The COLORADO Engineer

MAY, 1968

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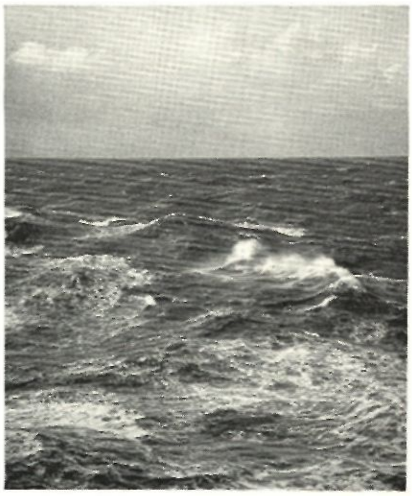

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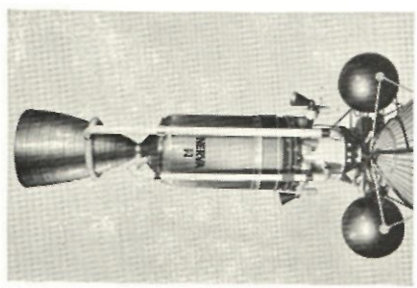

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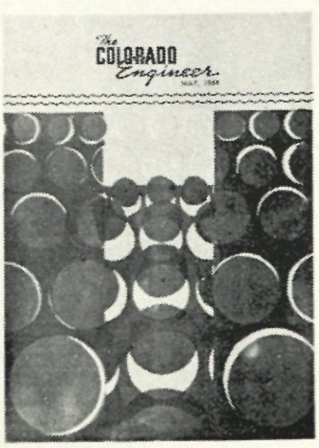

This month's cover: An artistic interpretation of "Earthquakes—Structural Effects" by Donna Demong introduces the feature by James Harris, beginning on page 12.

EDITORIAL:

NUTS AND BOLTS

At CU, as well as at other universities across the country and the world, there have been demonstrations, sit-ins, harangues, et cetera, all of which seem to point to a lack of effective communication between students and administrators. Some of the issues which have been debated are quite valid—others, trivial—but they have helped to bring to light the need for more student participation in the formulation of university policies.

Student government, often a joke but sometimes very effective, is the means for this participation. The Associated Engineering Students has in the past two years been rather exemplary in demonstrating what can be accomplished when there is effective student-administration communication. The tutoring program and the Freshman Newsletter are just two examples of Worthwhile programs that have been implemented by AES.

The Associated Students of the University of Colorado does not have such a good record. But recently, more active participation, more interest, more concern have forced the ASUC into a different position. The communication has begun. And what started the change?

Nuts and bolts are useless by themselves but when working together, they serve a very useful function.

—Kathy O'Donoghue

"I used to think IBM would be one of the last places for an M.E."

"I was skeptical about IBM as a place for a mechanical engineer to work. E.E.'s, sure. But M.E.'s?" (This is Dick Driscoll, B.S.M.E. '67, a Manufacturing Engineer at IBM.)

"I was wrong. There are plenty of opportunities for M.E.'s in just about all areas, especially in development and manufacturing.

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"It's sort of like solving a very difficult three-dimensional jigsaw puzzle. And it's a 'pure' engineering job. The kind I was trained for. Because, in the final analysis, product responsibility for manufacturing the memory component rests with one person. Me.

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DEAN'S COLUMN:

NOT RHETORIC BUT DEEDS

DEAN MAX S. PETERS

This past year has seen considerable excitement on our campus with student activities, faculty involvements, and administrative actions, much of which has made headlines. I have been very proud of the way our students and faculty have responded during the past year with responsible statements and the clear awareness that a university is primarily an educational institution. In our profession, we prefer to express ourselves not through rhetoric but deeds. In our college, students prepare themselves intensively to bring significant engineering solutions to the social problems caused by explosive urbanization and other social dilemmas. We are aware that social progress and well-being depend to a great extent on the enduring contributions our students are expected to make.

Many of the things which are very important to us as engineers would find little echo, unfortunately, in other areas of our university. Some personal examples are the concern I feel about the lack of coordinated national activities to develop new air pollution control methods and research approaches for solving some of our air pollution difficulties; the problem I see developing in our universities because of the minimal industrial cooperation and support for many of our educational functions; and the real need to attract more high school students into engineering as a career. The preceding are just a few examples of things which are extremely important to us as engineers, and they illustrate why we engineers often have a totally different approach to education than persons in other areas.

As we complete the 1967-68 school year, I extend my congratulations and best wishes for a bright future to all of our graduating seniors in engineering. I give my thanks to Kathy O'Donoghue for her work as Editor of the COLORADO ENGINEER and to Don Caldwell for the leadership he has given us as President of the Associated Engineering Students. We are looking forward to another good year in 1968-69 with Randy Lorance as editor of the COLORADO ENGINEER and Dick Langor as President of AES.

I am very much impressed with the job our faculty in engineering is doing at our University, and I am equally well impressed by the response from our students. I have said it before and I will say it again: "We are very special people—we are engineers—and in particular—we are engineers from the University of Colorado."

Max S. Peters

Dean

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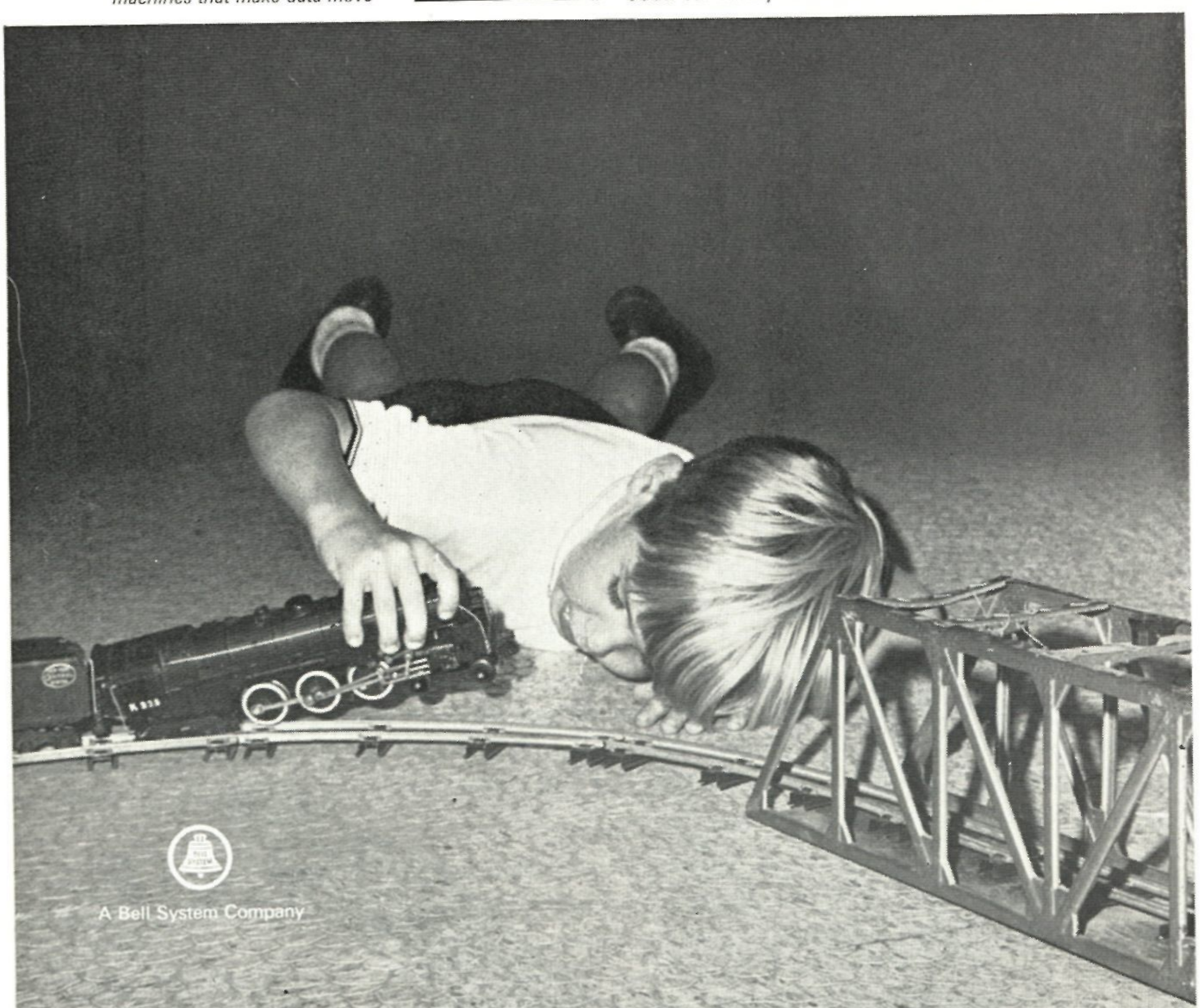

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TAU BETA PI ESSAY:

RADICALISM IN TODAY'S YOUNGER GENERATION

ROBERT FEARN

In recent years there has been a tendency among people of the younger generation to support radical ideas. Only a few years ago, the "beatnik" was the subject of widespread controversy (and the object of considerable contempt) because of his radical thinking. Today, the "hippie" has replaced the beatnik with ideas that are even more radical. Because the beliefs of these two groups and others like them are regarded as dangerous to society, they have received considerable attention from the older generation, a generation seeking the cause as well as the solution to what they consider unreasonable and immoral beliefs. Although the solution is by no means simple, a brief reflection on present day society can yield substantial information as to the cause.

