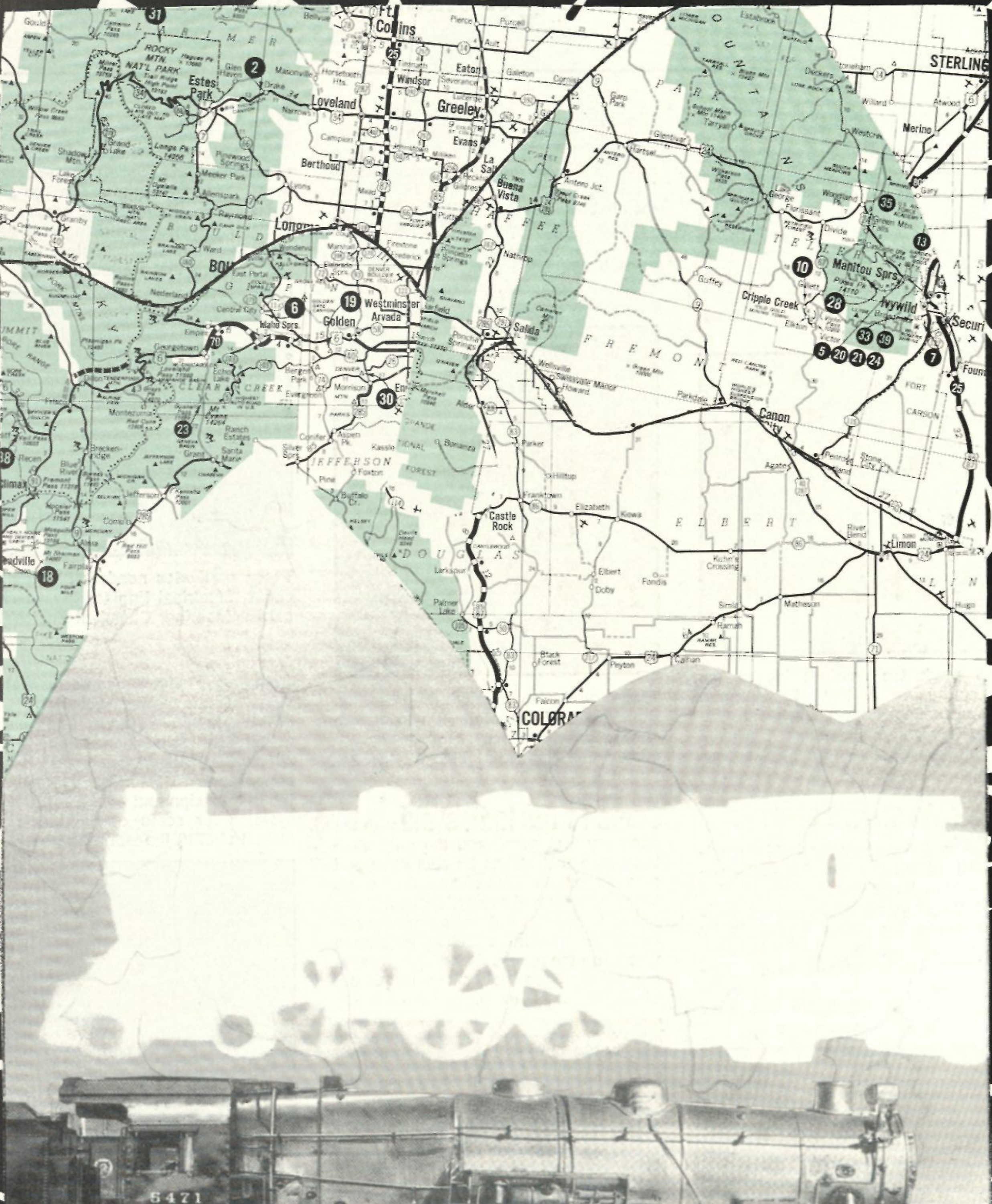
The COLORADO Engineer



JANUARY, 1968

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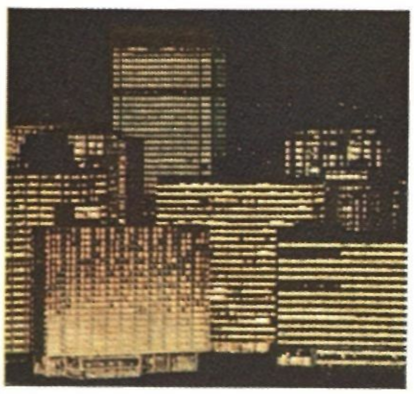

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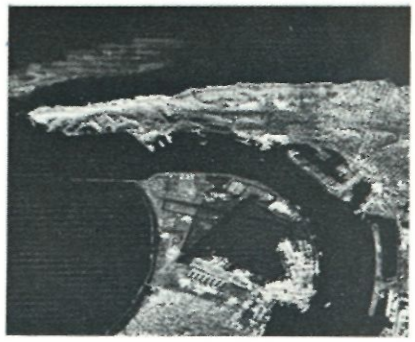

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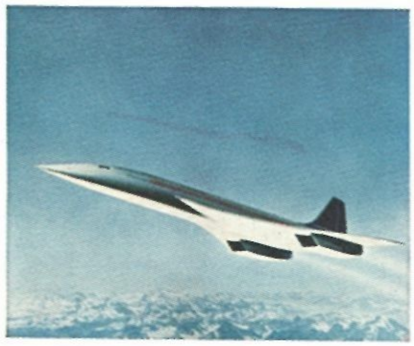

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The COLORADO Engineer

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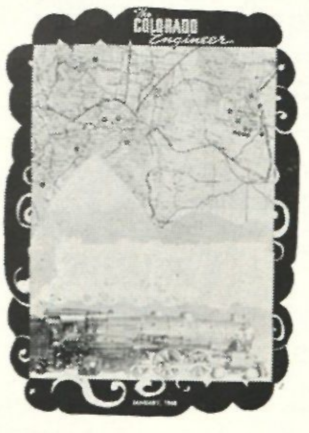

This month's cover: The coming of the railroads to Colorado began a new chapter in her story. Donna Demong records the story on our January cover. The tale of "Colorado's Railroads" is related by Les Bogunovich and Sam Carlsson, beginning on page 15.

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Joel Kocen (BS Commerce, Wash. & Lee '59; LLB, Wash. & Lee '61) left, is senior tax analyst at New York headquarters of Anaconda.

David Madalozzo (BSEE, Bradley '61) is plant engineer of the new Anaconda Wire and Cable Company mill in Tarboro, N.C.

Alvin Cassidy (BA Econ., Bellarmine '54; MBA, U. of Louisville '59) is director of financial planning of Anaconda Aluminum Company, Louisville, Ky.

Robert Zwolinski (BSME, Rutgers '57) is chief mechanical engineer with Anaconda Wire and Cable Company, New York.

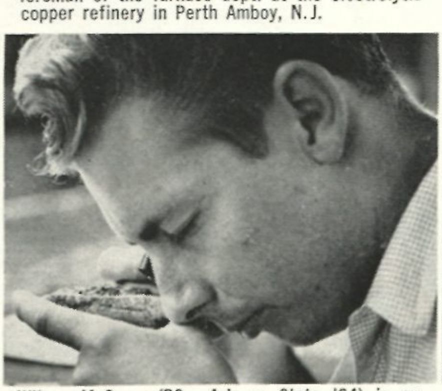
Willard Chamberlain (BE Metal. Eng., Yale '53) is manager of Anaconda American Brass Company's Valley Mills, Waterbury and Ansonia, Conn.

Robert Ingersoll (BS Geol., Montana Tech. '51 MS Geol., Montana Tech. '64) right, is senior geologist, Anaconda's mining operations, Butte, Mont.

Thomas Tone (BS Mining, U. of Arizona '62) is foreman of the furnace dept. at the electrolytic copper refinery in Perth Amboy, N.J.

Richard Symonds (BS Metal., U. of Nevada '57) is superintendent of the lead plant at Anaconda's smelter in Tooele, Utah.

Jay Bonnar (BS Met., M.I.T. '57; MS Ind. Mgmt., M.I.T. '62) left, is research administrator of Anaconda American Brass Company's research and technical center, Waterbury, Conn.



Wilson McCurry (BSc, Arizona State '64) is an assistant geologist in Anaconda's new mines dept., currently working on development of the Twin Buttes mine near Tucson, Ariz.

Terrence McNulty (BS Chem., Stanford '61; MS Metal., Montana Tech. '63; DSc Metal., Col. School of Mines '66) is senior research engineer, extractive metallurgical research, Tucson, Ariz.

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EDITORIAL:

The Value of Education

Why did you decide to come to college? To get an education? You've gone to classes for four years, fulfilled the requirements, are ready to graduate. But in the process, have you become educated?

It is unfortunate that the engineering curriculum is so regimented. Except for twenty-four hours of "socio-humanistic" courses, you, the engineering student, find yourself working problems, pushing a slide rule for one hundred and twelve other hours. To what avail? Well, you learn to be an engineer—but do you become educated?

Have you ever felt frustrated because you couldn't spare the time to go to an evening lecture (lab report due tomorrow)? Or because you couldn't read a book (the hourly next Thursday)? Here you are in the middle of the University and yet, how much of it do you know?

But perhaps you came to CU to become an engineer so you could make lots of money.

—Kathy O'Donoghue

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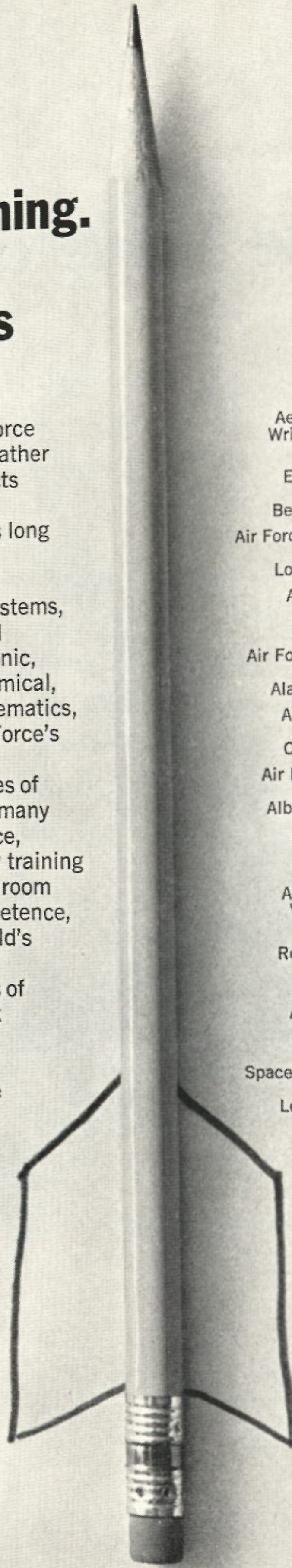

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DEAN'S COLUMN:

ASSOCIATE DEAN SEEKS INCREASED INTEREST IN ENGINEERING

GEORGE J. MALER
ASSOCIATE DEAN

In this same issue one year ago, Dean Max S. Peters and Editor Kathy O'Donoghue afforded me the opportunity to write a Dean's Column informing you of the activities of the Office of the Associate Dean. Graciously, they have again invited me to report to you on the progress of the past year and on our plans for the future.

Last year's efforts in visiting high schools, conducting career days, holding honors seminars, and our various other programs account – we hope – in some part for the increased enrollment of freshmen in our College of Engineering this fall. The Office of Admissions figures of a year ago indicated 377 new entering freshmen. This year the number was 466, an increase of nearly 24%. Our efforts in this area are being continued and expanded this year. During the fall semester, members of our faculty have visited forty-one high schools to present information on careers in engineering and on our College. Personally, I have had the opportunity to participate in six High School Counselor Clinics conducted by our Office of Admissions under the auspices of the Alumni Office. These have consisted of setting up meetings in Denver, Colorado Springs, La Junta, Monte Vista, Leadville, and Craig. In each city, high school counselors from throughout the surrounding area were invited to participate in a one-day session of case studies on admission to the University. Through this media, open discussion was stimulated and we were able to tell counselors about all aspects of the University. In turn, they provided us with valuable feedback. Two more such meetings will be conducted in January of 1968: one in Durango and one in Sterling, Colorado.

Last November 18, a High School Student-Parent Career Day was held in our Engineering Center. Three hundred forty-six high school students and parents attended the one-day session devoted solely to providing information on careers in engineering. During the morning session, Dean Peters welcomed our guests and Mr. Dwight Grotewold, Director of High School Relations, talked about the University and its admissions policies. This was followed by tours of the Engineering Center and departmental seminars. The tours allowed our visitors to become acquainted with each of the major degree-granting departments, while the seminars encouraged our visitors to meet in small groups with faculty members and students to zero in on each engineering area offered at the college. The pledge classes of the honor societies served as guides and as department representatives at the seminars. Lunch was served in the Kittredge Commons followed by a short tour of the residence halls. Two panel discussion sessions were conducted during the afternoon. One panel of all engineering students met with just the parents, while at the same time another panel of all engineering faculty met with the high school students. A second session of the panels was then held with the student panel meeting with the high school students and the faculty panel meeting with the parents. Responses to questionnaires at the end of the day's activities indicated that most students and parents found the day to be of real value. The student panel portion of the program was especially well liked by both high school students and parents. There is little question that our students did an outstanding job and they are still one of our best advertisements. A second such day is planned for February 17th.

This fall, materials about our College were again sent to all 260 high schools in Colorado for inclusion in the high school counselor's *Careers in Engineering Notebook* which was distributed last year at the High School Principal-Student Conference.

Last spring, four Saturday honors seminars were conducted by the College for 115 high school students who had demonstrated high interest and ability in mathematics and science in their high schools. The apparent success of this program has prompted planning for an Honors Institute to be held here in August. The program will consist of four days on campus for approximately 250 high school students. They will attend lectures, seminars, laboratory sessions, field trips, and tours. They will live in the dormitories and will be joined by some of our own students and faculty as well as some high school counselors and teachers and members of industry. This briefly summarizes our programs to attract the talented young men and women of our state to careers in engineering.

