Volts may do you more good than Aspirin...

An electronic device has successfully steadied hearts that were flailing at the verge of failure. Slim electronic tubes, mounted as a test in the ceilings of 15 operating rooms, cut the rate of post-operative infections to a fortieth of what it was before. A new fluoroscope system makes the patient more comfortable and permits the doctor to make his examination from a distant location where he observes by television. Indeed, several doctors may observe at one time. Future possibilities include a "listener" to tell just how the heart of an unborn infant is doing and a "looker" to locate bone fractures without radiation. Scientists over the world are working on new ways to help doctors treat the complex machine we call the human body. "Electronic Medicine" is a major research area at Westinghouse. You can be sure... if it's Westinghouse.

For information on a career at Westinghouse, an equal opportunity employer, write L. H. Noggle, Westinghouse Educational Dept., Pittsburgh 21, Pa.
THE ILLINOIS
TECHNOGRAPH
Volume 78; Number 8
May, 1963

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The Cover: by Gerry Welton, Industrial Designer

Automobile Air Pollution

Less and Less

about

More and More

Engineering—Tenth Ill. Export

A recent survey by the ISPE for the Governor’s Board of Economic Development has shown that engineering ranks among the top ten export industries in the State of Illinois. Since January 1, 1958, 24 state firms have been responsible for engineering planning and design on $729,978,000 in international construction.

As of last January, Illinois consultants had $391,990,000 in foreign construction in process or on their drawing boards. Another $200 million was reported as still in the planning stage.

How Popular Are Engineers?

Most engineering students tend to feel their social status is somewhat forlorn. For these wretched souls, here is an encouraging footnote. A Gallup poll recently asked public opinion about choosing a career. “Assuming a person was qualified to enter any of the following professions, which one would you first recommend to him?”

Public response was as follows:

1. Doctor .......................... 23
2. Engineer - builder .................. 18
3. Professor - teacher ................ 12
4. Clergyman .......................... 8
5. Government career .................. 7
6. Lawyer .......................... 6
7. Business executive ................. 5
8. Dentist .......................... 4
9. Banker .......................... 4
10. Other and don’t know .............. 15

But the best is yet to come! College trained Americans responded as follows:

1. Engineer - builder .................. 24
2. Doctor .......................... 18
3. Professor - teacher ................ 18
4. Lawyer .......................... 8
5. Business executive ................. 7
6. Dentist .......................... 5
7. Clergyman .......................... 3
8. Government Career .................. 4
9. Druggist .......................... 3
10. Other and don’t know .............. 12

Mount your white horses, engineers, and spread the word... Some seem to doubt our position in society. In the educated public’s eye we are held in highest esteem... Could it be others are only envious?

October 28-30 NEC Conference

Electrical engineering students should start planning early to attend the 19th Annual National Electronics Conference and Exhibition on October 28, 29, and 30 at Chicago’s magnificent lakeside exposition hall, McCormick Place. The NEC is a non-profit organization chartered in the State of Illinois. It serves as a national forum for the presentation of authoritative papers on electronic research, development, application, and education.

More than 20,000 engineers, scientists, and management representatives will attend the informative technical sessions of the 1963 NEC, and will be anxious to examine and discuss new products. The Conference presents a unique opportunity for engineering students to hear the latest electronic ideas and see the newest electronic developments displayed by virtually every electronics firm in the nation.

Illiac II Responds Again!

Gone are the “good old days” when mathematicians could idle away their time making endless calculations. After 85 minutes and 34 billion multiplications and additions (the equivalent of 80,000 man years; that is 160 men working with pencil and paper since the time of Columbus) the new Illiac II high-speed electronic computer has discovered and proved a new prime number. This number has 2,917 digits, and is the biggest prime number yet proved.

For those of us in doubt, a prime number is one which can be divided exactly only by itself. Prime numbers are 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, and so on. The larger they become the fewer there are. Even though an infinite number of primes exist, they are increasingly hard to find because of the tremendous computation required. The previously largest known prime had 1,332 digits—less than half as many as the new one.

The only way to determine if a number is prime is to test it. Prof. Donald B. Gillies of the U. of I. Computer Laboratory programmed Illiac II to examine 400 numbers. Of these only one proved to be a genuine prime number. Although such numbers may not be of general interest to the engineer, it is an interesting and pertinent discovery to the world of mathematics.

by Gary Daymon
Our gasoline isn’t good enough for some people...us

We like to think that American Oil products are the best you can buy. And they are. We also like to think we can improve the quality of our products without increasing the cost to the consumer. And we do. Consistently.

A considerable amount of work is done in testing catalysts and searching for those which will help produce the types of gasoline our customers want at the price they can afford.

One of the people engaged in the research and development of our manufacturing processes is John Mitchell, 24, a graduate Chemical Engineer from the University of Texas.

The opportunities for bright young scientists like John Mitchell are virtually unlimited at American Oil. American Oil offers a wide range of new research opportunities for: Chemists—analytical, electrochemical, physical, and organic; Engineers—chemical, mechanical, and metallurgical; Masters in Business Administration with an engineering (preferably chemical) or science background; Mathematicians; Physicists.

For complete information about interesting careers in the Research and Development Department, write: J. H. Strange, American Oil Company, P. O. Box 431, Whiting, Indiana.

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

Organic ions under electron impact • Radiation-induced reactions • Physicochemical nature of catalysts • Fuel cells • Novel separations by gas chromatography • Application of computers to complex technical problems • Synthesis and potential applications for aromatic acids • Combustion phenomena • Design and economics: new uses for present products, new products, new processes • Corrosion mechanisms • Development of new types of surface coatings.

STANDARD OIL DIVISION
AMERICAN OIL COMPANY
ATTITUDE

by Dean H. L. Wakeland

Many years ago a cave man picked up a stick. Rather than kill or destroy with it, he used it to measure with. He found that by laying it down in end to end patterns he could compare the length and sizes of various objects. In a small way he contributed to the world in which we live because he had a constructive attitude as opposed to a destructive one like many of his fellow men.

An attitude is comprised of many parts and often depends largely upon previous environments as did the attitude of the cave man. Ambition, ideals, ideas, mental ability, knowledge, health, stature and memories are only a few of these parts.

Students at the University of Illinois have, for the large part, been removed from their childhood environments in hopes of broadening both their educational and sociological experiences.

In early summer you seniors and some undergraduates will be going out from the university on many roads to seek what is to be. The knowledge you have stored will help to bring this new world into focus. The thoughts and feelings and emotions you have accumulated will control your behavior. How you put together knowledge and thoughts and actions (i.e., your attitude) will decide your standard of living, your happiness and your contribution to society.

How much knowledge have you? The sum total will surprise you, because it has come to you in driblets year by year, grade by grade. You probably never thought of it as a thing in itself, but only by bits and pieces.

Survey its fullness. It is not only stored in factual things like dates, formulas, mathematical rules, biological data, and places but you have also stored away sensory images, appraisals, and memories of experiences. These have added to your intellect and spurred your imagination.