As most people are aware, the world today is in a period of great scientific revolution. The world is growing and changing faster than it has ever done before. As a result of the expanding world and the expanding communication within it, each person is confronted with an ever increasing amount of information. Today, the amount of information that a person comes in contact with far exceeds his ability to learn and, as a result, he is not able to understand all of it. In order for progress to continue under these conditions, society incorporates two major means of solving the problems resulting from the unlimited amount of information confronting an individual man's limited intelligence. The two means, increasing education and increasing specialization, both aid the progress of society, but do not produce the same effects on the individual.

Strive for More Education

Members of today's younger generation have been continually told, since the time they were able to comprehend, that they should strive for more education and for highly technical and specialized jobs. For this reason, many people find themselves in college and pursuing a specialized field before they are really aware of what they are doing. Once in college for a short period of time, however, a student begins to think about his life. The first thing the student notices is that his inborn idea of education, as a process of learning about life, does not exist in college. The college is working toward a single end, the production of a more specialized labor force. Little or no emphasis is placed on anything outside a student's major field. The student finds that his education offers him no insight into real life. Most education, most specialized jobs, and most advice from members of the older generation are evidently incompatible with life as the student had hoped to see it. As the incompatibility between the preachings of society and natural life becomes more evident, the student's mind is subjected to increasing stress. If the coaching he has received from the older generation in his earlier life was sufficient, the student will combat the stress by convincing himself that he desires the extrinsic values imposed on him by society. If, however, his resistance to the stress is low and that stress becomes too great, he will react, and his reaction against education will soon extend to a reaction against all the teachings of society. In this way, the radical youth is born.

The older generation and its society attempt, of course, to stop this radicalism because it is considered dangerous to society. Many of these people, however, have failed to notice one important point. The free thinking radicals are not different people; they are people reacting in a different manner. They do not carry a seed of rebellion in them; they carry a seed of the natural world. It is this inborn feeling of the natural world that causes them to react against the world formed by society. The socially acceptible person and the radical person differ only in the forces to which they have yielded. The socially acceptible person has abandoned his inborn nature whenever it did not comply with the restrictions of society. The radical, on the other hand, has rejected society in order to comply with his own free will.

Resists Society's Control

It should now be evident that radicalism of the type seen in the beatnik and the hippie, is not temporary, nor is it the result of mental aberrations. The radical is a product of society, and the more society tries to control him, the more he will resist and the faster his philosophy will grow. It is the present society that must yield. People must take a closer look at the world they are offering to the younger generation and make the necessary changes.

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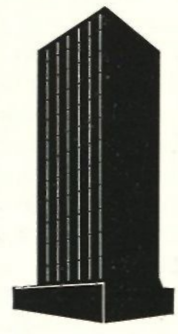

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EARTHQUAKES

STRUCTURAL EFFECTS

JAMES HARRIS

Earthquakes are the most frightening and destructive naturally occurring phenomena known to man. Not only do they level much of the work of men into piles of rubble, they also destroy one's faith in the firmness of terra firma. The destructive nature of earthquakes makes every structure potentially dangerous to human life, and because replacing these structures is expensive, structural engineers must be vitally concerned with the effects of earthquakes on whatever they may design. (See Figures 1a and 1b). Consequently much work is presently being done to learn more about what earthquakes are and do.

The mechanism of earthquakes, which is not presently understood fully, is a part of the study of seismology. The most acceptable explanation of what happens is known as the elastic rebound theory. This postulates that the crust of the earth is continually being distorted; the cause of these distortions is unexplained—they are simply acknowledged. As the crust of the earth moves, the rock is strained and stresses build up. When stresses reach a high level the rock will fail by fracturing along planes of weakness known as faults until a new position of equilibrium is reached. Large amounts of strain energy can be built up and released this way; the energy being transmitted through the material in the earth's crust surrounding the fault zone. The following diagrams give a simplified picture of the elastic rebound theory. Figure 2 (a) is the initial unstrained position, with imaginary lines superimposed on the rock; Figure 2 (b) is the strained configuration before fracture (notice the deformation of the lines); Figure 2 (c) is the equilibrium position after the fracture-slip. [1,16-7]

Earthquake Measurement

There are two methods presently employed for measuring earthquakes. The most familiar to the layman is known as the Richter Magnitude Scale, which measures the relative

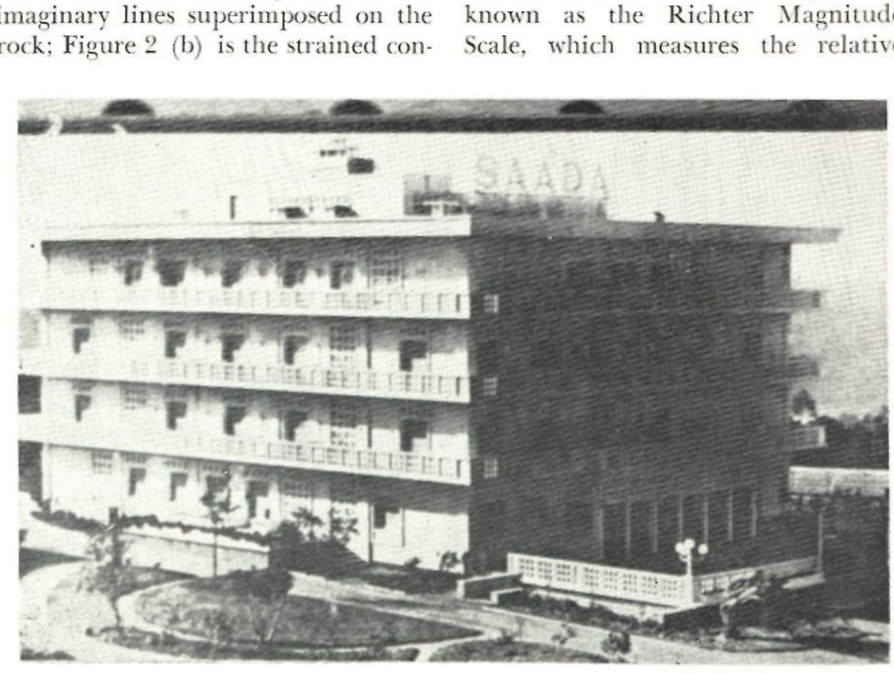


Figure 1a: Saada Hotel in Agadir Morocco Before Earthquake.

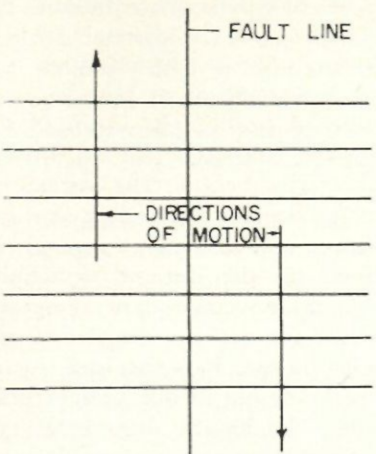


Figure 2a: Before Straining.

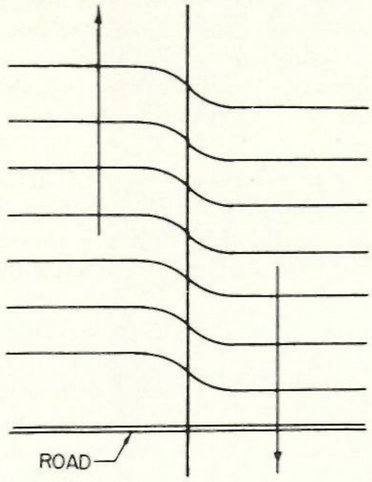


Figure 2b: Strain--Before Earthquake.

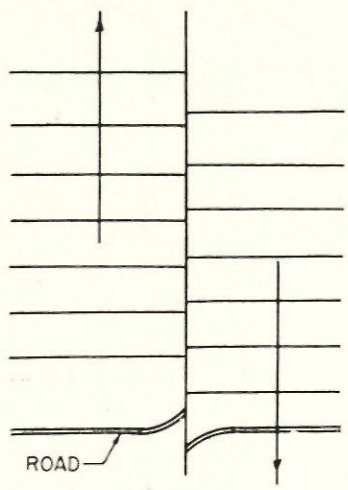


Figure 2c: After Earthquake. (1,17)
(Courtesy of American Iron and Steel Institute.)

amount of energy released in the earth movement. It is based on a logarithmic scale from zero to eight point nine. For each unit increase on the scale the energy increases about thirtyfold. To illustrate, the Alaskan earthquake of Good Friday, 1964, (magnitude 8.3) was over 30,000 times as large as the earthquake recently experienced in the Denver area. [5,3] A second method of measuring earthquakes is known as the Modifield Mercalli Intensity Scale and is used mainly by structural engineers. The criteria for measurement on this scale are only indirectly connected with the movement of the earth; rather they are based on observations of physical movement and damage of objects on or in the ground. The scale is arranged in Roman numerals from I to XII. For instance (in abridged language, intensity II is described "Felt by persons at rest, on upper floors, or favorably placed," while intensity XI is described, "Rails bent greatly. Underground pipelines completely out of service." [1,19-20] The two scales are based on such widely different measurements that no general relation between them will hold true, yet both are helpful in realizing the true size of an earthquake.

