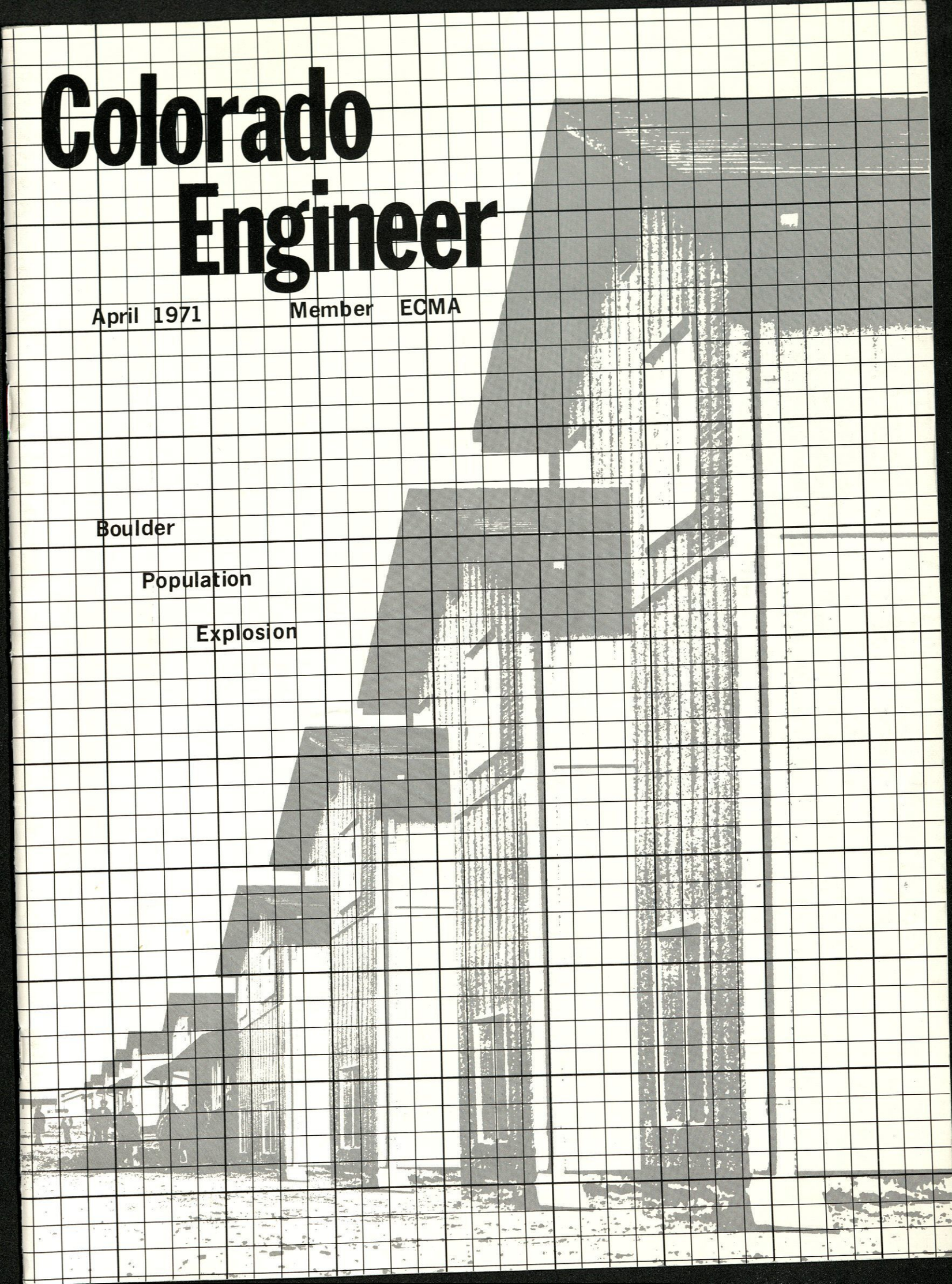
Colorado Engineer

April 1971 Member ECMA



Boulder

Population

Explosion

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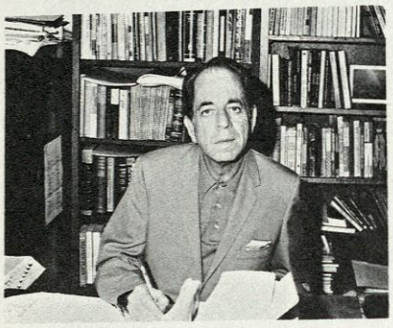
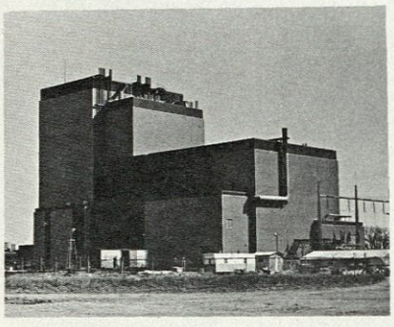
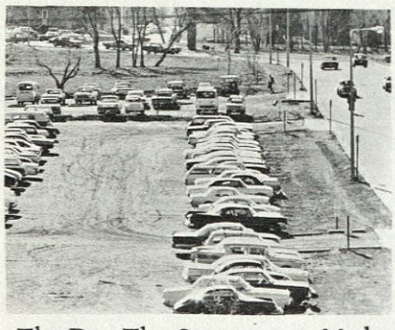
A Future New York? page 6



