COLORADO ENGINEER

FEBRUARY 1970

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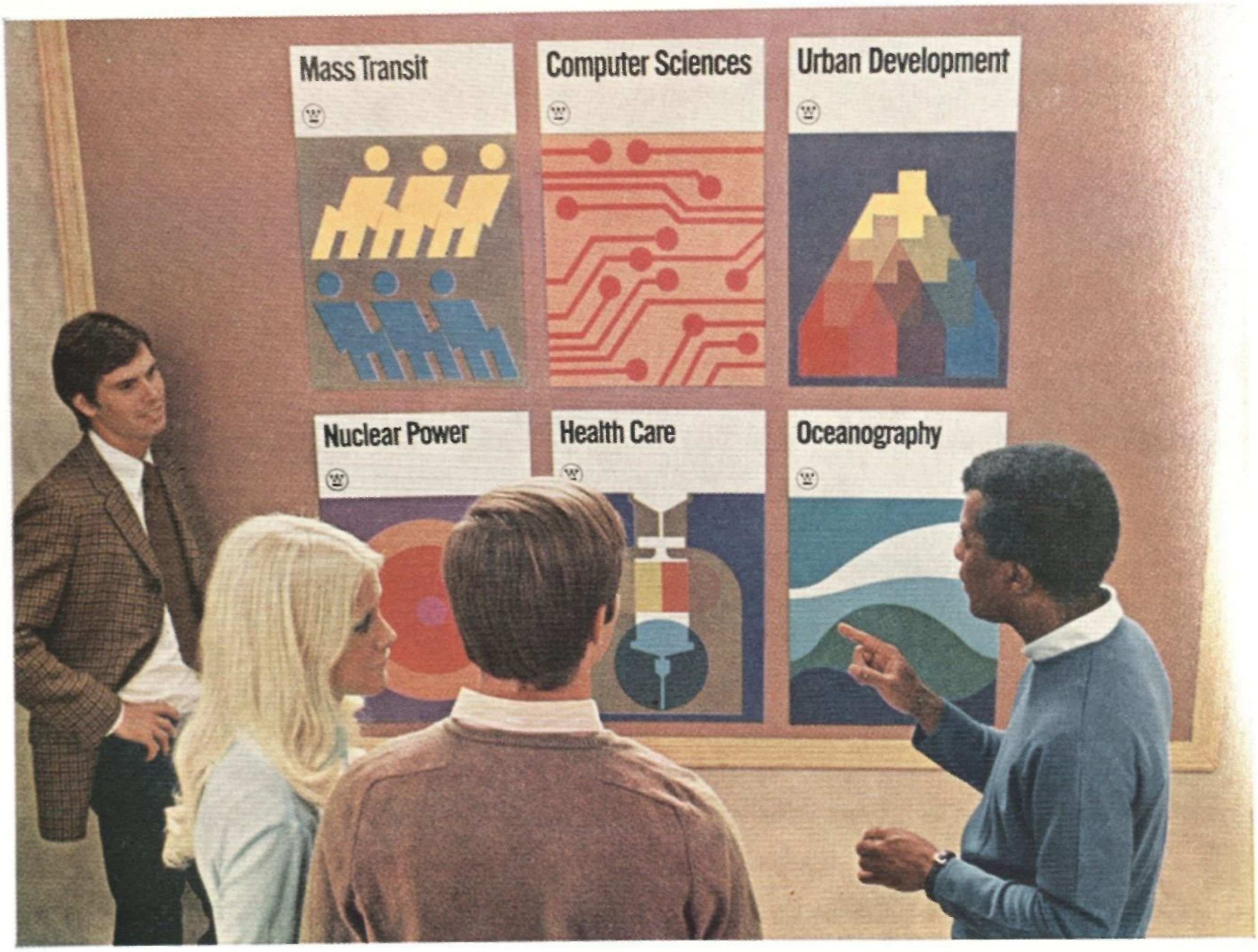

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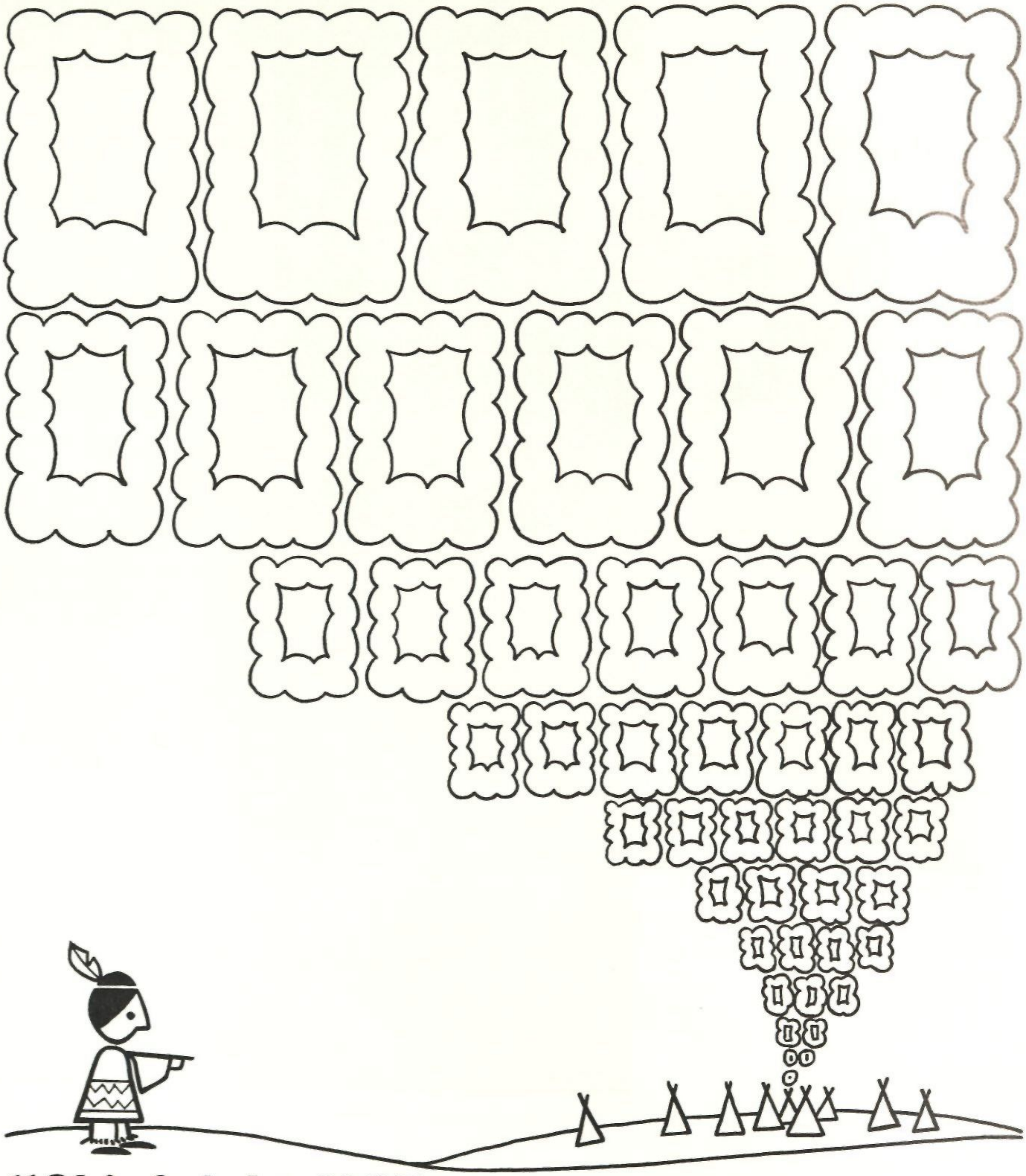

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IN THIS ISSUE

FEATURES

Page

SECTIONS

COVER

PHOTO BY JARED BEEBE

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Ever Hear a Mosquito Cough?