Now it is time to put these things to work. If you keep them locked up as a private possession—if you try to enjoy all that you have learned without connecting it to the pulsating life about you, then what you possess is not valuable property. And like real estate, if you let it lie idle, it will slowly but surely deteriorate into nothingness.

This is not to intimate that your knowledge is complete and finished. The greatest for you will meet in your effort to get along in the engineering profession is the temptation to allow your mind to develop the idea that you know enough. Yet every new sight and experience widens the area of your awareness of what there is yet to learn.

Besides knowledge and intelligence you have to have ability and efficiency. Ability means something more than book learning and technical skill. You might score one hundred per cent of marks in a written examination; you might have the "hang" of a routine experiment at your finger tips; but unless you display ability through craftsmanship you are not scoring one hundred per cent in your new life. And what is craftsmanship? It means doing habitually well whatever it is you have to do. You are not going to be given a seat behind an executive desk without showing some other ability than that of sitting.

"Efficiency" is a measurement of the quantity of work you produce, measured by time, and the quality of your work measured by its goodness. You are, in this new world, only as good as your performance proves that you are. Everything you do will not be a masterpiece. Even the great painters and sculptors had their uninspired days. But what you do should be workman-like, the best that you can do at the time you do it.

You have learned other certain fundamentals—patience, discipline, honesty, integrity, respect for the law, respect for proper authority, discretion, and prudence. Until now many of these have been learned under tutelage but now you are entering into mature responsibility. There have been men who were capable of governing a world, but who could not rule their own restless minds or bodies. Will you have obedience to others as well as obedience to your own principles? Will you be able to balance expectations against reality, fit into groups harmoniously, give sturdy allegiance to people and principles, and keep your balance in success or failure? Your personal answer to these questions in the future will reflect the kind of an attitude you have.

People talk about "having an aim in life." Have you one? Is it a fast dollar or to contribute to society? Planning for the future, mapping out the route to be taken, working toward realization of your aim; all this is a part of the joy of living. The great thing is to advance, so that you feel at the end of your career that you have in some measure fulfilled the potentialities that you now believe you possess.

It is a time to raise your head so that you can see some distance. The ambitious man will seek to make a mental picture of the professional territory as well as to acquaint himself with his own possibilities and limitations. Avoid day-dreaming about a fairy country but tie your plans to realistic goals. Also avoid trivialities. To multiply ten figures by ten in your head or to compute faster on a slide rule than on a desk calculator are definite tests of dexterity of the mind and body but in itself, nothing comes of either.

Have you that quality called "enterprise?" Have you the ability to think and do things and an aptitude for action which puts this knowledge to work? "Enterprise" is not a quality needed only in industry or business but in all phases of our society—governmental agencies, armed forces, welfare organizations and universities. All the vision and desire in the world will not add an iota to your success unless you also have the energy to work.

You are entering a society which places emphasis on leisure, comfort, time-killing pursuits, sensations, fads, and novelties. It will be difficult for you to stick to your goals and shun the easy living trend. But true happiness will come only through your own self-reliance and accomplishments. People who flitter away their time are cheating themselves into hocus happiness. They are stuffing into the coffers of their irreplaceable lifetime a senseless accumulation of trash, odds and ends, experiences, and synthetic emotions.

If you have an enthusiasm for living it will carry you through many difficulties. But enthusiasm is built on ideas, positive thinking, and an active life. Every visible successful act is first of all an invisible thought which only actions and application bring into being.

In this rambling account are a number of qualities which form your attitude. As you enter the mature phase of your life—the responsible productive phase—the most important thing you can possess for your employer, yourself, and society, is a right attitude. Will you be able to think beyond your environment and training with a constructive attitude, like the cave man did?
THE BELL TELEPHONE COMPANIES
SALUTE: TOM HAMILTON

When the Bell System recently product-tested the new Touch Tone telephone in Findlay, Ohio, they called on Ohio Bell's Tom Hamilton (B.S.E.E., 1960) to coordinate the project. Quite an honor since this was one of two Touch Tone trial areas in the entire country.

This happened on Tom's second assignment with the company. Since completing the project, Tom has joined the Fundamental Planning Engineer's Group. Here he makes engineering economy studies and submits programs for capital expenditures. Tom's performance has earned him the opportunity to attend a special six-month Bell System engineering course in Denver.

Tom Hamilton and other young engineers like him in Bell Telephone Companies throughout the country help bring the finest communications service in the world to the homes and businesses of a growing America.

BELL TELEPHONE COMPANIES

TELEPHONE MAN-OF-THE-MONTH

MAY, 1963
At the turn of the nineteenth century, railroads provided the only effective means of mass intercontinental transportation. In fact, the railroad industry virtually monopolized all long and short distance hauling merely because they had no competitors. As the automotive, inland water carrier and pipeline industries grew, the railroads' monopolies began to disappear.

By 1945, railroads were still the king of transportation, but the efficient and flexible trucking companies began presenting serious competition (especially on shorter hauls). As a result, railroads were forced to keep only an auspicious steady business volume even though total national business had grown. In general, since 1945 the percentage of railroad business has been steadily declining.

**Railroad Modernization**

Railroads are now developing specialized cars in an attempt to compete economically with other modes of transportation, to regain lost freight and to satisfy individual shippers. The specialized car is normally specifically designed for only one product. Its chief advantage is its increased size, and loads of one hundred tons, almost twice the capacity of older cars, are not uncommon for new cars.

**Size Advantages**

Size advantages can be explained best by stating an economic law in railroading: As the capacity of a car increases, profit also increases. This is rather obvious since it is easier to deploy one 100-ton-capacity car costing $25,000 than two 50-ton-capacity cars, each costing $15,000. Increased size results in a twofold profit increase: a decreased material cost for each car and a relative payload increase. In the newer cars the deadload to payload ratio is lowered. Likewise, it is reasonable to assume that the larger car has a greater payload volume.

In general, this necessitates more profit, but simultaneously, engineering problems involving excessive stresses on car wheels and rails are introduced. These will be discussed later.

**"Monster" Tank Car**

Before the rail-wheel problem is pursued, consider a new and interesting body design which has been successfully used on a tank car (See figure 1.) The body of this car was built to carry its own load; it has no conventional underframe. The General American Transportation Company built the 30,000 gallon capacity tank car, which is about twice as long as the old "standard" tank car. With the tremendous increase in the unsupported body span and the increased load-carrying capacity (70 tons vs. approximately 40 to 50 tons) this car is an all-around success.

---

This General America Transportation Company tank car has a capacity of 30,000 gallons and is about twice as long as the old tank cars.
## Maximum Load on Wheels of Various Diameters

<table>
<thead>
<tr>
<th>Nominal Wheel Diameter</th>
<th>Lbs. per Inch</th>
<th>Wheel Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 inches</td>
<td>800</td>
<td>26,400</td>
</tr>
<tr>
<td>36 inches</td>
<td>810</td>
<td>29,200</td>
</tr>
<tr>
<td>38 inches</td>
<td>820</td>
<td>31,200</td>
</tr>
<tr>
<td>40 inches</td>
<td>825</td>
<td>33,000</td>
</tr>
<tr>
<td>42 inches</td>
<td>830</td>
<td>34,900</td>
</tr>
</tbody>
</table>

### Exceptions to be permitted for a limited number of cars for heavy loads

which shall be subject to approval by Mechanical Division, A.A.R.