Prof's Corner page 9



Power Hungry? see page 12



The Day The Campus was Made Livable see page 12

Colorado Engineer

COLLEGE OF ENGINEERING • UNIVERSITY OF COLORADO

VOLUME SIXTY SEVEN • NUMBER 4 • APRIL 1971

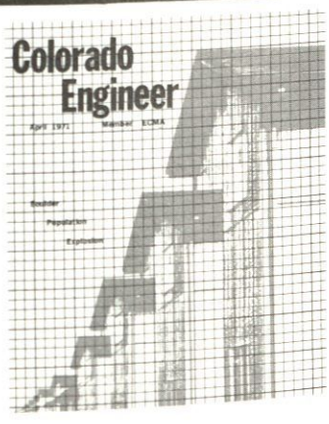
MEMBER ECMA

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. Entered as second-class matter March 9 1916, at the Post Office at Boulder, Colorado, under the Act of March 3, 1879. Subscriptions: Controlled free distribution to undergraduate students in the College of Engineering: Otherwise $2.00 per year. $5.00 for three years.
General Office: Engineering Center, OT1-7, University of Colorado, Boulder, Colorado, Publishers Representative—Littell-Murray-Barnhill, Inc., 369 Lexington Avenue, New York 17, N.Y., and 737 North Michigan Avenue, Cnicago 11, Illinois ....

ABOUT THE COVER: This month's cover by Bill McNair depicts the correlation between the population explosion and the unchecked suburban sprawl now taking place in the greater Boulder-Denver area.



From the Editors' Desk

CARL T. NEWMAN
Editor-in-Chief
1970 - 1971

We stand on the threshold of a new Renaissance – or a new Dark Ages – depending on our viewpoint as men of science towards the world. Today we see engineering being related to such areas as philosophy, theology, law, and sociology. While the COLORADO ENGINEER will remain a magazine for engineers, it will most definitely not be a strict technical journal. In keeping with the idea that the engineer of tomorrow must be a man of personal judgement, social maturity, and true concern, we will print articles dealing with the technology of the future, as well as the present. We plan to print articles of social interest, as well as comments from the faculty. Under the leadership of Carl T. Newman, this year's COLORADO ENGINEER has vaulted into a new high position of literary and social achievement. This is a position we intend to keep and expand. We will be No. 1 and *still try harder!* I hope you, as readers, will make use of the feedback column to express your opinions. On my own behalf, and that of the staff I can assure you that we will try to the utmost to make the COLORADO ENGINEER the finest in its class – and I am sure we will succeed in this endeavor.

Ron Fattor

The COLORADO ENGINEER at the beginning of the year had a depressing reputation to live with due to past editorial management failures. This year Carl Newman and the staff of the ENGINEER have laid a foundation of sound managerial policy that future staffs will benefit from. This policy foundation does not only benefit the staff members in direct ways but also benefits in the fact that it will release the ability to publish a magazine that the College of Engineering will be proud to let use its name.

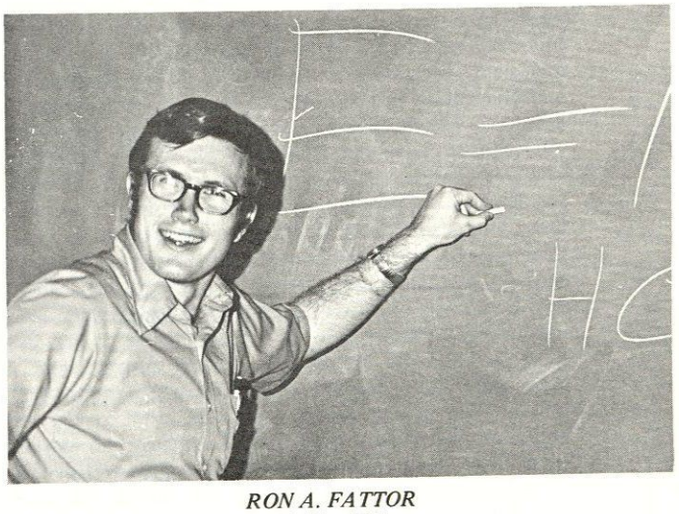
Next year looks to be even better for the COLORADO ENGINEER. With the addition of new staff members, applications for positions on the staff are available in the ENGINEER office ECOT 1-7, the COLORADO ENGINEER will become an asset to the students and faculty of the College of Engineering.