Energy liberated in an earthquake may cause various types of disturbances. Seismic tidal waves and large landslides are two which are important, but the one structural designers are most concerned with is vibration or shaking of the earth's surface. It is this which can cause disastrously sudden failures of buildings, such as the Saada Hotel in Agadir, Morocco shown at the beginning of this article, and it is against this which buildings can be strengthened to successfully withstand earthquakes.

(Figures 1a and 1b courtesy of American Iron and Steel Institute.)

Figure 1b: Saada Hotel After Earthquake. (1,40)

Random Movement

During an earthquake the ground moves randomly in all directions. The accelerations are equally as random and horizontal accelerations have been recorded as large as one-third of gravity. The magnitude of the earthquake does not always indicate the magnitude of the ground accelerations. The strongest acceleration on record occurred at El Centro, California, in 1940, [3,1] during an earthquike of Richter magnitude 6.7. Strong motion records, from which accelerations are measured, have been recorded for earthquakes as large as magnitude 7.7 with a corresponding acceleration of 18% of gravity. [9,121]

The dynamic response of buildings is related directly to the ground acceleration by Newton's law: force is

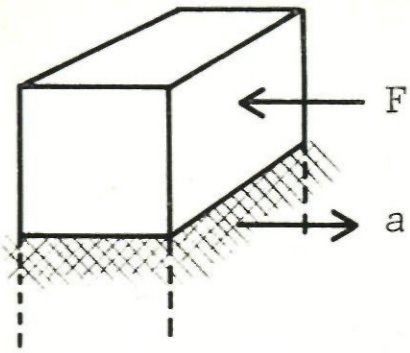


Figure 3a: Rigid Structure: F=ma

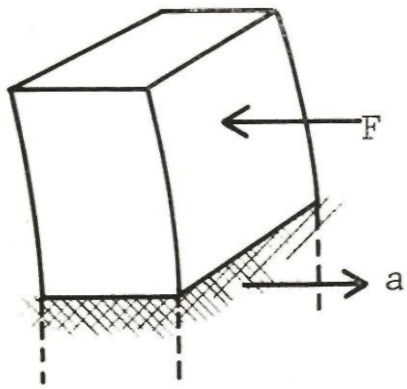


Figure 3b: Flexible Structure for Very Short Duration of Motion F<ma

equal to mass times acceleration (F=ma). Since buildings are complex continuous systems and not simple rigid bodies, no simple analytic relationships exist. Three generalized cases of response are shown in the Figure 3 (a,b,&c). (4,3) In these Figures no specific type of deformation is indicated; it is simply pointed out that deformations are produced, which in turn produce stresses in the various members of the structure. There is more than one possible way for the structure to deform, and in actuality several types of deformations probably interact, but separate explanations for each type are easier to visualize. Nearly all have one assumption in common: that only horizontal accelerations are considered. This is because structures are overdesigned with factors of safety in the vertical direction to begin with, and therefore, vertical accelerations are not normally considered important.

Structures Deform as a Shear Beam

The most common idealization of deformation for a framed structure is that it deforms as a shear beam. This means that the building is considered to be a series of lumped masses positioned at each floor, which are connected by shear springs. Floors are considered to be rigid and the columns in the framework are the shear springs. A mechanical analogy to this system is shown in Figure 4. The dashpots are symbolic of the damping in the system. Each shear spring acts as a beam which is fixed against rotation at both ends. Even when a building is idealized to this degree, analysis is still a difficult task, primarily because the system has as many degrees of freedom as there are floors, and because no general expression of the forcing function for ground movement exists. Even though there are serious drawbacks to this idealization, it is the basis for earthquake design in our present building codes. Under the shear beam type of deformation, stresses are induced in the columns. It is these stresses which must be allowed for when designing to resist earthquakes. It is easy to see that the horizontal shear forces accumulate until very large forces are induced in the columns in the lower section of the building. In massive structures this may cause failures in horizontal shear, such as shown by Figure 5.

A second type of idealized deformation is that of a cantilever beam in which the columns take additional compressive or tensile forces caused by the overturning moment in the structure. Not many failures due to moments were recognized in years past; (3,62-4) thus, the building codes tend to ignore this as a prime consideration. More recent evidence,

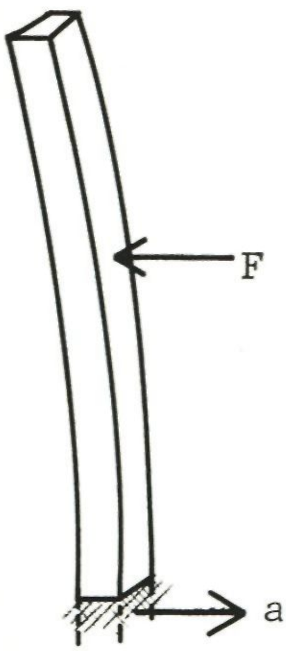


Figure 3c: Flexible Structure for Prolonged Duration of Motion Whose Frequency is Near that of Structure F>ma (4,3)

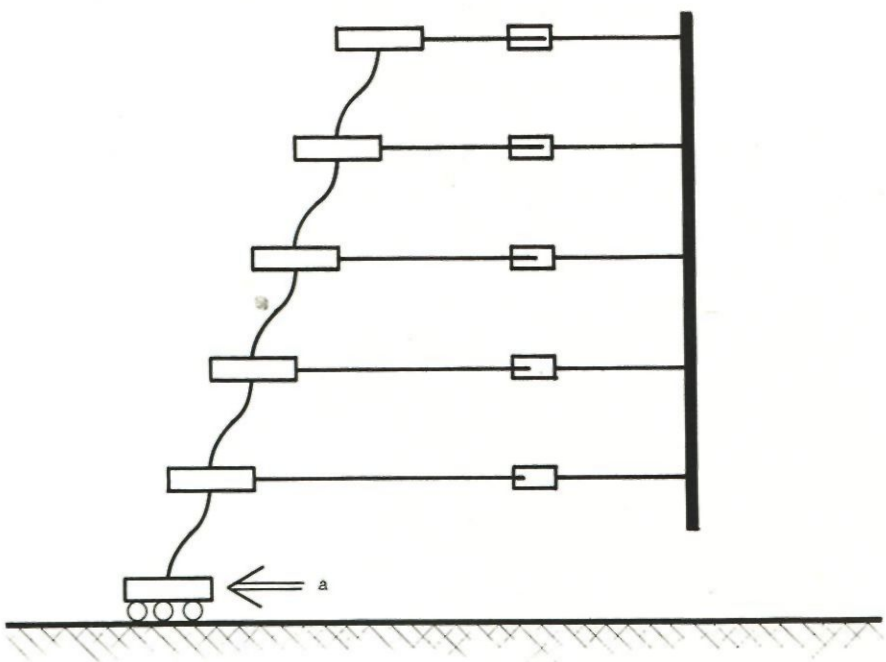


Figure 4: Mechanical Analogy of Shear Beam.

particularly from the Caracus earthquake of 1967, indicates that rigid structures when subjected to a strong "spike" of accelerated ground movement may fail as a result of compressive stresses in exterior columns induced by an overturning moment. Structures designed as ductile frames may in actuality act as rigid shearwall structures because of tile, brick or block walls and other so-called nonstructural elements. Shearwall structures are not to be confused with the shear beam deflections mentioned earlier. In shearwall buildings horizontal forces are resisted in walls, usually of reinforced concrete, rather than columns of a framing system. These shearwalls are also often used to support the building vertically. A simple example of a shearwall type of construction is a one-story building with the roof being supported by the walls. A common example in large buildings would be when elevator or stairwell shafts are used to support some or all of the weight of the structure. When a frame with infilled walls attempts to deform, stresses are taken in the infilled walls also and the structure becomes more rigid. In the case of tall buildings subjected to sudden acceleration this can completely change the intended response of the building so that a large overturning moment develops.

Figure 5: Column Shear Failure (2.58)
(Courtesy of American Iron and Steel Institute.)

Beam Failures

Both deformation effects which have been discussed so far are mainly concerned with stresses in the columns. The effects on beams should not be neglected even though a beam failure is usually not as dangerous as a column failure. In the analysis known as the exact method, (which is misnamed because it is not exact) deformation of beams as well as columns are considered. Figure 6 (a) shows that beams as well as columns are deformed, instead of all deformation occuring in the columns. This is a more realistic picture of deformations which actually occur in a frame than either of the two previously mentioned. One can see that in large or irregular frames, this analysis can quickly become quite cumbersome. An ironic thing about the exact method is that it neglects the shortening or lengthening of members, which for tall buildings can become pronounced in the exterior columns, thus destroying the accuracy. There is a method, known as the approximate cantilever method, shown in Figure 6 (b), which is more accurate than the exact method because shortening of various members is taken into account. (4,22-3) Neither of these two methods have borne fruit yet in the sense of contributing a usable method of analysis and design for most engineers. They are still in the research stage.