### Other Applications

Fortunately, such designs are not limited to tank cars. If the same materials, design features and load weights (the only general considerations for any body design) are used as in GATC’s monster tank car, it is reasonable that any load can have its own car.

Since the underside can be designed to accommodate wider, longer unloading mechanisms, the unloading time is shortened by utilizing the latest unloading devices. In the case of tank and hopper cars, a series of valves or wide-swing doors not only speeds up unloading but also decreases the “turnaround” time. From an economic standpoint this is very important for efficient utilization, since the new car can be used more times. For instance, Pullman-Standard has a hopper car with 40’ x 2’ unloading mechanisms. It can be loaded with 3,000 bushels of corn in 12 minutes and emptied in 2 minutes and 40 seconds. The total weights of this type of payload is approximately 168,000 pounds.

### Size Problems

Current trends toward increased payloads per car introduces two major problems: wheel-rail damage and incompatible coupler heights. The new, larger and heavier cars produce greater stresses on rails. Present track steels allow shear stresses of 40,000 to 45,000 psi. If a new car carries a 160,000 pound load, each one of its eight wheels supports 20,000 pounds. Ideally, the contact between wheel and rail produces no stress area (point contact).

Practically, the wheel and rail are deformed enough to produce an elliptical stress pattern of approximately 0.2 — 0.4 square inches depending upon the weight of the total load. This deformation produces a stress range of 50,000 — 67,000 psi, which exceeds the present allowable stress limit by 10 — 15%. Obviously, either the strength of the wheel and rail must be increased or other solutions must be found.

Fatigue considerations cannot be overlooked. Experimental evidence shows that stresses greater than 50,000 psi produce fatigue failures at approximately 16,000,000 cycles. A larger increase in stress (51,500 psi) induces failures at 4,000,000 cycles and 71,500 psi stress causes failures at only 1,150,000 cycles. The method of fatigue loading during the test was complete reversal. This test reveals that with greater wheel loads, rail life is decreased, and the safety factor concept is non-existent.

Plastic flow in rail heads is also a common occurrence. Simple distortion experiments were conducted and it has been shown that current loads produce compressive, tension and shear stresses which exceed yield stresses. Copper pins are inserted in the rail head at right angles to the surface. (See figure 3.)

The rails are used for several years and then removed for inspection of the pins. The bending of the pins in the direction of flow of metal is quite evident, thus establishing the fact that present wheel loads are producing stresses far beyond the yield point of the metal.

### Increased Rail Sizes

Several attempts have been made to reduce rail stresses. One suggestion is increased rail size. This idea is unsatisfactory since the cost of rails would increase proportionately with the additional steel needed, and it would not be economical to replace the old rails.

Likewise, a larger rail would not be justified since it produces exactly the same function as a smaller rail. Rails are designed with a convex surface for minimum rail-wheel contact. This particular geometric configuration reduces wear, friction, and flattening of the surface. Now consider the smaller and larger rail carrying the same load. Regardless of the size of the rails, the actual deformation between the rail and wheel produces the same elliptical area. The stresses incurred are identical, provided the same materials are used. Therefore, absolutely nothing is gained by increasing the rail size.

A larger rail requires special heat treatment. Heat treating of the metal decreases rail distortion since the rail is hardened, and the yield point is thereby raised. This is desirable, since the yield point increases, the metal becomes more brittle, and the fatigue properties are unsatisfactory. Therefore, what is gained in one way is lost in another. Still worse, the heat treating process costs 50 per cent more than standard rail production methods. Rail costs are currently about $115 per ton and $65 per ton must be added for heat treating, thereby making this solution economically undesirable.

### Greater Wheel Diameters

Now consider a satisfactory solution. Either the load per wheel must be de-
increased or the wheel diameter must be increased with increasing loads. Decreasing the load per wheel cuts the payload per car; therefore, this is undesirable since the objective is to increase payloads. Mathematical equations governing wheel diameters and loads have been developed. These indicate that internal stresses within the wheel and rail decrease in direct proportion with a decrease in load, but in even greater proportion with an increase of wheel diameter. Suggested wheel loads and diameters will no doubt be a common sight on newer cars, since this seems to be the only practical solution thus far considered.

**Coupling Complexities**

If wheel diameters increase, the height of the coupling mechanism increases also. This is easily understood. If the car remained at one height, the cushioning mechanism of the coupler would occupy the same space as the raised wheel axle; obviously, an impossible situation. Furthermore, present car designs consider the coupling mechanism as a part of the body rather than a part of the wheel assembly. This means that every time a larger wheel is used, the body must be redesigned to accommodate a coupler of standard height.

Presently, train loads consist of many varied products, but future plans suggest the intensive use of the integrated train concept—a whole train of high capacity cars which will carry only one product. Since couplings between these new and old cars are inevitable, coupler heights must be considered. The purpose here is to suggest a truck design philosophy which will permit new and old cars to be coupled. This truck design integrates the cushioning mechanism, and the dependence of coupling height on wheel diameter disappears exists since the couplers are no longer a part of the bodies but rather a part of the trucks themselves. Thus couplers can be kept at a standard height regardless of wheel size and without interference between coupler and axle positions.

Fundamentally, future redesigning for still heavier loads is unnecessary. If heavier loads are in demand, the body size increases and so does the wheel diameter. But since the body and truck assembly can be separated, the body no longer needs to be designed around a coupler height. The trucks (now including the coupler mechanism) will increase proportionally in size, and all coupler heights are consistently standardized with the rising load trends. Designs for optimum size of load and for variable wheel sizes can then be made without any concern for interference of operational elements.

To omit the other recent advances in new designs would be an injustice to the railway freight car industry. The most significant of these advances is the use of more functional materials such as stainless steels, aluminum, resins, plastics, spray foam insulators, reinforced concrete and fiberglass.

Mr. Nervi, new car design experimenter, claims that a reinforced concrete body is stronger than a steel body when the weight of the two materials are compared. In general, the body is easily made by applying cement to preformed steel reinforcing. The process is similar to latex plastering.

Plastic and fiberglass bodies also help to solve the weight and corrosive problem while resins and fiberglass provide a better lining for carrying liquid acid products.

The research possibilities for efficient railroad car designs are unlimited. A wide variety of materials which have been known for many years are only now being utilized. However, additional research will be necessary to find the best combination of material and body design for the transportation and protection of a specific product. With these new ideas and others, the railroad may again become the king of transportation.

---

**CIVIL ENGINEERS:**

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Your contribution—and reward—in our nation’s vast road-building program can depend on your knowledge of modern Asphalt technology. So prepare for your future now. Write us today.