Charles B. Shepard

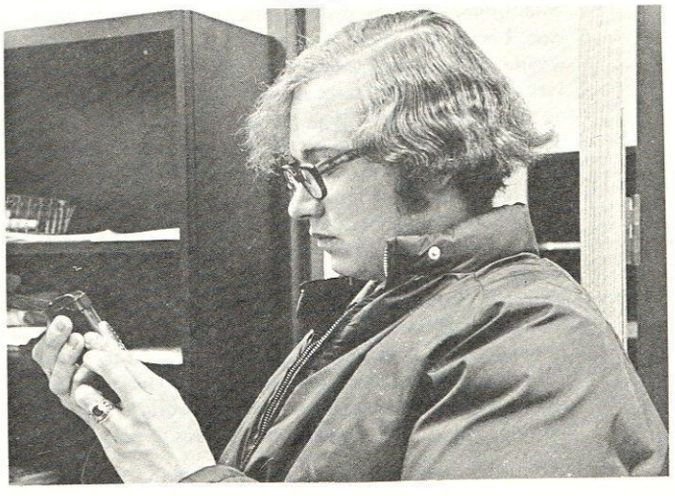
As the end of the year approaches I would like to take the time to formally thank this year's COLORADO ENGINEER staff. The whole staff have given themselves in a continuing effort to make the COLORADO ENGINEER better. In particular I would like to mention Fred Sprague and Bill McNair for having spent much more time than normally would be expected in an effort to achieve perfection. To the whole staff – Thank You for having made the COLORADO ENGINEER what it is today.

It is also with great pleasure that I turn the future of the magazine over to two of the most capable minds and sets of hands on the magazine – Ron Fattor and Charlie Shepard. To Ron and Charlie GOOD LUCK.

Carl T. Newman



RON A. FATTOR
Publishing Editor
1971-1972



CHARLES B. SHEPARD
Managing Editor
1971-1972

Dean's Column

An Optimistic View of the Future for Engineering and CU Engineers

As I hear more and more discussion by informed and uninformed people on the problems confronting our modern society, I become doubly convinced that we are now in an era where the engineer and scientist may be the only person who can really save our world. Because I am interested in saving our world, I am delighted that I, many years ago, decided to become an engineer. Instead of merely smiling when you read the two preceding sentences, I wish you would give them some serious consideration, especially if you are an engineering student at the University of Colorado. I really become very concerned when I go to public meetings and find people with no technical background at all expounding about the insurmountable problems of pollution in our world and how the world is doomed. Fortunately, the person who has prepared himself or herself to provide some real solutions is usually at one of these meetings and can stand up and point out that, while technology and science may have gotten us into some of our problems, if we will merely think positively, we can make certain that technology and science also will get us out of these problems. This is our challenge for the future.

As graduates in engineering from the University of Colorado, most of you will be going into important positions where you are going to be able to make contributions to solving the problems of our society. Because of the fact that life has become somewhat more realistic this year and jobs are not as plentiful for engineers as before, combined with the fact that there have been cutbacks in some of the aerospace and government-supported research industries with resultant lay-offs of chemists, physicists, mathematicians, and some engineers, there have been reports that engineers are no longer in demand. This is not true. We have repeatedly during the past 25 years run in cycles of a slight oversupply resulting in adverse publicity and people suddenly deciding not to go into the technical fields, with the result that four to eight years later there is a definite undersupply. At the present time, our Bachelor's degree students are in considerable demand. Admittedly, they may not receive four or five offers like they did several years ago, but they are still receiving offers if they are willing to go out and look for a job, and the offers are appropriate for the major efforts expended to get an engineering education. The same holds true for our Master's degree students. On the Ph.D. level, some of our engineering students are having to look quite hard for a satisfactory job, but nevertheless they are getting positions that are acceptable.

I do wonder why the newspapers and other public information groups make such a fuss about the fact that suddenly engineers do not have a completely free choice of as many jobs as they want. Instead, now engineers must meet real life and look around for a better job, but in general our students from CU, and especially the better students, are finding them without encountering major problems. I wonder if this same thing can be said for the arts and science graduates. In any case, I am very optimistic about the future demand for engineers. As long as we continue to give a real education to our engineering students, they are going to remain in demand by industry. The only concern I have is the tendency in some areas of the United States to start reducing the undergraduate programs to be exactly the equivalent of arts and science programs in numbers of hours and depth of coverage. Such programs cannot provide the kind of an engineer who is in demand by industry, and it cannot provide the kind of an engineer who can do the necessary technical work as well as have the required humanities and social science background to fit into modern society. At the University of Colorado, it is this kind of technical and broadening program we are giving our students.

I feel we are putting out a fine product from our Engineering College, and this is the primary reason our students are remaining in demand. I assure you that all of us on the faculty and staff of the College of Engineering are going to continue to try to maintain the standards of quality which currently exist in our undergraduate and graduate programs. The budgetary squeeze is hitting all of us, but again, we must admit that this is real life and such problems are to be expected. Because we are dedicated to solving problems, I assure you we will make every effort to solve the budgetary problems and come up with a program that continues to meet the real needs for engineering education.