PHOTO: ERNEST BRAUN

SOUND OFFF

INTERACTION
by Eugene P. Hawkridge

One of the geatest faults of philosophers and scientists of the classical era and the middle ages was their lack of communication with the laymen. They philosophized and hypothesized about subjects they knew little about and did not bother to test their conclusions. They could not "lower" themselves to consult craftsmen and farmers about the questions on their minds, and wouldn't even think of getting their hands dirty to find an answer for themselves.

We in the modern 20th Century have a tendency to smugly believe that we no longer possess faults of this nature. Unfortunately, we do. All too often there is an important lack of communication between different fields of study when such intercourse would likely be beneficial to each.

Take, for example, a sociologist and an engineer. It is not unusual if each regards the other with a mixed set of feelings bordering on suspicion and contempt. You can almost hear the sociologist saying, "These engineers–they live in a sterile world all by themselves–what do they know about the really **important** problems of society?" The engineer says, "Sociology–bah! The world would fall apart without us!"

The problems of our times–social, political, mental, medical, economic, military, artistic, technical–cannot, for the most part, be broken down simply. They are interelated: they have too many parameters–social aspects, political, economic, technical–to be handled effectively by any one field. Too often however, only one particular facet of a problem is attacked and nothing really concrete is achieved.

Consider the problem of governing the United States of America. Our government has become so awesome in size and so incredibly inefficient that **nobody** knows what's going on. Studies have been made to try to correct some of our government's deficiencies, but really concrete results have been rare and we are still losing ground. Part of the problem is that the same old people (or their understudies) are the ones dealing with the problem. What is needed is a broader application of current knowledge: what could an engineer, given some knowledge of political economics and policy making, do to automate the government?

Of course, no one can be an expert on everything. At the same time, many are the college students who majored in economics and but can't tell the difference between an atom and a -meson or who majored in engineering but have no idea who Keynes was.

A step in the right direction towards abating this problem is the combined business-engineering curriculum which is available here at C.U. But more needs to be done: an often voiced complaint among engineering students is there are many other things they would like to study but they simply have no room for them in their schedules. Why not create more combined-major programs on a five-year basis?

Another problem is that many of the courses offered outside the College of Engineering do not relate to the technical level of the average engineering student. What engineer wants to watch addition problems being done on the blackboard? Perhaps more specialized courses could be developed, in the vane of Engr. 300-Interaction of Engineering and Society.

Whatever is done, it is clear that as engineers we cannot sit idly by closed in our own little world, ignoring the problems of our society. We must, as much as is possible, interact with other fields to find solutions to what are really common problems.

(continued)

SOUND OFFF

Socio-Humanistic Studies In Engineering
By David Romaine Wood, Sr.

In today's tuned-in, turned-on generation, we engineers, who deal primarily with things rather than with people, must fight a tendency to say that the things we create are more important than the people for whom they are created. It is certainly easier to place a model in a wind tunnel or to program a computer than it is to develop meaningful relationships with our fellow man. Socio-humanistic studies assist the engineer to be less like the computer he programs and more like the human beings with whom he must live.

My goal as an engineer is to make a contribution to humanity which will be more than just a "thing"; it should be something that will benefit mankind. As an engineer, I feel that I will be responsible for the things I create. In order to determine the value of any contribution, I must be aware of its impact on human beings. It is not sufficient for me to say, "I'm only doing my job," if I create a Frankenstein's monster.

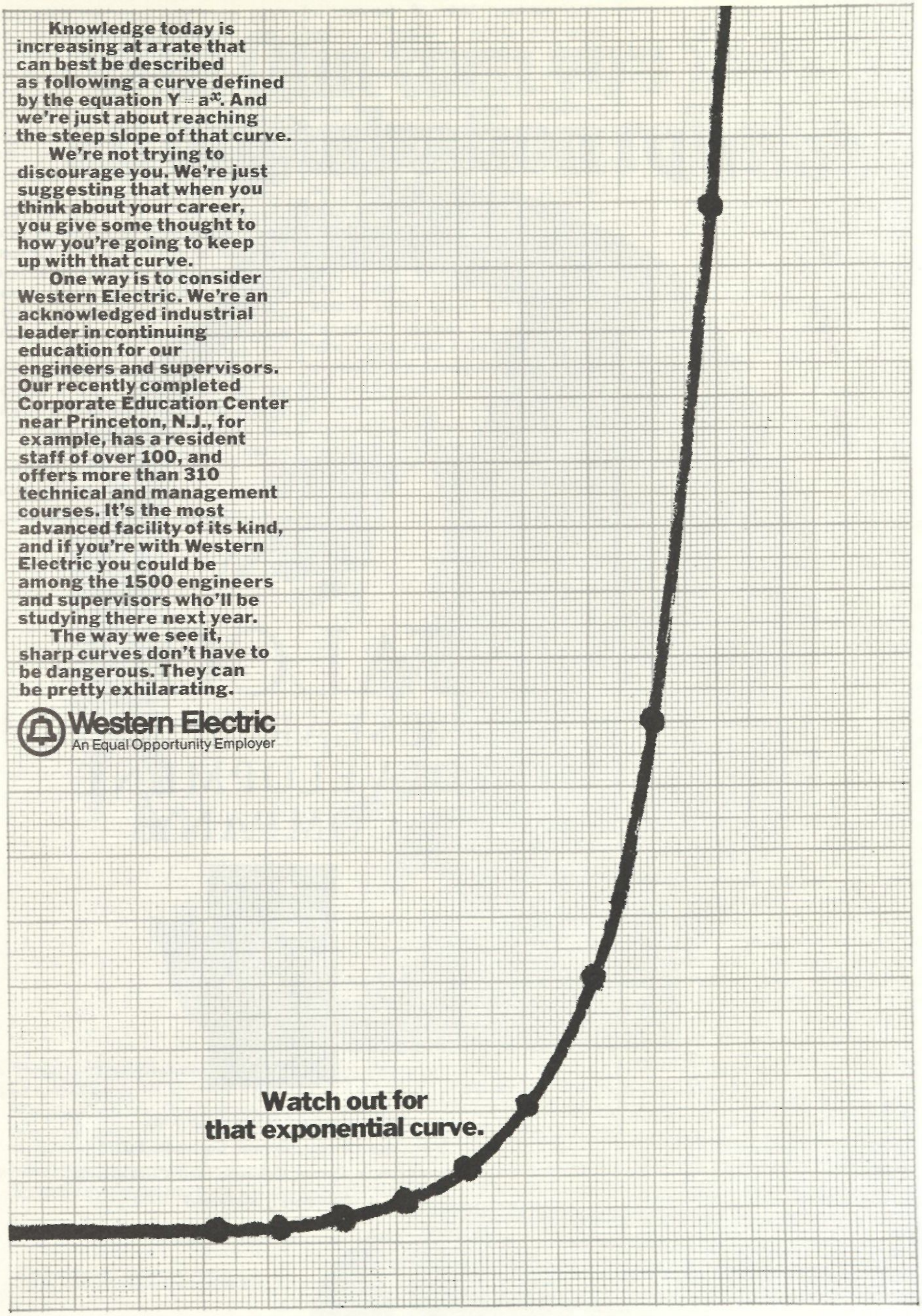
The awareness of humanity's ideals and goals comes largely from my pursuit of socio-humanistic studies. I have been able to develop a partial view of the condition of mankind through a study of contemporary social events as reflected in news articles and comentaries; but I have gained my perspective, which has enabled me to view man's problems more clearly, through the study of history from three different points of view. The first of these is history as reflected in literature. Literature presents, not a photograph in which we can examine minute details of the past, but rather a work of art which reflects a view of history flavored with the writer's personality. Literature lends insight into the attitudes and ideals of the members of a society.