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The Asphalt Institute, College Park, Maryland

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THE TECHNOGRAPH
FORGED...

to provide more strength at 60% less cost

You are looking at a simple forging. It will be machined slightly to make a rotor end-plate for a giant hydroelectric generator. This part must withstand radial loadings of 150,000 pounds on the coil-support surface as the 30-foot rotor spins.

Why use forgings for generator end-plates? Because forgings possess many special properties. The forging process is unlike any other, because forged parts start with refined metals, can be given almost any desired shape between impression dies under enormous pressure or by consecutive blows. Forging imparts added strength and toughness, permitting weight-saving design, reduced cost, greater safety in our high-speed world.

Continuing research and modern equipment of the forging industry have a major part in helping extend the ability of metals to withstand the ever-increasing stresses and temperatures and pressures created by today's dynamic civilization. Forged parts withstand the landing impact of a jet aircraft, yet are light and strong to reduce dead weight. Forged parts help restrain the tremendous pressures and temperatures of modern petrochemical equipment. They improve the performance of vital automobile components.

Forging has reduced the cost of many parts, too. Production developments in the forging industry often make forged parts cheaper than parts produced by other methods. Let us send you case histories of parts converted to forgings from higher cost methods. Address: Drop Forging Association, Dept. E1, 55 Public Square, Cleveland 13, Ohio.

For more information, see our 4-page, full color advertisements in these magazines: Machine Design, Product Engineering, Steel, Materials In Design Engineering and Automotive Industries.

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

FORGED

MAY, 1963
Efforts to apply lasers to machining and welding operations began soon after the laser's introduction in 1960. It must be stressed, however, that the laser is still being developed and more research and design will be necessary before the laser becomes a profitable machine tool. At present, the three major laser development areas are: laser materials, laser flash lamps or “pumps” with their electrical supplies, and the optical system.

A laser is a source of nearly coherent, monochromatic optical radiation which can be of high energy. The word LASER stands for Light Amplification by Stimulated Emission of Radiation. Figure 1 represents a typical ruby laser apparatus for pulsed operation. A capacitor bank (energy storage system) is charged from 3500 to 10,000 volts by a dc power supply. The pumping system is a flash-tube similar to the tubes used in photographic “strobelights.” A sufficient amount of energy is absorbed and re-emitted by the laser material in a narrow beam which is monochromatic, coherent, and of very high power. A lens or mirror system further focuses the beam (and increases the energy density on the workpiece), and the amplified light beam melts or vaporizes the target material as in Figure 2.

The laser operates on the basic theory governing the behavior of electrons in various energy levels. Under some conditions, an electron in an excited state E₂ can be stimulated or forced to fall back to a level E₁ and emit energy E₂−E₁ by again being struck by an energy E₂−E₁. Most lasers now in use are based upon the absorption of optical radiation over a band of wavelengths to excite electrons in the laser material to an excited state from which there is a rapid decay to a state possessing a much longer lifetime, called a metastable state. In stimulated emission or laser action, the electrons in the metastable state are caused to decay together in phase. In order for this to happen, there must be a population inversion (i.e., there are more electrons in the metastable state than there are in the state to which the electrons decay).

Various conditions that contribute to the total efficiency state are defined in terms of the metastable electron state, and are lumped into the term “pumping efficiency.” The first necessary condition is the required width of the absorption bands, or, more simply, the range of wavelengths that may be absorbed and thus cause an electron to land in the metastable level. Ruby, currently the most efficient laser material, has two such bands: one at 5500Å, about 500 Å wide, and one at 4100Å, of about the same width. The second condition is termed “quantum efficiency,” and refers to the percentage of photons absorbed from the pump thereby causing electrons to move to the metastable level. Most laser materials have quantum efficiencies from 70 to 90 percent.
100% : their efficiency normally is a function of temperature, which increases with decreasing temperature. Lastly, a condition of limiting energy efficiency refers to the ratio of the energy of the output light to that of the absorbed light. Ruby absorbs light of wavelength 5890A (energy 2.35 ev) and emits radiation of wavelength 6940A (energy 1.8 ev) for an efficiency of 80%.

Ruby has been mentioned as a laser material, and the properties and characteristics which it possesses are important in the consideration for application of any laser material. These include the wavelength of the pumping band and the output wavelength, the lifetime in metastable state, the strength of the pumping absorption line, the operating temperature, the resistance to thermal shock and optical bleaching, and the homogeneity and perfection of the material. The cost and availability of laser materials is changing very rapidly as new materials are developed. Those crystals possessing desirable properties are quickly brought to market by a number of firms, thereby reducing the price.

Probably the weakest link in present laser systems with the most limited life, particularly those using ruby, is the flash lamp used as a pump. The helical or linear xenon-filled lamp of the photographer, with slightly more rugged electrodes, is still the standard laser pump. Its life depends largely upon the operating level. As most lasers require quite considerable input energy to generate 10-15 joules of output, the lamp is stressed accordingly.

The lifetime and the average power-handling capability of the flash tube become crucial, particularly if the pump-laser efficiency is relatively low. Using a single 2000 joule lamp in an elliptical reflector with the lamp at one focus and a large ruby rod at the other, one laboratory obtained an output of 20 joules for an overall efficiency of 1%, one of the most efficient high power systems yet reported. The life of the pump under these conditions was approximately five or ten shots. Two obvious disadvantages of laser pumps are the low efficiency and the prohibitive expense-output ratio. If a 2% efficient pump is used, the other 98% of the energy must be removed as heat, and this cooling is extremely difficult. The whole area of laser pumps needs further research and development for laser machining to become a practical, inexpensive tool. A $100 lamp lasting five to ten shots may be suitable in a research laboratory, but it would be economically prohibited for most industrial uses.

Westinghouse has developed a unit called the HD-6, which is capable of handling the largest lamps and can run repetitively at a high rate at the lower energy levels. The voltages and energies required to operate the unit are lethal, and involve the incorporation of extensive interlocks and safety switches. The laser head is a universal mount around which a nitrogen gas stream (about 100 to 150K) is vented. The stream forms a dry window in front of the laser rod, preventing moisture condensation on the end of the rod. Both the safety system and the cooling system are significant advances toward improving the efficiency of laser pumps.

**Laser Optics**

An aspect of laser technology receiving much attention is laser optics. The field involves the reflecting system of the laser proper and the lens or mirror elements necessary to focus the nearly collimated beam from the laser.

The most common reflecting system is one in which the ends of the laser rod are polished flat and are plane parallel. Another technique gaining wide acceptance, however, is the use of contocal reflectors of "resonators." These have two major advantages of this scheme over the plane parallel reflectors: the optical alignment is much less critical and spherical surfaces are easier to fabricate than plane surfaces.

For machining applications, an optical system is used to focus the monochromatic light of the laser upon the workpiece, but there are limitations on the extent to which this is successful. In actual practice, the spread of the laser beam limits the degree of focusing.