I wish all of our graduating seniors in engineering the best of success. We think we have given you a background which will now permit you to move into the world at large with a responsibility and opportunity to use your intelligence and education to provide appropriate solutions to the problems you will encounter.

Max S. Peters

Max S. Peters
Dean

"He Measures Up"

When our recruiter says, "He measures up."
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Two questions he asks . . . .

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What has He done?
His . . . .
Goals; Accomplishments; Originality; Forceful Action; Work Load; Activities; and Follow through?

. . . . and begets the answers.

When the answers are impressive, he says, "He's got it . . . . He measures up!"

This, then, is what campus interviews are all about.

Anonomyous

This ad courtesy of
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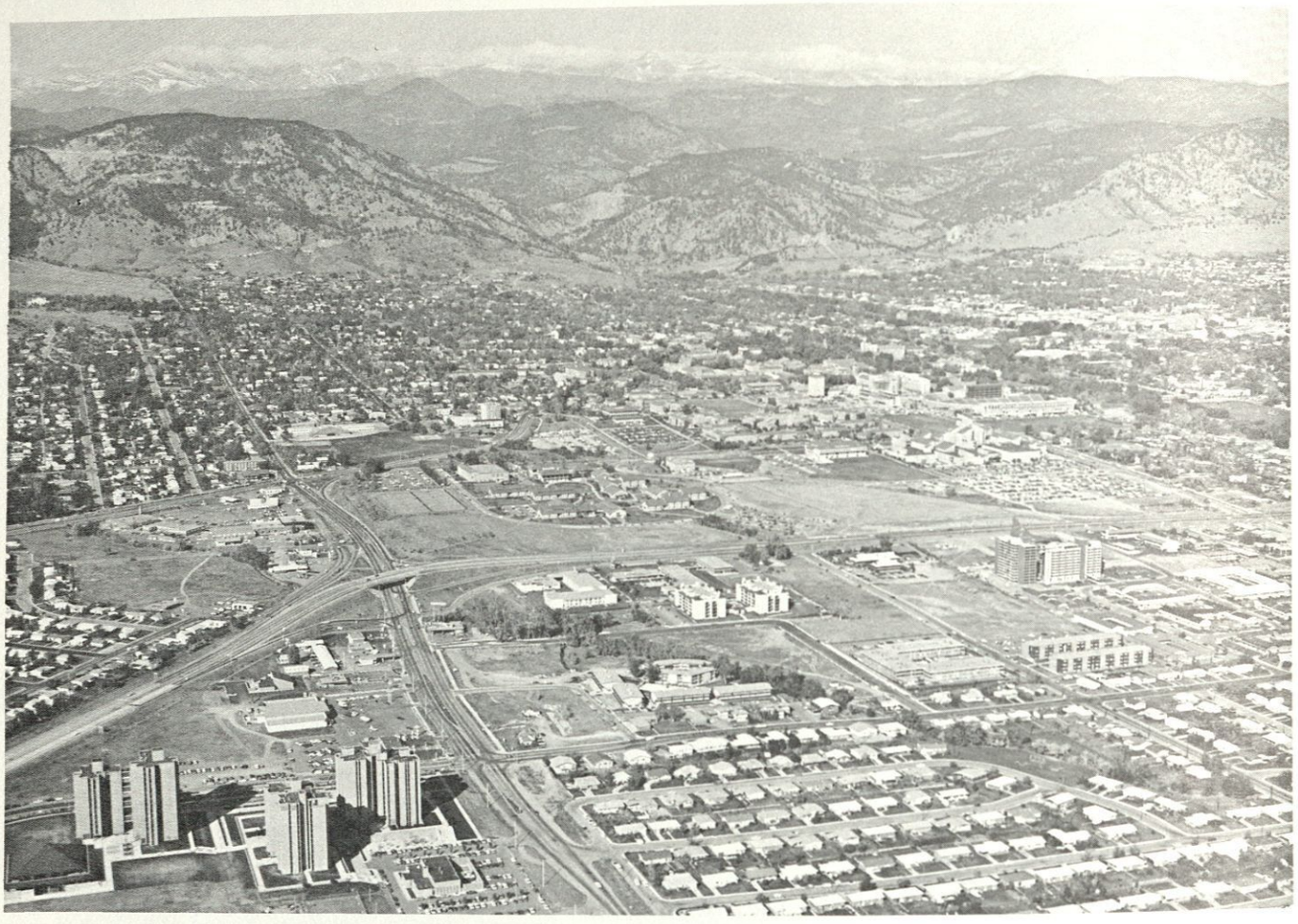
Boulder on the Exponential

By Jack Swan



Boulder population growth can be modeled in terms of a nonlinear differential equation with time-dependent coefficients. The growth process represented by this model is subject to the effects of varying birth and death rates and the effects of net migration. Migration for the Boulder community is then in turn subject to increases in the size of the business and industrial community.

