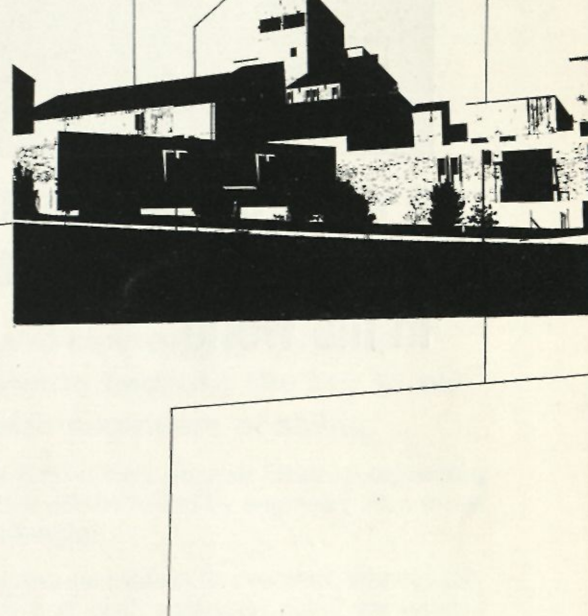
Dean Timmerhaus

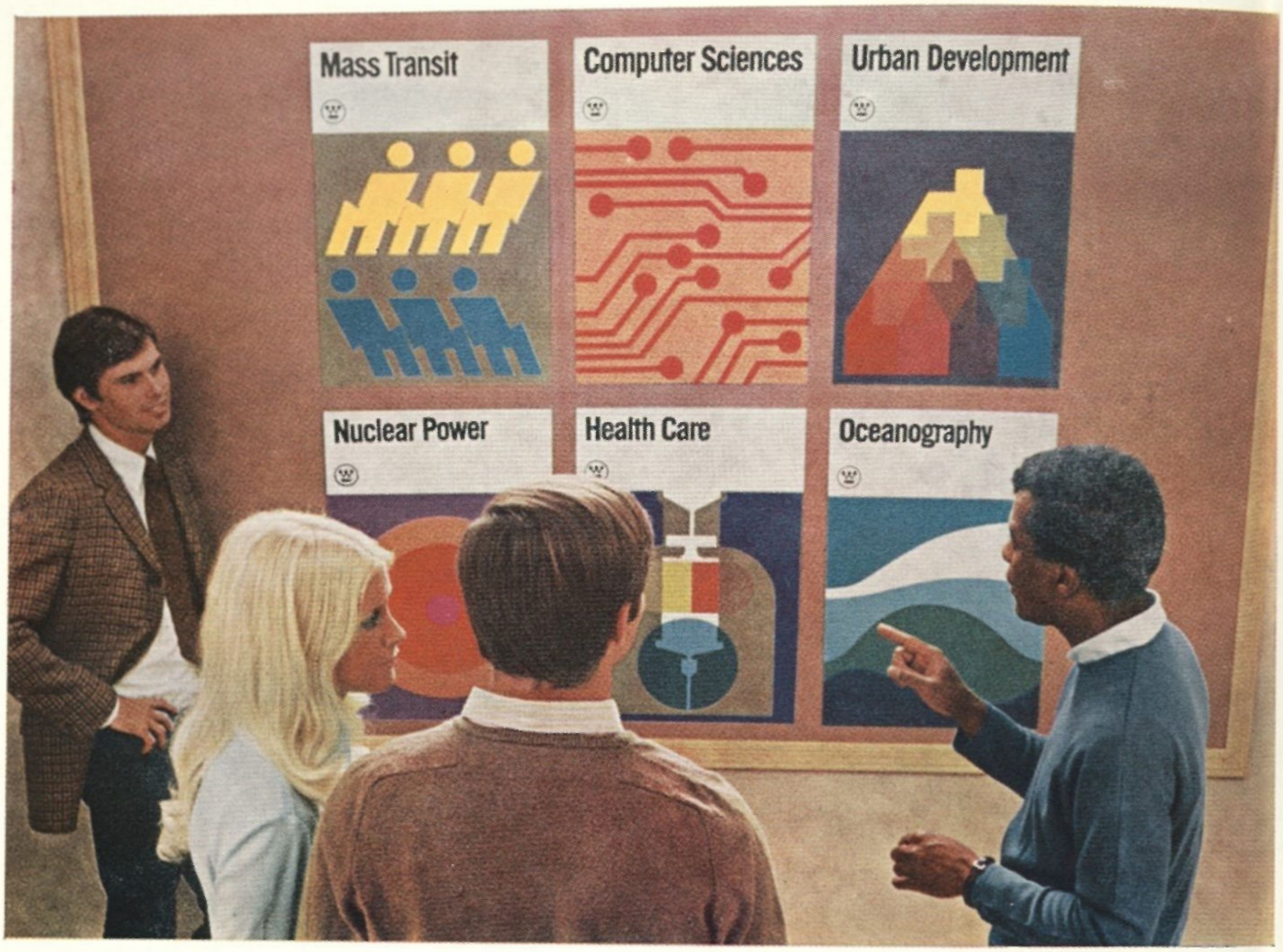
Colorado Engineer

ENGINEERING the ENVIRONMENT



October 1970

If you want to engineer a better world...



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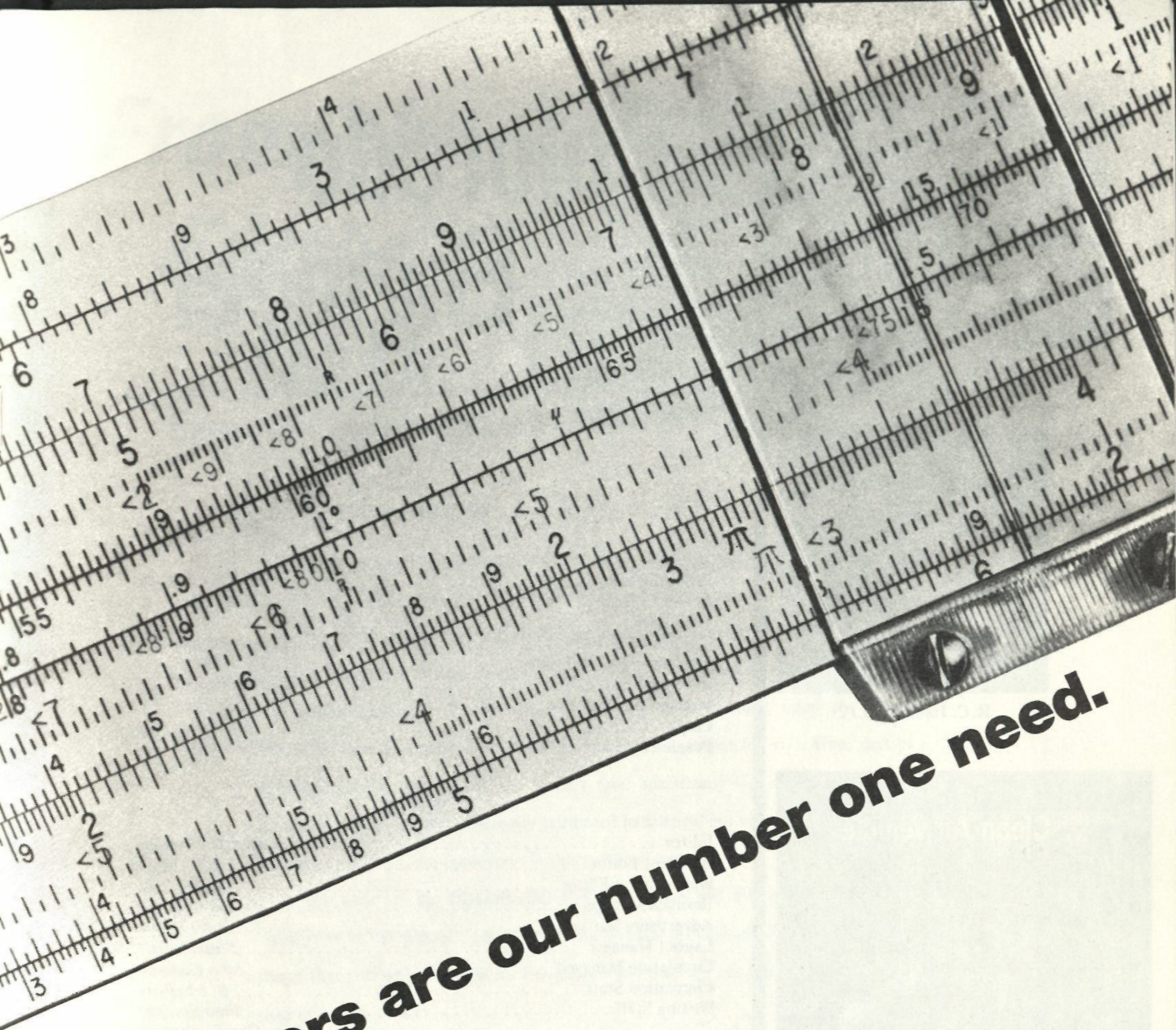