Oscillatory Damping

All real oscillatory systems have some damping present, which should be considered in a rigorous analysis.

EXACT ACTION COMPARED TO CANTILEVER ACTION IN TALL STRUCTURES

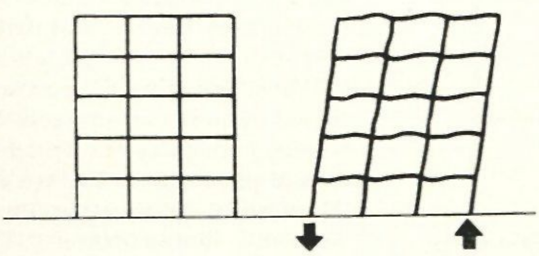
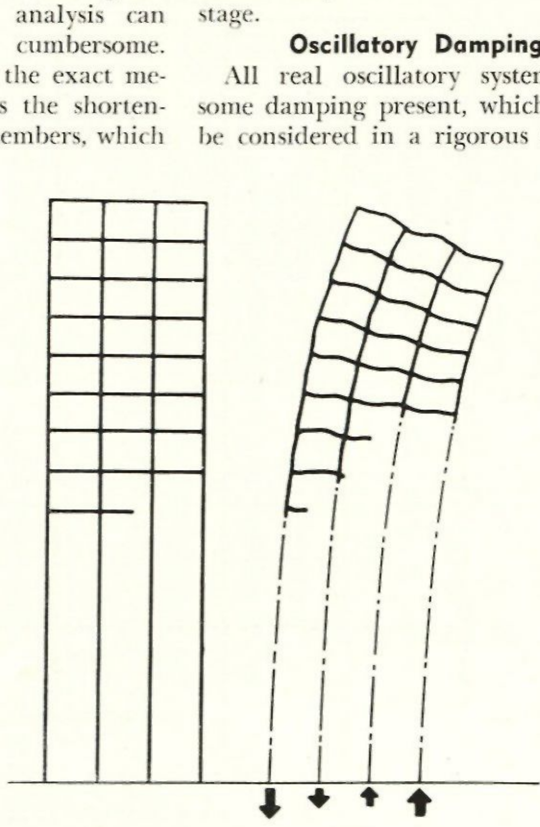


Figure 6a: Exact
Figure 6b: Cantiliver (4.23)
(Courtesy of Bethlehem Steel.)



In many mechanical systems it is undesirable because it causes loss of energy, but in a few systems damping is desirable for dissipating unwanted energy. As far as structural vibrations are concerned, damping is desirable and necessary. A moderate amount will lower deformations and stresses beneficially. The importance of damping has been pointed out by many authors. Old and apparently weak structures have been observed to resist strong ground motions even though their computed lateral load capacity appears too small, whereas structures designed for high lateral load resistance may suffer failures during the same apparent ground motion. One explanation lies in damping. Older buildings are often loose jointed and are capable of dissipating large amounts of energy without overstressing members. Nonstructural elements may also play a role in increasing ultimate strength and in absorbing and dissipating energy, as when a wall may slide back and forth within its frame. Many modern buildings are quite ductile and tough, but have a small amount of damping. During elastic vibrations, particularly when the frequency is near the natural frequency of the building, large deformations and high stresses occur. The building may be experiencing stronger accelerations than the ground, which the ordinary method of static design would not predict, consequently overstressing would occur. (9,125-8)

Infilled Walls

Since nonstructural elements play a role in stiffening a building and in damping vibrations, an explanation of how they fulfill their role is in order. The most prominent example of an important nonstructural element is the infilled wall. In most calculations of stress due to lateral load they are neglected. However, it is obvious that they stiffen a structure (See Figure 7). Considering the wall only, the top and bottom are subject to equal and opposite forces. To satisfy equilibrium the sides are subjected to equal forces to counterbalance the couple formed. When stress analysis is performed it is noticed that a large tensile stress exists on an inclined plane. Since most wall materials are brittle, high stresses may develop upon small deformation; and since these same materials are usually weak in tension, failure will occur on this inclined plane. If the applied stress is reversed, as in vibratory motions, this plane rotates ninety degrees. If this analysis were to be correct, failure of brittle' walls should occur before the frame is in any danger of failure and should result in cracks shaped like an X. Examples of this are shown Figure 8. If the analysis of nonstructural walls were to stop here, the picture might still be considered good, because the frame would not have been injured, and a large amount of damping would be introduced as the walls failed and slipped back and forth. However, there are other factors to cloud the picture. As mentioned before, tall ductile frames may be stiffened to such a degree by brittle walls that a rigid structure is the result. In this case the resultant force acts through the center of mass which may be far enough away from the ground reaction that the overturning moment will cause failure of exterior columns in compression (See Figure 9).

Failures Due to Non-structural Elements

There are examples of buildings which have failed structurally because of the effects of nonstructural elements, which would not have failed otherwise. In Caracus, Venezuela, some buildings apparently failed because they were constructed with brittle walls between upper floors while ground levels were left open. The added stiffness in the upper levels made shear and moment forces higher than they would have been with the frame only, yet the open columns on the ground level were designed without considering this. Figure 10 shows a building which was made of two nearly identical wings with a connecting stairwell between. The only difference was that one wing had an open ground level, while the other had all levels enclosed. The wing with the open level collapsed, while the other remained standing. It is also possible that the failures could have been caused by sudden stresses induced in frames upon explosive type failures of brittle walls. (8,43-5)

When designing a structure to resist earthquakes no one consideration will be enough to justify safety. The overall picture must be kept in mind. The type of deformation, the type of support, nonstructural elements, damping, stress concentrations, and dynamic effects must be taken into account. The starting point is to design lateral strength for capacity to carry a static horizontal force. Various building codes contain methods

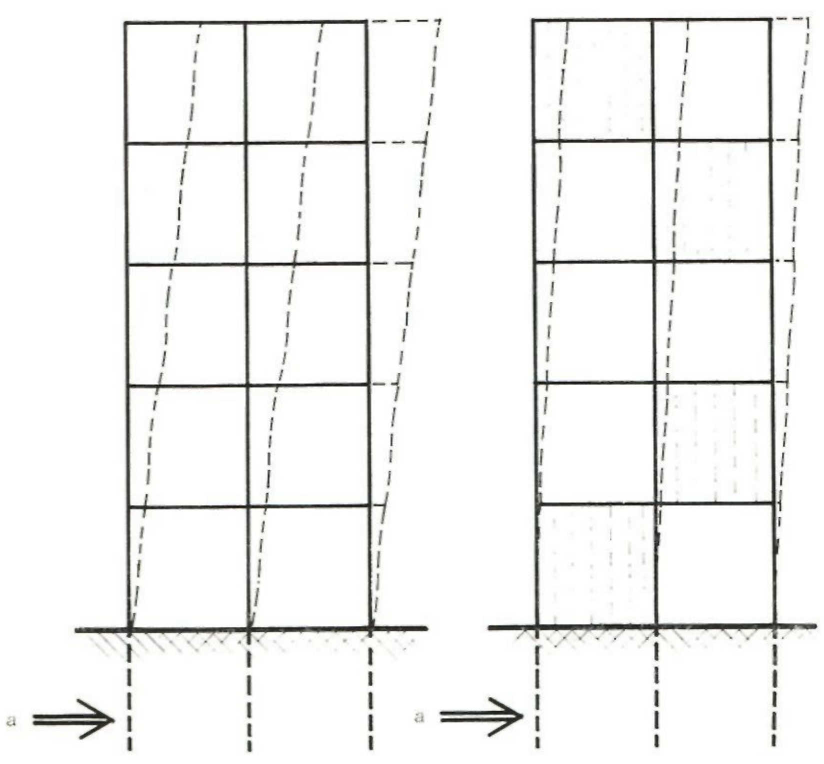


Figure 7: Effect of Infilled Walls

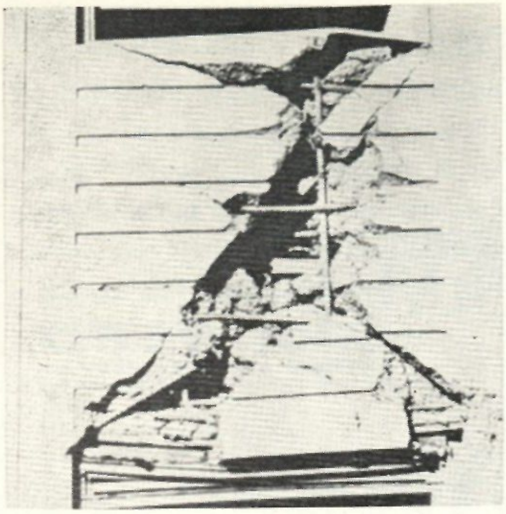


Figure 8: Detail of the X-Cracking in Exterior Reinforced Concrete Walls (6,10)
(Courtesy of Pacific Fire Rating Bureau.)