The model of population growth investigated in this study represents an effort to come up with a working model for Boulder's population that can be adapted to computer analysis. Population growth is seemingly infinite in complexity, and therefore this report cannot hope to investigate even the majority of factors that influence growth. It is therefore hoped that by studying what has happened to Boulder's population and what is likely to happen to change that population, some meaningful projections can be examined.

There are essentially four factors that influence a change in the size of population. These are the births, deaths, immigrations, and emigrations that occur over any specified time interval. Since birth figures are most logically figured on a yearly basis, this model will use a time increment of one year. If the population is defined as p and births factor, deaths factor, immigrations, and emigrations are defined as B, D, I, and E respectively, the model for the change in population size is;

$$dp/dt = Bp - Dp + [I - E]$$

This model would work perfectly if the birth and death coefficients were constant and if you could predict the number of people coming to and leaving Boulder. Of course this is not quite possible.

Looking at table 2, it is seen that the birth rate in Colorado has varied from 26.9 to 17.5 births per 1000 inhabitants in the last twenty years. It is also apparent that the birth rate has dropped consistently over that same interval. There are many reasons for these fluctuations. The more prominent factors seem to be the growing use of birth control devices, the large number of young people that have migrated to this state, and perhaps the social conscienciousness of the population in general.

The death rate has also varied to a similar extent over this interval. This is of course due in large to the advances in medicine. It is interesting to note however, that the difference between the birth and death rates has remained essentially constant at about 11.0 per 1000 inhabitants per year. It would also seem reasonable to assume that this difference will remain fairly constant over the next several decades. Therefore, in most projections for this model the birth and death rates will be assumed to remain constant, and will have the values that are contained in table 4.

Since Boulder's population is obviously going to increase in the future, the emigration factor can be ignored and a net immigration factor must be developed.

Growth Curve

With ever larger national populations, higher income levels, more leisure time, earlier retirement, and greater ease of migration in the future, the influence of Boulder's environmental attractions should increase rather than diminish. Boulder's attractions include a near perfect combination of pleasant summers and mild winters, an aesthetic setting that can hardly be matched, and a low population density in and around Boulder. This area also offers locational advantages for most new or expanding industries [i.e. IBM] . The population of Boulder is also exceptionally fluid due in large to the University of Colorado, and fluid populations create more service employment than that required for a less fluid population of the same size.

Continued on page 18

Table 1
Boulder Population

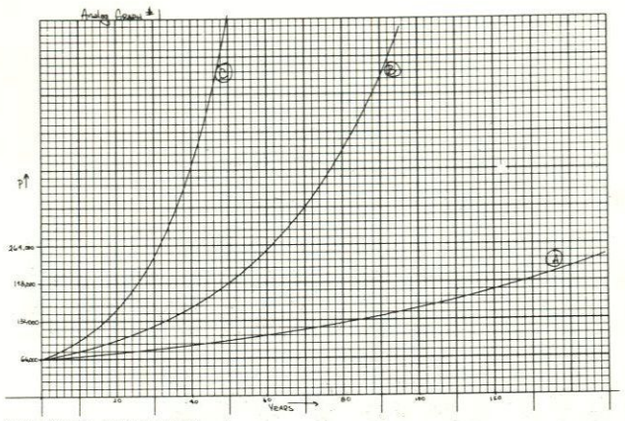
Year	Number	Increase	% Increase
1970	65,789	28,071	73.7
1960	37,718	17,719	88.6
1950	19,999	7,041	54.3
1940	12,958	1,735	15.5
1930	11,223	217	2.0
1920	11,006	1,467	15.4
1910	9,539	3,389	55.1
1900	6,150	2,820	84.7

Table 2
Colo. Birth Rate – Births/One Thousand People

1951--------26.9	1960--------24.5
1952--------26.9	1961--------24.3
1953--------26.0	1962--------23.2
1954--------25.6	1963--------22.0
1955--------25.2	1964--------20.9
1956--------25.1	1965--------18.9
1957--------24.4	1966--------17.7
1958--------24.8	1967--------17.5
1959--------24.3	1968--------18.0

Table 3
University of Colorado (Boulder Campus) Enrollment Growth

1941-------- 3,727	1956-------- 9,844
1942-------- 3,519	1957--------10,363
1943-------- 3,086	1958--------10,357
1944-------- 3,237	1959--------10,495
1945-------- 4,421	1960--------11,054
1946-------- 7,686	1961--------11,732
1947-------- 8,798	1962--------12,352
1948-------- 9,183	1963--------12,675
1949-------- 8,866	1964--------13,545
1950-------- 8,061	1965--------14,693
1951-------- 7,086	1966--------15,691
1952-------- 7,110	1967--------16,877
1953-------- 7,262	1968--------18,217
1954-------- 8,220	1969--------20,387
1955-------- 9,051	1970--------21,482