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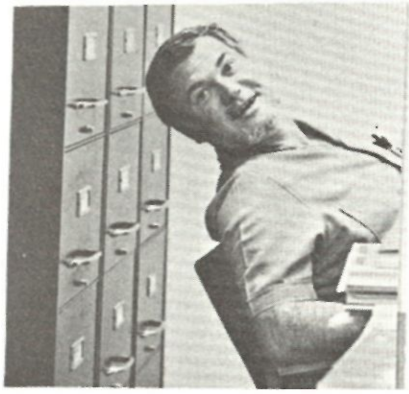
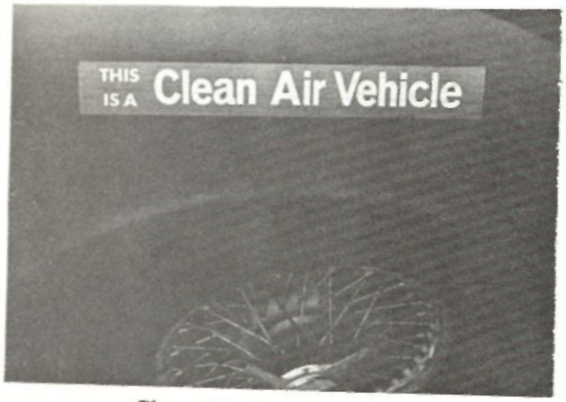


R. C. Johnson p.12



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Colorado Engineer

COLLEGE OF ENGINEERING • UNIVERSITY OF COLORADO

VOLUME SIXTY SEVEN • NUMBER 1 • OCTOBER 1970

IN THIS ISSUE

STAFF

The contents of the Colorado Engineer is published by the students of the University of Colorado, College of Engineering, four times per academic year in October, December, February, and April. No part of this magazine may be reproduced without the express written consent of the editor.
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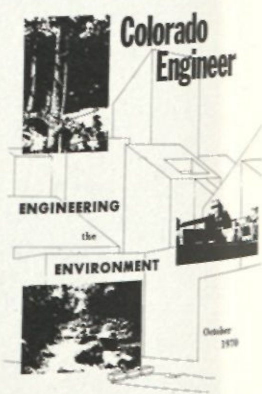
THE COVER: This month's cover features graphic photography by Donald Kramer of the Northwestern Publishing Company, Evanston, Ill. The pictures are of the Engineering Center and of Left Hand Canyon near Boulder and represent some of the considerations in "Engineering the Enviroment."



From the Editor's Desk

For the past two years publications of all kinds (COLORADO ENGINEER included) have been reproducing pictures of polluted lakes and streams, mountainsides cluttered with empty Budweiser cans and McDonalds hamburger wrappers, and myriads of shots of Public Service Companys' exhaust stacks, all featuring editorials with the overwhelming theme: "Look what technology hath wrought upon the world." Although there are many factors which separate our present life style from that of a Utopian Society, not all of the world's (and specifically not the United States!) problems can or should be directly attributed to science, but rather to the demands of the people who are the consumers in this technical age.

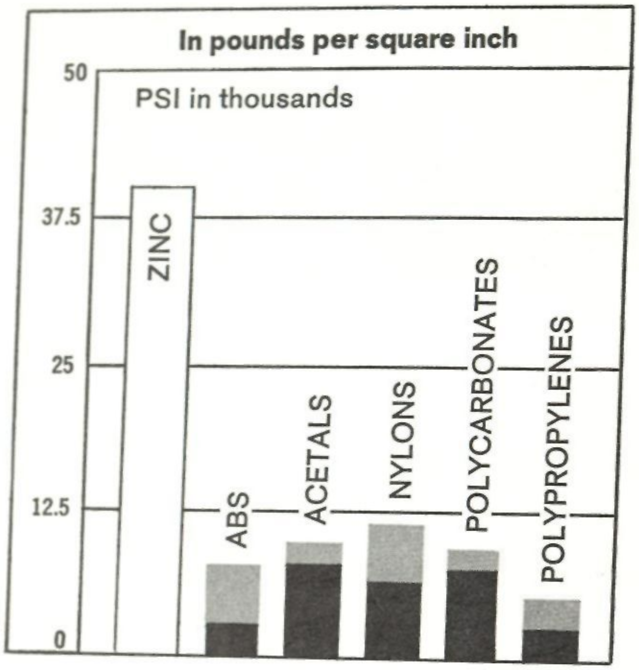
In this issue of the COLORADO ENGINEER we will attempt to acquaint our readers with the possible solutions to the world's technological problems. It is our hope that this will stimulate further interest in attacking our problems, resulting in a higher quality of life.

CTN

P.S. As is stated on the previous page, the COLORADO ENGINEER is published by the students of the College of Engineering. This also implies that the opinions expressed in the COLORADO ENGINEER are those of the student body in general. If you are a student at CU and would like to have your opinions expressed, applications for the COLORADO ENGINEER Staff are still being accepted in ECOT 1–7

BASIC DESIGN DATA—Zinc Die Castings vs. Plastics

Tensile Strength



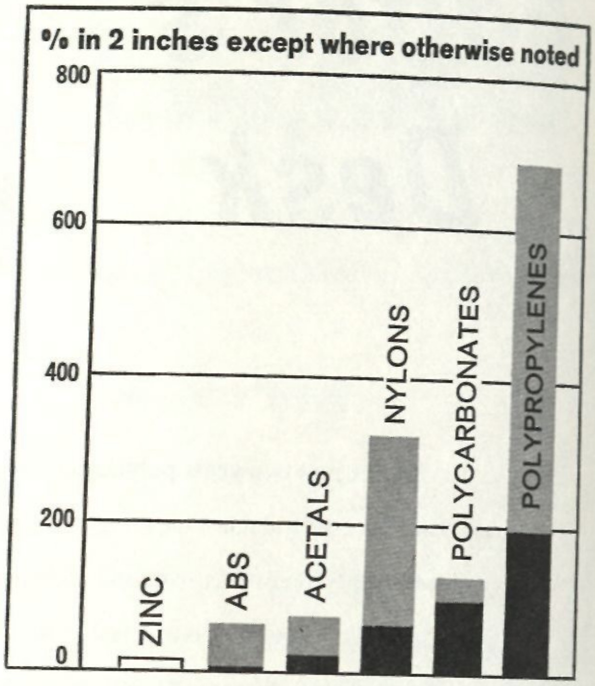
ZINC DIE CASTINGS	TENSILE STRENGTH—psi	
	As Cast	After 20 yrs.
Alloy SAE903, ASTM AG40A, No. 3	41,000(1)	32,000(2)

Source (1) ASTM B86 (2) Reports of ASTM Comm.

SOME PLASTICS USED FOR INJECTION MOLDING	TENSILE STRENGTH(3)—psi	
	As Molded	After 20 yrs.
ABS { High Impact, High Heat Resistant, Medium Impact	3,500- 8,800	Not Available
ACETALS { Homopolymer, Copolymer	8,800-10,000	Not Available
NYLON (Type 6, 6/6, 6/10)	7,000-12,400	Not Available
POLYCARBONATE (Unfilled)	8,000- 9,500	Not Available
POLYPROPYLENES (Unmodified Copolymer)	2,900- 5,500	Not Available

Source (3) Modern Plastics Encyclopedia- 1969-70

Elongation



ZINC DIE CASTINGS	% ELONGATION 2 in.	
	As Cast(1)	After 20 yrs.(2)
Alloy SAE903, ASTM AG40A, No. 3	10	14

Source (1) ASTM B86 (2) Reports of ASTM Comm.

SOME PLASTICS USED FOR INJECTION MOLDING	% ELONGATION 2 in.	
	As Molded(3)	After 20 yrs.
ABS { High Impact, High Heat Resistant, Medium Impact	3—60	Not Available
ACETALS { Homopolymer, Copolymer	25—75	Not Available
NYLON (Type 6, 6/6, 6/10)	60—330	Not Available
POLYCARBONATE (Unfilled)	100—130	Not Available
POLYPROPYLENES (Unmodified Copolymer)	200—700	Not Available

Source (3) Modern Plastics Encyclopedia- 1969-70

ZN-438

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Dean's Column

As we start our new school year, I welcome all of our students and faculty and wish a successful and productive year for each of you. In particular, I give my best wishes for success to Carl Newman as the new Editor of the COLORADO ENGINEER and to Bob Powell in his position as President of Associated Engineering Students.

Last year, our engineering students and faculty started to recognize their responsibility to speak out on campus matters, and I was very proud of the way we handled ourselves in doing this. I hope this coming year will be one in which we continue this responsibility with an emphasis on providing real "solutions." As engineers, we can do "our thing" by avoiding the arm-wavers and the weeping and wailing of the doom forecasters while pointing out that it is time to look for solutions to our problems and we are equipped to do this.

The technology of my generation has permitted us to develop an amazing level of efficiency in areas such as transportation comfort, living comfort, and recreation facilities. While developing these good aspects of life, we have also caused problems. However, once the decision is made to seek a solution to these problems, there is absolutely no question that these solutions will be accomplished effectively and rapidly. A technology which put a man on the moon, once the decision to do this was made, can certainly solve the other problems of man-made pollution, overpopulation, transportation snarls, etc. We engineers are the ones equipped to solve these problems, and we can and will do it.