The second of these viewpoints is from a study of history itself. This study gives us a road map through time with significant landmarks presented in detail and with the road between the landmarks outlined.

The third viewpoint is that of anthropology. Through anthropology we see the material from which the map of history is drawn. The course in anthropology which I am now taking is on the origins and development of religion. This course outlines man's fascination with those things which he cannot explain and also the factors which lead to changes in the structure of his culture.

If we are to improve man's lot, we must not repeat the mistakes which were made by previous generations. We must learn about the past and profit from it. "To be ignorant of what occurred before you were born is to remain always a child."(quote from Cicero: "Orations", Section 120)

(continued)


Knowledge today is increasing at a rate that can best be described as following a curve defined by the equation $Y = a^x$. And we're just about reaching the steep slope of that curve.
We're not trying to discourage you. We're just suggesting that when you think about your career, you give some thought to how you're going to keep up with that curve.
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The way we see it, sharp curves don't have to be dangerous. They can be pretty exhilarating.
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Watch out for
that exponential curve.

SOUND

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Engineers: There's A Revolution Going On

Throughout this country and many others, the college campus has become the scene for change. Campuses are being split by the crises' and echoes of protest and dissension. Today's jargon is described in terms of the Black, Brown, radical, and leftist demands. Once small minorities, these groups are gaining acceptance and recognition as they shout their rights with vigorous determination. We are now witnessing a movement from the "greater undecided group" (better known as the silent majority) towards positions conducive for change. All of the groups seeking change are becoming closer. This is not to say that there is a common goal, but that there is a common ground; a common understanding.

What should this mean to the engineering student? Nothing?! "Apathetic engineers" has been the standard phrase used to describe the engineering student in terms of the "modern revolution." Is this true? Does this matter? At this university, the answer to the first question is no. This was evidenced quite clearly by last year's ASUC election when over 50% of the engineering students voted. But within our own school the positions were nearly given away. In AES presidents Irv Susel's own words, "No one really wanted the jobs!" It is obvious that the engineering student should be concerned with ASUC positions, but even more obvious that there be a concern for their own administrative offices.

This serious lack of interest in engineering affairs is disgusting and a discredit to our school. Engineers are society's "action" people. Probably the most constructive (though the most destructive) achievements of man were science and engineering oriented projects. The prime motivation for achievement, though, has been the dollar!!!!$$$$$$$$. Engineers must begin to expand and explore beyond their equations. The realm of engineering extends deeply into our social system and engineering students (and engineers) are ignoring (maybe they don't know) and sidestepping this crucial corner of their field. How can one construct for his own society if one doesn't even know in what manner his development will affect the masses? Engineers must proceed into the relevant social areas in which they are a most influential component. Motivation to the problem or situation can only be achieved when on "attempts" to understand the situation.

You don't earn extra pay when you graduate because you took philosophy or education courses, or became involved. But you can't possibly be effective by placing all your variables into one equation. You can't understand the field if you only glance at a small sector of it. Don't think I mean that engineering is the wrong place to be. Whatever comforts you is the right place for you.

Engineers **are** in. Don't hide the fact. Start to realize what the engineering field is all about by exploring all of it. I've seen too many unhappy engineers in the field who realize now that they missed a great opportunity; an opportunity to get involved, which approaches a new height every day.

I worked for a large engineering firm and life outside of school is neither exciting nor mentally rewarding. But it pays in U.S. currency; all your life: for a dollar.

Darryl Stafford
AES Committee Chairman

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POLL

IN LAKE

POLLUTION IN LAKE MICHIGAN
by Jeff Berven

The engineer is the architect and builder of today's bewilderingly complex and technical society. He is no longer a tool that is used to build an industrial plant, run a power station, construct a dam, or design a supersonic transport. It is apparent that the engineer can no longer just do his job and not consider how his work might affect people. An engineer may no longer build a highway through a ghetto without first finding some place to move the people who live there. He can no longer vent a waste gas from a plant or discharge a liquid waste into a stream without first thinking about what happens downwind or downstream. It is demanded of the engineer today that he not only do his job, but that he also make judgements in the socio-economic spheres that affect hundreds, thousands, or even millions of people. Is he prepared for it? No! Many engineers are not even aware of the influence and responsibility they hold in today's society. It is imperative that this change. We can not go on todayas we have in the past.

UTION

MICHIGAN

To emphasize this point, the following article on the pollution of Lake Michigan is written. No engineers are mentioned, yet thousands were indirectly involved in the pollution of the lake, and thousands are involved in trying to clean the mess up. Although engineers were not directly responsible for this example of water pollution, they are the ones who carried it out and on whom some of the guilt must ultimately rest. Could they have done anything else?

Engineering 300, "The Interaction of Engineering and Society", taught by Proffessor Robert S. Ayre, Chairman of the Civil Engineering Department and Professor R. Curtis Johnson, Chairman of the Chemical Engineering Department, is an example of courses which are making their appearance on many campuses across the country. Engineers have come to realize their place in society and have in typical engineering style taken action to follow up this realization. One of the papers that has been prepared by students in this course is the following one by Jeff Berven on "Pollution in the Great

Lakes." Jeff brings to this paper some first hand knowledge since he has worked in a steel mill in the Hammond-Gray area, is familiar with the pollution problems as they appear from the outside, and has also some knowledge of the expenditure and concern of the companies and professional men of the area.

If you're interested in giving serious thought to the relationship of the engineer to society and you wish to receive course credit for doing some of this thinking, perhaps you would like to contact Drs. Ayre and Johnson about Engineering 300.

The Great Lakes constitutes the largest reservoir of fresh water in the world, but Lake Erie is considered a "dead lake" and Lake Michigan is dying from the garbage and wastes that flow into it from the cities and industries that line its shore. What has been done in the past to pollute Lake Michigan and what is being done now to avert it is a subject of controversy and a series of complex interrelated problems.