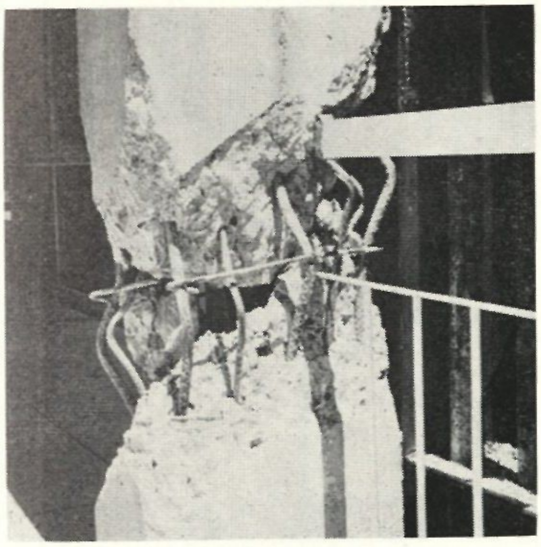


Figure 9: Column Compression Failure (8,44)

Figure 10: Palace Corvin Hotel (8,45)
(Figures 9 and 10 courtesy of Portland Cement Association.)

of arriving at this hypothetical force based on the mass of the structure, the seismic activity of the region, the fundamental period of vibration of the structure, and the type and arrangement of the structural elements resisting the load. (7,2314) Then one must consider whether ductility will lead to excessive deformations; buildings built close together have been known to knock each other apart while vibrating back and forth. It is important that the ductility of the structural elements be compatible with the nonstructural elements. It is important that the damping exist to a worthwhile degree. One effect that is often neglected and that occurs nearly always is torsion. Torsion is produced by random three dimensional motion and will always occur when the center of rigidity does not coincide with the center of gravity, which is the case in most unsymmetrical sections. Stress concentrations will occur, especially at reentrant corners. Methods are available to approximate torsional stresses and should be used.

The only rule which stands fast in earthquake design is to think comprehensively. All possible stresses should be considered and provided for. There are no effects which can be ignored before they are at least considered, even though it may turn out that some are rarely important. It is the duty and responsibility of the designer to make every effort to avoid catastrophic failures of buildings.

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TAU BETA PI ESSAY:

THE ROLE OF ENGINEERING IN HUMAN ENDEAVOR

BOB LARSON

It has traditionally been the social sciences and medicine which contributed to a better understanding of human beings, and the physical sciences which contributed to an understanding of nature. And engineering has always been an applied science, putting this understanding to work in order to attain a goal. Engineering has longest been associated with physical science, first in building temples, military machines and roads, and then in digging mines and building civilian roads and structures. Finally engineering became associated with the industrial revolution, in building metal tools, machinery, and railroads. And engineering assisted the march of materialism and mass-production, for engineers ("ingenious men") were the inventors who gave the world (for better or worse) the mass-produced automobile, electric power, motion pictures, phonographs, radio, airplanes, and finally television. Throughout history, engineering, in one form or another, has been applying mathematics and natural science to ensure man's survival against the forces of nature, and to increase man's comfort.

Engineering and Human Sciences

Nowdays there are some instances where engineering is involved not only with natural sciences, but with some "human sciences" (psychology and medicine), and is carrying on research efforts in these areas as well. The invention of the electronic computer has made a powerful new tool available to economists, sociologists, anthropologists and others to help them quickly understand a massive amount of information about human activities. Computers are also helping doctors better understand the nervous system of animals. Scientists and engineers in California are using computers to analyze the functions of neuron groups behind a fly's eye to better understand visual perception in higher animals. Engineers have helped to devise medical machines like the heart-lung machine; now the laser is being used in some operations to burn tissue in a very controlled way.

And yet engineering can be involved in social progress even more. for parts of all our big cities must be reconstructed to ensure everyone a decent living standard, and engineers might be able to devise the most economical way to do it. Someone must find much better and more economical ways to dispose or use sewage and industrial wastes, in order to help clean up rivers and air, and engineers are probably the best-trained people to do this task.

Social Progress and Electrons

Perhaps social progress is like electron current in a wire: electrons moving in a hectic, random fashion in every direction but slowly tending, on the average, in the direction of an applied electric field. Man's many activities, at times fervent, at times in opposite directions, at times colliding, might be like electrons in a wire. Man's spirit of striving for a better world and his ingenuity then would have the same effect of directing the electron motion in a wire. According to R. Buckminister Fuller, man's goal is to increase the order in the universe. Entropy, or disorder, is continually increasing according to observed natural laws of thermodynamics. Man, through creative synthesis of ideas and materials for his own purposes, tends to increase order in the universe, says Fuller. This is the engineer's function in human endeavor, to order nature for the purpose of man's well-being, by applying natural principles to obtain the best leverage on nature.

What Spiders Did With That Much Gold

The only practical method I found for solving this problem is exhaustive search and correlation of the given data. The specific method I used involved initially assuming all characteristics for all planets and eliminating those that the data or combinations of data suggested. This method, with no further assumptions, gave the following correlations:

Penta I: Insects, Decadent, Diamonds, Airless

Penta II: Hydrogen, North Pole

Penta III: Stone Age

Penta IV: none

George: none

At this point, a trial assumption had to be made. I chose to assume the landing place on Penta I, since that was all that was necessary to complete the characteristics of Penta I. The choices available at this point are Highest Mountain and Equator. Equator, if chosen, leads to a contradiction, so Highest Mountain is the correct choice. Adding in this correlation adds to each planet:

Penta I: Highest Mountain

Penta II: Crustacean, Feudal System, Sugar

Penta III: none

Penta IV: none

George: none

At this point, a further trial assumption had to be made. I chose to assume the atmosphere of Penta III, as it had the most characteristics already determined and only two choices were available for the atmosphere. I chose Chlorine, but that led to a contradiction, so Oxygen was the correct choice. This choice uniquely determined the remaining characteristics for all the planets, yielding:

Penta I: Insects, Decadent, Diamonds, Airless, Highest Mountain

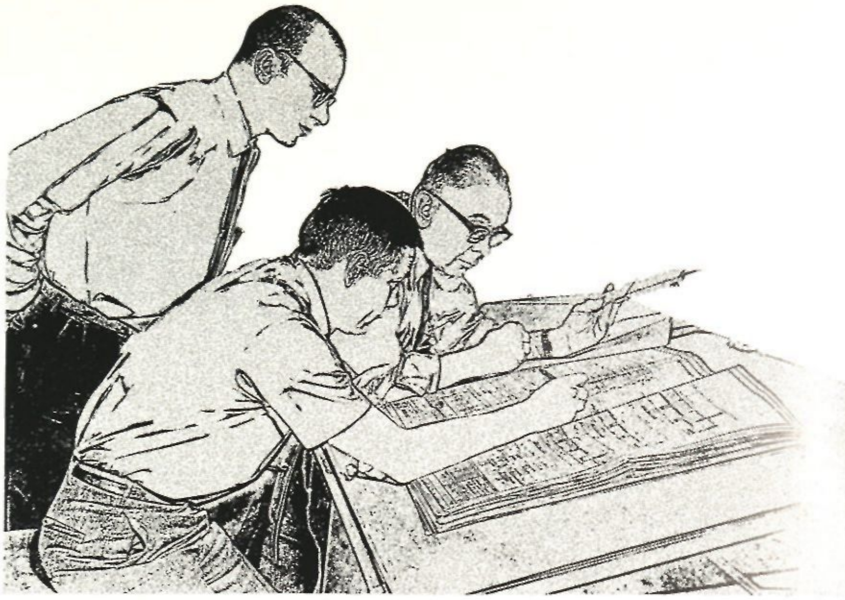
Penta II: Crustaceans, Feudal System, Sugar, Hydrogen, North Pole

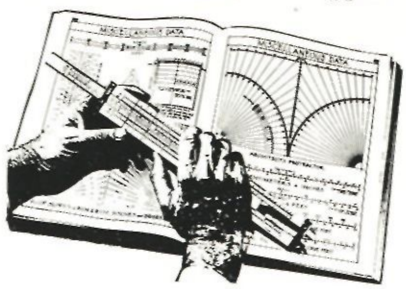
Penta III: Humanoid, Stone Age, Gold, Oxygen, Anywhere

Penta IV: Reptiles, Atomic Age, Copper, Chlorine, South Pole

George: Arachnid, Industrial Revolution, Plastics, Methane/Ammonia, Equator

As for the order in which Finster visited the planets on the route, since the largest delivery is adjacent to another large delivery, the order is uniquely determined by the location of the largest delivery and the direction of the adjacent large delivery. Thus, Finster went first to George then to Penta IV and on around the pentagon counter clockwise to Penta I in minimal time.