The apparent success of last year's experiment of starting physics in the fall semester of the freshman year has lead to full implementation during this year. Reports of mid-term grades just in indicate that the program thus far is coming up to expectations. Of the total entering freshmen, approximately two-thirds are qualified to start physics and calculus. The remaining one-third start with a slower math sequence and postpone physics until the second semester. Selection for participation is based upon a predictive index that includes college board scores, rank in class, and scores on our own mathematics aptitude test. The intent of the over-all program is to provide the opportunity for those adequately prepared upon entrance to advance more quickly into departmental programs and at the same time, it does not exclude slower students from pursuing successful engineering careers.

The *Freshmen Newsletter* continues to be published monthly to assist those undecided in selecting their field of engineering and to give general information and facts about all branches of engineering in our college.

Our counseling program continues its usual good job and is at present in full swing. Counselors are conducting mid-term interviews with all freshmen.

Work in the area of relations with industry continues with major emphasis on development of continuing education programs. Last year, five five-day summer short courses designed explicitly for industry were planned and offered. A somewhat expanded similar program is in the offing for the coming summer.

Recently, orders have been placed to procure television equipment which will allow for some experimentation with TV and TV tapes on all levels of instruction in the College of Engineering. This will be an important adjunct to the work in progress in our Self-Study Laboratory. The addition of a half-time director for the Self-Study Laboratory has allowed us to make considerable progress in the development of teaching aids for engineering.

I continue to be well pleased with the efforts, activities, and continued good planning by the Associated Engineering Students. My one great hope would be to stimulate greater participation in the many fine activities conducted by AES.

Although I feel that considerable good activity is underway in our undergraduate programs, much remains yet to be done. With the continued support of the student body and faculty, I feel confident that we will continue to make excellent progress.

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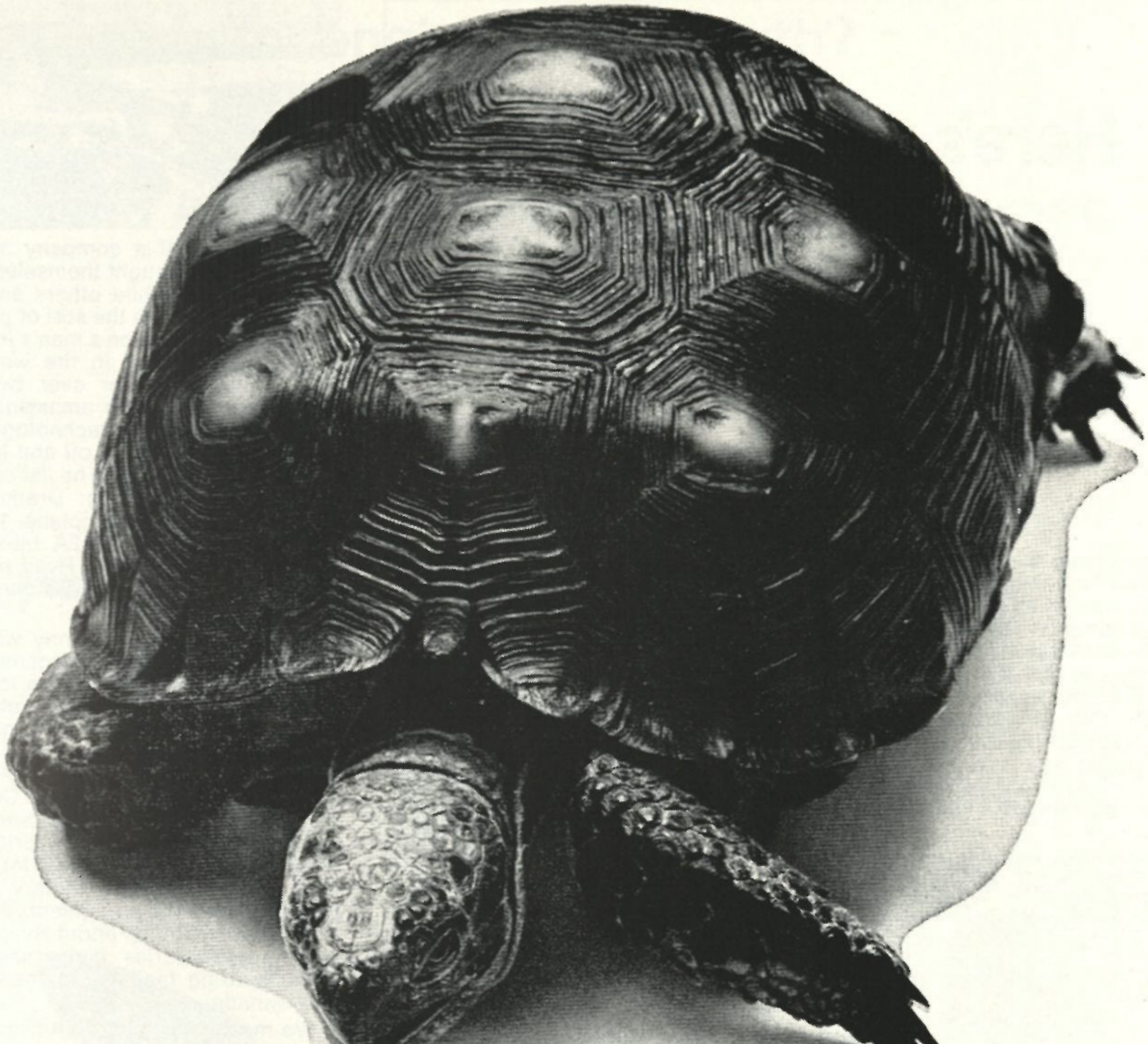

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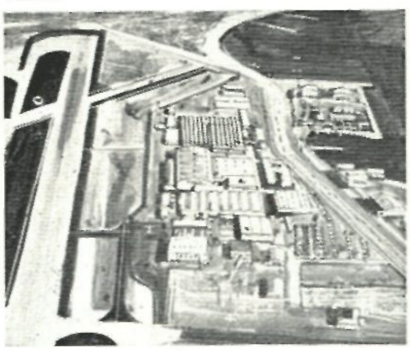

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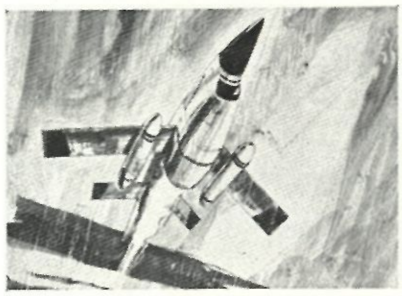

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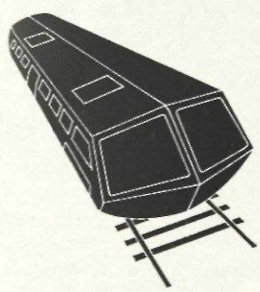

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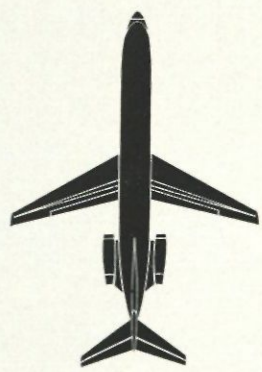

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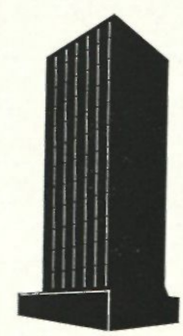

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Colorado's Railroads

LES BOGUNOVICH
SAM CARLSSON

When the western division of the transcontinental railroad was being considered by the United States Congress in 1850, three routes were given highest consideration. They were through New Mexico, Colorado, and Wyoming. Land for the railroads was to be donated by the government in the form of land grants. In 1860 the Union Pacific Railroad agreed to build rails west as the Central Pacific Railroad built east from California. The two were to meet at Ogden, Utah to complete the transcontinental railroad. The route the railroads decided upon was the route north of Colorado, through Cheyenne, Wyoming.

Colorado Resources Developed

It was also during this time that gold and silver had been discovered in Colorado, the lumbering industry was being developed into a major source of timber, and the cattle and coal-mining interests were beginning to prosper. The most efficient transportation for these materials was the railroad. This need for the railroad made the Union Pacific line through Cheyenne seem tantilizingly close, and in 1867 the Denver Pacific Railroad and Telegraph Company was organized to connect Denver and Cheyenne.

The great potential wealth in the gold and silver attracted most of the railroad interests; many small railroads were formed within the state and concentrated on hauling the ore to smelters and reducing mills. But by 1873 there were five major railroad lines in Colorado. See Figure 1. The Denver Pacific connected Denver with Cheyenne and the Union Pacific Railroad. The Kansas Pacific directly connected Denver with Kansas City and thus the eastern states. The Colorado Central connected Denver with the gold camps of Blackhawk and Central City, and Boulder with Longmont. The Boulder Valley connected Brighton and Boulder with the coal fields around Marshall. The Denver and Rio Grande, which was to become the largest railroad in the state, connected Denver with Colorado Springs, Pueblo and Canon City.

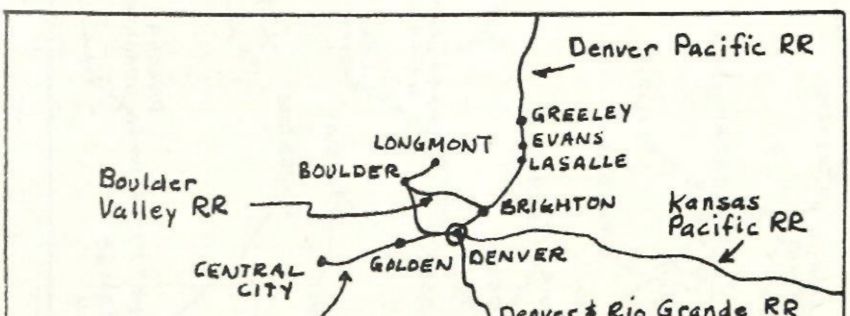

Figure 1 — The Railroads of Colorado — 1873

Railroad Boom Hits Colorado

The railroad building boom was at its peak during the years from 1867 to 1885, when over 800 railroads were proposed for construction. Obviously a great number of the proposed railway systems were never built, and of those built, most failed.

The price of silver was decreased considerably in 1893 by government action and consequently Colorado, because of its large silver mining in-

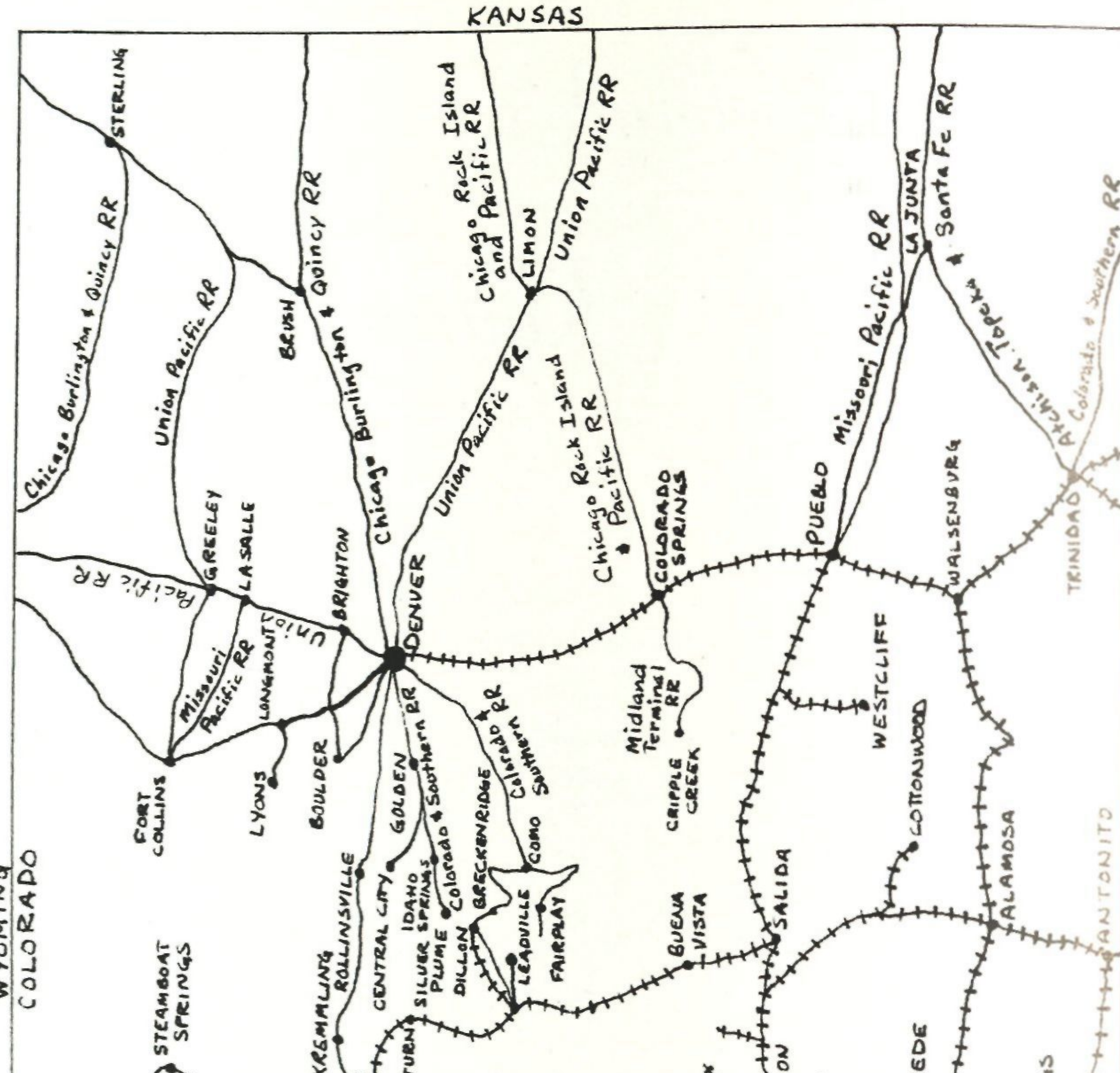

Figure 2 — The Railroads of Colorado — 1920

terests, went into an economic depression. The result was a curtailment of most railroad construction within the state and the failure of many smaller railroads. However, the Denver and Rio Grande was unlike many other roads in that it had not depended to such a large extent upon the metal mining industry for income. It had extended its services to the lumber, fruit, cattle, and coal-mining industries — seemingly unimportant when metal mining was going strong. By 1920 the Denver and Rio Grande was the largest railroad system in Colorado, as indicated in Figure 2.