I hope all of you students recognize that the education you are receiving here at the University should be the most important aspect of your present activities. Certainly, you must remain aware of and be involved in the national and world situation to some extent. However, your education must come first so that you will be prepared on graduation to make the necessary technical contributions to the solutions needed, as well as to be involved with society in considering our national and world problems. When I speak of your education, I am therefore including not only the essential engineering and other technical courses but also the vital humanities and social sciences courses to give you the necessary overall perspective to do the right job in the future as an engineer.

I assure you that our engineering faculty will be doing its very best to provide the appropriate education for you at all levels here at the University. Let us make this the year when we fix our goals on working together for solutions.

Max S. Peters

Dean

PROF'S CORNER

by Dr Drietlein

EDITORS NOTE: Dr. Drietlein holds a Ph.D. in Physics and last year originated and headed the Ecology Studies class. He was voted "Best Teacher of the Year" by this same class, and is an "Aware Prof" who can see both sides of a problem.

The human species appears to be an example of poor genetic engineering, just as the dinosaurs ultimately proved to be. Not only do we destroy the mother earth that nourished us but we delight in destroying each other with the most tenuous of justifications. With these apocalyptic thoughts in mind, one might wonder what there is left to say.

The ability to change still resides in the individual, because mutations occur in the individual and not in the silent majority. Since the technological man has effectively shaped the social conditions by establishing a scientific milieu in which it grows, he shares a major responsibility in directing its evolution.

How does the engineer view society? Perhaps a viewpoint, skeletonized by a technical description, is his first oversimplified approach. It would go something like the following:

Society is a fluid composed of individuals. Clearly it is not an ideal fluid since it exhibits friction and turbulence. The analytic difficulty of dealing with turbulence forces a simplistic point of view. It is "well known" that the Reynolds' number characterizes the flow of a non-ideal fluid. The expression for the Reynolds' number is

$$R = \frac{V * D}{v}$$

with v=velocity of progress, d=size of society, and v=viscosity (coefficient of conservatism). When R exceeds a critical value, Rc, turbulence and unrest result. The problem becomes one of maximizing the velocity of progress V, minimizing the friction characterized by v and, at the same time, avoiding turbulence. Obviously a compromise must be reached since the demands, as usual, are incompatible. Both a society moving too fast and a society with no conservatism is demonstrably unstable. The only unambiguous conclusion to be drawn seems to be that "d" should not be too large, an argument favoring local government and disfavoring bureaucracy.

Now the above picture has serious failings as nowhere is the role of the individual as an innovator and steersman of society intimated. Most people seem to be content to be carried along in the current of events down the drain to extinction. The average pliant engineer, perhaps willingly, perhaps unconsciously, subscribes to one or more of the following:

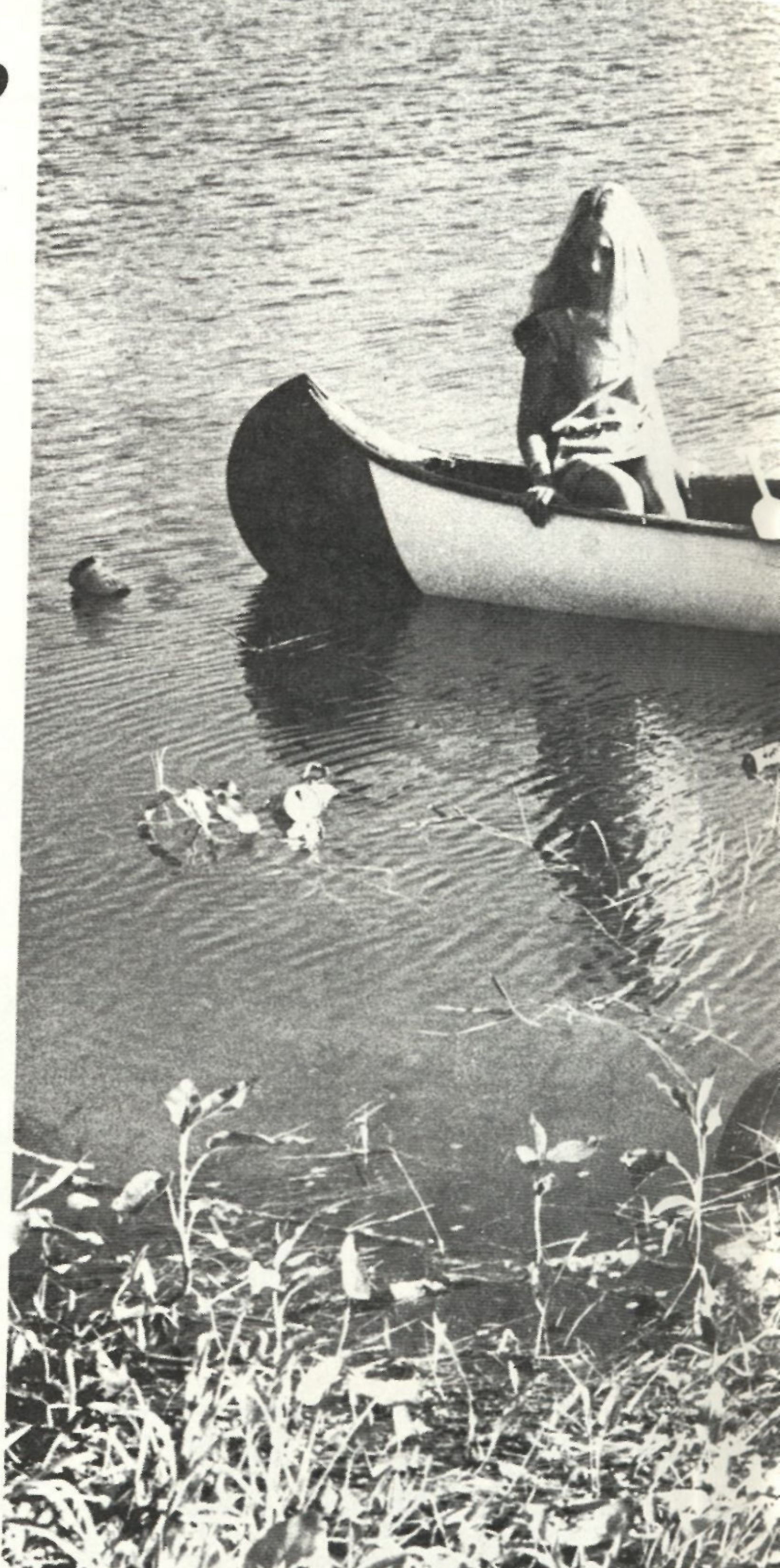
1) Planned obsolescence–running through the earth's resources recklessly by designing disposable items and programming finite lifetimes in order that idle hands be left busy.

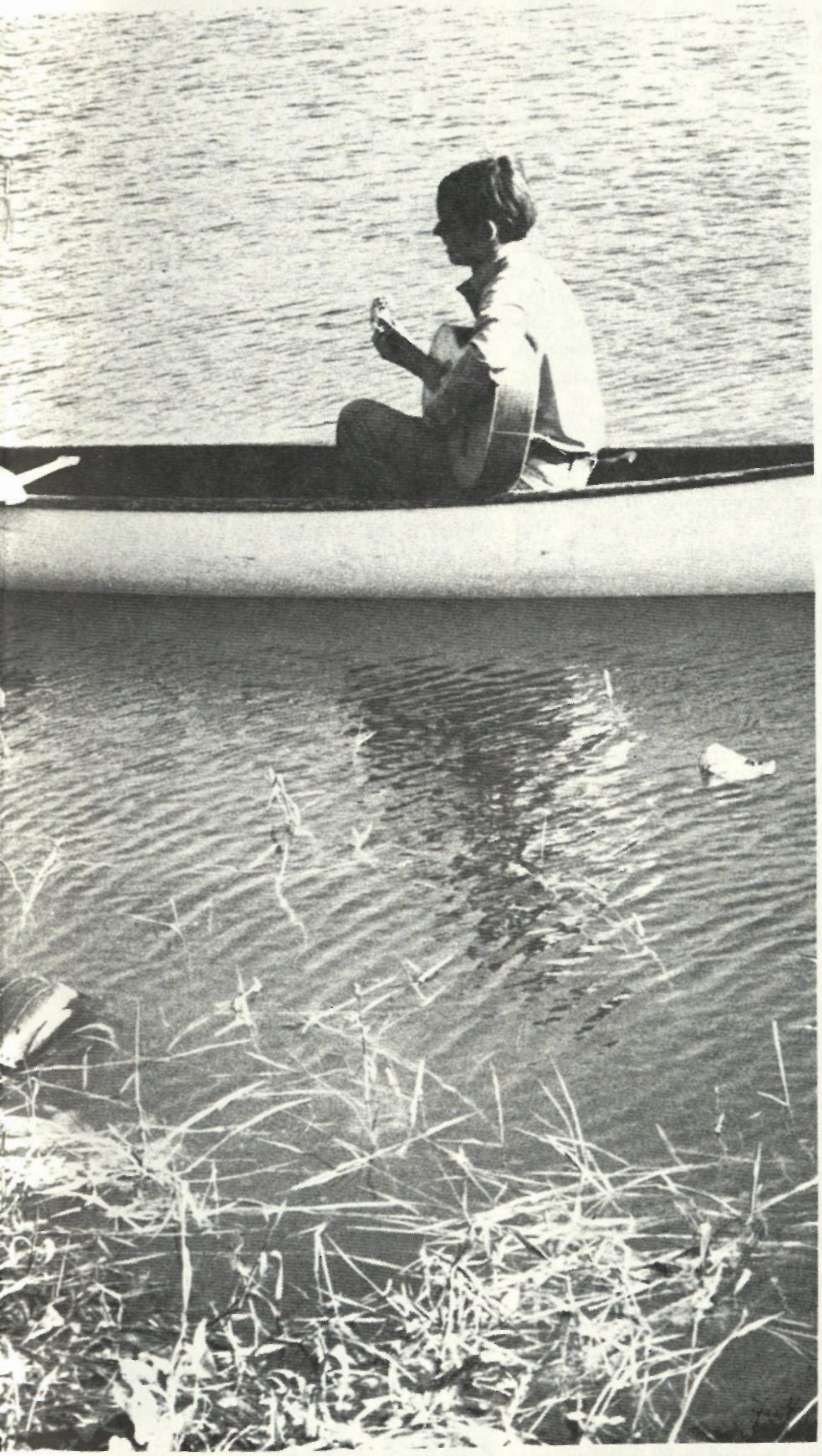
2) Useless gadgetry–devices preventing natural human functions, such as walking, from occurring. The final result is not only atrophication of the limbs but also of the brain.