The Great Lakes–Superior, Michigan, Huron, Erie, and Ontario–contain about twenty percent of the world's fresh water resources. Lake Michigan is the third largest in size, has a surface area of 22,400 square miles, and a land drainage area of 45,460 square miles. Lake Michigan is bordered by the states of Wisconsin, Illinois, Indiana, and Michigan. The southern tip of Lake Michigan is the site of one of the largest strip cities in the United States. The complex starts in Milwaukee, extends south through Chicago, and continues eastward through a vast industrial complex in Indiana. Seven million people live on land in which tributary streams of Lake Michigan flow., This figure does not include Chicago, which dumps its waste water into the Des Plaines River.

In order to appreciate the problems of Lake Michigan today, it is important to know the history of the water pollution controversy which has centered on the southern tip of Lake Michigan. In 1840 a private organization, the Chicago Hydraulic Company, built the first pumping station and reservoir for the citizens of Chicago using the water from Lake Michigan. The intake pipe was placed 150 feet off shore, and the water, which served about one fifth of Chicago's total area, was distributed in wood mains.

A water tunnel extending two miles into Lake Michigan was completed in 1867. From then until 1900, Chicago extended its water intake cribs farther and farther out into the lake in order to avoid pollution and contamination caused by the flow of domestic wastes into Lake Michigan through Chicago and Calumet Rivers. Chicago was contaminating its own water supply and, in doing so, was plagued by typhoid fever, cholera, and dysentery. In 1854 a cholera epidemic took the lives of over five per cent of the population. Between 1860 and1900 the death rate was 65 per 100,000 people annually from typhoid fever.

Rudolph Hering, an engineer, proposed that a canal be dug through a small ridge that divided the flow of water into Lake Michigan from the flow into the Des Plaines River and eventually the Mississippi River. This would change the direction of the Chicago and Calumet Rivers from into Lake Michigan to the Des Plaines River. It would serve two purposes. First, the canal would prevent the contamination of Lake Michigan, and secondly, it would dilute Chicago's wastes as they flowed down the Mississippi. Construction was started, and the first of three canals was completed in 1900. The last was completed in 1922.

A new problem of a different nature occurred for Chicago when St. Louis started proceedings in the federal court at Chicago on July 10, 1899. St. Louis claimed the canal would pollute its water supply–the Mississippi River. The state of Missouri argued in the Supreme Court that the filth of one and a half million people would pollute its water supply and at the same time make useless all the water plants below the mouth of the Illinois River.

In April of 1901, Secretary of War Root cut the flow in the canal from 400,000 cubic feet per minute to 200,000 cubic feet per minute to stop the lowering of the level of Lake Michigan which had caused various harbors and canals to become too shallow. Later, strong evidence in support of the St. Louis case came when St. Louis showed that the number of typhoid fever cases had increased by seventy per cent since the opening of the canal. In the final summary before the Supreme Court, the legal representativies of the Chicago Sanitary District proved that typhoid germ could not be contagious after traveling in water from Chicago to St. Louis, and that the real source of the St. Louis water contamination was the sewage of towns directly above St. Louis on the Mississippi. On February 19, 1906, the Supreme Court ruled in favor of Chicago.

A second dispute came when Chicago found it necessary to divert not 200,000 cubic feet per minute but 600,000. Canada made a formal protest about it, and finally the whole issue again ended up in the Supreme Court. Chicago found that it was defending itself against Michigan, Wisconsin, Minnesota, Ohio, Pennsylvania, and New York for, among other things, the lowering of the Great Lakes and the subsequent hindrance to shipping, destruction of fish life and the natural beauty of lake shore line, and loss of hydroelectric power at the Niagara Falls Power Plant. The sides were not uneven, since Missouri, Mississippi, Kentucky, Arkansas, Tennessee, and Louisiana supported Illinois in its right to divert water into their waterway. Chicago and Illinois were backed by these states so that the levels of the Mississippi and river commerce could be maintained.

On April 15, 1930, the Supreme Court decided against Illinois. The Chicago Sanitary District was ordered to reduce its diversions of water from Lake Michigan until 1938 when Chicago was expected to divert not more than 90,000 cubic feet of water per minute and compensate for the rest of the wastes with a sewage treatment plant.

The controversy still rages. In

November of 1967, Chicago asked the state of Illinois to file suit against individual companies in Indiana for polluting its water supply. The two states have begun a co-operative policy to stop this water pollution. Although the attention of the public has been focused on Indiana and Illinois, pollution occurs up and down the shore of the lake including Wisconsin and Michigan. Small plants such as paper mills and small communities do their part to pollute the lake but receive little publicity.

Chicago has spent billions of dollars developing a good water system and draws about a billion gallons a day from Lake Michigan for five million people. It has disposed of its wastes in the tributaries of the Mississippi so as not to pollute its water source. Yet ten miles to the southeast and beyond, a vast industrial complex including the cities of Whiting, Hammond, East Chicago, and Gary, Indiana, spreads itself across Michigan's southern shore.

The complex includes ten steel mills, five oil refineries, and numerous other plants including everything from a bleach factory to a paper mill. Six of these plants accumulate over a billion gallons of wastes per day. In these wastes are 3,000 pounds of cyanide, 3,500 pounds of pheonols, 35,000 pounds of ammonia nitrogen, and fifty tons of oil. It is impossible to tell what percentage of this finds its way into Lake Michigan, but a great deal does. The Grand Calumet, Little Calumet, and the Indiana Harbor Canal are sources of only anaerobic life(i.e. life that thrives without oxygen). The wastes are so concentrated that all the dissolved oxygen in the river has been used up. As a result, methane, a product of anaerobic bacteria, constantly bubbles from these water ways. Ammonia and odorous organic substances scent the air. In fact, no aquatic life can be found at all in the Grand Calumet River except for anaerobic bacteria and a few primitive sludge worms. The public beach at Whiting, Indiana, has been closed for over ten years as a health hazard.

There has been a large growth of algae from an excess of nutrients. These nutrients are in the form of phosphates from synthetic detergents and agricultural fertilizers and the nitrates from fertilizers. Every stream flowing into Lake Michigan carries these chemicals. The algae growth has become so dense that it has choked out fish life and ruined boating and swimming in places. The algae is also helped along by the fact that small, medium, large sized communities dump raw sewage or sewage with the minimum of treatment directly into the lake.

Not all the problems may be pinpointed on the southern tip of Lake Michigan. A good example is found above Green Bay, Wisconsin. Paper mill refuse there has turned a public beach into a marsh where there has been no swimming for 25 years. Also, on the western shore of Lake Michigan is a five mile catch basin which now is so choked with weeds and algae that it is impossible to fish, swim, or boat.

Fortunately, something is being done to curb water pollution so that the rate of pollution is being reduced. Again the notable changes have come from the industries on the southern tip of Lake Michigan. The large corporations have started pollution abatement programs, trying to meet the federal deadline for water purity standards. Even the waste treatment plants in Hammond, East Chicago, and Gary are now chlorinating their wastes in order to reduce the bacteria count.

As advances are made, other problems occur. An example of this may be found in Hammond and East Chicago. Because smaller industries have started discharging wastes into public sewer lines, these lines have become overloaded. They often overflow in dry weather to say nothing of what happens when it rains.

Ex-Secretary of the Interior Stewart Udall has stated that it will cost 15 billion dollars to clean up the Great Lakes. He has laid down a seven-part program consisting of: (1) Removing phosphates from treated wastes, (2) Building new sewers, (3) Enforcing and strengthening the existing laws, (4) Building dams to control agricultural pollutants, (5) Replacing the septic tank system, (6) Accelerating research, and (7) Spending the 15 billion dollars wisely. We must. We have no choice.