Standard and Narrow-Gauge Track

Before 1870, two widths, or gauges, of railroad tracks were used in Colorado. The standard-gauge track used 56½ inch spacing between the rails and the narrow-gauge track used a 36 inch spacing between the rails.

The standard-gauge was at first limited to use on the plains of Colorado because of the difficulties encountered in running the track through mountainous terrain. The narrow-gauge, on the other hand, provided the engineers with much-needed maneuverability as they built the railroad beds. Curves could be made sharper and grades steeper for the narrow-gauge than for the standard-gauge. The engines and cars were made smaller and lighter, in turn allowing smaller requirements for rails, ties, bridges, and tunnels. Even on the plains, narrow-gauge track could be laid at less than half the cost of standard-gauge.

Track Size Is Standardized

However, the biggest drawback for the narrow-gauge was freight hauling capability. The smaller narrow-gauge trains could not handle the enormous loads the standard-gauge trains regularly carried, and so were not used extensively throughout much of the rest of the United States. Following 1870, the standard-gauge locomotives were being built powerful enough to pull the great loads over the mountains and the technology involved in making railroad beds was improved sufficiently to make the maneuverability provided by the narrow-gauge less important. These facts, coupled with a government regulation setting all future track widths equal to that of the standard-gauge, brought about the eventual conversion of all narrow-gauge railroads in the state to the standard-gauge tracks.

Locomotives

Steam locomotives were most commonly classified by their wheel configuration. The largest wheels on the locomotive were the drivers and were positioned under the boiler to take advantage of the weight of the locomotive in obtaining traction. The smaller wheels fore and aft of the drivers were called the pilot truck and trailing truck, respectively. These smaller wheels helped maintain the stability of the locomotive on curves and in the switch-yards as the train was switched from one set of tracks to another.

Figure 3 depicts the wheel configuration on a 4-6-4 locomotive; that is, a locomotive with a four-wheel pilot truck, six driving wheels, and a four-wheel trailing truck.

Most of the Colorado narrow-gauge locomotives were of the 2-4-0 and 2-6-0 types. They were much smaller and lighter than the standard-gauge locomotives. For example, the driving wheels of the 2-6-0 were about the same size as the trailing wheels of the 4-6-4, and the weight on only the pilot truck of the 4-6-4 would equal the combined weight of two of the 2-6-0 locomotives.

Power Differences

The most important difference between the narrow-gauge and standard-gauge locomotives was the power. A narrow-gauge 2-6-0 could pull a 160 ton load up a 1.5 percent grade at six miles per hour. The standard-gauge 4-6-4 could pull a load of 1700 tons up the same grade at 30 miles per hour. As indicated before, this was one of the main reasons the narrow-gauge was replaced by the larger standard-gauge.

And finally, by 1956, all the standard-gauge steam locomotives were replaced by the quieter, more efficient, and more powerful diesel locomotives.

Grade and Locomotives

The incline of the railroad bed as it goes up a mountain is referred to as the grade. It is, mathematically, the slope of the bed expressed as a percentage; i.e., a seven percent grade reaches a height of 370 feet over a horizontal distance of one mile.

Railroading on steep grades requires powerful locomotives and maximum traction between the drive

(Continued on page 20)

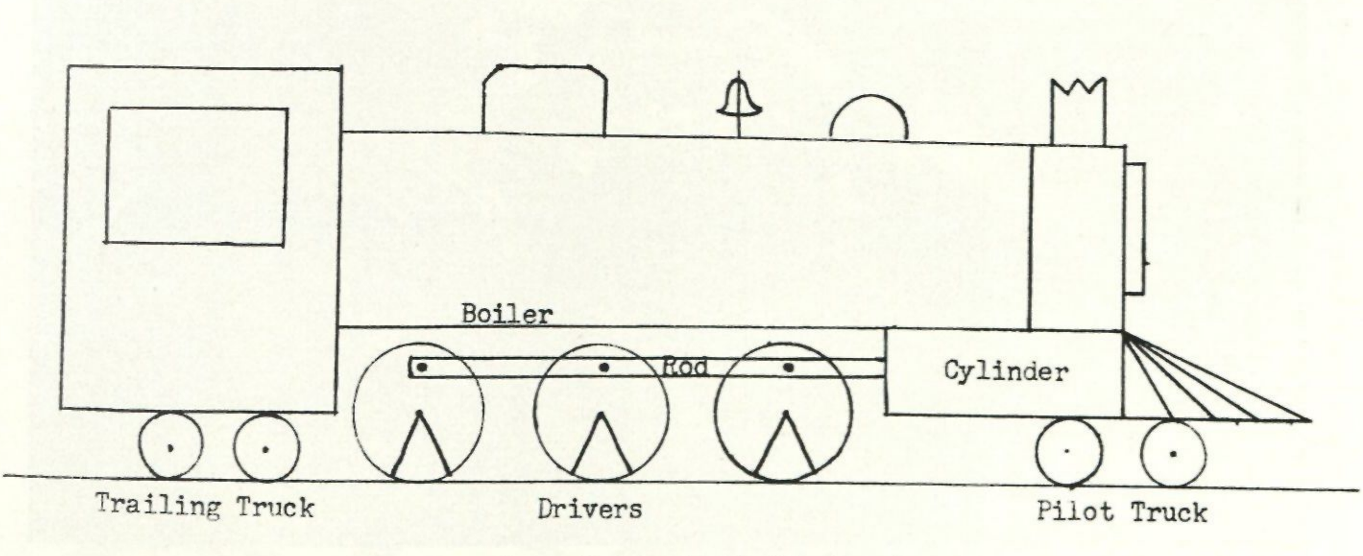

Figure 3 — A Typical 4-6-4 Wheel Configuration

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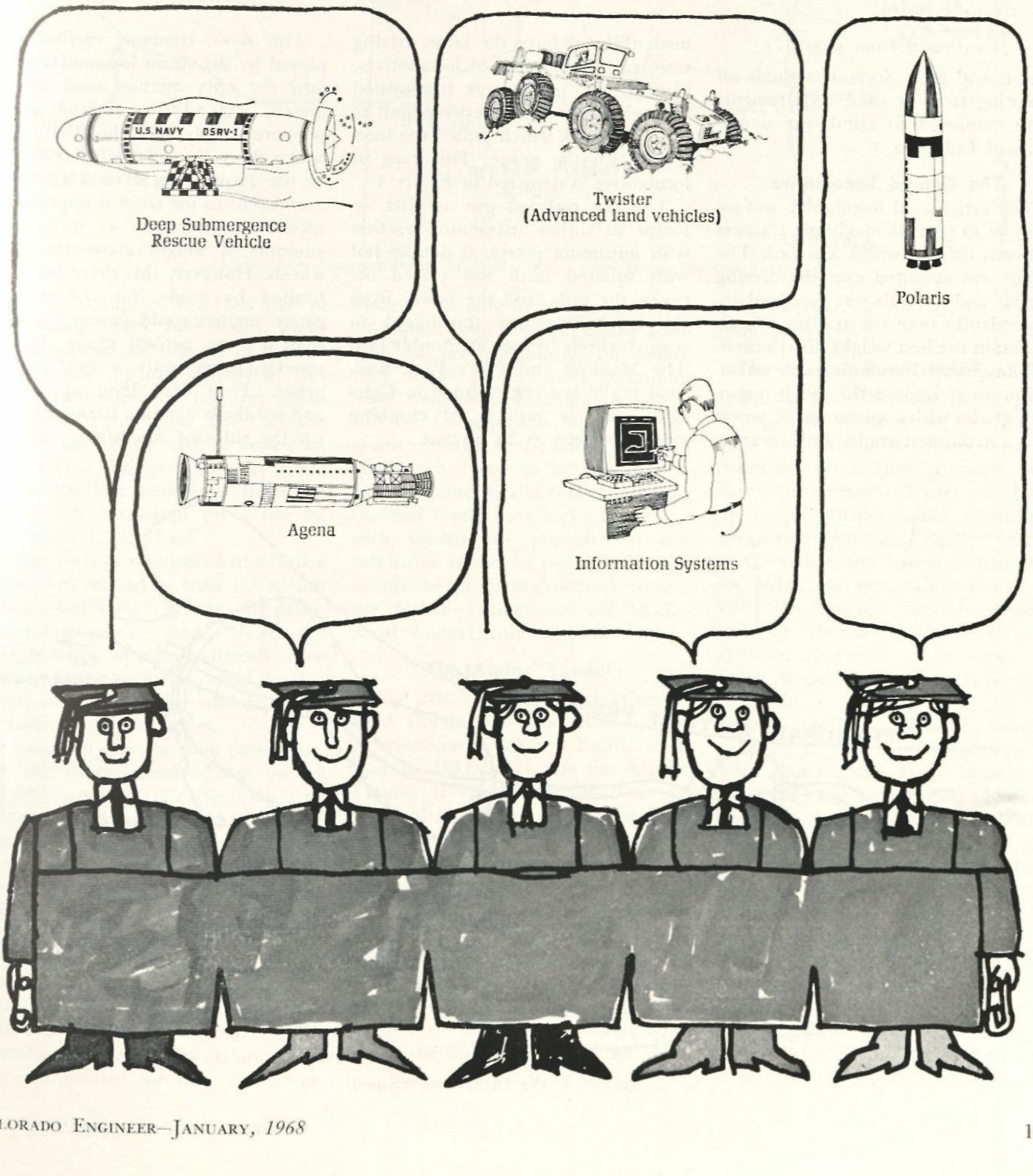

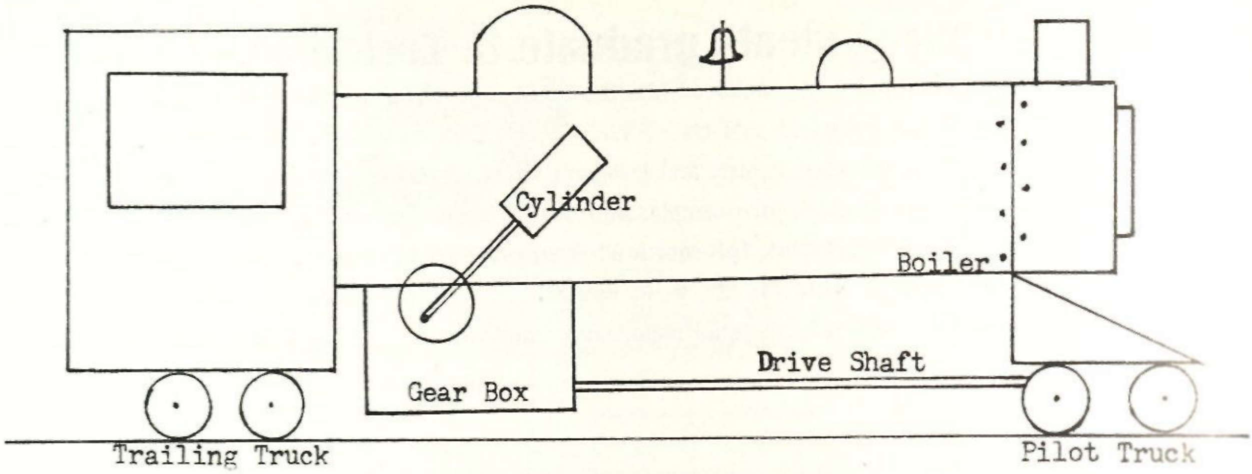

Figure 4 — A Typical Geared Locomotive

(Continued from page 17)

wheels and rails. Several methods attempting to meet these requirements were employed to climb the mountains of Colorado.

The Geared Locomotive

The articulated locomotive was an attempt to provide maximum traction between driving wheel and rail. The boiler was mounted over the driving wheels and the cab was mounted independently over the trailing wheels to obtain the best weight distribution.

The geared locomotive was an attempt to overcome the steep mountain grades with a minimum of power and a maximum grade. This arrangement did not have the large driving wheels of other types of locomotives; instead, the power was transmitted through a gear box and drive shaft to the pilot truck which pulled the locomotive up the grade. This type of locomotive is depicted in Figure 4.

The cog railroad was another attempt to utilize maximum traction with minimum power. A double rail with squared teeth was placed between the rails, and the power from the locomotive was transferred to cogged wheels fit into the double rail. The Manitou and Pike's Peak Railroad is the last cog railroad in Colorado, and is capable of climbing grades as steep as 25 percent.