**Laser vs. Electron Beam**

Thus far, only the hardware of the laser has been discussed. The laser apparatus and its machining uses are best appreciated by a comparison with electron beam machining, to which laser machining is most similar. At the present state of laser development, the relative cost of laser machining as compared with electron beam machining can only be surmised. It is assumed that laser development will result in the construction of laser machines with the same general power delivery abilities as present electron beam machines, future costs can be compared.

Electron beam machines which fulfill these needs cost an average of $50,000 to $75,000. Large laser systems capable of delivering the power densities required now cost about $25,000. It is expected that repair costs to laser systems using large capacitors would be relatively high because of capacitor replacement.

The difference most often quoted between lasers and electron beam machines is the necessity of having and using a vacuum enclosure with the electron beam. Certainly, the lack of a vacuum system is the major advantage of the proposed laser machines, since between 10 and 50% of the time spent with the electron beam machines is used in the operation of the vacuum system. Thus, in those areas of interchangeability, the laser will enjoy an operating cost advantage over electron beam. The maintenance of the laser will also be less by the omission of vacuum equipment.

Thus, lasers that can be used as machine tools will cost about the same as an electron beam machine, with possibly same downward adjustments for the exclusion of a vacuum system, on the other hand, operating costs of lasers will perhaps be less than that of electron beam, again primarily because of the vacuum systems, depending upon capacitor and pump life.

It is not believed, however, that lasers will supplant electron beam machines when powerful lasers are built. Rather, each of the two systems will be used in those areas which fit its capabilities best.

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**Figure 2. Typical Laser apparatus for pulsed operation.**

**MAY, 1963**
An Engineer Speaks

(Edited by Stuart Unsheld from an interview with Carl E. Reistle, president of Humble Oil, printed in The Oil and Gas Journal, April 29, 1963.)

Industry today needs more engineering talent, not more engineers. Computers and automatic equipment allow the engineer to do more work and to create more in a given time; so it follows that to do the same work from one year to the next requires fewer people. The only reason for a company to have the same number of engineers—or more—is that it is an expanding company. Engineering graduates are facing greater competition as well as the demands placed upon them by the increasing complexity of their profession.

Better Training

I would like to see universities adopt a five-year engineering course. The first four years would provide a broad engineering background; the fifth would be a year of specialization. By this I do not mean the trade-school type of specialization. If a man were thinking of going into production, he might take advanced courses in hydraulics or thermodynamics. If it were refining, he would want some advanced organic chemistry.

A man with a good engineering education can move from one phase of the industry to another. We don’t really divide engineers into, say, petroleum and chemical engineers. That is a kind of specialization we’ll see less and less.

Counseling

The unfortunate thing about young engineers is that they don’t take advantage of the counsel that is available to them. A great characteristic of the human being is a desire to share his knowledge. A young man can get worlds of sound advice—if he has an inquisitive mind.

Keeping Up

An engineer should spend one-fourth of this time—his own time—keeping up with his profession. An engineer has as much responsibility to keep up to date as he had in getting his original education. It is not the company’s responsibility. Dr. Thomas Stelson of Carnegie Institute of Technology has estimated that new knowledge replaces past engineering training at the rate of 10% a year, and that a graduate loses his college training through disuse or “decay” at the rate of 10% a year.

If this is true, and I believe it is, then an engineer must increase his knowledge at the rate of 20% a year just to remain of the same value to his company.

But to advance, an engineer must increase his value to the company; and that is why I say he should spend 25% of his own time in furthering his professional knowledge.

All kinds of material are available—through professional societies, through libraries, by keeping in touch with old college professors. The engineer who succeeds is the one who takes advantage of engineering news material.

Keys to Advancement

Other than keeping up, certain attributes are essential to advancement.
1) Moral integrity
2) An inquisitive mind
3) Ability to communicate with others—to get their cooperation. He must sell his ideas and he must convince people of the value of the results he hopes to achieve.
4) The desire to accomplish things without asking. “What’s in it for me?” This means seeking opportunities for using his talents and abilities. It means putting extra time and effort into a job. The man who leaves work 10 minutes early isn’t going as far as the man who leaves 10 minutes late.
5) An interest in his work
6) Good judgment
Those who demonstrate these qualities promote themselves.

Management

A company’s greatest assets are its people, and the biggest challenge to management is the effective utilization of men. Management has an obligation to give its men an opportunity to create. The man who isn’t being challenged by his job is deteriorating, and no company succeeds by carrying a bunch of deadheads.

Social Responsibilities

If an engineer develops an idea to do a 10-man job with only three men, he should also concern himself with the other seven. He should ask himself, “Where can we use these men? Can they be trained? Should we consider early retirement?” He is usually the first to know of the new problem being created, and there’s no reason for him to pass all the responsibility to other segments of management.

There is more to automation than technology. If an engineer automates people out of jobs, then he should work with management to see what might be done with the surplus. The engineer should feel obligated to participate in solving the problem he is creating.

Smaller Work Forces

In the future we will be using fewer people for the same amount of work. This trend toward reducing work forces is not over and never will be. But we soon will have one million people in the United States, and to render the same service to the public will require us to expand. The economy is growing, and even if we merely maintain our position, we must grow.
Allison Will Build Mobile Atom Plant

Allison Awarded Atomic Contract

Allison Lands Key Nuclear Contract

- Award of a multimillion-dollar contract to Allison by the Atomic Energy Commission for construction of a mobile Military Compact Reactor highlights the progress Allison is making in energy conversion programs.

Objective of the high priority project is the design, construction and operation of an extremely mobile, lightweight powerplant capable of generating 3000 kw. of electricity. The plant will have a high temperature, liquid metal-cooled reactor coupled to a power conversion system. In addition to its military field use, the MCR could serve as a power source in civilian defense and power failure emergencies. Allison, the energy conversion Division of General Motors, was selected by the AEC as prime contractor on the basis of company capability to act as systems manager for the complete project.

In other fields, first and second stage rocket motor cases designed and produced by Allison for Minuteman have achieved a 100 per cent reliability record. Too, Allison research has made significant progress in the development of cases from lighter weight materials, titanium and plastics, and now is in position to meet the case needs of the future... whatever they may be.

Allison also maintains its position as foremost designer, developer and producer of turboprops. Current emphasis is directed toward developing engines of greater power with maximum fuel economy, and without increasing engine size.

Acceptance by the Army of the Allison 250-horsepower T63 turbo-shaft engine for Light Observation Helicopters is further evidence of Allison capability in the gas turbine areas.

Perhaps there’s a challenging opportunity for you in one of the diversified areas at Allison. Talk to our representative when he visits your campus. Let him tell you first-hand what it’s like at Allison where “Energy Conversion Is Our Business.”

An equal opportunity employer
Malleable artillery shell pierces 2 feet of solid oak at a velocity of 2,000 feet per second. In U. S. Army tests, pearlitic Malleable 105 millimeter shells were fired at 112% of rated maximum pressure. The new Malleable shells pierced the solid barricade, performing to the exacting requirements of the specification...proof of STAMINA.