3) Energy abuse–designing overpowered products which are changing the biosphere irremedially. This overkill is designed to be used on both animate and inanimate objects.

How much better it is to believe that man can live harmoniously with the earth rather than fight it or kill it! Whether the genetic forces have reached the point where it is impossible to rectify the self-destructive trend upon which the average man has embarked is not clear. There are those who will continue to try to reverse our course, and, hopefully among them the engineers who feed power into the hands of society. Responsibility is born with the creation of technology. It cannot be relegated exclusively to the user. Otherwise the engineer is the slave of his devices when meant to be master. The stereotyped picture of the engineer as the irresponsible, callous, device-making idiot-savant must be changed by activating strongly the humanistic and individualistic element in the engineer if for no other reason but because of the genetic imperative of survival.

Goodbye, lake.



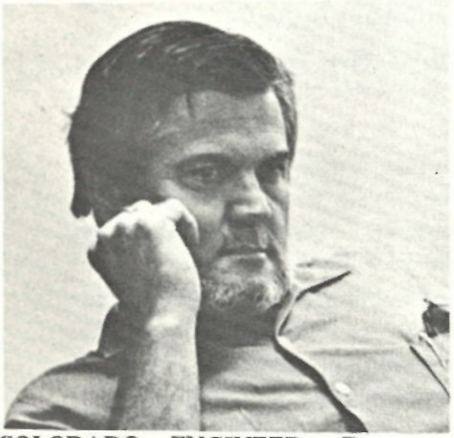


Colorado Engineer Interviews

R.C. Johnson

Dr. Curtis Johnson, chairman of the Chemical Engineering Department at U.U., is an avid environmentalist. He is presently working on a project, "Model of Colorado," which is directed towards advanced planning and simulation of communities. It entails collecting data on all factors affecting the environment, computerizing the data, and simulating the "cause and effects" of varying these factors. In essence, the crux of the project is to spend a few dollars "polluting" the computer rather than a small fortune polluting the environment.

We were fortunate in capturing Dr. Johnson for an interview bemidst his busy schedule of chairman "doings, teaching, and lecturing to various organizations throughout the state.



COLORADO ENGINEER: From an ecological viewpoint, what shape would you describe the world to be in today, and in what direction is it headed?

DR. JOHNSON: For a broad generalization, it's in good shape here and bad shape there. Overall, it's in rather bad shape and is headed downward into even worse conditions . .

COLORADO ENGINEER: Of all the problems in the world right now, which do you find to be the most critical?

DR. JOHNSON: The problem of population is still the most critical, because the amount of pollution is strongly dependent on the number of people.

COLORADO ENGINEER: By what motivation are the students at the University being encouraged to pursue the ecological fields? Also, who may interested students contact to find out more about ecological studies in their field?

DR. JOHNSON: Well, there are many programs which are only partially organized right now. For example, one that has been only partly thought through, but still, I think, can be worked out in detail, is a program with Professor John Bushnell in biology. He is giving his attention more to a combination of the biological and social sciences and the humanities. There is no official program, but working with him or some of his associates, a student could work out a suitable combination of courses that would satisfy his interests, and I am sure the Professor Bushnell would be glad to meet with any student that had this type of interest. There are within many of the departments specific research projects or seminars that are devoted to various facts of environmental problems. About all you can do is ask people within your department who is working on something like this. One way to find out is to have your advisor get in touch with Professor David Rogers in biology, because from the questionaire that we sent out, Rogers has put together this information; it has been computerized, it can be queried, according to department, discipline, subject, whether it is a course or research, whether it is just developing, or ongoing; many things can be asked of this computerized data bank. Dave Rogers is the man to contact there. There are certain departments whose whole reason for existance is environmental matters, and geography is one of them. This campus has been fortunate in attracting good geographers. One of the most famous geographers in the world is Gilbert White, who heads the Institute of Behavioral Sciences, and is a professir if geography. He is the man who headed President Thieme's Environmental commission and turned out a recent report on what the university should be doing.

COLORADO ENGINEER: What should the university be doing?

DR. JOHNSON: The report came up with a few rather broad conclusions. (You many recall it was a rather "blue ribbon" committee, and blue ribbon committees often leave details to subcommittees, as I think is the case here). Essentially, however, he gave strong support to: number one, establishing a central coordinating agency at the university, probably within the office of the Vice President for planning and research, who is Ted Manning. It did recommend that some budget be allowed so that projects could at least be seeded. It recommended that some sort of information system be established, and I feel quite possibly that what Dave Rogers has is the beginning of this type of system. A couple specific recommendations are in regard to departmental attitudes. This is a tough subject.

COLORADO ENGINEER: What pressures are you putting on your department as far as acquainting students with the environmental problem?

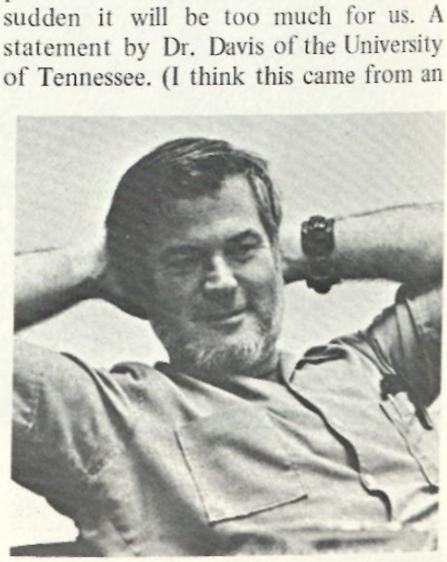
DR. JOHNSON: The department itself is pretty much oriented in this way. At least five of the eight or nine in our dept. are actively involved in things concerning the environment. For example, air pollution research is being done by Dean Peters; water pollution and resources by Dr. West, some environmental modeling by myself, and work with an ecological wind tunnel by professors Kreith and Krantz; I see furhter involvement for other members of the department as certain aspects of their specialties become involved.

COLORADO ENGINEER: How are you stimulating interest in your own classes?

DR. JOHNSON: There are several ways this can be handled. One is, in the overall curriculum, just to not let a student out without some background in ecology, and so I'm getting harder and harder to bypass in this regard. But even within a traditional course, one can slant problems in such a way that the principles which an engineer needs to know can be taught using examples of amounts of pollution, and methods of waste treatment, as well as problems on chemical manufacturing. So by just changing the vehicle but not changing the subject being taught, one can emphasize problems of pollution.

COLORADO ENGINEER: Everyone is always referring to survival to stir up attention. Exactly what is survival?

DR. JOHNSON: There are, again, various degrees of doom that people predict of the human race, and by survival I honestly mean whether the human race will continue to exist or not. There are numerous statements, for example, those quoted by Ehrlich, others who are sometimes considered to be such prophets of doom that they are not to be listened to – I don't agree with that. We quote in one talk that we give, a man named Richard Felgler, who is a biologist, and he gives the human race 50 to 100 years on the assumption that our present rate of population increase will continue, and therefore the accelerating degree of pollution will continue, and all of the sudden it will be too much for us. A statement by Dr. Davis of the University of Tennessee. (I think this came from an



article in THE SATURDAY REVIEW), says that even by the year 2000 the average American will be lucky if he's as well off as today's average Asian. That is just a few years off! A social scientist, who's name I will not give because I don't know if he would want to be quoted along with his name, gives us less then ten years – his reason is that he feels there is no way of bypassing nuclear war, and so he believes that we're going to go out in Tom Lehrer's big barbeque.