The most common method employed by the steam locomotives, and now the only method used by the diesels, was adhesion-traction drive, or more simply, just the friction between the rails and the drive wheels of the locomotive. It was the most convenient to use since it required no special equipment — just large amounts of weight above the drive wheels. However, this drive was very limited by grade, for the narrow-gauge engines could master no more than a seven percent grade and the standard-gauge only a five percent grade. Thus very long approaches and roadbeds winding back and forth up the sides of mountains were re-

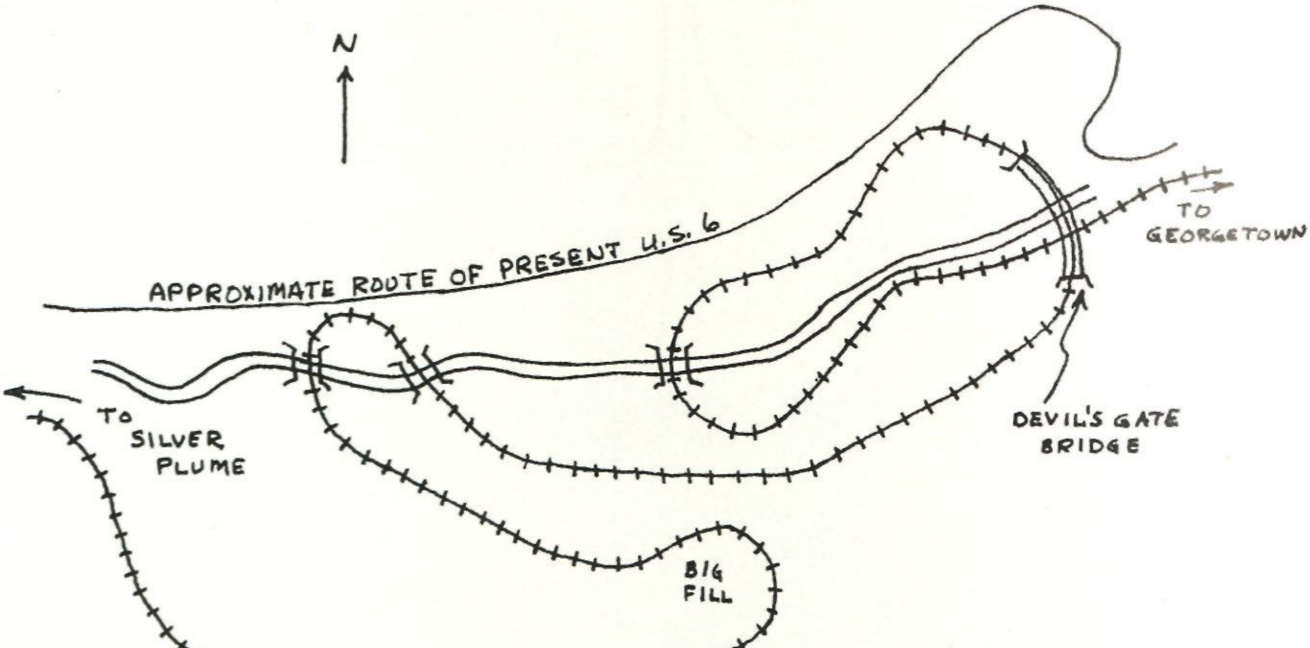

Figure 5 — The Georgetown Loop

quired to use the adhesion-traction drive. But in this manner the same locomotives that pulled the trains across the plains were used to cross the mountains.

The Georgtown Loop and Bridge

The extreme example of this restriction by grade was the Georgetown loop and bridge, as shown in Figure 5. The railroad made an ascent of 638 feet above Georgetown to Silver Plume in four and one-half miles. In doing so, the rails had to cross Clear Creek four times, make four complete 180 degrees turns, and climb grades up to two percent. Yet the distance between the two towns was only two miles. One of the bridges the trains had to cross was Devil's Gate Bridge, a spindly metal tressle 300 feet long and curved 18 degrees. It supported the trains 96 feet above Clear Creek.

Construction engineers had a choice when they wished to cross the mountains of Colorado – go over the passes or tunnel under them. Often the maintenance of the railroads over passes during winters would be far more costly than the one-time cost of tunneling under them.

Operation over the high passes during the winter involved the use of helper engines, extra crews, and large rotary snow plows. Often trains were snowbound for days in the passes because the snow drifts were more than the rotary plows could handle so that even the rescue trains would be stranded. Long wooden snow-sheds were built over the tracks in an attempt to provide protection from the snow and keep the trains going. But this type of protection was finally abandoned after a few train crews were suffocated because the snow covering the sheds restricted the air supply to the sheds.

Tunnels were indeed the solution to the snow problem, but getting them built proved to be a problem almost as difficult as that of the snow. Driving the tunnels was a slow and arduous task, for little, if any, heavy equipment was available to take the place of man- and animal-power. The holes for the black powder (dynamite was not yet available) were drilled manually, and the blasted rock was loaded manually into hoppers pulled by mules. There were no means available for pre-determining the condition of the interior of a mountain other than visual examination of the surface. Consequently, the expected granite interior of the mountains very often turned out to be soft crumbling rock and as the tunnel was dug the roof would have to be shored up with timbers to prevent cave-ins. Admission of two of the most famous tunnels in Colorado's railroad history, the Alpine Tunnel and the Moffat Road Tunnel, concludes this article.

The Alpine Tunnel

The first bore through the Continental Divide was completed by the Denver, South Park and Pacific Railroad in 1881. This was the Alpine Tunnel. It was constructed at an altitude of 11,500 feet and linked Denver with Gunnison City. Engineers the world over regarded it as an engineering marvel. It remains the highest tunnel ever bored.

Most of the work was done by hand, with the already slow progress slowed even more by the rarified air and sub-zero temperatures. All but small sections of the 1,771-foot bore had to be supported by timber shorings because of the loose rock in the mountain. Over 500,000 linear feet of redwood lumber were used. The tunnel required 19 months to complete, and after completion, had a maximum width of 10 feet, 10 inches and a maximum height of 13 feet, 9 inches. The narrow gauge trains made it through with little room to spare.

Although the tunnel was abandoned in 1910 due to the switchover of the railroads from narrow- to standard-gauge tracks, most of the timbered sections of the Alpine tunnel stand today.

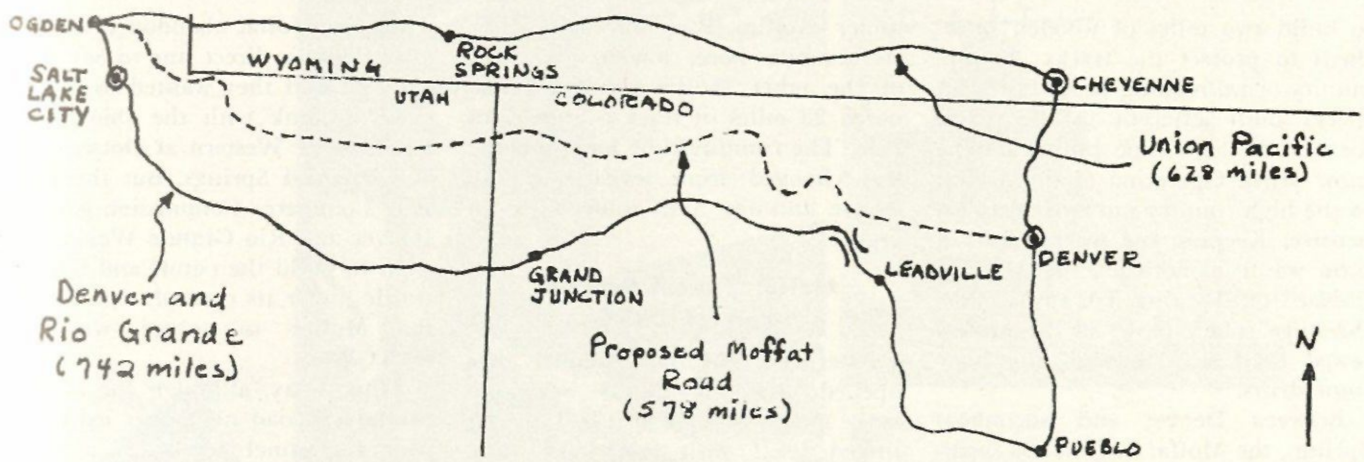

Figure 6 – Proposed Route of Moffat Road from Denver to Salt Lake City

The Moffat Road and Tunnel

By the year 1900 the Denver and Rio Grande Western and the Denver and Rio Grande railroads had an east-west connection through the mountains between Denver and Utah by way of Pueblo, Salida, Gunnison, and Grand Junction. Farther north, in Cheyenne, the Union Pacific had the oldest east-west railroad line. In 1902, the Denver and Rio Grande and the Denver and Rio Grande Western shortened their route by going under Tennessee Pass near Leadville.

David Moffat, a Colorado mining millionaire, visualized building a more direct route from Denver to Salt Lake City, as shown in Figure 6. His railroad to be (the Denver, Northwestern and Pacific) was to extend westward from Denver to Steamboat Springs by way of Boulder Canyon, Rollins Pass, and Winter Park. By 1911, the tracks had reached as far as Craig, Colorado but Moffat died before his dream was completed.

On 11,600 foot Corona Pass, the highest standard-gauge railroad pass in the United States, the winters were so severe that engineers were forced

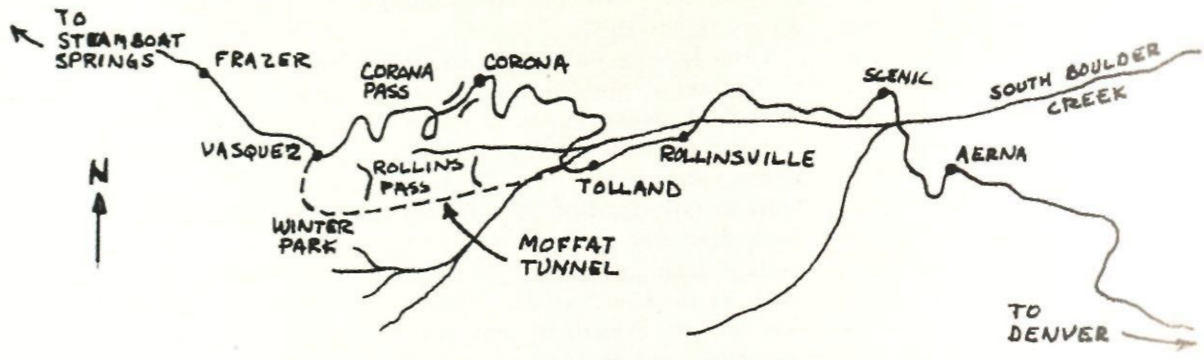

Figure 7 – The Moffat Road and Tunnel

to build two miles of wooden snowsheds to protect the tracks. A community of railroading people lived in shacks built adjacent to the sheds, for months at a time buried by the snow drifts. Operation of the Moffat in the high country was extremely expensive. Keeping the tracks clear of snow was a mamoth job that was not finished until spring. For two winters the huge rotary plows of the Moffat sawed their way through the huge snow drifts.

Between Denver and Steamboat Springs, the Moffat had had 55 separate railroad tunnels, with thirty of them in a seventeen mile stretch, and finally in 1922 the Moffat tunnel under Rollins Pass was completed. Its six-mile bore, longer than any of the other Moffat tunnels, eliminated 23 miles of track over Rollins Pass. The running time for this route was changed from seven hours to twelve minutes. This route is shown Figure 7.

Moffat Tunnel Becomes Part of D&RG

After the Moffat Tunnel was opened, the line finally began to make money. Although it had not yet linked itself with Salt Lake City, local traffic in the form of coal, oil, and livestock from northwestern Colorado gave revenue to the line. Then the Moffat abandoned the idea of building a direct line to Salt Lake City. Instead they wanted to build a cutoff to link with the Denver and Rio Grande Western at Dotsero, east of Glenwood Springs. But the Interstate Commerce Commission gave the Denver and Rio Grande Western the right to build the cutoff and have all traffic under its control, thus forcing the Moffat to merge with the D&RGW.

Thus today, although the original Moffat railroad no longer exists, the Moffat Tunnel serves as a major transcontinental link between east and west.

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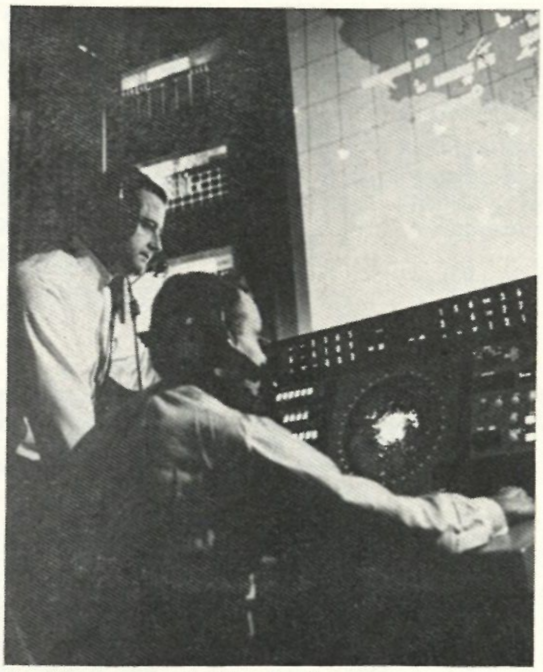
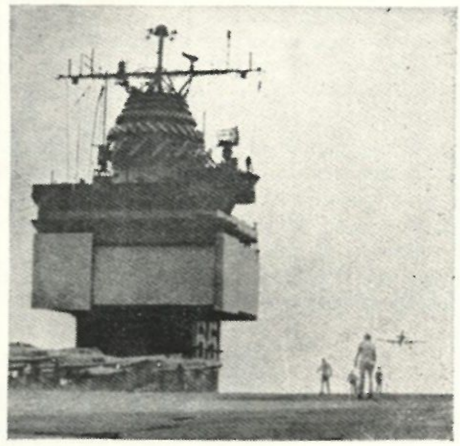


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FORD MANAGEMENT: THE EDSEL AND THE MUSTANG

DEAN REYNOLDS

In September of 1957, Ford Motor Company launched a new middle-priced automobile which had already cost $250 million to market and was calculated to be an instant success. Ford expected to realize a good return by selling 200,000 of its new line the first year. The Edsel was the biggest failure in automobile history. Exactly two years, two months, and fifteen days later Ford had sold less than 110,000 Edsels, and had lost $350 million in the process.

How could this happen? Ford Motor Company had money, brainpower, and supposedly, the experience to prevent such a mistake.

The Contrast

In contrast, Ford launched a smaller and better planned automobile in September of 1964. This car, the Mustang, was such an instant success that the Ford balance books looked better than at any time since 1959. It is true that Ford had had success with the Falcon and Comet in the very early sixties, but the Mustang set records beyond all expectations.

What talents and changes caused the remarkable comeback of Ford in those seven years? The answers were not difficult to find. Lack of experience and ignorance of marketing techniques in the early fifties had been replaced with maturity and intense operations research techniques by the early sixties.

Even before Ford discontinued the Edsel, the car-buying public had its answer to the Edsel fiasco, and it was widely accepted. The Edsel, it was thought, had been made, designed, and promoted in a calculated manner, and the public simply would not respond to such unspontaneous wooing.

It is true that the Edsel was supposed to be the product of a precisely calculated risk. It was not. Public taste changed before the Edsel could be designed and marketed, and Ford was not aware of the change. Old-fashioned selling methods were used at a great loss, and the name "Edsel" was chosen arbitrarily after over eight thousand purchased names had been discarded at the last minute.