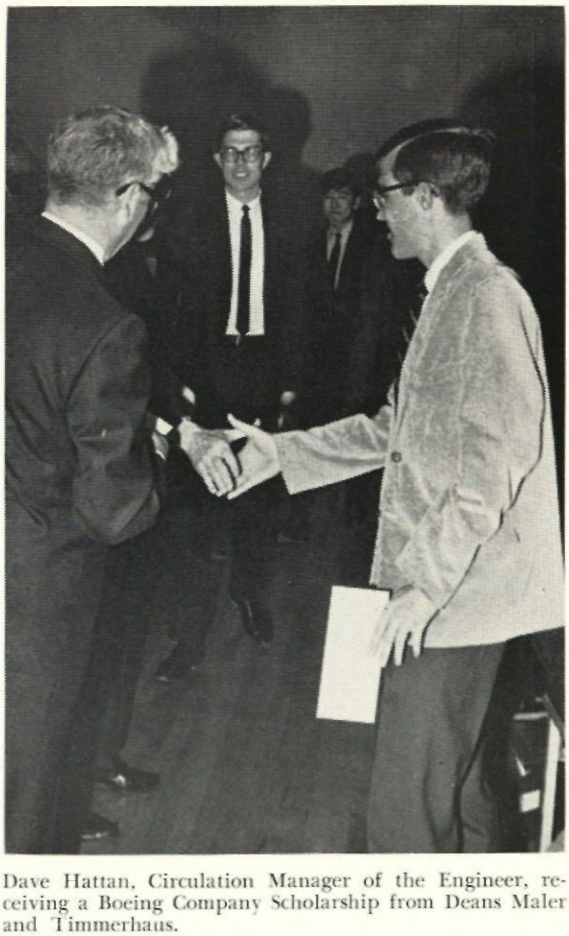

CAREERS WITH
BETHLEHEM
STEEL

E-DAYS

LUNCHEON AND HONORS CONVOCATION

Kathy O'Donoghue, Editor of the *Colorado Engineer* presenting Award to Mr. Burton G. Dwyre, retiring advisor to the *Engineer*.

Allan Thaut receiving the Colorado Engineering Council Outstanding Senior Award from Mr. Orley O. Phillips while runners-up, Herman Husbands and James Harris look on.

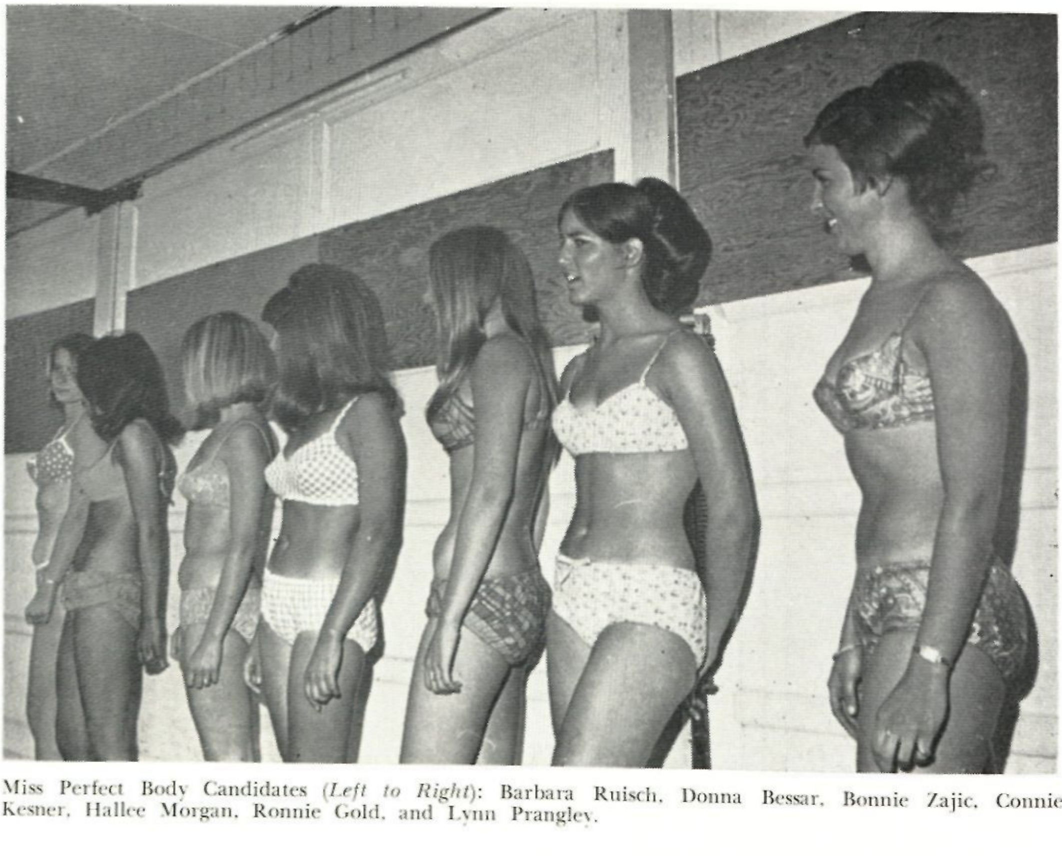


Dave Hattan, Circulation Manager of the Engineer, receiving a Boeing Company Scholarship from Deans Maler and Timmerhaus.

ENGINEERS' BALL

Engineer's Days Queen Candidates *(Left to Right)*: Sherry Saxe, Zoe Brown, Louise Bates, Queen Jeanie Brinkman, Linda Boy and Janice Jaggers.

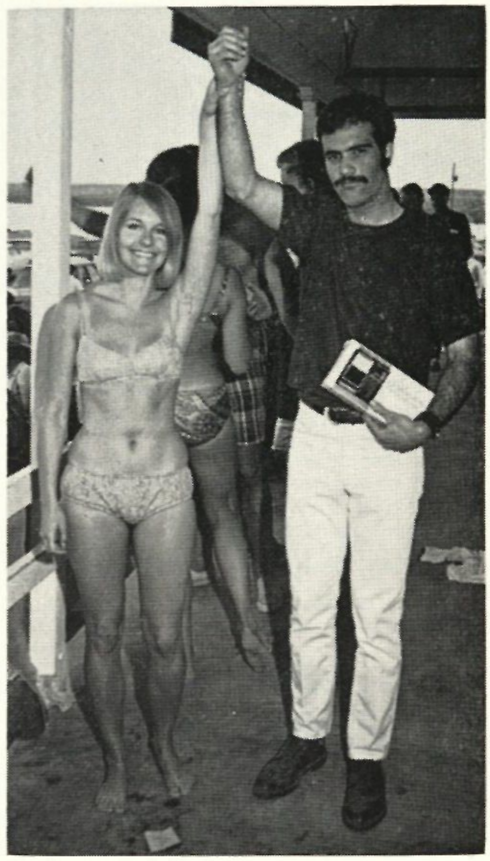
PICNIC

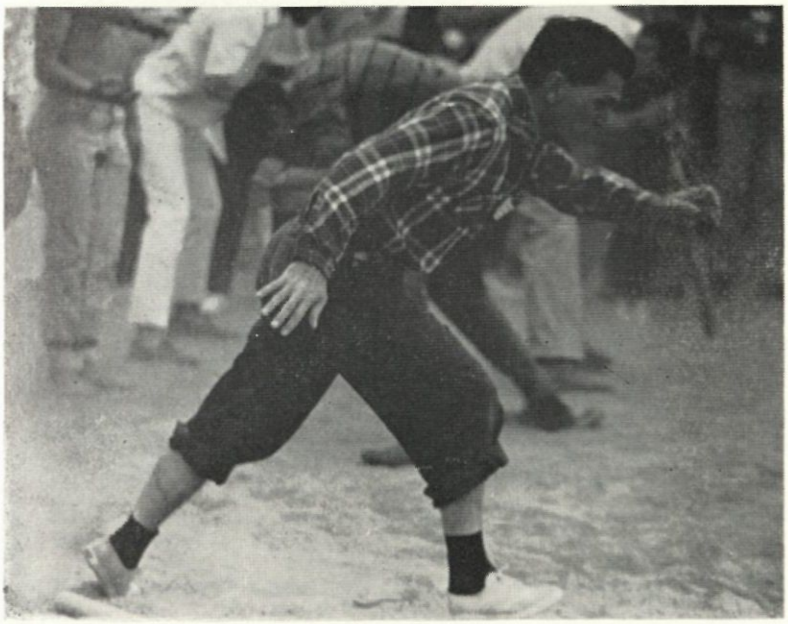


Miss Perfect Body Candidates *(Left to Right)*: Barbara Ruisch, Donna Bessar, Bonnie Zajic, Connie Kesner, Hallee Morgan, Ronnie Gold, and Lynn Prangley.

Meanest Prof Harley Carley (*Left*) with runners-up Madman May and Dirtie Herbie and Miss Perfect Body, Lynn Prangley.

Beard Contest Winner with his shaving partner Bonnie Zajic.