"Guaranteed for Life" is the hallmark of confidence the manufacturer of this vise has had in its all-Malleable housing since first designed in 1917. These machinist's vises really earn their reputation as the most abused tool in the workshop, and about one million are now in use. All carry this unconditional guarantee...proof of STAMINA.

Pearlitic Malleable shoe for air-powered compactor delivers 900-pound blows at the rate of 350 per minute. Day after day, month after month, this rugged casting batters away on dirt, gravel, clay and rocks without significant wear or damage...proof of STAMINA.

Add Greater Stamina To Your Products With Malleable Castings
New Products Corporation
CUSTOM DIE CASTINGS SINCE 1922/BENTON HARBOR, MICHIGAN
MAY, 1963
How many of you awaken thoroughly refreshed only to be greeted with those persistent Hill Bus fumes? Yes, our atmosphere is no longer the flower-scented paradise our forefathers once enjoyed. Maintaining a healthful atmosphere is becoming increasingly difficult in today's industrial society. Many industrial processes (including Hill Buses) pollute the atmosphere to such an extent that unfortunateness, sickness, and even death are common.

Atmospheric pollution is not a new problem. Air pollution laws date back to the thirteenth centuries when attempts were made to control the smoke and soot which resulted from the incomplete combustion of coal.

Only during the last twenty to thirty years, however, has it become a serious and often fatal problem. Thousands of tons of sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide, hydrocarbons, and other pollutants are poured into the earth's atmosphere daily by various industrial processes and automobile engines. These impurities have affected not only the public health but surrounding vegetation and animal life as well.

A number of disastrous air pollution incidents have occurred within the last 35 years. In 1930, in the Meuse Valley of Belgium, 6000 became ill and 60 died; in Donora, Pennsylvania, in 1948, 6000 became ill and 20 deaths occurred; in London, in 1952, an estimated 4000 people died; and recently, in December of 1962, 163 fatalities were reported in London. These unpropitious incidents illustrate the seriousness of air pollution.

Likewise, contaminated air is also thought to be a contributing factor to lung cancer.

Economic Loss

Economic losses due to air pollution are just as exasperating. This factor alone would warrant attempts to control the problem. Air pollution can damage building materials, decrease farmer, livestock and dairymen's profits, shorten the life of home furnishings and clothes, and blighten large sections of urban areas.

These facts are undisputed, but it is extremely difficult to establish a dollar value for these losses. Nevertheless, considering all factors, Surgeon General Luther L. Terry has estimated that air pollution costs the people of the United States at least seven billion dollars per year. Industry and government have found that air contamination control is a costly problem, yet they have also recognized that it is even more expensive to ignore.

LA Air Pollution

One of the most serious air pollution areas in the United States is Los Angeles, California. A combination of factors, including topography, climate, industrial growth, and an abundance of automobiles, has resulted in an air pollution problem which is the number one public problem. It has resulted in millions of dollars of research and study, and many more millions in contamination control equipment.

Extensive studies in the Los Angeles area have shown that automobile engines are the largest single source of air contamination. Currently more than two and a half million automobiles in Los Angeles county burn over five million gallons of gasoline a day. On a weight basis, approximately seven per cent of the gasoline entering an automobile engine is emitted as an organic pollutant in the exhaust. This exhaust consists mainly of hydrocarbons, oxides of nitrogen, aldehydes, and particulate matter.

United States auto industries have become increasingly aware of the growing problem. For the past ten years they have been pouring millions of dollars into research. Likewise, car manufacturers have agreed to work in the public interest and exchange information and share patents freely in a cross licensing arrangement. Inventors have submitted more than 100 devices and ideas for evaluation by a special committee of the Automobile Manufacturers Association.

The 'Blowby' Breakthrough

At last a successful breakthrough—the blowby—has been developed. This deceptively simple unit is standard equipment on all 1963 cars and trucks. It collects unburned gases, which would otherwise be released into the air as fumes, and sends them back through a tube to the engine, where they are burned. This device reduces automobile air pollution by 25 to 40 per cent, depending on driving conditions, the size of the engine, and its mechanical condition. The remainder of the smoke-producing hydrocarbon and carbon monoxide come from the exhaust gas.

Positive Crankcase Ventilation

The importance of eliminating blowby gases that leak past the piston rings and collect in the crankcase has been recognized for many years. . . . A breather is installed at the top of the crankcase and an outlet, or road draft tube, at the bottom. A vacuum is thus created at the end of the tube which draws the fumes out of the crankcase into the atmosphere. When the car is moving the system works well, but it is ineffective for city delivery trucks, taxis, and other vehicles operating at slow or idle speeds for extended periods. Positive Crankcase Ventilation, PCV, was developed to prevent excessive sludge formation in these "slow" engines. Since manifold vacuum is high at light load and slow speed, it is used to draw fumes from the crankcase into the intake manifold, where it is mixed with incoming fuel and air, and then passed into the
cylinders to be burned.

General Motors engineers working on an industry wide program to decrease air pollution discovered that PCV also substantially reduces the volume of unburned hydrocarbons released to the atmosphere. Car manufacturers, therefore, agreed to install PCV on all autos manufactured for sale in California, and later decided to include the device on all new automobiles.

The critical mechanism of PCV is a valve the size of a man's thumb. At light load and low speed, manifold vacuum holds the valve closed, thereby restricting the flow of ventilating air and fumes to a suitable volume that can pass through a small orifice in the center of the plunger. (See Fig. 1) As the throttle is opened, manifold vacuum drops and a spring forces the valve from its seat, permitting increased flow from the crankcase to the intake manifold. The valve is necessary because the volume of air entering the manifold at idle must be limited to maintain a suitable engine fuel to air ratio.

Unfortunately, fumes passing through the valve are contaminated with oil, water, carbon, and unburned particles of fuel—all are ingredients of sludge. After prolonged use the valve either sticks or becomes completely clogged.

When the valve sticks in the open position the idling mixture becomes too lean and the engine vibrates and frequently stalls. If the valve sticks in the closed position, very little ventilating air can pass through the crankcase and internal pressures build up, thus pouring fumes out of the breather cap or pushing oil past seals and gaskets. If the valve becomes completely clogged the engine idles roughly because of a rich mixture, crankcase pressure builds up even higher, and sludge forms rapidly.

Thus it can be seen that PCV is not by any means the perfect solution, but at the current time it is the best device available.

Other research teams are working on devices to help control and reduce the percentage of hydrocarbon and carbon monoxide in automobile exhaust. Three methods which are currently under test are:

1) Catalytic Burner
2) Flame Afterburner
3) Added air into the exhaust manifold

Catalytic Burner

The General Motors catalytic burner meets, under some conditions, the strict requirements of the California Motor Vehicle Pollution Control Board—the board that has prompted manufacturers to help solve the pollution problem. The converter is functionally and structurally satisfactory, but catalytic life doesn't meet the control board's minimum standard, which requires a minimum life of 12,000 miles.
The converter replaces the conventional muffler in an exhaust system. It is placed as close to the engine as possible for maximum heat transfer to the catalyst during the warm up and constant speed driving.