COLORADO ENGINEER: Do you believe, as does Ehrlich, that if we can get the population down we can avoid nuclear war?

DR. JOHNSON: I believe so. People go to war when they run into each other, and the more crowded we are and the more uncomfortable we are, the better our neighbor's territory looks, and this is what can lead to the conflicts. The Second World War was started to a great extent because of the expansion – nations desired to expand into other nations' territory and its natural resources.

COLORADO ENGINEER: As population increases and natural resources are reduced, the object is to capture natural resources?

DR. JOHNSON: That's right. We try to find a way of replenishing these resources when we should be concentrating on keeping the population down and recycling our used resources.

COLORADO ENGINEER: What are you doing about survival?

DR. JOHNSON: Well, I have only one child!

COLORADO ENGINEER: And with regard to your "Model of Colorado"?

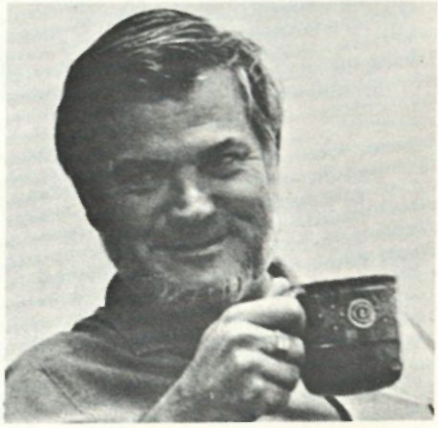
DR. JOHNSON: So far the modeling work we are doing is, well isn't very far along, I should mention this, but when it is done its purpose will be to allow people to play games with the model, as is done in war or business games. The model won't tell us what to do; what it will tell us is, within hopefully a reasonable degree of accuracy, given a certain population pattern, given a certain industrial base, and given certain known natural resources or purchasable resources, we will have, as the years progress, a certain need for these resources. There will be a certain point at which we will run out of resources, for instance the availibility of water, and we would expect the population and its particular distribution to create so much pollution of some eight different kinds, and we would expect it to produce so many problems that we call conflict in nature, such as crime, legal problems, and medical and mental problems. We feel that a good model can predict what the levels of these things are going to be, and therefore, one might say, the level of our discomfort. A good model should also tell us that after we have paid for the counter-measures against crime and disease and pollution, we should have so much money left, and this tells us what could be left to buy the goodies, meaning swimming pools, baseball fields, green belts and art museums and other humanities that we don't have to have to survive, but that we need to live.

COLORADO ENGINEERS: When you are gathering up data to construct the model, where do you obtain most of your data? How much of it is approximations?

DR. JOHNSON: Most of it is rather approximate. We don't have a lot of data yet because we are still busy building the logic of the model. Model building of this type suggests that you try to logically relate cause and effect in a theoretical way. Then, having related these things, you wish to verify the model with real data. Now, what are the real data? Well, obviously we need to know something about the population and its distribution. O.K., this tells us something about where to go. For one thing we can go to the country or the city offices, or the state, depending on the size of the political or geographical subdivision we are considering. If we don't quite know where to go, we would search out a good demographer within the department of sociology or geography and discuss with him how to get the data. Among the resources, we need, obviously, water to survive. How do we know how much water there is? Well, there's a department somewhere that worries about water, or else its the water company itself, and they have statistics on availability of water over many years – not only the availibility for a year, but the average flow of the stream, the peak flows, the minimum flow one might expect – so we would go to the water company to get this information. In another class, we've already correlated some population figures and use of water – how much water each person uses – we can get from each large industrial concern the amount of water they use. The same thing may be said for power. The power company has statistics over the year as to how much power is used by the community. If we subtract out the amount of power used by the large industries, which we can find out, then we can divide the rest of the power by the number of people and we can get some idea of the average use of power and how it is increasing. Gasoline, presumably, we can find out from the gasoline tax collectors, and so on. In other words, there is no one place for the information, and, in most cases there is no mathmatical model yet that says how much is used as a function of the population or industry or other things, so we still have to devise the various submodels that fit into the overall program.

COLORADO ENGINEER: In other words, your program is directed towards community advanced planning?

DR. JOHNSON: Yes, that's right. We hope to take the past figures to fit coefficients into the model, and then use this with projected population or supposed addition of the industry or business to predict what will happen in the future, based upon extrapolations of given trends, and recognizing that any time one extrapolates a mathmatical relationship, the further he extrapolates it, the more uncertainty there is in the answers.



COLORADO ENGINEER: How do you feel about suburbs and their supposed lack of advanced planning?

DR. JOHNSON: First, of the various forms of pollution, the most difficult to pin down is one called aesthetic pollution. What one person happens to like, somebody else will consider to be rather bad; for example, there are houses in this community, houses by the hundred, if not by the thousands, that I wouldn't be caught dead in (I wouldn't be caught living in them either). I think they're ghastly exhibits of non-architecture and they just shouldn't be allowed to exist, but they do. This is bad enough, and there isn't an awful lot one can do to improve the aesthetic feeling people might have. Things are made worse by zoning variances which allow far too many filling stations and little business establishments to appear in the midst of otherwise rather decent housing areas. I don't know how to solve this exactly, except to get tough home zoning.

COLORADO ENGINEER: What is the relevance, or effect, of the aesthetic surroundings on the population?

DR. JOHNSON: Probably, the only effect it has is that as you look around, you don't see anything attractive to look at. This bothers me because the setting of this town is beautiful, and it's a shame that we are ruining with man-made monstrosities what would otherwise be an extremely beautiful place. Now this is my idea on the aesthetics. Obviously, as I mentioned, these houses that I feel are monstrosities are selling, and they're selling for high prices, so somebody must like them; I've met some of the people who live in some of these monsters, and the people are very nice, so it's a difference in taste. I came here from a community where we had an art jury, There was no house that could even be painted without the approval of the art jury, and the result was the most beautiful community I've ever seen. It created a little more uniformity then one would like, but it sure kept the monstrosities out. Communities can be done this way.

COLORADO ENGINEER: How can the engineer, along with his colleagues and their backgrounds, be of use in community planning?

DR. JOHNSON: First, and this is my big hang-up I suppose, I believe that a community consists of several spheres of influence. Everybody lives within hardware, which is engineering, they live with a certain economic base, they have certain relationships with their neighbors, which is sociology and political science, and being mammals and living in a living world we have a biological sphere, or ecological sphere within which we live. Any change that is made, for example construction of a highway, is likely to affect any or all these things. A highway is an engineering project. It obviously takes money, it may divide a community, it requires political decisions, and can effect the ecology of the area, among other things. A plan for any development like this, whether it be a highway, a housing development, a new school, whatever it is, needs to take into account all of these factors, and our problem is that in the past we have not. In general, the two factors that have been considered, for example, within the housing development, have been pretty much the engineering of it, the building of it in other words, and the financing of it, the economics. The social, political, and biological factors have been pretty much neglected. Part of this is due to the fact that the inter-relationships are extremely complicated, and part of it is due to the fact that even when people wanted to relate to each other, they spoke different languages – the language of the economist the political scientist, and the biologists are somewhat different, and nobody seems to be able to understand the engineers. Our feeling is that the one language which we can all learn to speak, with varying degrees of fluency, is mathmatics. The one tool which is available to handle complicated mathmatical relationships is the computer. So, modeling and simulation are, in my opinion, the only way that we can work on future community planning. This is not easy, the models are difficult, many of them as yet unformulated, many of the little tiny boxes in a flow diagram will require one or more doctoral theses just to fill in the information, and yet, if we are to do an effective job of future planning of a community (a community being anything from a small town to the whole globe) we're going to have to go to these computerized models. One reason we say that they are going to have to learn the techniques of engineering is that the engineers are ahead of the rest of these people in terms of computer usage, partly because we have been more mathmatical, and partly because engineering problems have been a little easier to formulate, a little more exact then sociological or biological problems. We have to recognize that in those sciences we are not going to have exact solutions because we cannot have exact measurements and living things have a tendency to do unpredictable things at times. Still, it seems to me that we've got to put together the whole business of community planning on a simulation basis, play games with it – remember it doesn't cost anything except some money to do this. You can put through a highway on the computer, and you haven't hurt anybody; you've spent a few hundred dollars, but maybe you found out that to put this highway there would be totally disastrous whereas another location you had not previously thought of might turn out to be very satisfactory.