The Edsel had its beginnings as early as 1948, when the management at Ford recognized that the Mercury, Ford's middle-priced car was competing with three General Motors products: Pontiac, Buick, and Oldsmobile. Some Ford officials felt that to battle GM, that Ford should have a competitor for each GM car. Of course, the post-war boom was no time to introduce a new line, but after the boom had ended and sales began to slump in the mid-fifties, Ford could use a boost.

Further, market studies indicated that Ford was producing customers for GM. Ford car owners were trading up to the larger GM cars instead of Ford's Mercury.

There was no problem when it came to Ford's recognition of the enormous risk it would face. No major automotive manufacturer had introduced a new standard-sized make since 1938, when Ford had launched the Mercury.

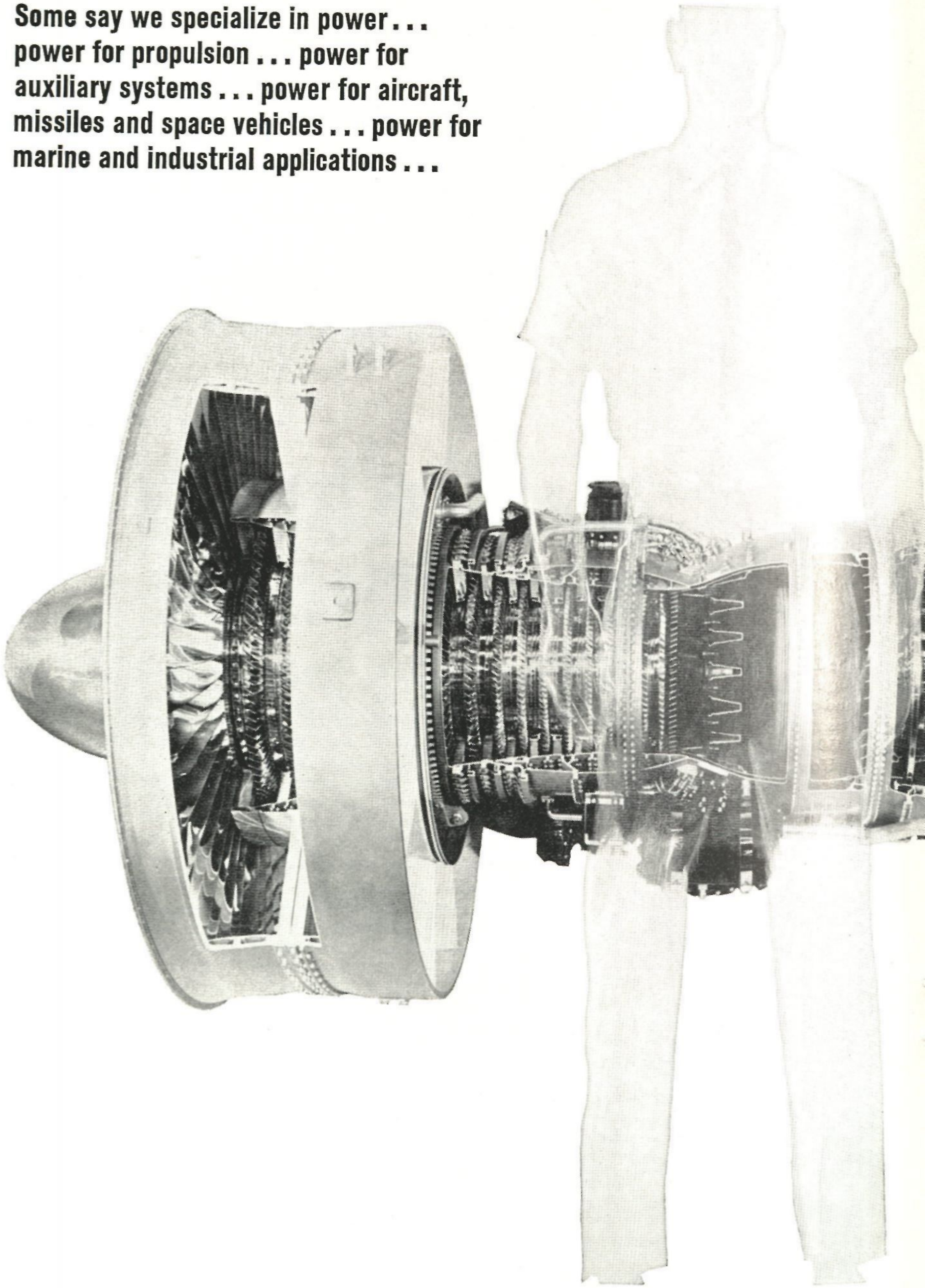
In April, 1955, Ford set up its Special Products Division. The first decision made by the new division was that the newest of the nineteen automobiles currently on the market were too similar, and that a unique new car would be very much in demand. Ford designers had fully styled the "E-car," as it was then known, by the summer of the same year. The E-car could be easily recognized from other makes because of its distinctive looks, both front and rear.

Needed: A Name

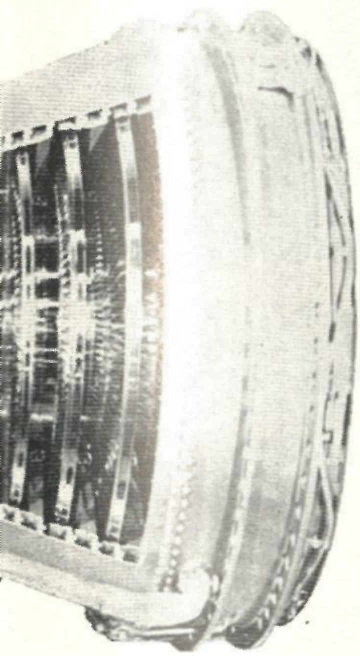
The next step was to give the E-car a name, and for this, Ford employed the Columbia University Bureau of Applied Social Research. Columbia interviewed hundreds of recent new car buyers in two states and prepared a list of names most often mentioned in the poll. Ford's idea was to give the E-car its own unique personality. The Ford car had no image of social pretension as the low-priced model, and the Mercury even less as somewhat of a hot-rod. Small wonder Ford car owners were trading up to competitor's automobiles. The personality of the E-car was to be fit for the young family executive on his way up.

(Continued on page 28)

Some say we specialize in power . . . power for propulsion . . . power for auxiliary systems . . . power for aircraft, missiles and space vehicles . . . power for marine and industrial applications . . .



. . . they're right. And wrong.



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The loser Ford will never forget — the 1957 Edsel.

(Continued from page 25)

Armed with a list of two thousand possible names, researchers next walked the streets of New York City asking what free association each name brought to mind. These results were tabulated and stored.

An advertising agency was called in and worked for some weeks in compiling still another list of six thousand possible names.

By this time it was spring of 1956, and the dies for the new car had to be made, and some would bear its name. The advertising agency set about to trim its list to ten names. Top on the list was Corsair, which had done well on all occasions.

Committee Chose Edsel

A meeting of Ford executives was held to finally determine the name. Coincidentally, all of the Ford brothers were out of town, and the chairman of the board conducted the meeting. He felt the name must be decided upon immediately, and did not particularly like any of the final choices. Led by the board chairman the committee decided to call the car "Edsel" without regard to any of the experts' selections. In fact, the name choice was amazingly arbitrary in the face of Ford's expenditures in order to make the choice a scientific one. All of the Ford brothers went along with the choice of the committee.

In November of 1956, the public learned that the new Ford automobile had been named Edsel. It has been said that the time lag between this announcement and the actual appearance of the Edsel nearly one year later had something to do with leaving the car-buying public somewhat stale on the name.

Next, Ford set out to establish 1200 Edsel dealers from coast-to-coast. Why Ford chose to establish new dealers still remains somewhat of a mystery. There were numerous dealers already handling Ford products, but Ford took much care and spent great sums in establishing new Edsel dealers. Once Ford had signed these Edsel dealers, the Edsel program could not be discontinued. The Edsel had to get into production.

By June of 1957, Ford Motor Company had set aside $200 million in production money, and $50 million for initial advertising of the Edsel. The first advertisement for the Edsel appeared in *Life* in July, 1957.

Advertising Overdone

So intense was the advertising for the Edsel during the summer of 1957, that Ford officials later felt the resulting publicity actually hurt the Edsel cause. Wire services picked up stories about the new car, and by late summer, the public was hysterical to see the new car. As weeks went by and the public saw more advertisements, it visualized the Edsel as a dream car, different from anything it had ever seen.

Finally, early in September, 1957, the Edsel was revealed to the public, and nearly four million people presumably saw the Edsel in its first day in the showroom. To the disappointment of some, the car had four wheels and an engine, just like any other car. The Edsel was different, though. For less than $4000, the Edsel was a radically-styled 4000 pound plus monster with up to 345 horsepower. It had gadgets inside including eight warning lights and even a push button array for the automatic trans-

A good name for a small sporty Ford and the 1964 Mustang began its career as a winner.

mission located on top of the steering wheel post, right in the middle of the wheel. The Edsel was longer than the biggest Oldsmobile, and as wide as any American car has ever been.

All was not disappointment, as the Edsel sold 6500 cars the first day, and the first month, September, had some sales.

Bad Publicity Caused By Poor Quality Control

Soon after the new Edsels began to sell, a grave error in Ford's management of quality control was discovered. In its rush to supply the dealers with Edsels, management had neglected to set and maintain rigid quality control standards, and Edsels began to fall apart at an ever-increasing rate. Consumers Union – which bought cars on the open market so as to test undoctored samples – purchased and tested an Edsel. The rear-axel ratio was wrong, an expansion plug in the cooling system blew out, the power steering pump leaked, the rear-axel gears were noisy, and the heater would not shut off. Same was, of course, published by Consumers Union. This was not the only bad publicity the Edsel received, and while not all Edsels were that bad, it was only too typical of the publicity the Edsel received. Ford later estimated that only about half of the first Edsels performed as they were supposed to.

Despite costly advertising gimmicks Ford put on during the ensuing months, Edsel sales went from mediocre to poor. Dealer panic set in, but this time Ford management handled the situation well, and by December, dealers were ready to get sales moving again. Sales would not move, however, despite everything Ford did. At the end of the 1958 model year, Ford had sold less than 35,000 Edsels.

The 1959 Edsel was much lighter than its successor, and had less horsepower. It actually began to sell in November of 1958. Sales progressed somewhat during 1959, but were still only one-fourth of that needed to make a profit. The 1960 Edsel appeared and was discontinued in November of 1959.

Ford had attempted to give the public a large, luxurious, powerful car. Instead, just as the Edsel was discontinued, the Falcon was an instant success in the compact car field. The Edsel had been a giant step in the wrong direction.

The Mustang: Success

The Falcon was introduced by Ford in 1959, and was very successful. It was the product of very careful planning and recognition of the market. The Falcon had been designed and produced so as to hit the market when it was wanted. With stark simplicity and relatively few defects the first year, the Falcon was conservative much as the Model T had been.

The success of the Falcon was slowed by the revamping of Chevrolet's Corvair with a new model called the Monza. The Monza appealed to young people, and a jazzed up Falcon still bore connotations of conservatism. It was in May of 1961, that Ford began to develop a sporty new model.

In 1962, Ford had designed the basic Mustang, and its shell began to emerge at automotive races where Ford was having tremendous success.

Before Ford would market a new

(Continued on page 33)

Got an idea?

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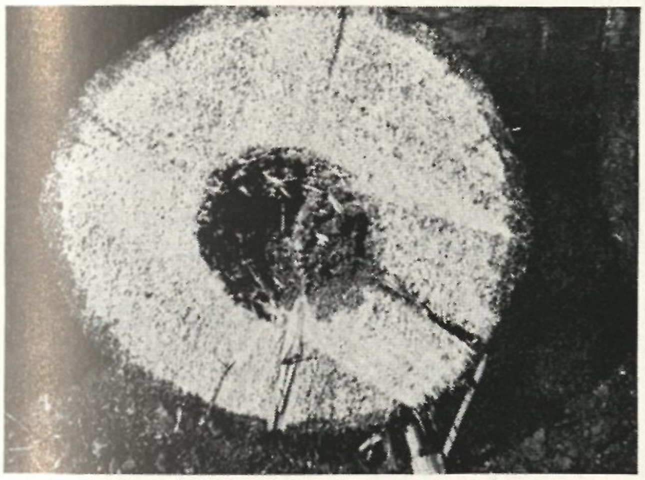
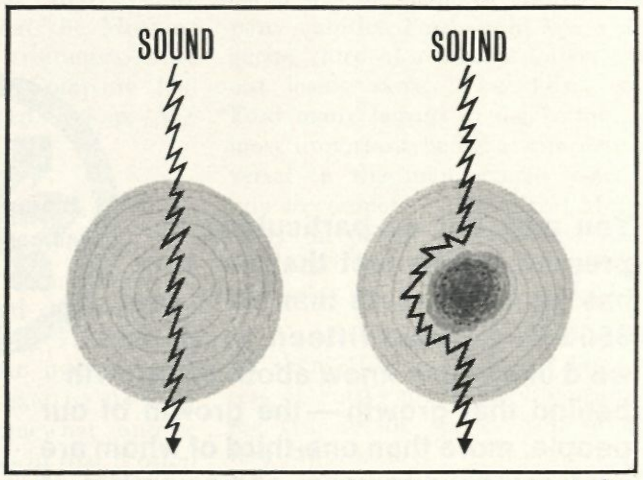


1. Edison engineer, Dick Popeck, wanted to find a more effective method of determining the amount of pole decay.



2. Dick's idea: Measure the time required for sound to travel through a pole. Sound takes longer to traverse a decayed pole.

3. Transistorized circuitry was designed. And a Sonic Pole Tester was built and tested.

4. Ed Hines, Director of Research, (left) discusses patent coverage with inventor Dick Popeck.

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DETROIT EDISON

(Continued from page 29)

car, a tremendous market research study was undertaken. Models of a small, sporty Ford were made, and public reaction and acceptance were measured. The need for a car of this size had been established by the Falcon, and Ford felt that if it could avoid a boner in styling, it would have what the young set really wanted: the economy and simplicity of the Falcon and the sporty look of a more costly vehicle.