An air pump, which is belt driven from the engine, takes in air through the carburetor air cleaner and discharges it into the exhaust pipe, far enough upstream of the converter's entrance to provide mixing. This air must be added since exhaust gas seldom contains enough oxygen to burn all the combustibles.

The catalyst bed, formed with a lead-resistant catalyst produced by Oxy-Catalyst, Incorporated, is inclined to the converter shell. This provides better gas velocity distribution throughout the bed and minimizes height.

With severe driving conditions, a malfunctioning carburetor, or a fouled spark plug, increased amounts of fuel and air combine and ignite in the converter, resulting in an excessive amount of heat to the bed. These high temperatures warp the grid and shell, and even some loss of catalytic activity if the high temperature is sustained. This problem is eliminated by a bypass valve at the converter entrance which can direct exhaust either under or through the catalytic bed. A thermoswitch with its probe located in the center of the bed senses the catalyst temperature and by means of a solenoid valve actuates the bypass valve.

The catalytic converter still requires more development, especially to extend the life of the catalyst. Its operation has been improved somewhat by injecting extra air into exhaust ports rather than the conventional exhaust pipe.

Flame Afterburner

Another device that created early enthusiasm is a flame afterburner. Due to many difficulties however, enthusiasm has waned. Its operation depends upon an auxiliary flame burner in the exhaust system. Numerous design problems have eliminated this device from further development. The problems include:

1) Special alloys to withstand the very high temperatures.
2) Complicated methods to maintain gas pressure and sustain burning.
3) The requirement and expense of additional fuel.

Added Exhaust Air

Another seemingly simple device is the addition of air into the exhaust manifold to ignite undesired gases. Ford Motor Company is leading this development. They are utilizing two refinements to improve its results—a burning box to extend the time for hydrocarbons to combine, and added insulation to decrease the warmup time of the box. This method is not entirely satisfactory, and it does not work on compact cars... Mass production is a long way off.

The satisfactory elimination of automobile air pollution has thus far thwarted development engineers, who are working on a near crash program. Even after the expense of thousands of working hours and many millions of dollars, the problem is not entirely solved. All that can be shown is a simple blowby device, and various other semi-satisfactory units.

Still, what the future holds is unknown. The problem of air pollution by automobiles must be solved, or else the serious air contamination problem will become even more widespread. Only through the continued efforts of engineers and scientists and the expense of millions of dollars will the solution be found.

New FILM-THIN Copper-clad Laminates for space-saver or multi-layer printed circuits

Synthane copper-clad laminates are now being produced with a base laminate of only .0035" and up—with 1 or 2 oz. cladding available on one or both sides. A pre-impregnated glass cloth with epoxy resin filler is also available for bonding multi-layer circuits. These new materials are produced under clean room conditions. Property values are comparable to military specs for the same materials in standard thicknesses. Write for folder of Synthane metal-clad laminates.
We will not offer you just a job

(but if you’re interested in a career, talk it over with us)

When we invite a man to join the Bethlehem Loop Course, we are not offering him a “job.” We are inviting him to begin a career. And, for that reason, we train him—thoroughly—before he begins his first work assignment.

The Bethlehem Loop Course

Since its beginning some forty years ago, the Loop Course has trained about 2,000 men who now occupy responsible positions at all levels of supervision and management. The name comes from the fact that members of the course make an observational circuit (or “loop”) of a steel plant during their basic training program.

New loopers report to our general headquarters in Bethlehem, Pa., early in July. They attend a basic course lasting five weeks. It includes talks and discussions by top Company officials, educational films, and daily plant visits. The Loop Course is not a probationary period. After completing the course, every looper is assigned to a Bethlehem activity where he receives additional specialized instruction before beginning actual on-the-job training.

Plenty of Opportunity

Because of the size and diversity of its operations, Bethlehem offers unlimited opportunities to “get ahead.” It’s one of the nation’s largest industrial corporations, with about 130,000 employees, engaged in raw materials mining and processing, basic steelmaking, manufacturing of finished products, structural steel fabricating and erecting, shipbuilding, and ship repair. We operate steelmaking plants in the East and on the Pacific Coast; shipyards on the Atlantic, Gulf, and Pacific Coasts; manufacturing units and fabricating works in twelve states; and sales offices in most leading cities. Our new research laboratories, in Bethlehem, Pa., are unexcelled by any industry.

Read Our Booklet

The eligibility requirements of the Loop Course, as well as how it operates, are more fully covered in our booklet, “Careers with Bethlehem Steel and the Loop Course.” Copies are available in most college placement offices, or may be obtained by writing to Manager of Personnel, Bethlehem Steel Company, Bethlehem, Pa.

Opportunities are better than ever at Bethlehem Steel
In aircraft parts, as in men, excessive stress accelerates the aging process. And stress aging per hour varies for each aircraft. Yet the present way of determining servicing schedules is based primarily on hours flown. Now Douglas researchers have developed a device which, when installed on an aircraft, provides a more positive method of determining check-up times for aircraft parts. Called a “Service Meter,” and weighing less than 1½ pounds, the Douglas unit computes the accelerations encountered by its aircraft in relation both to number and severity. It allows servicing to be performed on the basis of the true work age of parts, and will be an important aid to maintenance procedures that keep aircraft young.

Research like the foregoing has helped build the Douglas reputation for producing the world’s most reliable aircraft.

AEROSPACE GERIATRICS

...A STIMULATING AREA FOR CREATIVE ENGINEERS

If you are seeking a stimulating career in the thick of the most vital programs of today and tomorrow, we invite you to contact us. Write to Mr. S. A. Amestoy, Douglas Aircraft Company, 3000 Ocean Park Blvd., Santa Monica, California, Box 600-M. An equal opportunity employer.
Are you low and depressed? Or perhaps you are a struggling, underprivileged, underdeveloped engineer caught in the grasp of this scholarly jungle. If so, meet 18 year old Miss Kathee Hrudka—the solution to every engineer's problem.

Upon graduation in LAS she plans to go to Africa as a social worker for the Peace Corps; however, any engineer worthy of his slide rule could surely convince her to rectify his own domestic enigma.

Many convincing routes could be devised, but as a start we suggest you join the Ochesis Dance Concert as a dancer, Campus Chest, and Star Course...her campus activities. Likewise, you should learn to water and snow ski, dance, and write music as well as play the piano...Don't worry about "the cabin on the lake" she can provide that—provided you are convincing enough!
Result: "Cushion Recoil" provides a dramatically smoother ride in 1963 Ford-built cars

The challenge given Ford engineers was to design suspensions that would permit wheels virtually to roll with the punches—not only in a vertical plane but fore-and-aft as well. Conventional suspension systems provide only a partial solution to road shocks by limiting wheel recoil to an up-and-down motion.

