. To do the engineering involved requires, at least for young men, the most varied experience possible. This means working at a number of different jobs involving different science and technology and different products. This kind of experience for engineers is one of the best means of learning how to conceive and design — how to be able to meet the changing requirements of the times.

For scientists, look to those new fields in biology, biophysics, information, and power generation that afford the most challenge in understanding the world in which we live.

But above all else, the science exploration of the last several decades means that the tools you will use as an engineer or as a scientist and the knowledge involved will change during your lifetime. Thus, you must be in a position to continue your education, either on your own or in courses at universities or in special courses sponsored by the company for which you work.

Q. Does General Electric offer these advantages to a young scientist or engineer?

A. General Electric is a large diversified company in which young men have the opportunity of working on a variety of problems with experienced people at the forefront of science and technology. There are a number of laboratories where research and advanced development is and has been traditional. The Company offers incentives for graduate studies, as well as a number of educational programs with expert and experienced teachers. Talk to your placement officers and members of your faculty. I hope you will plan to meet our representatives when he visits the campus.