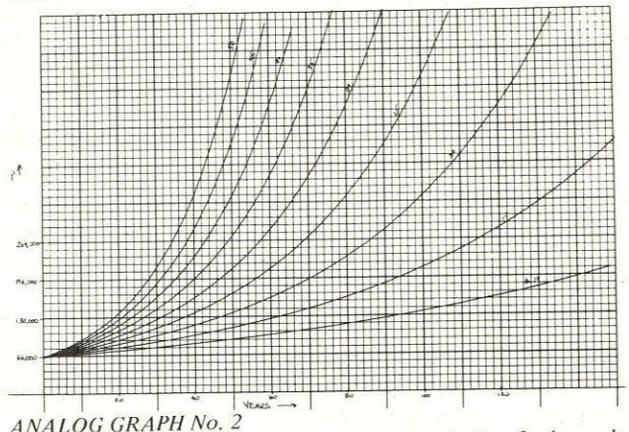
ANALOG GRAPH No. 1
Curve A represents no net migrations (i.e. BI and CU = 0.0). This is the growth curve that Boulder could expect if there were no net migrations.
Curve B represents a constant university population (i.e. CU = 0.0).
Curve C represents Boulder's growth if it continues at the rate that it experienced during the sixties.

Table 4
Boulder County Vital Statistics 1968 (latest figures)

Births/1000 inhabitants	Deaths/1000 inhabitants
18.5	7.0

Table 5
Boulder Population By Ages 1960

AGE	NUMBER	PERCENT
under 5	3,812	10.1
5-9	3,045	8.1
10-14	2,659	5.7
15-19	4,998	13.3
20-24	5,316	14.2
25-29	3,029	8.1
30-34	2,387	6.4
35-39	2,124	6.3
40-44	1,874	5.0
45-49	1,735	4.6
50-54	1,391	3.8
55-59	1,171	3.1
60-64	1,129	3.0
65-69	991	2.6
70-74	836	2.2
75-79	580	1.5
80-84	395	1.0
85 & over	246	0.6



ANALOG GRAPH No. 2
Since dp/dt = (B-D+CU+BI)p = Ap. Graph No. 2 shows how Boulder's population will increase depending on how B,D,CU,&BI vary. The curves range from A = 10.0 / 1000 inhabitants to A = 50.0 at 5.0 increments.

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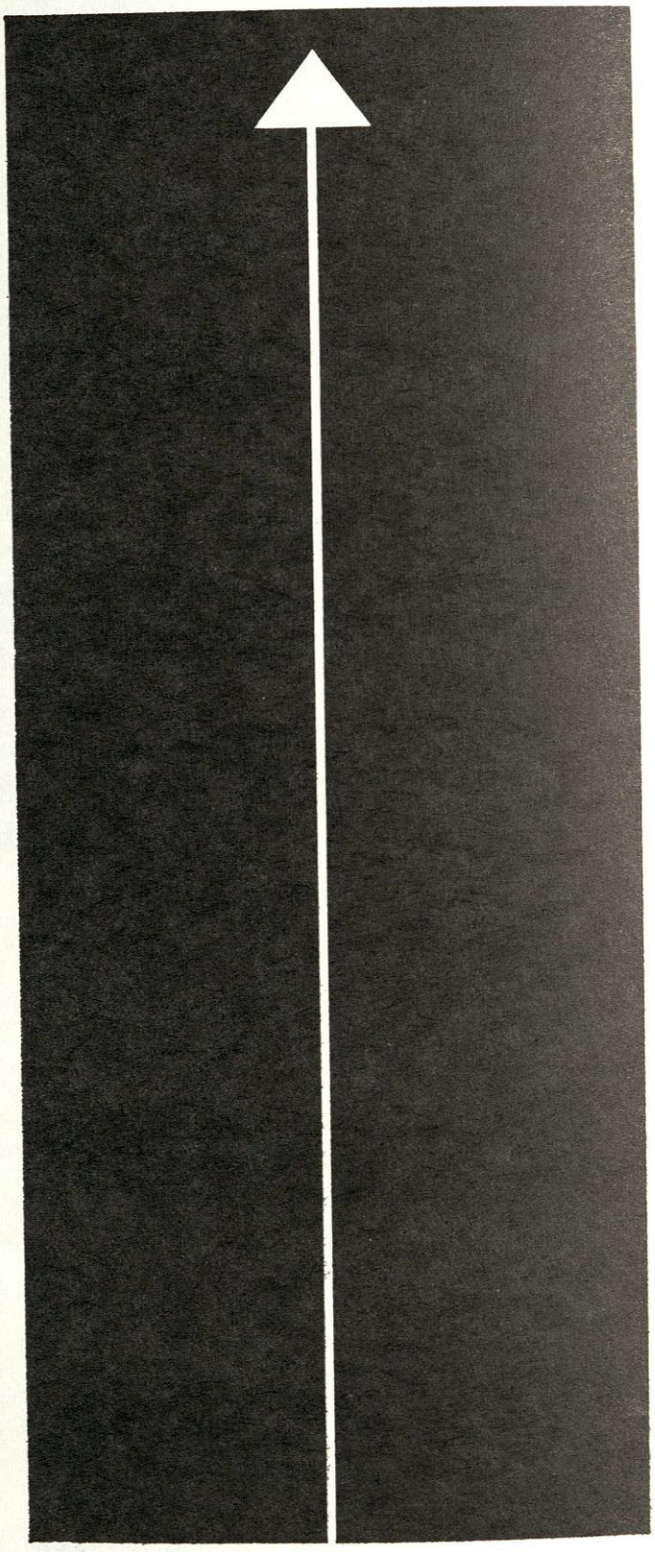