The population explosion, urban concentration, and industrial expansion in the United States will make it necessary not only to use but to reuse most of our water. The daily available water supply flowing in our rivers has been estimated at between 1,100 and 1,300 billion gallons per day. Presently, we can capture between 560 and 700 billion gallons a day in dams, reservoirs, and ground water reserves. Today we use about 355 billion gallons a day. By 1980 between 570 and 600 billion gallons will be needed, and by the year 2000 the daily use will reach between 900 to 1,000 billion gallons. This is between 80 and 90 percent of all the water flowing in all the streams and rivers in the United States. Without reuse and treatment serious times are ahead. We can no longer afford the luxury of mistakes as we have made in the past.

Perhaps the best way to summarize the hope for the future of Lake Michigan, the Great Lakes, and our national waterways is to quote Murray Stein, the Health Education and Welfare Department's enforcement director: "The crux of pollution abatement is establishing individual pollution sources, defining corrective steps, and then following through to see that they are carried out. The Great Lakes situation is the biggest problem we've ever tackled. But the important thing is that it has now been tackled, and with reasonable co-operation it should be possible to clean it up. In the meantime, we've just got to hope for scientific advances that will make possible the undoing of the damage that's been done already." Can engineers help? Can they do anything else?


CAVU*

how good is your math?

1. After a particularly difficult mechanics quiz, a certain dazed sophomore made the remarkable discovery that if he took a certain number a subtracted it from 1 and took the reciprocal he had the number 1/(1-a). He then took this number and repeated the same process of subtracting from one and then taking the reciprocal. Several hours later he discovered that after 1000 times the resulting number was 1000. Find the number he began with.

2. Using only the operations of addition, subtraction, multiplication, and division, find some way of combining eight 8's so that the resulting expression equals 1000. Can you find another solution which uses only seven 8's and the same four operations?

3. It is now the year 2066 and you are a visitor to the planet Octavia. The inhabitants on this planet have only 8 fingers so their number system is based upon the base 8. Their monetary system has 20 ziggles to the zaggle. The price of a souvenir is 6 zaggles, 11 ziggles. If you are offered a discount of 1/5 for six, how many does six cost?

4. A T.A. grading papers for Professor Maler had to grade five papers. Being in a mischievous mood, the student formed all possible sums of two different test papers and gave these to the professor instead of the five individual marks. If the numbers are 110, 112, 113, 114, 115, 116, 117, 118, 120, and 121, find the five marks.

5. The nine digits 1 through 9 can be arranged in such an order that the first three will be 1/3 of the last three, and the middle three will be equal to the result obtained by subtracting the first three form the last three. In fact, this can be done in four different ways. There is only one way, however, that in which the sum of the first two digits will be 10, the sum of the 4th and 5th will be 11, and that of the 7th and 8th will be 12. What is this arrangement?

6. If someone offered you as many dollars for each nickel as you had nickels in your pocket, and also as many dollars for each dime as you had in your pocket, and they gave you 394 dollars after you agreed, how many nickels and dimes (total) did you have in your pocket?

7. If you had ten coins in your pocket (all nickels and/or dimes), and someone offered to pay you according to the procedure in the preceeding problem, or to give you 75 dollars instead, would you be smart to take the 75 dollars assuming you did not remember the ratio of nickels to dimes in the ten coins and that any combination of nickels and dimes is equally probable.

1. The easier way to solve this problem is to start to compute the 1000 terms. The original term is a. The first term is 1/(1-a). The second term is 1/(1-1/(1-a)) = (1-a)/(-a). The third term is 1/(1-(1-a))/(-a) = a. This every third term equals a. Therefore the 999th term equals a. This 1000 = 1/(1-a). Therefore a = 999/1000.

2. 8(8 x 8 + 8 x 8) - (8 + 8 + 8) = 1000. By simply factoring out another 8 from the first bracket 8 x 8 (8 + 8) - (8 + 8 + 8) = 1000 is obtained.

3. The easiest way to solve this problem is to first convert the numbers to base ten and then work out the problem. Twenty in base 8 is just $2(8) + 0(8^0)$ or 16.Thus there are 16 ziggles per zaggle (in base 10). The cost of one souvenir is then $6(16) + 1(8) + 1(8^0)$ or 105 ziggles. Six will cost 630 ziggles. With a 20% discount, the six cost 504 ziggles. Dividing by 16 yields a total cost of 31 zaggles, 8 ziggles (in base 10), or by converting to base 8, a cost of 37 zaggles, 10 ziggles.

4. The sum of the ten numbers is 1156. Since each score is counted four times, divide by four to get 289 which is the sum of the five scores. Call the five tests p, q, r, s, and t in numerical order. The sum of p and q (which are the lowest scores) must be 110. The sum of p and r must be 112. The sum of the two highest scores, s and t, must be 121, and the sum of r and t must be 120. The sum of p, q, s, and t is then 110 + 121 or 231. r is then 289 - 231 = 58. By simple subtraction, the five scores are then 54, 56, 58, 59, and 62.

5. In this problem we are looking for an arrangement ABC/DEF/GHI where 3(ABC) = GHI and ABC + DEF = GHI. From this it can also be seen that 2(ABC) = DEF. From these 2 multiplication relations, the following equations may be formed:
(1) 3C=10w+I
(2) 3B+w=10x+H
(3) 3A+x=G
(4) 2C=10y+F
(5) 2B+y=10z+E
(6) 2A+z=D
By adding (2) and (3), and also (5) and (6), and substituting in the values A+B=10, D+E=11, and G+H=12 we get x=2+w/9 and z=1+y/9. Since w and z are carries from multiplication by 3 and 2 respectively, the largest values they can have are 2 and 1 respectively. Since x and z are carries and therefore whole numbers, w and y must equal zero. Then x=2 and z=1. Therefore equations (1) and (3) become:
(1) 3C=I (3) 3A+2=G
From equation (3) we see that A=2 or 1 since G must be one digit. Therefore B=8 or 9 since A+B=10. However if A=2, G=8 from equation (3), but since B also equals 8, this is impossible. Therefore A=1 and B=9. From equation (1) C=1,2, or 3 and I=3,6, or 9 respectively, but since A=1 and B=9, then C=2 and I=6. Therefore ABC=192, DEF=2(192)=384, and GHI=3(192)=576 giving 192/384/576 as the arrangement sought.

Answers to 6 & 7 and crossword puzzle will appear in our next issue.

Brassiere Engineers Help Support Femininity

There is more to brassiere design than meets the eye. In many respects, the challenge of enclosing and supporting a semi-solid mass of variable volume and shape, plus its adjacent mirror image—together they equal the female bosom—involves a design effort comparable to that of building a bridge or a cantilevered skyscraper.

Hundreds of bra designers, many with engineering training, eagerly accept this challenge and apply their unusual skills eight hours a day, five days a week. The center of this activity is a five-block stretch of skyscrapers flanking Manhattan's Madison Avenue in the shadow of the Empire State Building. More than 200 brassiere design innovations are sent to the United States Patent Office each year from this area.