Ford also knew the young set would react to a good name. The Monza had shown that. Ford itself conducted a study that ultimately showed the three best names were Cougar, Mustang, and Torino. Mustang was chosen by Ford officials on the basis of study information.

Rather than market a completely new car, Ford chose the Falcon drive train in the Mustang. Costly retooling was avoided, since only the body showed any real change. More important to sales, the defects that had plagued the Edsel were avoided since the engines and transmissions had already been in production for several years.

Advertising and Marketing Well Planned

Market time for the Mustang came within a few months after the public found out about the sporty new Ford. Advertising had been held to a minimum, and when the public saw the Mustang, the advertising intensity was increased Established Ford dealers were used to distribute the Mustang, so that if it didn't sell, Ford merely discontinued production, and very little dealer investment would be lost.

Notably, the Mustang was hitting the market where no established line of cars existed, much as the successful Falcon had done. Ford was no longer hitting General Motors head-on in the costly battle for sales. Instead, Ford was establishing completely new lines of cars, a practice known to the industry as model proliferation. Ford had already had success in this field with its now established Falcon, Comet, Fairlane, and Thunderbird. Unbelievably mammoth General Motors was spending millions of dollars trying to catch up with Ford in its newly established small car lines.

There was no doubt that the Mustang would be accepted after the first month of sales. Ford's only problem for a while appeared to be making enough Mustangs so that dealer stock would not run short. Quality control standards were rigidly maintained throughout, however, and the quality of the new Mustangs was good. To the surprise of even Ford's officials, Mustang's first year showed a record 418,812 sales.

Mustang had hit the market at an optimum point. Mustang sales continued to set records. Sales of full-sized Fords and Mercurys increased indicating that the Mustang was producing Ford customers. Once again, Ford Motor Company had lived up to Henry Ford's axiom, "We are winners!"

Maturity and Present Day Ford Management

The structure of management at Ford has not changed drastically in the last ten years. The Ford family still owns 40 percent interest, and does not hesitate to exercise its power. Ford still is somewhat unique in large business terms in that it often bypasses organizational lines. Robert McNamara had many men between him and the top executive levels on his way up to the presidency. Ford is refreshingly different in the cutthroat automotive business. Management is young, brainy, alertly aggressive and restricted neither by traditional practices nor rigid organizational structure.

The biggest difference in top management levels at Ford recently is education of individual personnel. Most division heads are educated as engineers, and consequently, are not subject to the sneering and friction experienced by some of the "Buck Rogers" types of a decade ago.

Typical of the modern Ford management, top level research engineers have been assigned the project of determining the optimum level of new car inventories in the hands of dealers. The answer could be worth millions of dollars. Nothing less than a mathematical model demonstrating interrelationships of all principles involved satisfies the new Ford management.

Ford Learned From Its Mistakes

Ford, more than any of the big three automotive manufacturers uses computer techniques and sophisticated research methods in all phases of automotive production. It learned from the Edsel failure not to ignore what research had indicated. Large corporations have often been accused of rigging markets and dictating to the customer. The consumer certainly dictated without peer when Ford tried to sell the Edsel. $50 million of advertising is a lot of advertising to ignore.

The Edsel was a tragic failure, and the only good Ford could tangibly claim was the demonstration of company stability. Ford could lose a staggering third of a billion dollars without losing rank. The Edsel gave Ford many lessons in marketing, the most important being a complete reversal in the management view of how to compete with General Motors. Sheer firepower is GM's hallmark, and Ford learned to respect GM in this way. Says one high official:

"We are like Chinese bandits. We hit them [GM] and run." The success of Ford's model proliferation in the last decade speaks well of this new approach.

Ford now realizes that it is suicide to hit GM head-on, and has gone even further in measuring its performance in absolute terms instead of GM's. In short, Ford management now realizes that Ford Motor Company is an entirely different creature than GM, and that Ford requires markedly different organization and policies.

Ford discourages direct comparisons with its biggest rival, but obviously believes in its brand of management in the long haul. Maturity has set in, and while Ford is not beyond mistakes, neither is General Motors. Ford now believes it is no longer impossible to take over from General Motors.

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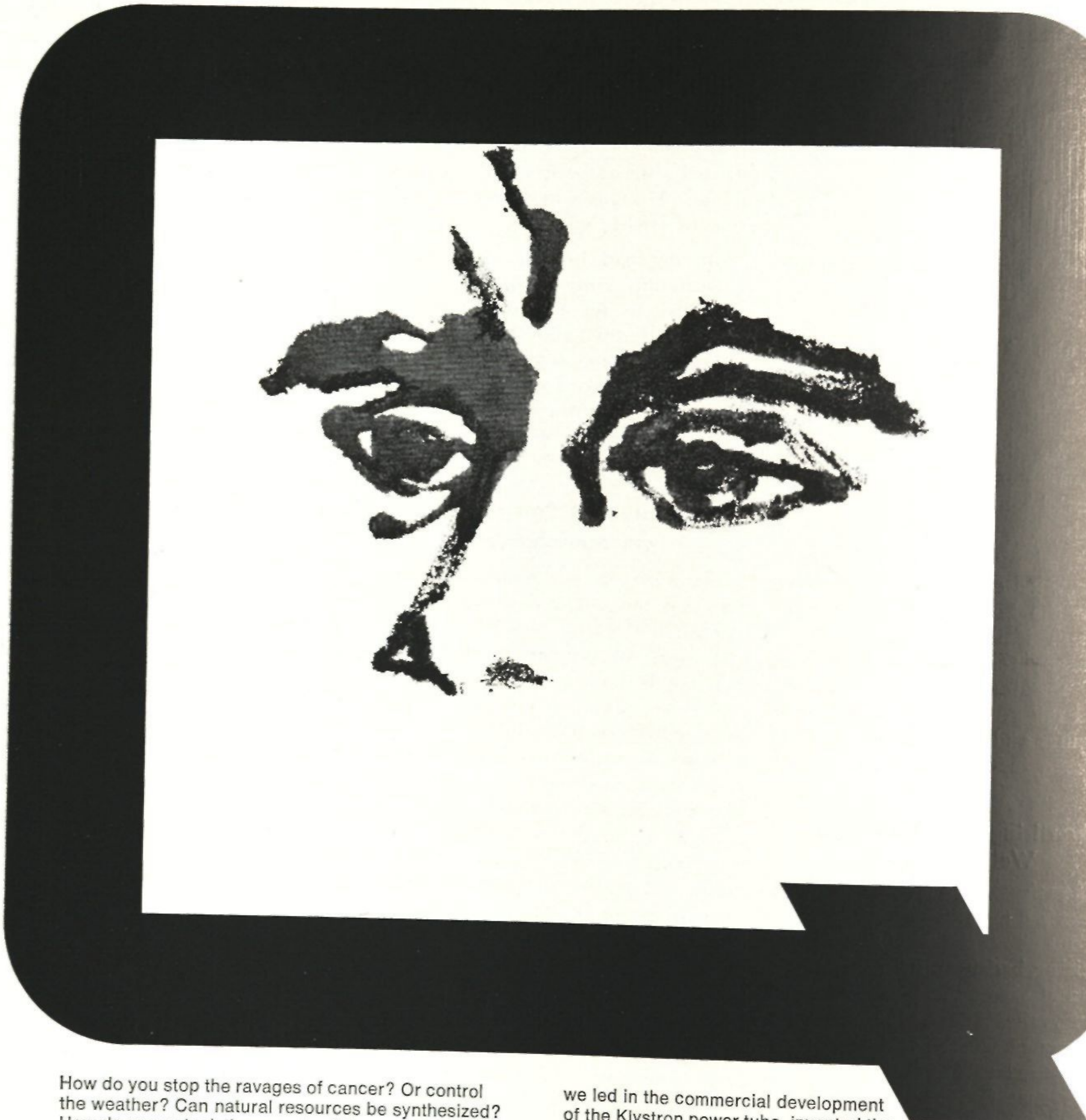

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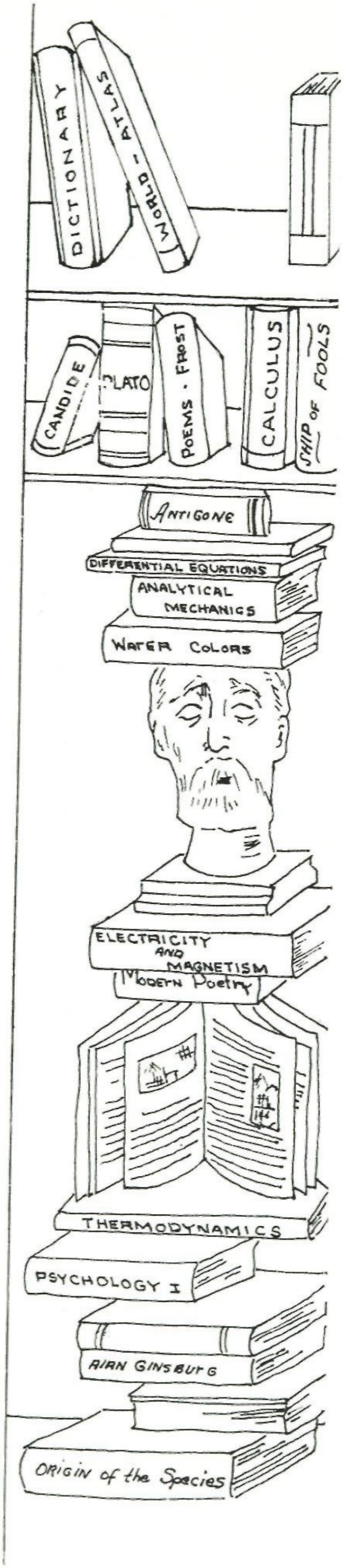
BOOK REVIEWS



1967 Steam Tables

Electrical Research Association. New York: St. Martin's Press, 1967, 146 pp., $18.50.

The *1967 Steam Tables* diligently documents the thermodynamic and physical properties of water. *1967 Steam Tables* was prepared with two main objectives in mind: (1) the tables would be in accordance with the International Skeleton Tables determined at the Sixth International Conference on the Properties of Steam held in New York in October 1963, and (2) they could easily be incorporated into analytical expressions to be solved with a computer.

Data on the properties of steam extended to higher temperatures and pressures was obtained from experimental work by laboratories around the world.

Included in addition to tables normally associated with steam data are tables of specific heat capacity and transport properties, dynamic viscosity and kinematic viscosity, thermal conductivity and Prandtl Number. Also included are the International Skelton Tables—1963, of the saturation line, specific volume, specific enthalpy, dynamic viscosity and thermal conductivity for water and steam.

The tables of specific enthalpy, entropy, and volume range from zero to 15,000 pounds of force per square inch and from 32 to 1500 degrees Fahrenheit.

Phase diagrams also are included for determination of the dynamic viscosity of water and steam as a function of temperature at various isobars, the kinematic viscosity of water and steam as a function of pressure for various isotherms, the thermal conductivity of water and steam as a function of temperature for a spectrum of isobars and critical mass flow per unit of area as a function of initial pressure and temperature.

A very adequate list of conversion factors for each property in all major systems of measurement is compiled and is easy to use.

All tables are presented in a forthright manner—the data are not crowded, different styles of type are used whenever possible to facilitate interpretation and the formulae used to obtain theoretical correlations with experimental data are presented in the appendices with all units clearly indicated. Also, the eyepleasing quality of the low-gloss flat white paper should be mentioned.

However, two sets of information that are noticeably missing are the temperature-entropy plot and the Mollier Chart. If these two charts were included, the *1967 Steam Tables* would be, in this writer's opinion, the compleat thermodynamic data book.

—*Sam Carlsson*

Digital Logic and Computer Operations

by Robert C. Baron and Albert T. Piccirilli. New York: McGraw-Hill, October, 1967, 321 pp., $13.50.

The principle aim of *Digital Logic and Computer Operations* is to introduce the fundamentals of the computer to the reader who has a basic mathematical background. Using diagrams, text questions, and lab experiments and demonstrations, the authors have created a good book for anyone who is just becoming acquainted with a computer.

Logically constructed, the book presents each idea in conjunction with diagrams in order to further their explainations. The history of the computer introduces the reader to the different types of computers and to the basic elements of the digital computer. The various number systems (binary, octal, etc.) are then explained in order to lay the foundations of the computer system. Expanding the idea of this system, the authors present next a chapter on logic reasoning and truth tables, followed by an enumeration of the various codes used by the computer. Then assembling these ideas, a few arithmetic operations are discussed as well as types of memory and the control element. The different input/output equipment available and a short introduction to computer programming complete this elementary summary of the basis of a computer.

Digital Logic and Computer Opera-

tions presents a fairly comprehensive study of the basic functions of a computer. Describing the fundamentals of all computers instead of the specific operations of one computer makes this book a valuable guide to the beginning computer student. Being a current book, it discusses the various uses the computer has found quite recently. The usefulness of any computer, however, depends on the capabilities designed into it, so it is of great value for one to understand the basic operation of the computer.

A well-written book, it develops four elementary building blocks of the computer in the first chapters, and then proceeds to organize these building blocks into the various working elements of the computer field. Written solely for the beginner, it makes no reference to specific electronic parts or complicated formulas, but follows a plan involving diagrams and problems to present the working idea behind the computer. The exercises at the end of each chapter are a definite learning instrument, but could be supplemented with an appendix giving some of the answers in order to show the student that he was on the right path. But, generally speaking, the book is an excellent guide for people unfamilar with computers.

—Terry Lawry

Engineering Manual

Second Edition; Robert H. Perry, Editor. New York: McGraw-Hill Book Company, 1967, 770 pages, $11.75.

The *Engineering Manual* is a compact volume containing reference data, not only on general engineering principles, but also on six specific fields of engineering. Prepared by a staff of specialists under the direction of Dr. Robert H. Perry, also editor of the *Chemical Engineers' Handbook*, the *Engineering Manual* is a ready reference, source on questions which commonly arise concerning engineering.

The *Manual* is divided into nine sections, the first three being devoted to general principles of interest to all engineers. Section 1, "Mathematical Tables and Mathematics," contains fifteen standard reference tables from Five-Place Common Logarithms to Wire and Sheet-Metal Gauges. It also presents condensed sections on the basic areas of mathematics, with definitions, principles and methods. Section 2 is "The Engineering Core." Here, the basic engineering areas of thermodynamics, fluid flow and heat transfer are covered. In Section 3, the physical, chemical and mechanical properties of elements and compounds, as well as extensive data on metallic and plastic construction materials are contained.