COLORADO ENGINEER: How do you go about convincing the "average" citizen of a community that this computer modeling is not so inaccurate as they might think it to be? → → 18

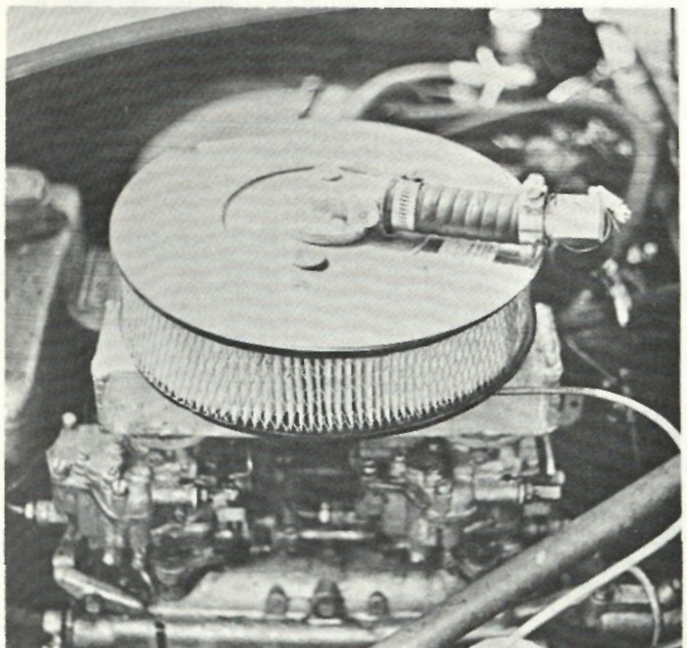
Clean Air Car Race

EDITORS NOTE:Steve Boulter (Shown with car on top picture) is presently building a steam car based on plans drawn up by Richard Smith, California Steam Car Design. Anyone interested in working on this project may contact Steve at ex. 6994 or leave word in the COLORADO ENGINEER office.

Once again MIT and CIT are found on the freeways, this time sponsoring the second transcontinental car race. The first of these events took place in 1968 in which the enterprising CIT students challenged the ingenious MIT students to race in their wonderful electric cars across the United States. The winner of that wacky race was the CIT car holding the lead with 30 minutes, not bad once one considers all the problems that arose.

That race set the pace for the most recent transcontinental Clean Air Car Race (CACR). This time universities across the nation are entering and they are using all types of power sources, the main object being emissions control instead of speed.

To win one had to qualify in many fields and have the best formula combination. The winning formula called for the performance, tested in Cambridge, to be added to the elapsed time which was then multiplied by the emissions factor. The tests in Cambridge, given by Ford, General Motors and NAPCA, tested the braking, acceleration, noise level, and emissions. The emissions were tested three times during the race once at Cambridge, again at Ann Arbor, and lastly Pasadena. The emission factor is the actual tested emissions of the car divided by the federal government standards for the 1975 cars. If any of the cars could surpass these standards the car was given a bonus.



The race was set to cover the major freeways of the United States and come to a total distance of 3600 miles. Starting in Cambridge, Massachusetts, the race proceeded to Toronto (541mi.), then on to Ann Arbor (243 mi.) From the testing in Ann Arbor the race progressed to Champaign (403 mi.) to Oklahoma City (668 mi.), to Odessa, Texas (565 mi.) on to Tuscon, Arizona (605 mi.), and finally to Pasadena, California (537 mi.)

The cars themselves were allowed two crews. The technical crew and the driving crew. It was the technical crew's problem to build the car before the race, and the driver's job to drive the car across the country and fix anything that went wrong. The only requirement on the drivers was that they had to have been enrolled in a university the semester before the race.

In every car there was also a little man with a book scribbling furiously–the race official. The officials kept track of everything that happened to the cars during the race and made sure that all major work done to the car was done in the service areas by the driving crew. Although the technical crew could advise the drivers, they personally were prevented from any actual work on the car once the race began. Among some of the penalty rules were ones causing a time penalty for all towing done to the car, such as to the areas designated for repairs. This towing in several instances caused position of the cars to change.

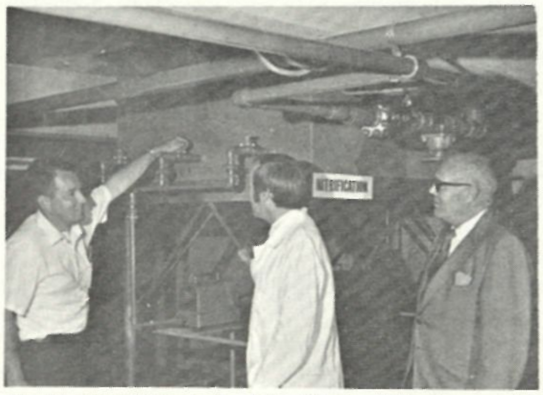
The cars in order to maintain an order of fairness were divided into five categories as to engine power. The Rankine cycle, basically a heat engine, and external combustion, consisting of the source a piston or turbine and the condenser. The second was the Brayton cycle, technically a thermodynamic cycle composed of adiabotic and isorbaric changes in alternate order as seen most often in the gas turbines. The third is the electric with the cars having to find recharges at the service areas instead of from another engine in the car. The Electric hybrid is the one that has either the second engine for power or to recharge itself. And last but by all means not the least is the internal combustion engine, in which the ignition

(Continued on page 18)

INDUSTRIAL WATER

Where Willl It Come From?

Presently both the industrial and urban communities of Denver have been using potable water, which is acquired by trans-mountain diversion. With the prediction of an increase of industrial development and a rise in population in the Denver Metropolitan area, the City of Denver faces the problem of an inadequate water supply. An expansion of the trans-mountain diversion for potable water would be very costly and construction would be very time consuming. Therefore the idea of renovation of wastewater for direct reuse applications has recently become of great interest to the Denver Water Board.



Dr. K. Daniel Linstedt of the Civil and Environmental Engineering Department illustrates operation of the main nitrification unit for Richard Heaton, Water Board researcher, and M.E. Barber, Chief of Operations for the Denver Board of Water Commissioners.

One such method for the successive use of water is presently being tested in Denver by a pilot water purification plant developed by the Denver Board of Water Commissioners in conjunction with a research project being directed by Professors K.D. Linstedt and E.R. Bennet of the University of Colorado Department of Civil and Environmental Engineering. The pilot plant is designed to treat wastewater effluent from the Metro Denver Sewage Treatment Plant and produce water of sufficiently high quality to be used in large-volume industrial operation. If the pilot plant is successful and a much larger plant is constructed it would supply useful water to Denver's factories thus freeing an equal amount of potable water for urban Denver.

The pilot plant will use three basic stages in the treatment of the water. The first and most revolutionary is the use of living bacterial nitrifiers to convert the ammonia in the effluent into nitrates. Ammonia in sewage effluent is sufficiently corrosive that it must be removed from water intended for industrial use.

With the ammonia removed, the effluent passes into a slurry tank, where lime or alum is added to precipitate the

Ready to put the plant on stream are Kenneth J. Miller, sanitary engineer for the Denver Board of Water Commissioners; Benjamin Harding, C.U. engineering senior; James L. Ogilvie, Water Board Manager; Richard Heaton, Board researcher; Dr. Edwin R. Bennett and Dr. K. Daniel Linstedt, Civil and Environmental Engineering Department professors; and M.E. Barber, Chief of Operations for the Board.

phosphates. In a full-scale operation, the settled solids would be heat-treated to recover the lime for reuse.

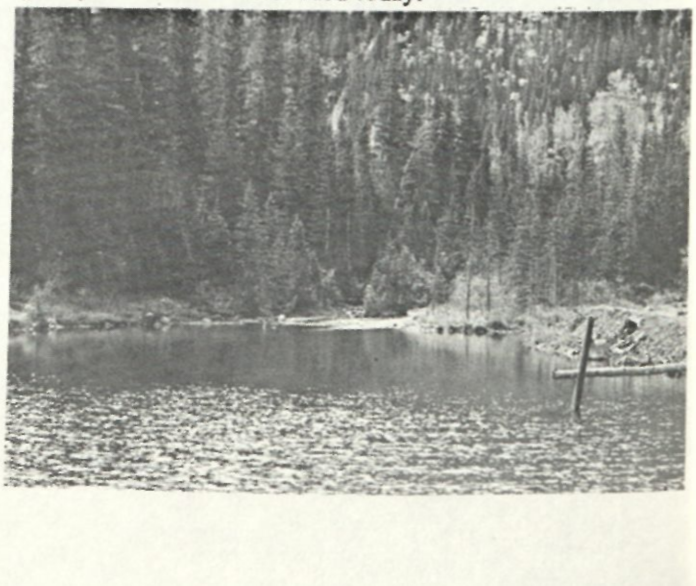
Finally, the water which remains is treated with carbon dioxide to remove its alkilinity; it is filtered, chlorine is added to destroy microorganisms, and the water is ready for use in industry.