Why so many patent applications on brassieres? More than $450 million is spent annually on brassieres in this country alone. How much of this cash a bra will attract is a direct result of how well it does its job. And its performance, of course, depends upon the design.

By the 1930s, women had secured a certain measure of equality with men and felt they could relax a bit. Their dresses were designed to the natural female form, which meant that women, after having been flattened for the decade following World War I, began looking for something that would help them fill out the front of their dresses. So the uplift bra was invented.

At first, the uplift consisted only of a cotton band stretched across the torso beneath the bosom. It was called the "bandeaux." Later, to reduce the obvious visual effects of lateral and vertical motion, and to provide firmer support, breast cups were added and held up with shoulder straps.

To form a basic breast cup all it takes is two curved pieces of material sewn together along the curve. The resulting container will approximate a hemisphere or a cone, depending upon the sharpness of the curve. The resulting seam, under pressure, often proved irritating to the wearer. Hence the evolution of cup design has centered to a large degree on getting the seams out of the way of sensitive areas. Cups are now frequently designed in multi-sections which, when properly pieced together, produce a form-fitting hemisphere or cone. The cup may be made up of four to eight triangles, trapezoids and other quadrilateral sections in mixed combination.

Bra sizes have been standardized somewhat over the years, although bras of the same nominal size will differ in terms of comfort, form-fit, support, construction, durability and price. There are two basic measures used to characterize a brassiere's size. Inches to indicate the basic size, while alphabetical designations denote variations in the volume of the bust cup.

Most brassiere designers work only with the "ideal" model size, which happens to be 34-B. To arrive at tooling requirements for other sizes, they extrapolate. Commercial sizes range from 28-AAA to 55-DD. The 34-B "ideal" is not entirely an arbitrary designation. Rather, it represents the bust line considered most pleasing to the artistic eye of most dress designers–although there is room here for disagreement.

Bra size, contrary to popular belief, is measured with a tape measure initially across the **top** of the chest, not across the bust. If this measure is 34 inches, the bra size is 34. There are several ways to make a volumetric determination of cup size. If the bust is considered essentially a half-sphere, the designer may use any of the following formulas to determine the volume of the breast cup:

$$V=\frac{D^3 x .5236}{2} \text{ or } V=\frac{r^3 x 4.1888}{2}$$

$$\text{or } V=\frac{4 \pi r^3}{2}$$

where V equals the volume of one-half sphere, D equals the diameter of the sphere, and r equals the radius of the sphere.

If the bust is conical, the formula which may be used is:

$$V=\frac{D_b^2 \text{ x h x } .7854}{3}$$

where D equals the diameter of the cone's base and h equals the height of the cone.

One can readily see that it might be rather difficult to measure accurately some of the variables, especially if the individual bust exhibits more fluidity than rigidity. Therefore, designers prefer to make their initial volumetric determinations experimentally on live models with firm busts. The customer is told to determine her individual bust size by measuring the number of inches

around the top of the chest, then measuring the girth across the highest part of the bust. If the difference between the two measurements is 1 inch, the cup size would be A; 2inches, B; 3 inches, C; 4 inches, D.

To achieve support, designers must consider ways to provide an uplift against the vertical (downward) and sometimes tangential force of the woman's bust. This force, of course, is due to gravity. The object of the designer then is to keep the bosom at a pleasing equilibrium in the face of gravity.

There are a number of methods of achieving bust equilibrium. First and most obvious is the addition of straps to the top of the breast cups. However, this solves only part of the problem since the weight of the bosom often is more than the straps can sustain without cutting uncomfortable into the wearer's shoulders.

So the lower contour of the breast cups usually are attached to a wide band which completely encircles the torso and latches (by means of hooks and eyes) at the back. This skin-tight band tends to provide a firm anchor beneath the bosom–a horizontal plane below which the bosom cannot slip. To meet expansion characteristic of the rib cage, the band may contain expandable rubberized sections and elastic gussets at points where excess pressure might cause the weares discomfort. These gussets serve similar functions to the expansion joints in bridges and ships.

Where larger cup sizes are required, the above measures still might not be enough to offset the downward vertical force of the bosom. Additional uplift support is then provided by sandwiching various rigid or semi-rigid structural members between the layers of material that make up the breast cup. The structural members may consist of (1) starched or plasticized material; (2) vertical, curved or tangentialwire forms, or (3) bones and chicken feathers.

The structural members act much like shoring timbers used in coal mines except that the retaining member is angled down and in against the rib cage rather than out and away. Because they are secured at both top and bottom of the cup, they act as segments of a retaining wall.

Another method of offsetting the downward force of the bosom–and retaining undesirable lateral movement of the semi-fluid masses–is exemplified in the design of the "Action" bra. This bra employs the principles of cantilever suspension, setting up a situation involving opposite and equal vector forces. Extending from each shoulder strap is an S-shaped strap which runs across the top of the breast cup and down to the central point between the two cups, then underneath and up the outside edge of the opposite cup.

In effect, a figure 8 is created which behaves in cantilever fashion. Part of the downward vertical force on one breast acts in conjunction with that of the other, partially cancelling it–that is, converting the downward force into a restricted horizontal or diagonal force equal and opposite instead of in parallel.

Within these basic designs there are virtually unlimited engineering combinations. The Lovable Co., which ships more than a quater of a million bras each week, has developed a simple device called the T-strap. This strap is affixed to the cup with a small metal T-shaped fastener at the end instead of beingsewn to the cup. Along the top, inside contour of each cup are small, evenly spaced holes (six in all) into which the metal devices may be inserted. Thus the strap may be secured anywhere along the top of the bra, either to provide a more comfortable vector angle, or to make the strap conform to the angle of the dress straps so that the bra straps do not peek out.

Undoubtedly, the most impressive challenge comes in the design of a strapless bra. Since the cable-type support of shoulder straps is not available, all uplift must be provided form the bottom, often without the security of a straight-around skin-tight band.

The problem is generally solved by fabricating a wire cage for the breast cup, with a heavy, semi-circular wire running under each cup. This double-U, with additional vertical supports imbedded in the lower band, resembles a suspension bridge. The structural principles are almost identical.

Arthur Garson, who has been designing brassieres for 35 years, recently was awarded a patent on a completely self-supporting strapless bra that does not require auxiliary supporting means such as uncomfortable wires or bones in the breast cup. To accomplish this feat, Mr. Garson departed somewhat from conventional materials practice in that he uses plastic in his design. Plastics are rarely used in place of wires and bones because those that resist the heat of the wearer's body generally are too costly for mass production.

Sandwiched into the outer triangular sections of the new strapless cup are curved and flexible plastic stiffening members, shaped to conform to the conical side portions of the cup. These impart rigidity and upright self-supporting characteristics to the cup. The cup itself is made of a stiff but flexible material which cooperates with the laterally-spaced plastic members to impart additional support.

The quest for new and different methods of enclosing the bosom goes on at a fever pitch. New markets are constantly being explored, and new markets mean new designs. One Madison Avenue designer, an engineer by training, is convinced that he can apply the aerosol principle to the brassiere. He has developed a quick-hardening plastic compound which he intends to spray on a perfectly form-fitting plastic bra-- one that can be peeled off at the end of the day. However, one major problems remains. He has not yet found a satisfactory method of containing the bust in the proper configuration while the liquid bra is being sprayed on.