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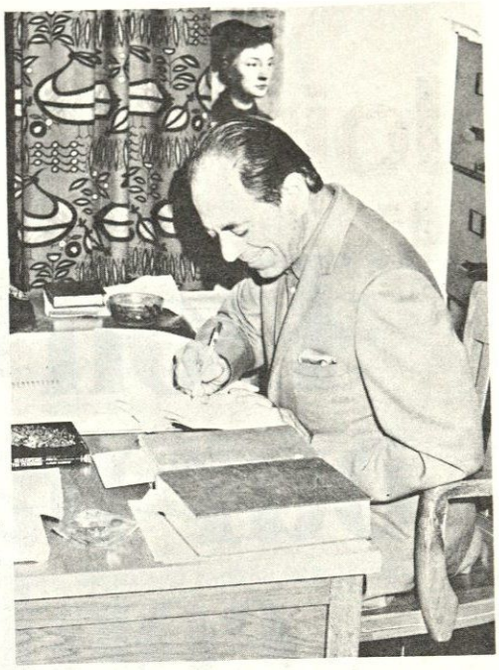
PROF'S CORNER

By William B. Markward



WILLIAM B. MARKWARD– *Professor of English and Comparative Literature*

In an age when many "learned" professors would rather do research than teach, Dr. William B. Markward is a refreshing iconoclast.

He has made the statement, "If I thought I would discourage anyone from literature, I wouldn't teach it since I am here to act as a guide, to help you learn and enjoy the subject." This is in marked contrast to many professors who often expect only the diehards to **enjoy** *their subject and teach accordingly.*

Dr. Markward's classes (on The Bible as Literature, and Shakespeare) are the best to be had on campus. His background includes: BA, Park College, Missouri; MA, University of Northern Colorado; PhD, University of Birmingham (England); Graduate work in Elizabethean studies, Stratford-on-Avon (England); graduate work in literature, University of Grenoble (France); Graduate study, Northwestern University; University of Wisconsin; Stanford; in French, literature, and theater; special studies in art, Kansas City Art Institute. Before coming to CU in 1945, he taught high school; spent three years in Army Intelligence during World War II; and has had numerous experiences in radio and television work. It is with great pride that The Colorado Engineer *presents Dr. Markward's comments:*

I cannot tell you how many times I have taught Dante's *Inferno*. You see I have been at the University of Colorado since the autumn of 1945, arriving with the droves of returning World War II vetarans. Each time I have traveled downward with Dante and Vergil, I have wondered at there not being a special circle for those who have damned themselves by choosing a life work not out of love but for some other reason. Surely there is no greater pleasure than that which comes from working at something you enjoy, and no deeper hell than spending a life-time doing that which brings you no happiness.

Long ago I chose teaching, not for the monetary returns – who could be so naive? – but because I'm a missionary at heart, I suppose. I don't mean the usual kind, or perhaps I do. I wanted to share with others the pleasures, aesthetic and intellectual, that great literature, art, music, and the other humane arts had brought me. To say it another way, I wanted to get young people excited about plays and poems and novels and all of the other aesthetic creations of man. And I am convinced that there is no real learning unless it is accompanied by excitement.

My love of literature came very early, for I grew up on a Midwestern farm in a house without electricity, radio, picture magazines, or any of the other easy pleasures. There was a large library, and I did have a writer father. I think maybe I was seven when he started me reading Charles and Mary Lamb and Dickens. I moved on to Dumas pére and Scott, and Hawthorne and Melville, and Shakespeare and Keats. I was greedy; I could not curb my appetite. Father took time to listen to my enthusiasms, answer my questions, and lead me on to other plays and novels and poems. He had a beautifully resonant voice and regularly on Friday evenings he read aloud to us – usually from the Bible or from Shakespeare or from Byron or Mark Twain. His taste was universal, and what he read really didn't matter, we were truly entranced by it all. On Sunday afternoons he presided over our hand-crank Columbia and played us concerts of Caruso, McCormick, Scotti, Melba, Homer, Gluck, Calve, Schumann Heink, and others. Father's love of music was contagious as was his enthusiasm for literature. I think maybe a little of it came to me. In turn, I hope I may have "infected" at least a few others.