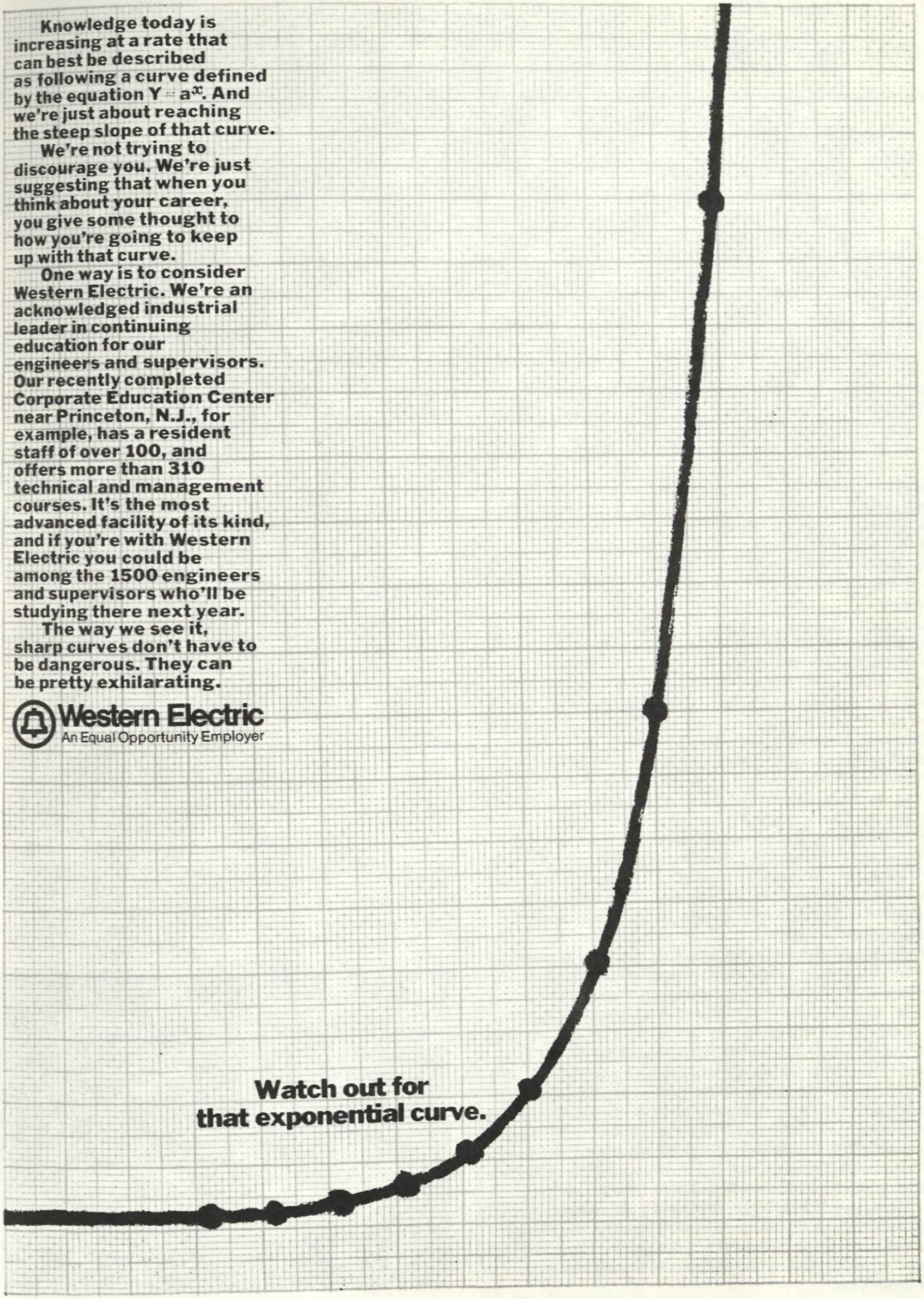
Presently the pilot plant only produces five gallons of industrial use water per minute which is used for testing. If the tests prove positive then it is assumed that Denver will build a larger plant capable of producing ten million gallons of water a day.

Although washing operations, irrigation, and home use are not recommended for this water, methods similar to those which ordinarily purify water taken from today's contaminated rivers could be used to make this water more useful to the general public.

Professors Bennett and Linstedt have conducted some research at the University of Colorado on the problems encountered in this type of operation. It probably would require removing traces of organic constituents and inorganic contaminants such as chromium and arsenic, which water picks up in passage through Colorado's streams and Denver's industries. Though present only in very minute quantities, it is necessary to remove such elements so as to assure the usefulness of the water

The development of this pilot plant has given the Denver Water Board a cheaper and more productive way of supplying useful water for industry. In addition there is the possibility that successive use water may someday be renovated to a **quality better than water used today.**




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.
One way is to consider Western Electric. We're an acknowledged industrial leader in continuing education for our engineers and supervisors. Our recently completed Corporate Education Center near Princeton, N.J., for example, has a resident staff of over 100, and offers more than 310 technical and management courses. It's the most advanced facility of its kind, and if you're with Western Electric you could be among the 1500 engineers and supervisors who'll be studying there next year.
The way we see it, sharp curves don't have to be dangerous. They can be pretty exhilarating.
Western Electric
An Equal Opportunity Employer
Watch out for
that exponential curve.

R. C. Johnson

14 →→→

DR. JOHNSON: For one thing, you try to put into your city government people that understand this kind of thing. For example, our present mayor is an atmospheric scientist. He has participated in many inter-disciplinary seminars, he's obviously a man who understands this kind of thing. We have talked to some of the people in the city planning department, and we've realized that other people we have talked to, in general sharp young men who understood this kind of thing told us some of the pit falls – they had already investigated some of these things. The big problem is that for this good example we can probably come up with a hundred communities who have something close to absolute dolts running them. While they might be nice gentlemen to go fishing with, they're not the people that should be planning communities. This is where the problem lies. As an educator, we are continually trying to find ways to reach the people who are not going to have an interest in being professional mathmaticians, engineers, or planners.

of the fuel propells the pistons causing a transmission of the energy to the wheels. Of this last group of 32 cars thirteen were propane powered, six used the unleaded gas, four using more than one fuel and 6 using natural gas. The final entry used diesel fuel. Most of these cars were modifications of the existing cars and existing propellants.

Heading the group representing CU's entry is Steve Boulter, a Junior in EE. He and his crew worked parts of the summer on the Sunbeam Alpine that they converted into a propane burning car. The actual system consists of the propane tank, a heat exchanger, and the propane carburator. The fuel flowing via a system of check valves leaves the tank and passes through the tubing into the heat exchanger. The tank is mounted in the trunk. Here, powered by the hot water from the engine, the propane is converted into gaseous form and propelled by pressure into the mixer.

The propane carburator mixes the air with the propane gas in the correct proportions which is thenpassed into the regular carburator. To run on propane the regular gas is shut off, but regular throttle and chokes still control the speed. This car was designed to use either regular gas or run on the propane mixture by simply cutting off the supply of one or the other.

After the setup for the propane further adjustments were made to the car to aid in further cutting the emissions. The spark gap is closed by 4 degrees on both sides to reduce the presence of hydrocarbins and the compression ratio is lowered if possible. The carb is then set for the minimum feedthrough of Nitrous oxides. The final and most expensive part is then found just off the exhaust manifold. A small tube 4" in diameter and 12" long with a coating of a platinum compound that raises the temperature of the exhaust gases to reburn them eliminating the exhausted hydrocarbins. These mufflers found on indoor fork lifts cost about $180 each and estimated life is one year.

Steve has future plans for someone to take over and work on the next race. The idea is one of powerment by a steam engine and drive by hydrostatic drive lines. He bases his prediction on the idea that the steam car will come then go again in the next 10 years.

Don't get the idea though that only these boys are working on ideas to better the situation of our environment. In 1966 the California cars had exhaust emission control on their cars and in 1968 the whole of the United States had it. Then in 1970 California again went another step by cutting fuel evaporation from the gas tank and carburators. 1971 will see many cars running on unleaded gas with a predicted 90% of the 1971 cars on it. In 1973, exhaust recirculation will come into existence and possibly catylitic mufflers cheap enough for the average car, and before the end of the '70's most of our car emission problems are speculated to be solved.

FEEDBACK

Reflections 20

EDITORS NOTE: Feedback will be a regularly featured column of criticism, complaints, praise, and opinion of our readers and staff.

Many things should be. But aren't. Engineering responsibility should be. Engineers have an understood responsibility to the society they serve. Understood by whom? Underestimated by many. Neglected. Isn't it unhappy?

Today the world dies. Dreams of breathing deep, soundless sleep, and trout; their reality is of today's talk and yesterday's thinking. Action? I

Action has died in a maze of preparation. Too much has been sacrificed to good intentions. When will one ever learn that only he can change the world? When will anyone care?

Every day I hear the echo of the engineers' prayer: "Eight hundred plus, per month, fringe benefits. . . I'll have it made. . . " They'll have it spent. Spent on golf, a Lincoln, a fifty thousand dollar hole to hide in so they won't have to face the responsibilities of their mistakes.

What I'm trying to say is, if you help build the "button," you are also responsible when it goes off; whether someone else would have been there to take your place or not. When you design a power plant knowing that it may very well pollute your neighbors' river, it's not just too bad, it's your disaster area. Think about it!

There is a responsibility that you impose upon yourself when you decide to educate that head of yours. A responsibility that says you will learn every parameter associated with whatever device you decide to develop. A responsibility that says you will respect the rights of your brother.