In Sections 4—9, a noted authority in the fields of architectural, chemical, civil, electrical, mechanical and nuclear engineering has summarized the basic principles and design methods of his discipline, with all significant data clearly presented.

The *Engineering Manual* is well-organized and indexed and is thus easy to use. Over three hundred illustrations, graphs and charts contribute to the clarity of the sections. Noticeably missing is a section on aeronautical engineering. However, the information continued on the other disciplines, as well as the general engineering data, is fairly complete, although not detailed, and references are cited where appropriate.

The *Engineering Manual* is a valuable book for any practicing engineer or engineering student. It provides easily found information on the everyday type questions which arise in the study and practice of engineering.

—Kathy O'Donoghue

Engineering: Its Role and Function in Human Society

Edited by William H. Davenport and Daniel Rosenthal. New York Pergamon: Press, 1967, 284 pages, $7.50.

Engineering: Its Role and Function in Human Society, part of the Pergamon Unified Engineering Series, is an anthology of essays and articles attempting to relate engineering and humanism. The book is divided into four sections which examine different approaches to the relationship, comparing and contrasting the foundations of each area by presenting the historical views of each group, the problems which bring them together, and the future as viewed by engineers and humanists.

Part I, "The Viewpoint of the Humanist" traces the changing attitude of the humanist toward science and technology, beginning with the Nineteenth Century aloofness as expressed by John Henry Newman and Samuel Butler and developing into the modern concern and interest of D.A. Piatt and Aldous Huxley. The eight essays of this section, written from 1852 to 1963 demonstrate well the changes which have occured in the last one hundred years.

In Part II, "Attitudes of the Engineer," the viewpoint is reversed. The engineer looks at himself and society through the eyes of such men as Herbert Hoover, John C. Calhoun, Jr. and R. B. Lindsay. The engineer has changed from an aloof, self-conscious specialist to a very out-spoken and socially concerned individual who considers the human element integrally in his work.

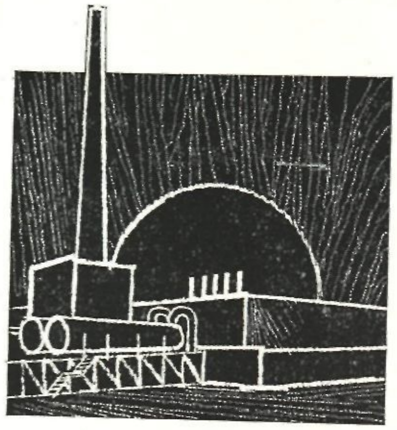
"Man and Machine." the third part, considers the effects of technology on civilization and studies the question of the future relationships between man and machine. From Sadi Carnot to Norbert Wiener, the machine is dissected in its effect on human society.

The last section, "Technology and the Future," considers the role of science and engineering in the future of man. It emphasizes the responsibilities of the engineer, which do not stop with engineering but encompass the welfare of future civilizations. Robert L. Heilbroner, Vance Packard and Rachel Carson are among the fourteen authors presented in this final section.

Engineering: Its Role and Function in Human Society was compiled as a textbook for engineers in courses on the history of technology or sociology of engineering or for non-engineers in courses on engineering. The authors, one an engineer, the other a humanist, have attempted to present both sides of the question clearly. It is an unusual approach which they have taken, but one which is definitely needed.

The Pergamon Unified Engineering Series was established to fill the gap between the engineering sciences and the social sciences. The texts of this series add to the study of engineering an awareness and understanding of human values and social responsibilities which round out the engineers formal training.

—Kathy O'Donoghue



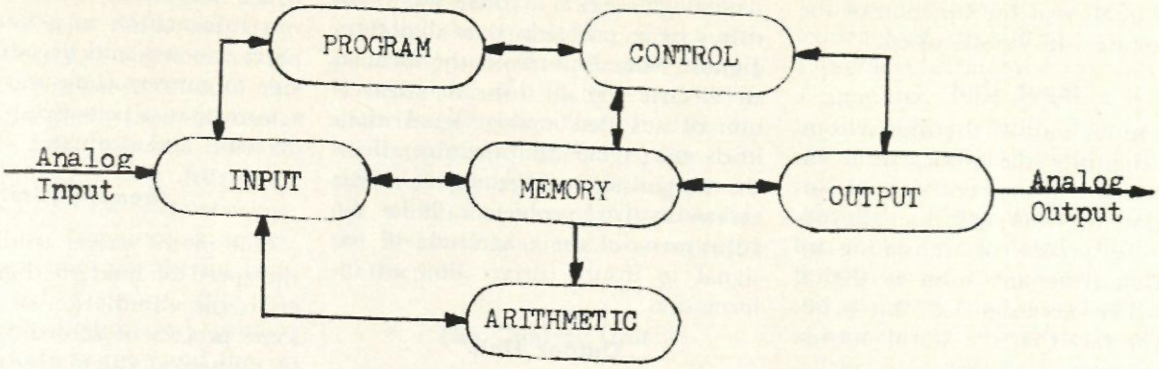


Figure 1 — Digital Computer Components

DIGITAL COMPUTER MAKE-UP

WILLIAM HINES

The applied mathematician of today does not concern himself with numbers but rather is interested in a conceptual or theoretical approach to understanding man's oldest science, mathematics. He devises and proves mathematical models and methods to obtain solutions to a wide variety of mathematical problems. After developing an efficient method of solving a problem, the mathematician need only substitute a given set of data which corresponds to the problem in question; thus the problem at this point reduces to busy work. Being rational, man has always sought to rid himself of this burden. His answer to laborious computations is the computer. But in solving this problem, he has also opened the doors to a vast number of areas in which the benefits of computers are just now being realized. Indeed, the computer holds much promise for the future and probably ranks as one of the most important inventions of our generation.

The characteristics which set the computer apart from ordinary calculating devices and which make it superior to them are its ability to retain information and its ability to differentiate between quantities. Just how are these abilities built into the computer and how do they work in conjunction with the basic elements of the computer?

The History

Computers are divided into two branches: digital and analog. The digital computer is descended from the abacus, a mechanical extension of the idea of finger counting, and is mechanized to use actual numbering systems by utilizing the two extremes of a condition to represent the presence or absence of a number. The analog computer arose from the straight-edge and compass construction of the ancient surveys and utilizes voltages, shaft positions, rate of change, or some other analog of a discrete quantity. However, this paper will concern itself only with the digital computer.

All digital computers contain the following basic units: (1) input unit, (2) output unit, (3) memory unit, (4) arithmetic unit, (5) control unit, and (6) program unit. These units are illustrated in Figure 1 and it is with this schematic representation in mind that the function of the components will be discussed.

Input Unit

The input unit of the digital computer compiles the information introduced into it and encodes this information for computer use. Encoding is the process of translating information from any form to digital form. The necessity for this arises from the fact that the world outside the computer is analog or quantitative.

The two main classes of encoding are digital-to-digital and analog-to-digital. Digital-to-digital conversions are a problem of time and amplitude adjustment. The problem of time arises from digital inputs operating at a slower or faster rate than the internal computer. The input unit solves this problem by sampling digits as they become available and storing them until it is possible to transfer them out at the computer's rate. Digital-to-digital conversions may also require amplitude adjustment to change the logic of data which is true at some incoming value and is true at another value within the internal computer.

Analog-to-digital conversion involves more problems than digital-to-digital. Most input is in the form of an electric signal; thus, the conversion of a scaled analog signal often loads the signal and thereby affects the magnitude of the signal. This rather involved problem calls for the adjustment of the magnitude of the signal to insure correct flow of information.

Output Unit

The output unit of the computer is essentially the opposite of the input unit. The function of this component is to decode the information in the computer, which is of digital form, to any other form. The most common decoding involves changes of digital-to-digital and digital-to-analog. Both methods of decoding involve the same problems as does encoding and the output unit solves them similarily. Once the decoding has been performed, the output unit releases its data in any one of a number of forms – typewritten, pictorial display, punched cards, etc.

In summary, the main functions of the input unit and the output unit are encoding and decoding respectively. Encoding is necessary to convert information to a form the computer can use and decoding is necessary to convert computer findings to a form that a person can readily understand and evaluate.

Memory Unit

One of the major contributions to the speed of modern digital computers is the elimination of the cumbersome process of recording the results of numerical calculations by the use of memory units in which intermediate results are automatically and quickly recorded, stored, and fed back into the circuits of the machine as needed. The memory unit is analogous to the human mental process of remembering but differs in one important aspect: the memory in the computer is not subject to forgetfulness.

The memory is subdivided into cells, each cell storing what is commonly called a word. A word may be a binary number, or binary coding for a word in the linguistic sense, or some combination of letters, numbers, and other symbols in a binary coded form.

Memory devices are divided into two groups called volatile and permanent. A volatile memory device is one that loses its stored data if the device loses its power source, or after a certain amount of time. A permanent memory device retains its stored data despite a power failure or the passage of time. Volatile memories are based on an on-off type of electric circuitry while permanent memories use a magnetic device to store information. The most common permanent memories are tapes, cores, and drums.

Storing data on magnetic tape is done by passing the tape under a recording device which will magnetize the tape in one direction to indicate a true state and magnetize it in the opposite direction to represent a false state. Thus, binary information may be impressed on the tape as it passes by. A reading device would then be able to interpret the information by noting in which direction the magnetic field lies.

Another device that can be used for permanent magnetic storage is the ferrite core, which consists of a ring of magnetic material. There are two directions of magnetization:

hence, the storage of two logical states is possible. Ferrite cores are magnetized by electrical currents as are tapes. The core is more durable and faster than magnetic tape but magnetic tape is less expensive and requires no circuitry. These differences in properties make the magnetic tape better suited to function as an external memory and the ferrite core, as an internal memory (the external memory being used primarily for temporary storage and the internal memory being used primarily for permanent storage).

The magnetic drum is another form of storage and is essentially a stack of magnetic tapes. The surface of the cylinder is coated with a magnetic material and data is recorded on this in a similar fashion as the tape. The drum is divided into channels along its axis and each channel is divided into sectors. Each channel is like one magnetic tape and each sector corresponds to a word. With respect to performance, the magnetic drum acts like a combination of the tape and core memories.

The Arithmetic Unit

The arithmetic unit performs all the arithmetic computations which the computer operator desires. It is this unit from which most comparisons between desk calculators and digital computers are made. This comparison is good although it must be remembered that digital computers can be mechanized to perform all known arithmetic operations and that not all, but most, arithmetic operations can be reduced to some form of addition or subtraction.

Arithmetic operations are performed in the digital computer by electrical circuits. The design of these electrical circuits stems from the fact that all arithmetic operations can be reduced to just two logical operations. These operations come from the field of mathematical logic. However, the important concept is to realize that these circuits can indeed be built to perform the arithmetic operations.

The arithmetic unit also employs two special memory cells to hold the numbers actually being worked on by the electrical circuits. The first of these is the accumulator register which receives the sum in addition problems or the difference in subtraction problems. The other is the multiplier-quotient register which contains the multiplier in a multiplication problem while the product is being formed by repeated additions in the accumulator. In division, the multiplier-quotient register contains the quotient as it is being built up, while the accumulator contains the dividend as altered by repeated subtractions.

The Control Unit

Up to this point, nothing has been said about the regulation between the various units of the computer. The function of the control unit is to provide this regulation which is necessary in order that the computer performs its operations in a logical manner.

The basis of the operation of a control unit is the repeated application of electrical circuits, called gates, which are opened or closed by voltage pulses. There are electrical connections from each of the memory cells to the accumulator and multiplier-quotient register, and from these to the electrical circuits of the arithmetic unit. These connections are interrupted by the gates. Thus, the process of control consists of opening the proper gates, at the proper times, to connect the desired combination of memory cells and arithmetic units. Each gate is designed so that only the correct combination of pulses will cause information to flow (or not to flow) from one unit of the computer to the next. But this leaves the problem of just when is the proper time and which is the proper gate. This problem is solved by the program unit.

The Program Unit

Although the program unit is the last in this discussion of digital computer makeup, its importance should not be underestimated. In digital computers, the method for starting, performing, and stopping control at any time is called programming. The digital computer is capable of performing many varied operations in its arithmetic unit but this does not mean that it will automatically do them. It must be ordered to do them and do them in the right sequence. It is ordered to do them by the set of logical, sequencial instructions prescribed by the digital computer operator.

Thus, the operator determines the sequence of steps necessary to solve a problem within the capabilities of a computer. This sequence is placed in the program unit. The program unit (through the action of the control unit) causes inputs to be accepted (through the input unit), the problem to be manipulated (through an interaction of the memory unit and the arithmetic unit), and the answer to be displayed (through the output).

Summary

To say that this article has exposed the inner workings of the modern digital computer in all its detail would be a rather erroneous statement. However, it has provided a brief look at the basic components of the digital computer which, for their seeming simplicity, combine to form a machine which is revolutionizing the sciences.

Briefly then, the units of the digital computer work together to solve a problem in the following manner. The input unit takes in information and translates it to a form with which the computer can work. The control unit, as instructed by the program unit, regulates the flow of data between all units and especially between the arithmetic unit (where all computations are performed) and the memory unit (where data is stored). After the completion of the problem, the output unit transfers information out of the computer and into a desirable form. The time required for the computer to do this in most cases is a mere matter of seconds. Man has truly devised a highly productive and capable machine to eliminate laborious computations.