Brassiere design is one engineering activity, at least, in which the United States is far ahead of the Soviet Union. The Russians are about 30 years behind, according to Mrs. Ida Rosenthal, 77-yearold matriarch of the American foundation industry and head of Maidenform, Inc. She recently returned from a tour of the Soviet garment industry and found that the bra designers on the other side of the Iron Curtain have not yet discovered stretch fabrics, foam padding, hooks and eyes or the strapless bra.

Meanwhile, the Americans are forging ahead and may soon get a breakthrough that will provide a spray-on brassiere in an aerosol can.

OUR THANKS TO CHRIS YOUTZ OF *THE AUBURN ENGINEER* FOR ALLOWING US TO PRINT THIS ARTICLE.

FINAGLE'S LAWS

Axiom # 1: In any calculation any error which can creep in will do so.

Axiom # 2: Any error in any calculation will be in the direction of most harm.

Axiom # 3: In any formula, constants (especially those obtained from engineering handbooks) are to be treated as variables.

Axiom # 4: The best approximation of service conditions in the laboratory will not begin to meet those conditions encountered in actual service.

Axiom # 5: The most vital dimension on any plan or drawing stands the greatest chance of being omitted.

Axiom # 6: If only one bid can be secured on any project, the price will be unreasonable.

Axiom # 7: If a test installation functions perfectly, all subsequent production units will malfunction.

Axiom # 8: All delivery promises must be multiplied by a factor of 2.0.

Axiom # 9: Major changes in construction will always be requested after fabrication is nearly completed.

Axiom #10: Parts that positively cannot be assembled in improper order will be.

Axiom #11: Interchangeable parts won't.

Axiom #12: Manufacturer's specifications of performance should be multiplied by a factor of 0.5

Axiom #13: Salesmen's claims of performance should be multiplied by a factor of 0.5.

Axiom #14: Installation and Operating Instructions shipped with any device will be promptly discarded by the Receiving Department.

Axiom #15: Any device requiring service or adjustment will be least accessible.

Axiom #16: Service Conditions as given on specifications will be exceeded.

Axiom #17: If more than one person is responsible for a miscalculation, no one will be at fault.

Axiom #18: Warranty and guarantee clauses are voided by payment of the invoice.

Bougar T. Factor, Chairman
Committee of the International
Society of Philosophical
Engineers

By Harold Dunn (August, 1967)

SON OF BARON IN THE BUFF

(The wit and wisdom of the C.U. Aeros)

"RPM are how fast airplanes are going when the speed can no longer be measured in miles per hour."

"Airplane pilots know that atmosphere just means air, but it sounds more dignified to say it the firstway."

"The Federal Aviation agency has the vitalsome job of finding out what is meant by the secret letters F and A and A."

"There are no such things as gremlins but they live in World War I airplanes when there are."

Our discussion of flight invariably turns our attention to the subject of birds. "Here is a queer-type bird. A OSCRIDGE that does not fly but runs like a horse. Except he uses only two legs which makes him a queer-type horse too."

"In aviation history there was first the Wright brothers, then Linbergh, then on to now."

"Man has been able to fly for only a drop in the bucket."

"I looked around in my brain until I found that flying jennies are just to twinkle an eye and know they meant to say airplane."

"Olden-time pilots caps with goggles were a great source of comfort when taken off."

"BOO!! I did not mean to scare you so bad, but misfortunately that is how I feel when I think about people trying tofly in dangerous planes of long ago."

"Orville Wright was born in 1871, supposably on his birthday. He died of a broken health from 1948 to the present."

"They both lived in PRE-ME times."

"The Wright brothers first fley on a KITTY HAWK."

"Question: where did the Wright brothers' first flight take place? Answer: on page 19."

"Aviation will not be like it should be until it gets like it was when we did not have any and appreciated such things as aviation offered."

"One night I was sleeping in my bed. Eeek what was that! I heard a pilot talking somewhere but could not see him anywhere. I finally solved the mystery by forgetting to turn off my radio."

"Jet planes fly faster buthelicopters can fly straight up and down, so it is about six of one and one for all."

"Airplane has a plural known as squardron."

"Look at a jet plane. Did it have a propeller? Then it is not a jet plane."

"Without motors in airplanes the law of gravity would be maintained much more enforcedly."

"Not counting things with wings, the earth holds on to everything else with its grabity."

"One good way I figured out to tell between monoplanes and biplanes is one of them has more wings than the other when I can ever think which it is."

"The meaning of fuselage has a very short memory in my mind."

"Agyroscope is something only "encyclopedias know for sure."

"Correct by being wrung but as an airplane is flying, does the high pressure sweep over the plane's wing or under it? I wrecked by brain trying to think which."

"Airplane flaps are on the wings in case I ever want to know."

"If I say strut, what I am saying depends on whether I am saying it of a rooster or an old airplane."

"Propellers are so long and heavy. tjeu rea;;u are not good for anything except being propellers."

"I thought out twice how the altimeter works, but I forgot it three times."

"Pilots always carry altimeters with them, I forgot what they use them for, but they remember an that is what is important."

"An altimeter is a thing in an airplane. Maybe it is for pilots to look at, I do not know. It takes all my knowing to know it is a thing in an airplane."

"One good thing to remember about flying is don't."

"In learning how to fly oncest I took and umprella and jumped off our roof. I was found to have several critical cuts and bruises, but the sprung ankle was about my best injury."

"One thing you should always do in finding directions from the north star it is hope it is night time."

"One of the most important things to remember about landing and airplane is Oh I forgot what I started to say."

"It is best to land against the wind instead of just plane air. The wind is like air, only pushier."

"Anytime there is a force pushing one way, there is one pulling the other way. Only jet planes can understand this well enough to make it work for them."

"Get a ballon. Blow it up. Let it go through the air. Wow, because now you understand about jet planes."

"One of the MAINEST things we have learned through jet airplane research is who blown baloons act that way."

"When you put fuels and oxygen together, you get BOOMS."

"Some broken windows result from jet plane's ASONIC booms."

"From a girl student, "I think flying is more fun than just about anything. Of course my uncle is a registered pilot and I may be a little pregnant."