So, learn if you want to. Learn if you think you can do some good. It's needed. Have faith. The money that's needed will come–there may even be a way without it. Some say money is god, and god is dead; so man, don't sell out for money.

Think about the thing you develop; judge its worth fairly. Then do whatever you understand to be right with whatever thing you can "get into" doing: D.D.T. . . A.B.M. . . R.C.A. . . L.S.D. . . .

James R. Mateyka

Educated Barbarian

It is ironic that many of us today, as engineers, get a diploma for four years of admittedly difficult technical work without having the faintest notion of what a "liberal education" is, in its broadest sense.

We, as engineers, must give an honest damn about the war, pollution, and social problems. If we do not, we fit the description of the "Educated Barbarians," as J. P. Getty refers to strict technical men. The job *and responsibility* of tomorrow's engineer will be not only to tell it like it is, *but also tell it as it should be.*

The future engineer must have maturity of thought and a sense of responsibility to man rather than sheer infantile devotion to a myriad collection of objective facts, no matter what the consequences. To do this, we must become *aware* engineers and rid ourselves of "pride" in being ignorant of the arts. We must study the concepts of Marxism-Leninism and all the other great social issues of our times since, if we ignore them, we run the risk of being future dupes–like Nazi scientists available (and quite willing) to create the whims of a madman. We must be truly educated in all aspects of social problems since–when all the shouting is over– *it will be up to us*, with our unique ability to maneuver science, to clear the smog, create the pollution-free engine and, in short, to use our knowledge to *help* mankind, not to threaten him.

It is our duty to be aware of the times, to place self-introspection on an equal level with scientific discovery, lest we fit the classic phrase of "Big science, little men."

Ron A. Fattor

Industrial News

What's New At CU

High school students who enroll as freshmen in the CU College of Engineering are immediately offered opportunities for experimentation in problems of environmental control. This year two freshmen working under the direction of acoustics specialist Robert Chanaud, for example, determined boom characteristics of the Boeing SST and boom strengths and annoyance levels in the Rocky Mountain front range region. The students' recommendations are framed in a proposal to the state legislature to control supersonic passenger overflights in the State of Colorado.

Problem-solving projects in transportation and low-cost housing by freshmen have resulted in recommendations for improving the CU campus busing system, and in a proposal to mass-produce 76 million new and rehabilitated homes, with suggestions for promoting public acceptance of a reformed building industry.

Realism on the part of educators at CU is further exemplified in the recent change in title of the School of Architecture to the College of Environmental Design. Architectural engineers trained in the College of Engineering may specialize in urban and regional planning as preparation for taking an active role in tomorrow's environmental design.

Interaction between university-level research and the control agencies of community, state and nation marks the beginning of what promises to be a life-or-death matter. As in other major universities across the country, teachers at CU are doing their best to prepare young people for the unprecedented challenge of cleaning up our air, our water, our cities, and, in fact, our way of life, during the short time that remains for action.

Chips

Then there was the Indian chief who installed electric lights in the tribal latrine, thus becoming the first Indian to wire a head for a reservation.

Then there was the Pollock who tried to beat the train to the crossing. He hit the seventy-sixth car.

Recent tests in the biology department prove that grasshoppers hear through their hind legs. When a tuning fork was placed near the grasshopper, it was found in all cases that the insect would hop. There was no reaction to this stimulus, however, when the insects legs were removed.

Puzzle Page

FS-1

```
      IEFB
DJFH)JBCCCDAJ
     JCBFI
      IJDBD
      IABHG
       GHEFA
       GIJHD
        FFFFJ
        FFFFJ
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FS-2

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    IHGFE
    GFHAD
   FJIIBE
  BIGJJF
 EFJFED
EBEBDI
CIHGFE
GGGBEFJHJE
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FS-3

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         CEGIF
EJFAH)FJHIGBADGE
      FDAJJC
       FDCCCA
       DHJBAI
        EFEIID
        JIGEBJ
         JCEHIG
         JEADJA
          IACJE
          IACJE
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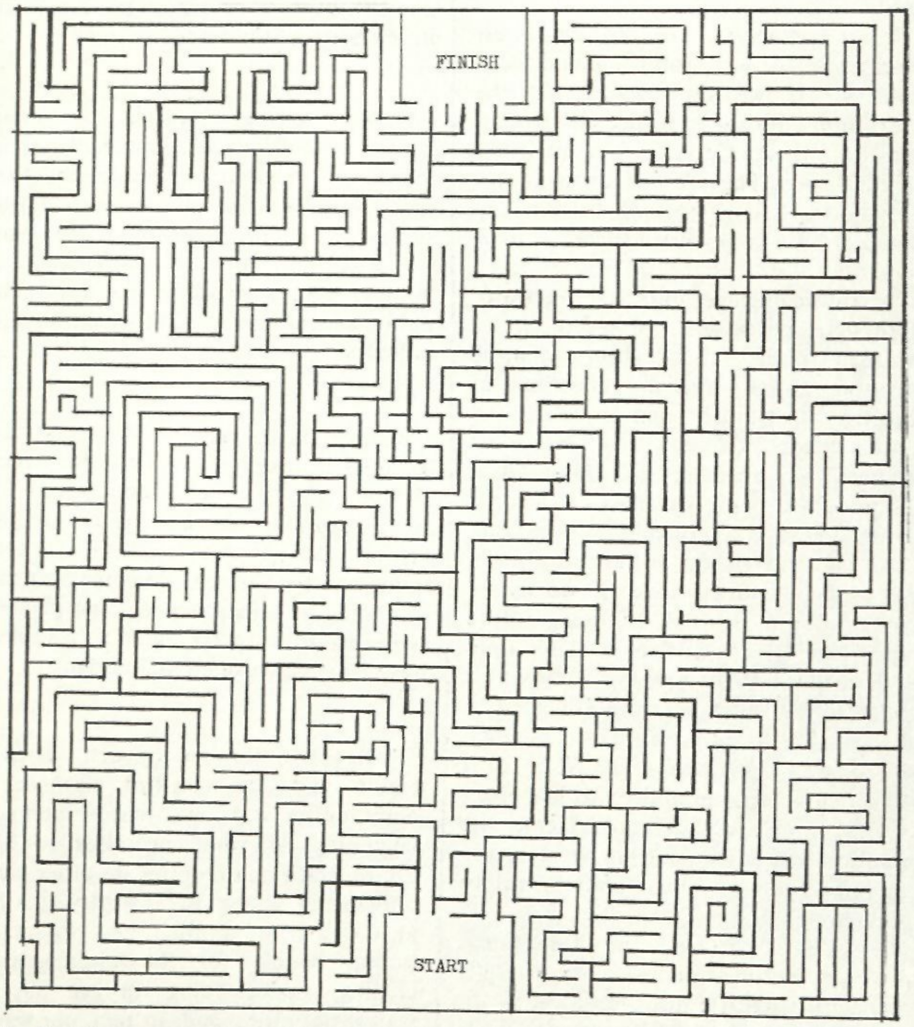

The first 4 correct entries to FS–1, FS-2, FS-3 will receive a six pack of beer. The letters stand for numbers and the letters do not represent the same numbers in different problems. All entries must be sent by U.S. Mail to the Colorado Engineer Office, Engineering Center, OT1–7.

Three Indian squaws of the Al-jabr tribe were seated in their wigwams with their families. One, seated on a deer hide, had one child. The second, seated on an elk hide, also had one child. The third seated on a hippopotamus hide, had twins.

That proved that the squaw of the hippopotamus was equal to the sum of the squaws of the other two hides.

Little Johnny walked to the blackboard of his third grade class and did a difficult problem for the rest of the boys and girls. First he added two and three, then multiplied that by four, then added five. Upon doing the operations correctly, the teacher commented, "That's pretty good, Johnny."

To which he replied, "Pretty good? Hell, that's perfect!"

Ted Sandel and his date drive due North at an average speed of 45 m.p.h. for 1 hour. Mike Popa and his date start from the point 10 minutes later and drive SSE for 27 minutes at an average speed of 20 m.p.h. At the end of two hours Mike Popa has gotten further than Ted Sandel. Explain.

A tourist was introduced at Albuquerque to an Indian with a reputedly perfect memory. Skeptical, the tourist asked: "What did you have for breakfast on October 4, 1913?" The Indian answered, "Eggs." The man scoffed. "Everyone eats eggs for breakfast. He's a fraud."

Eight years later the traveler's train stopped again in Albuquerque, and he saw the same Indian lounging on the platform. The tourist went up to him and said jovially, "How!"

The Indian answered, "Scrambled."

At the Circus in Denver last summer a man was observed near the camels. He picked up a straw, placed it squarely on a camel's back and waited. Nothing happened. "Wrong straw," he muttered, and hurried off.

Not long ago, an upset citizen nervously asked a prominent astronomer whether it was possible for the atomic bomb to destroy the earth.

"Suppose it does," said the scientist with a casual shrug. "It isn't as if the earth were a major planet."

"Do you believe in clubs for women?" a friend asked W.C. Fields.

"Yes," replied Fields, "if every other form of persuasion fails."