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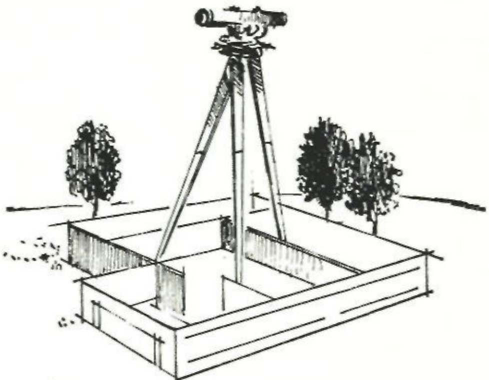

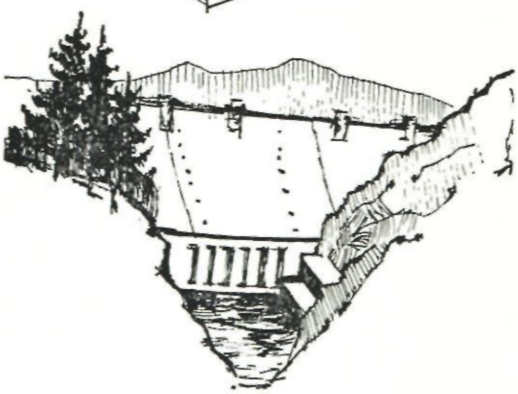

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PUZZLES:

APPLICATIONS OF MATHEMATICS IN DEALING WITH THE NATIVES AND THE PROBLEMS OF ZAN

MIKE COLGATE

In the year 2222 Phineus Fitzgerald's seventeen times great grandnephew, Finster Fitzgerald, found himself on the planet Zan, just one-hundred million miles from the sun Parallax Four. Finster, a Fueler Third Class, was on a pass from the Space Marine base which was in the exact center of the visible surface of the planet's only moon (which, like our own, showed only one face to the planet). Finster was overdue because, although he was on a twenty-four hour pass and had only been gone since early morning, Zan had a rotational period of precisely fifteen times that of the planet Earth and Finster was already more the six Earth days late. (The reasons for Finster's lateness comprise another story, which may appear in a future issue.)

Zan was a planet of many odd features, not the strangest of which was the peculiar manner in which its inhabitants behaved. They always traveled in groups of four, and in each group there was one who wore a hat, another who had flat feet, a third who wore strange looking shoes and the last who was a confirmed drunk. Neither the flat-foot nor the one with shoes would speak a word to strangers, while the drunk would answer questions only with riddles. The hat wearer would answer questions only with "yes" or "no", and then only one question per stranger, but he was either a consistant truth-teller or a consistant liar and it was impossible to tell which. As if those peculiarities were not enough, neither of the natives in each group who would answer questions would answer unless addressed by their correct name, which put strangers at a decided disadvantage.

Finster was walking down the road which led to his spaceship (and, ultimately, Zan's capital city). He knew that the 22,000 mile-per-hour ship was parked (in a metered zone) just midway between the fork in the road and the capital. When Finster got to the fork, however, he couldn't remember whether he should take the right or left road. While gazing into the sky, racking his memory, he noticed that the moon was exactly overhead and was half-full, so that the Space Marine base was cut in half by the advancing shadow.

Eight minutes and 35 seconds later, as the sun was just half hidden behind the flat Zan horizon, the answer to Finster's problem came walking down the road in the form of a four-man group of natives. In the half-light of the setting sun, Finster could see only that the tallest of the group was wearing a brown derby and that shortest was barefoot and quite sober. He could, however, hear quite clearly the song they were singing:

"Zug would be taller if he wore shoes; flat feet make you shorter than guys who drink booze; you can see Ug is taller than the one we call Lug; and Herman is shorter than Ug, Lug, or Zug."

Before Finster could ask a single question, however, an ugly, venomous nastisnapper oozed out of the bushes and bit him on the leg. Knowing the venom took exactly twenty-four hours to take effect, that he could average ten miles per hour walking on the road, and that the only places anti-nastisnapper venom could be found were in the capital city or back at the Space Marine base, Finster immediately asked the drunk how far it was to the capital. The drunk answered, "It is one-thousand times as far to the moon." Finster then asked the tallest native a question designed to determine which road to take and started off in a race against time (or nastisnapper venom, if you prefer.)

1. What were the names of the drunk and and the native with the hat?

2. What question did Finster ask the tall native?

3. Did Finster go to the capital city or to the moon and did he arrive in time?

ANSWERS TO LAST MONTH'S PUZZLES

First of all. I (we?) must apologize for the first problem given in last month's issue. Those readers who succeeded in getting Phineus out of the buffalo grass with the maximum possible headstart on the race to the river undoubtedly noticed that the Indian should have caught him twenty-eight yards from the river crossing. The only way to explain Phineus's escape is to suppose he ran straight for the river and swam across, rather than crossing at the regular crossing. This assumption puts Phineus at the river four yards ahead of the Indian. For those readers who failed to get Phineus out of the buffalo grass, a workable solution does exist. Once one considers the fact that Phineus can generate a greater radial velocity than the Indian up to twenty-five yards from the center of the circle, it is easy to see how he could get to a point seventy-five yards from the perimeter, exactly opposite the Indian, then run to the edge and have a 14.16 yard headstart on the race to the river.

The most efficient method of crossing the desert involves three journeys into the desert. On the first, one gallon of water is left twenty miles deep in the desert, the other gallon used on the forty mile round trip. On the second, two quarts are left forty miles deep in the desert, the other six quarts and half of the water at the twenty mile point used on the eighty mile round trip. The final journey reaches the other side of the desert, as the stores of water are just sufficient to replenish what has been used to those points and two gallons are available for the final eighty miles. Thus, six gallons or forty-eight pints are necessary in all, and at one hour work and one hour walking per pint, four days will be necessary for the crossing.

To determine the correspondance between office and feather color, it is only necessary to examine the clues given. The Head Medicine Man wore neither blue nor red, and neither the Head Chief nor the Assistant Medicine Man wore yellow feathers. The Assistant Chief didn't wear blue feathers (his son did) and the Head Chief couldn't wear blue because he was friendly with two of the others. This leaves only the Assistant Medicine Man to wear the blue feathers. Since the Assistant Medicine Man would not likely be on bad terms with his own father, the Assistant Chief couldn't wear yellow feathers. Thus, only the Head Medicine Man could wear yellow, and the green feathers must belong to the Assistant Chief, as he couldn't wear the red feathers. That leaves the red feathers for the Head Chief. Therefore, Phineus presented the bones to Red, Yellow, Green and Blue, in that order.

If anyone comments on Tanganoxie being in Kansas rather than Missouri, tell them it was possesed of an urge to move west nearly as strong as Phineus Fitzgerald's.

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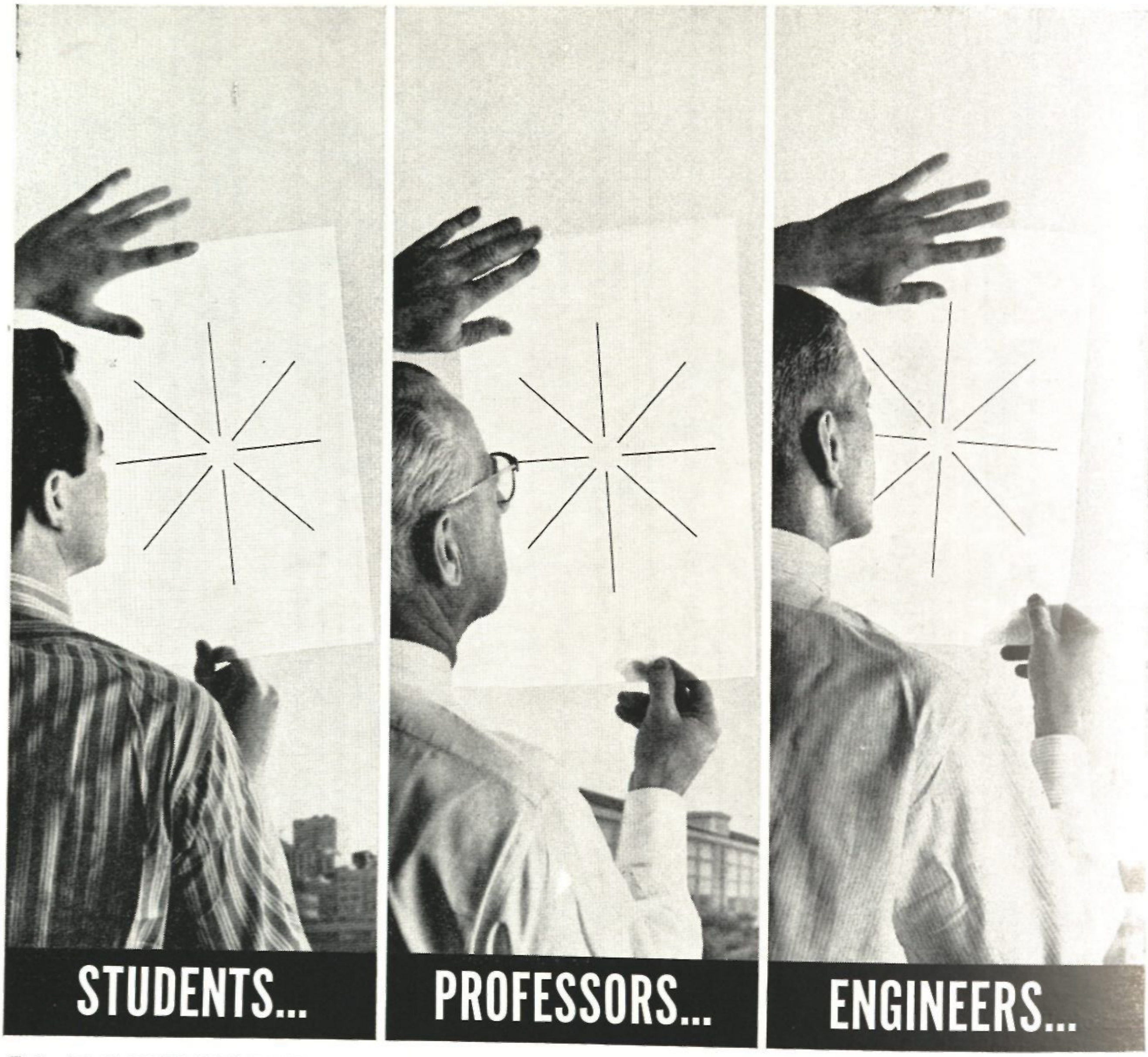
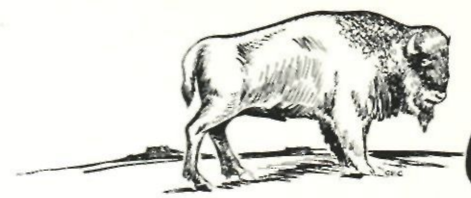
The answers to this month's puzzles from the planet Zan will appear in March, precluding any interference in interplanetary communications.


STUDENTS...
PROFESSORS...
ENGINEERS...



Chips

The engineer just back from hunting was describing the trip.

"Well, there was that big black bear hiding behind the tree. I realized that I had only one shot and that had to be bounced off the canyon wall. Well, I calculated the angle of approach, the windage, and how much the bullet would deflect due to the flattening after hitting the canyon wall."

"Did you kill the bear?" asked his friends.

Replied the engineer: "No, I missed the wall."

Not long ago, one of our city-bred engineering graduates was making a trip through the country. As he passed a fertile field he spied an unusual sight—a farmer helping a calving, and he stopped his car to watch the spectacle. He could tell that the farmer was having an awful time assisting the cow.

Presently he got out of the car, approached the farmer and said, "Want some help?" And so, sweating and straining, he assisted the farmer in the difficult task. Then at last the calf was born.

Gratefully, the farmer accompanied the engineer to his car to see him off. But, hesitating as he wiped his brow, the engineer looked up and said: "Say, mister, just how fast was the calf going when it hit the cow?"

Little Boy: "We've got a new baby at our house."

Neighbor: "How nice. Did the stork bring him?"

Boy: "No, he developed from a unicellular amoeba."

Wasn't it Albert Einstein who took a stitch in time?

"Boy, am I scared! I got a letter from a man saying he'll shoot me if I don't stay away from his wife."

"Well, all you have to do is stay away from his wife."

"Oh, yeah? He didn't sign his name!"

"How did Pat get his black eye?"

"He was leading the life of Riley and Riley came home."

Upon seeing a little girl lead a cow along a country road, the parish minister stopped her and asked, "Little girl, where are you taking the cow?"

"To the bull," replied the young lassie.

"Can't your father do it?" questioned the clergyman.

"Nope," answered the little girl. "Only the bull."

Patient (shortly after returning from the operating room): "Why are all the blinds drawn, Doctor?"

Doctor: "There's a big fire across the street, and I didn't want you to wake up and think the operation was a failure."

The farmer told his young son to watch a bull that was in the pasture with a red cow and a brown cow to see if they were mating. Meanwhile the farmer talked with the parson in the parlor.

The boy came running in and said, "The bull's getting it off the red cow."

His papa, very embarrassed said, "No, son You say 'The bull surprised the red cow.' "

The boy came running back soon and said, "The bull surprised the brown cow."

"He did?"

"Yeah, he got the red cow again!'

Historians have done an extensive study of this country's past Presidents and they have discovered some surprising things about the Presidency. With Roosevelt, they found that the Presidency could be a lifetime job. Truman showed them that anybody could be President. Eisenhower demonstrated that we didn't really need a President. Kennedy proved that it was a dangerous job. And now, Johnson is demonstrating that it is dangerous to have one.

Overheard in a math class: "On the last quiz, I got docked three percent for placing a decimal point upside down."

The regular noontime poker session of a group of electronics engineers is neatly labeled with a sign reading: "Probability Seminar."

"My wife is afraid someone will steal her clothes."

"Why doesn't she have them insured?"

"She has a better idea than that. She's got a guard in the closet to watch them. I found him there last night."

Sweet young thing: "Have a cigarette?"

Elderly lady: "What! Smoke a cigarette? Why, I'd rather kiss the first man that comes along."

Sweet young thing: "So would I, but have a cigarette while you're waiting."

The difference between amnesia and magnesia is that the fellow with amnesia doesn't know where he's going.

"She's a new girl with us and just fresh from the country, so we'll have to show her what's right and what's wrong," said the engineer to his assistant.

"Very good, sir," replied the assistant. "You show her what's right."

Did you ever hear the story about the farmer who was milking a cow on the side of a mountain? He slipped and would have fallen five hundred feet if he hadn't had something to hang on to. The poor cow saved him—but the neighbors thought it was an air raid.

"I've changed my mind."

"Thank Heaven! Does it work any better now?"

—Randy Lorance