The solution? Exclusive Cushion Recoil suspension design in all Ford-built cars for '63! Cushion Recoil, with cushioning action in a fore-and-aft plane as well as vertical, smoothes the jars and jolts of rough roads, adds to your comfort, safety, and driving pleasure. Even the thump of freeway tar strips is reduced, and on deeply rutted roads you experience better control of the car. Furthermore, your Ford-built car is spared the wear and tear of road-induced vibration.

Another assignment completed—one more example of engineering excellence at Ford and new ideas for the American Road.
Advanced solution to a heat transfer problem

Complex, long duration satellites and manned spacecraft must get rid of large amounts of internally produced heat. Through unique fabrication techniques and know-how with exotic materials, Garrett-AiResearch is building active (fluid cycle) radiator systems for cooling space vehicles.

Garrett is also developing heat transfer systems for applications from cryogenic temperatures to 2000°F, using heat transfer fluids such as Coolanol 139, Freon 21, FC-75, mercury and alkali liquid metals including potassium, rubidium and cesium.

This critical development work is supported by more than a quarter century of Garrett heat transfer experience. It is one more example of Garrett's proved capability in the design and production of vital systems and their components for spacecraft, missile, aircraft, electronic, nuclear and industrial applications.

For further information about the many interesting project areas and career opportunities at The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles. Garrett is an equal opportunity employer.
A story going the rounds concerns three pregnant squaws who slept on animal skins—one, on an elk skin; another, on a buffalo skin; the third on a hippopotamus skin. The first squaw had a son; the second, a son; and the third, twin boys.

Which proves: the squaw of the hippopotamus is equal to the sons of the squaws on the other two hides.

Very proud parents: "Edith is taking a correspondence course in trigonometry. Speak a few words in trigonometry dear."

M.E.: "Going around a lot with women keeps you young."

2nd M.E.: "Why's that?"

M.E.: "I started going around with women when I was a freshman two years ago, and I'm still a freshman."

An I.E. was discovered by his wife one night standing over his baby's crib. Silently she watched him. As he stood looking down at the sleeping infant, she saw in his face a mixture of emotions that she had never seen before—cruelty, admiration, doubt, despair, ecstacy, incredibility. Touched and wonderd ring alike at his unusual parental attitude and the conflicting emotions, his wife with her eyes glistening, arose and slipped her arm around him. "A penny for your thoughts," she said in a tremulous voice.

He blurted them out: "For the life of me, I don't see how anybody can make a crib like that for $3.49!"

Papa sparrow returned to his nest and proudly announced that he had made a deposit on a new Buick.

A professor wanted to call a friend in Gopecck. The operator had trouble understanding the name of the town and asked the professor to spell it. "The name is Gopecck, operator," said the professor; "G for gnu, O for one, P for phycic, E for eye, C for chandeler, K for knight."

Did you hear about the absent-minded professor who sent his wife to the bank and kissed his money goodbye?

The day after finals, a Chem.Eng. walked into a psychiatrist's office, tore open a cigarette, and stuffed the tobacco up his nose.

"I see that you need some help," remarked the startled doctor.

"Yeah," agreed the student. "Do you have a match?"

A motorist after being bogged down in a muddy road paid a passing farmer ten dollars to pull him out with a team. After he was on the road again, he remarked to the farmer, "I should think that at that price you'd be pulling people out of this stuff day and night."

"Nope," drawled the farmer, "at night's when I tote the water for the holes."

"It isn't the amount of money that a fellow's father has that counts here at college."

"No, it's the amount of father's money the son has."

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.

Then that sweet hand I held last night.

Four aces and a king.

Prof: "Well, is the theory clear to you now?"

Student: "Yeah, just as though it had been translated into Hindustani by Gertrude Stein and read to me by a tobacco auctioneer."

During a grouse hunt one sportsman was shooting at a clump of trees near a stone wall. Suddenly an angry face popped over the top of the wall. "Cure you, you almost hit my wife!"

"Did I?" cried the man. "I'm terribly sorry—have a shot at mine over there."

"What a day! I lost my job, I lost my billfold, my wife ran away with the electric light man, the Cards lost to Brooklyn. It's unbelievable—leading by three in the eighth and they lost to Brooklyn."

The orator had held forth for a long time his talk punctuated only by an occasional pause for a drink of water.

A man near the front commented, in a loud whisper, "First time I've ever seen a windmill run by water."

The scene is a train compartment in Rumania. The characters: A Russian officer, a Rumanian, an old lady, and an attractive girl.

The train enters a tunnel. The passengers hear a first kiss, then a vigorous slap.

The old lady thinks: "What a good girl she is, such good manners, such fine moral character!"

The girl thinks: "Isn't it odd that the Russian tried to kiss the old lady and not me?"

The Russian thinks: "That Rumanian is a smart fellow: he steals a kiss and I get slapped."

The Rumanian thinks: "Am I a smart fellow! I kiss the back of my hand, hit a Russian officer, and get away with it."

A lonely chick taking a look around the electric incubator of unhatched eggs — "Well, it looks as if I'll be an only child. Mother's blown a fuse."

There is only one engineer who ever got rich. He recently died in Colorado and left a fortune of $50,000 which he amassed through unceasing toil, superhuman perseverance, remarkable ingenuity, and the death of an uncle who left him $49,000.

Our unabashed Dictionary defines bachelor as a rolling stone who gathers no moss.

Mother: "Now, Junior, be a good boy and say 'Ah-hih' so the doctor can get his finger out of your mouth."

Captain: "Why didn't you salute me yesterday?"

ROTC Recruit: "I didn't see you, sir."

Captain: "Oh, that's all right then, I was afraid you were mad at me."

And then there was the butcher who backed into a meat grinder and got a little behind in his orders.

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Answer to last month's Brain Buster number 3.

White and Mrs. Black played against Black and Mrs. Pink at one table. At the other table Green and Mrs. White opposed Pink and Mrs. Green.
Once upon a time there was a creature known to joke smiths as "the efficiency expert." When he wasn't being laughed at, he was being hated. Kodak felt sorry for the poor guy and hoped that in time he could be developed into an honored, weight-pulling professional. That was long ago.

We were then and are much more today a very highly diversified manufacturer. We need mechanical, electrical, chemical, electronic, optical, etc., etc. engineers to design equipment and processes and products for our many kinds of plants, and make it all work. But all the inanimate objects they mastermind eventually have to link up with people in some fashion or other—the people who work in the plants, the people who manage the plants, and the people who buy the products. That's why we need "industrial engineers."

A Kodak industrial engineer learns mathematical model-building and Monte Carlo computer techniques. He uses the photographic techniques that we urge upon other manufacturing companies. He collaborates with medicos in physiological measurements, with architects, with sales executives, with manufacturing executives, with his boss (G. H. Gustat, behind the desk above, one of the Fellows of the American Institute of Industrial Engineers). He starts fast. Don Wagner (M.S.I.E., Northwestern '61) had 4 dissimilar projects going the day the above picture was sneaked. He is not atypical. Want to be one?

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ROCHESTER 4, N.Y. · An equal-opportunity employer.