Terry Gooding, Kentucky '65, met the challenge in mining at St. Joe

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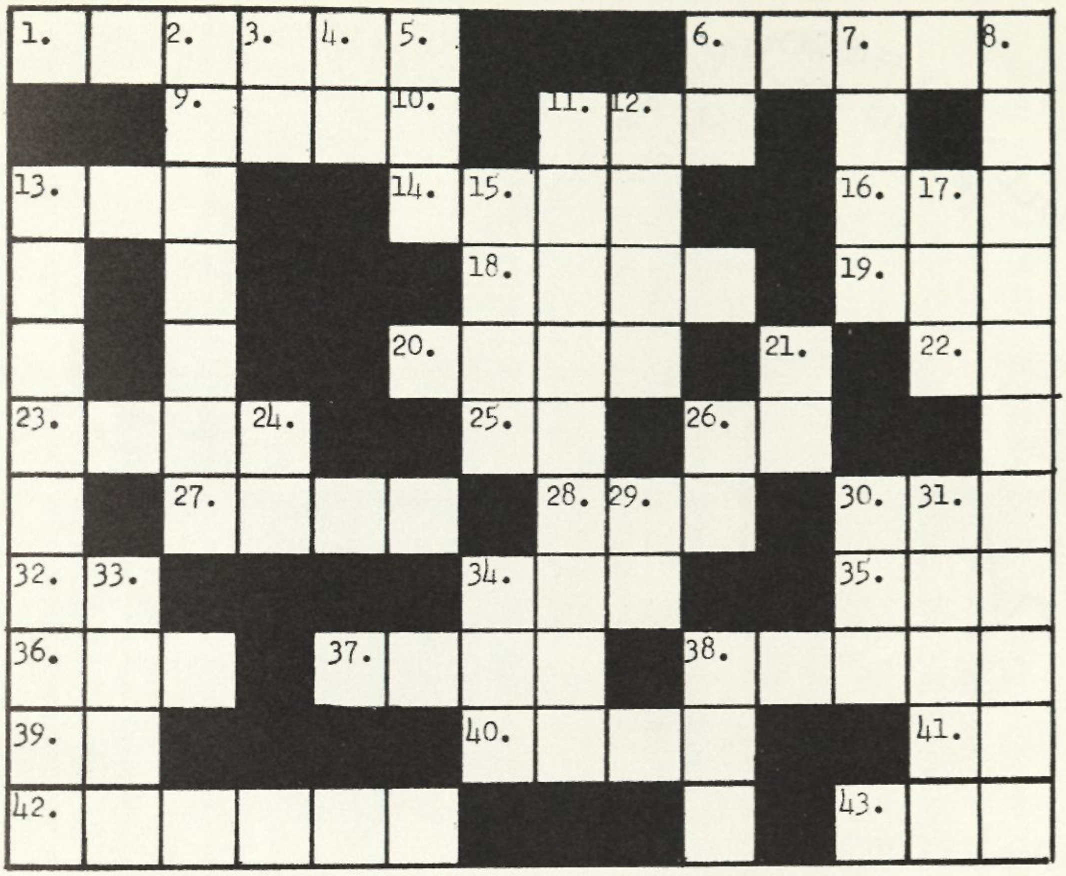
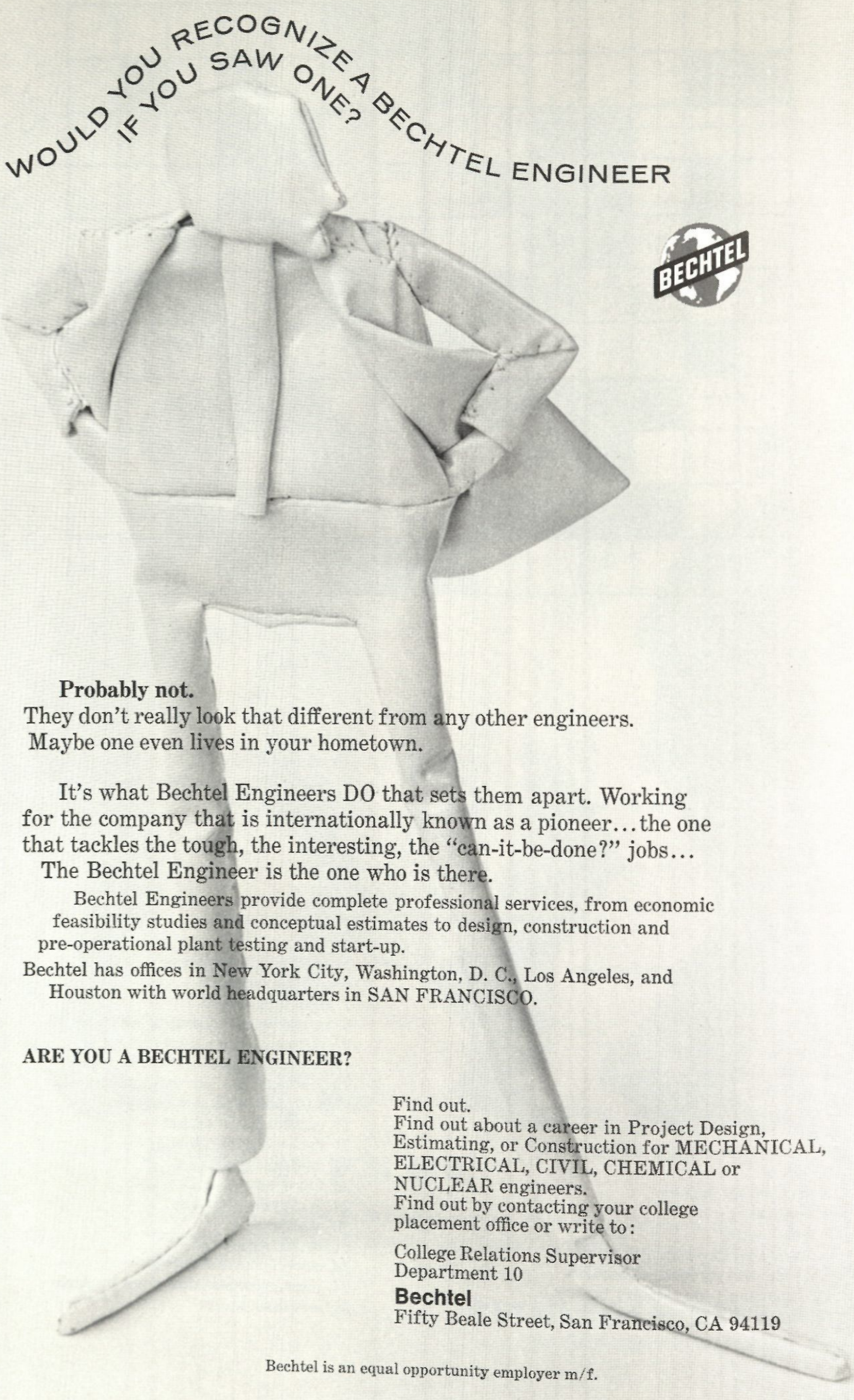


ACROSS

1. to retreat
6. a bird of India with the ability to mimic human speech
9. to and upon
11. measurement of the strength of an electrical current
13. electrically charged atom
14. infant
16. total result
18. branch of Indo-Chinese languages
19. the self
20. on who writes verses
22. in chemistry, mercury
23. elementary, abbr.
25. in chemistry, manganese
26. in chemistry, iron
27. rodents larger than, but resembling mice
28. Rural Electrification Administration
30. sin/cos
32. in chemistry, radium
34. atmosphere
35. frozen water
36. Associated Engineering Students
37. a solid with six equal, square sides
38. combining form meaning backward, behind
39. toward
40. asymetric, abbr.
41. in chemistry, europium
42. existence, being
43. donkey

DOWN

2. defeat
3. upon
4. thing
5. big, slow, clumsy person
6. melting point, abbr.
7. organ used to smell
8. in matrices, a system in which all of the constant terms k_1 are zero
11. inductance measurement, 10-9 he
15. element that can with others like itself to form molecules
17. exclamation of disgust
21. in chemistry, beryllium
24. mother, slang
26. fourth note of musical scale
29. in chemistry, erbium
30. small bird
31. 43,560 square feet
33. indefinite period of time
34. loose, sleeveless robe worn by Arabs
38. root mean square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