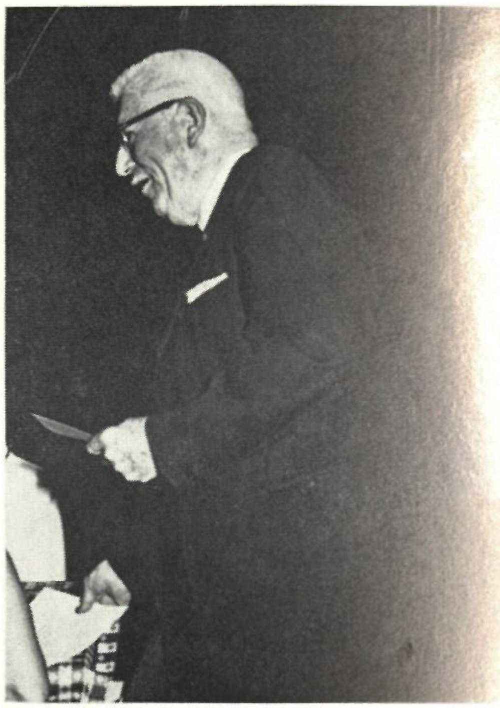


Dean Peters demonstrating his winning form in the Dean's Challenge Race.

Below: Fun and games at the E-Days Picnic.

COLORADO ENGINEER BANQUET

Above: Kathy O'Donoghue, Editor (1967-68) and Randy Lorance, Business Manager (1967-68) and Editor (1968-69).

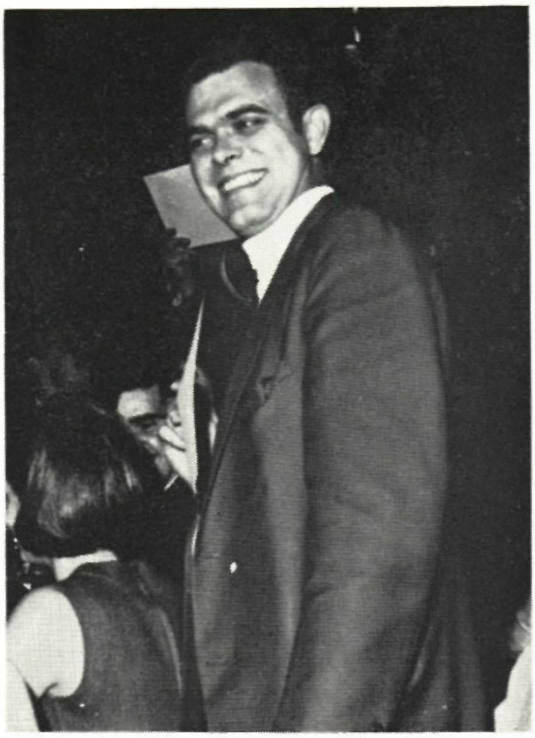


Right: Dean Emeritus Charles A. Hutchinson presenting the Certificates of Merit to staff members, an annual tradition at the *Colorado Engineer* Banquet.

Dean Peters speaking at the *Engineer Banquet.*

Above: New Editor Randy Lorance with the new Business Advisor, Mr. Larry Feeser.

Below: Associate Dean Maler and Dean Peters posing for this picture.



Gary Taylor, photographer, receiving his *Colorado Engineer* Award.

Donna Demong, *Engineer* artist, at the banquet.

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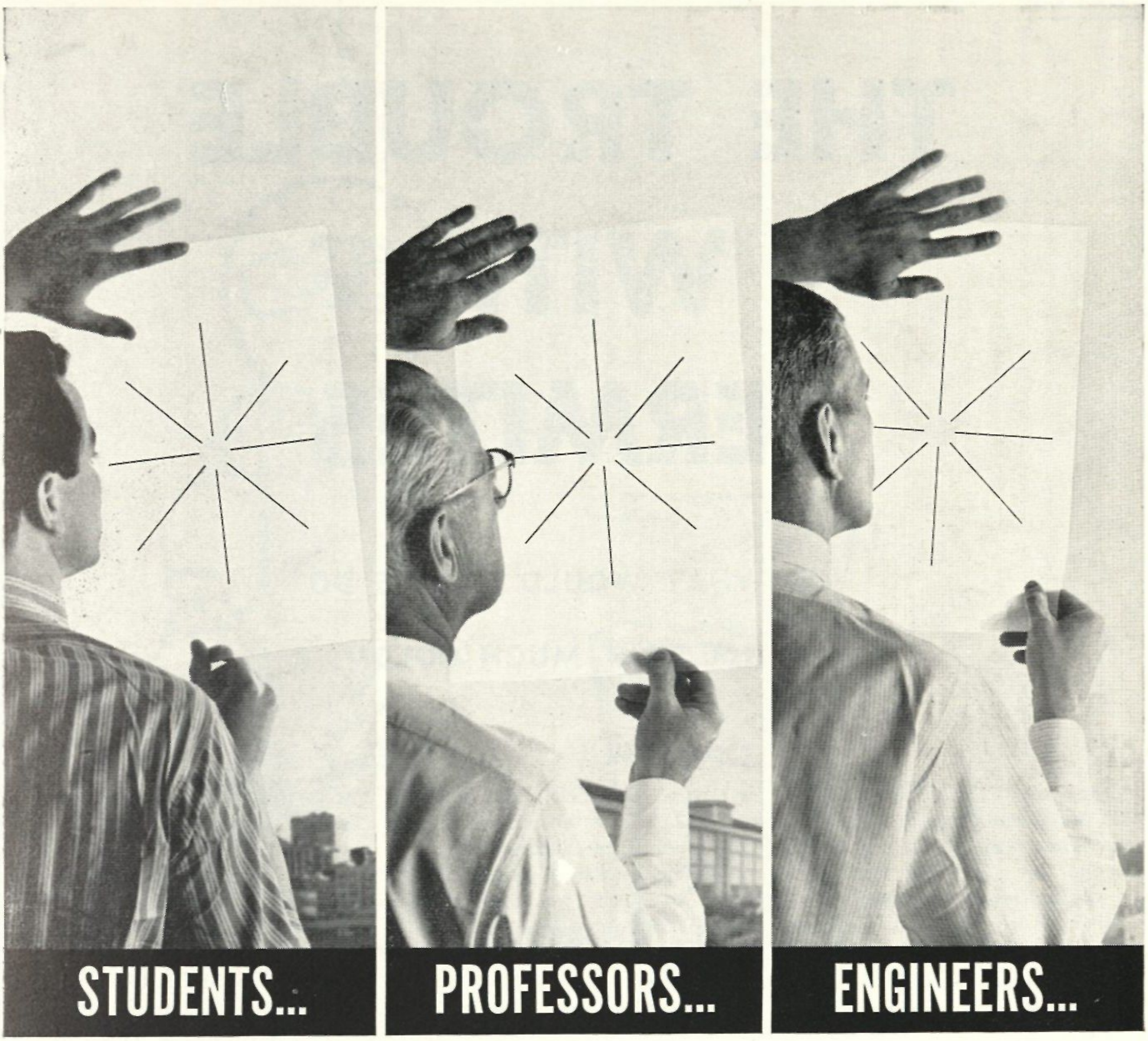

STUDENTS...
PROFESSORS...
ENGINEERS...

PUZZLES:

THE TROUBLE WITH TERMITES

(OR WHAT WOULD SPIDERS DO WITH THAT MUCH GOLD?)

MIKE COLGATE

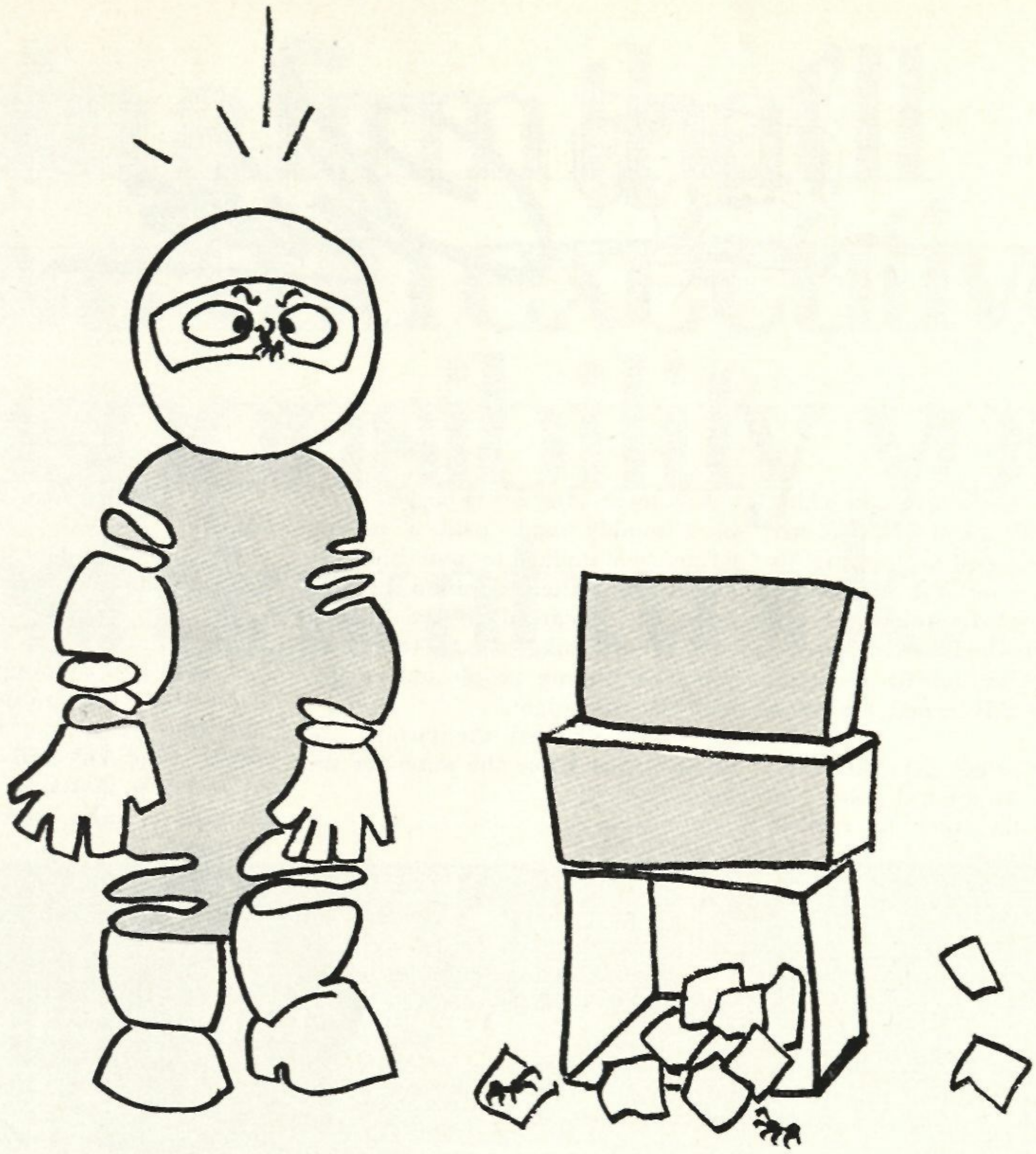
In the year 2223, Phineus Fitzgerald's seventeen times great grand-nephew, Finster Fitzgerald, was given a dishonorable discharge from the Space Marines for deriliction of duty, fraternizing with the natives, overtime parking and practicing logic without a license. (*Colorado Engineer*, January 1968) He immediately found employment with the Penta Systems Distribution Services, Ltd. (P.S.D.S.), which gave rise to the following problem:

The P.S.D.S. was located in the Penta Cluster, a system of six stars arranged in the form of a regular five-sided right pyramid, with the star Penta Prime at the apex and the stars Penta I, Penta II, Penta III, Penta IV and George spaced evenly around the base. The home office of the P.S.D.S. was located on the single planet circling Penta Prime; Finster's duty was delivering cargo from that planet to each of the single planets circling the stars in the system. The five stars comprising Finster's delivery route were numbered in order when they were named, with Penta I at Galactic North and the numbering proceding clockwise around the pentagon to George in the fifth position.

The organization and implementation of an interstellar delivery service present several sticky problems and the P.S.D.S. was no exception. To show a profit, an optimum of speed and efficiency was of utmost importance, so Finster was told immediately that his job depended upon his completing his route in the least possible time—no excuses. The order in which the planets were to be visited and the cargo to be delivered to each were to be on an invoice memo in the delivery ship's safe. Also in the safe was to be a pamphlet describing each planet, the inhabitants, the cultures, available landing space for delivery vessels and what merchandise was normally delivered to each planet.

Finster checked out his ship and cargo (copper, sugar, plastics, gold, diamonds) and took off. After attaining maximum velocity, however, he opened the safe and was horrified to discover that a hoard of Antares III termites had eaten most of the contents. Only scattered scraps of both invoice and pamphlet were left. Finster salvaged what he could, although there was no way to tell in what order the scraps were to be read. Furthermore, it was obvious that at least 90% of the material was missing altogether. Below are the decipherable portions of the available scraps (seperated from each other by dashes) presented in the order in which Finster fed them into his onboard computer.

—about these humanoid oxygen breathers—reptiles expect delivery at their south pole—methane/ammonia atmosphere prevented industrial revolution until very recently—23,000 KILOMASS SUGAR—feudal system, similar to Terra's dark ages, as should be expected among a race of crustaceans—ends our discussion of this world of swirling chlorine and acid rain. The next star system clockwise is inhabited by a curious race of methane/ammonia breathers who—decadent remains of a former intergalactic empire—land the delivery of gold anywhere on the planet—have no naturally occuring diamonds because their planet totally lacks atmosphere, so they must import them. In the *next* system clockwise delivery vessels *must* land near the north pole —10 KILMASS DIAMONDS—stone age culture on the planet of the third star—the planet orbiting Penta I with its race of insects—land on top of the highest mountain. Moving on clockwise to the next star, we find that the inhabitants of its planet value sugar above all else, even though they must import it.—need copper desperately, as they have just entered their atomic age.—10 KILOMASS GOLD—27,000



KILOMASS PLASTIC MA—land on only level surface, near the equator—arachnid ruling race finds many uses for imported plastic ma—world of insects. In the next system clockwise, we find a hydrogen atmosphere, giving rise to—24,000 KILOMASS COPPER—unlike the planet of Penta I, this world has a methane/ammonia atmosphere—

If the delivery ship's velocity was reduced by about one light-minute per hour for each kilomass of cargo and if the ship's empty velocity was five light-years per hour, in what order did Finster visit each star, where did he land on each planet and what did he deliver to each? The linear distance between adjacent stars on the route was 7.2 light years and Finster *did* complete the route in minimum time.

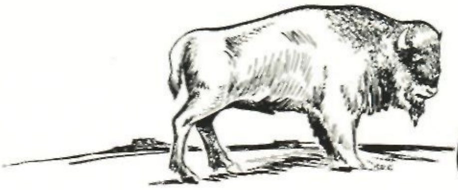
The Too-Many-Suspects and Not-Enough-Evidence Case —Solved at Last.

The following is from the diary of Mydih Wattsit, friend, counsellor, etc.

February 6: I confronted Sherlock with the apparent lack of sufficient evidence and my fears that the case was unsolvable. His reply was typical: "Murder is obviously shorter than the deceased, but of at least average stature and arrived not less than twelve days ago. Therefore, Mr. Harold Wilcox is our man and I have so informed the constable."

His reasoning, it seems, was as follows: The positioning of Hayden's *Criminal Law* and the ladder show that someone who could not reach the top shelf while standing on the floor was present at the time of the murder. The victim was obviously tall enough and the same reasoning eliminates Lord Beckwith and his son. From the butler's testimony, it is clear that the bell was rung the second time *after* the cord had been broken apart and wrapped about the victim's neck. This obviously eliminates Wee Willy as a suspect, because he could not have reached the truncated cord to pull it. Finally, from the gardners' testimony, it can be deduced that twelve days had passed since the argument, eliminating Dr. Hastle and leaving only Harold Wilcox. (Since each gardner was *off* the same number of days, they obviously both *worked* the same number of days. Therefore, each worked five days and was off seven days, making a total of twelve days.

See "What Spiders Did With That Much Gold" on page 20.



Chips

A young lady had a dream in which a handsome male angel flew into her bedroom and scooped her up into his arms. They flew out the window together and traveled through the air. Finally, they reached a castle in the sky and soared in through an open window. He gently tossed her on a luxurious bed.

"What are you going to do now?" she asked in a frightened voice.

"That's up to you," he replied, "it's not my dream."

He: "Give me a kiss."

She: No answer.

He: "Won't you please give me a kiss?"

She: Still no answer.

He: "Are you deaf?"

She: "No, Are you paralyzed?"

A snowflake in an avalanche never feels responsible.

"But darling, this isn't our baby."

"Shut up, it's a better buggy."

When Jane returned from a ride, her mother noticed that one of her shoes was muddy.

"Why is just your right shoe muddy and not your left?" she asked.

"I changed my mind." Jane answered.

Low neckline: Something you can approve of and look down on at the same time.

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

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

A girl's best asset is a man's imagination.

A man's incomplete until he's married—then he's really finished.

Girls get minks the same way minks get minks.

Don't worry about what you do in your life. God grades on a curve.

She: "Where did you learn to kiss like that?"

He: "Siphoning gas."

He drove quite a distance into the country, stopped the car and asked the girl, "Are you a Chesterfield or a Camel girl?"

Somewhat confused she asked, "What do you mean?"

He said, "Would you rather satisfy or walk a mile?"

The height of bad luck: Seasickness with lock jaw.

"Am I the first man you ever made love to?"

"Umm . . . might be. Your face looks familiar."

A small kid, running out of a burlesque show, was grabbed by a doorman who asked him what was the matter. The kid said, "Mama told me if I ever looked at anything bad I'd turn to stone, and I can feel it starting!"

Hear about the new deodorant called Vanish? It makes you disappear and everyone wonders where the odor is coming from.

The current re-emphasis on education in colleges is typlified by the University of Colorado ruling that no athlete be awarded a letter unless he can tell at a glance which letter it is.

Lectures are like steer horns—a point here, a point there, and a lot of bull in between.

They're got a new parlor game called BUTTON, BUTTON, HERE COME THE FOLKS!

"Show me a home where the buffalo roam, and I'll show you a house full of Chips."

Engineer to blind date: "I never believed in reincarnation, but what were you before you died?"