At any rate, when I was twenty, and had earned my A.B. in Classics, I went forth to teach the humanities and to direct plays and to sponsor debate teams and to act as assistant track coach in a small high school in western Nebraska.

I managed. I was young. But my great joy that year came when my senior English class became so excited by *Macbeth* that they wanted to study another Shakespearean play. Our principal, who was a rare pedagogue said, "Why not? If that's what interests them, go ahead. If they want to spend the rest of the year with Shakespeare, let them." "But what of the course of study?", I asked. "To hell with the course of study" was his reply. So we spent the rest of the school year with *Hamlet, Othello* and *King Lear.* The students even demanded extra sessions. Thank GodI had that experience. I knew I had headed myself in the right direction.

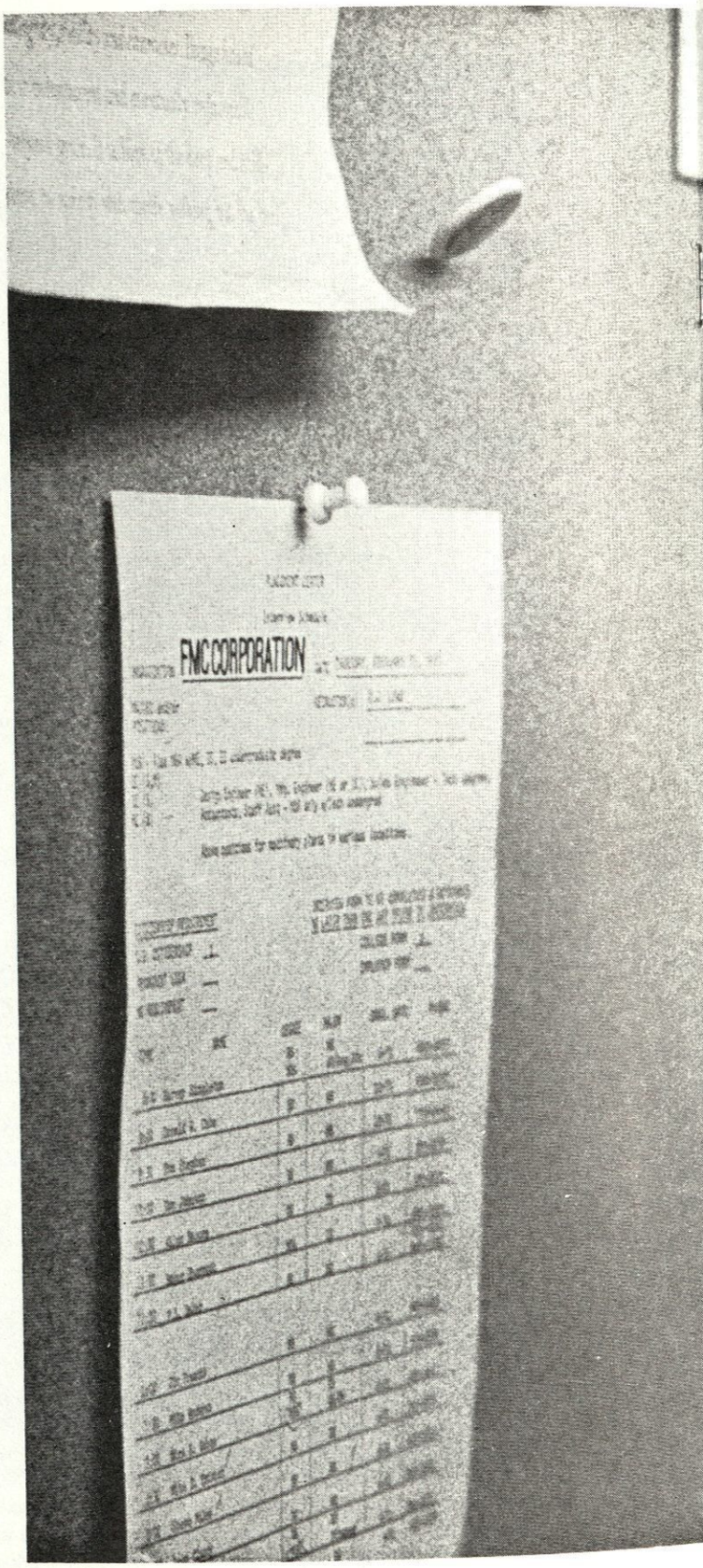
For some thirty years now I have been about this work with students – all kinds of students – from arts and sciences, education, engineering; on the campus, at the extension center, in correspondence, indeed every nook and corner of academia. All have provided a challenge to me, and the humanities have provided a challenge to them. And they have, I hope, come to realize that the humanities belong to them all, not merely to those who have chosen to specialize in the humane arts.

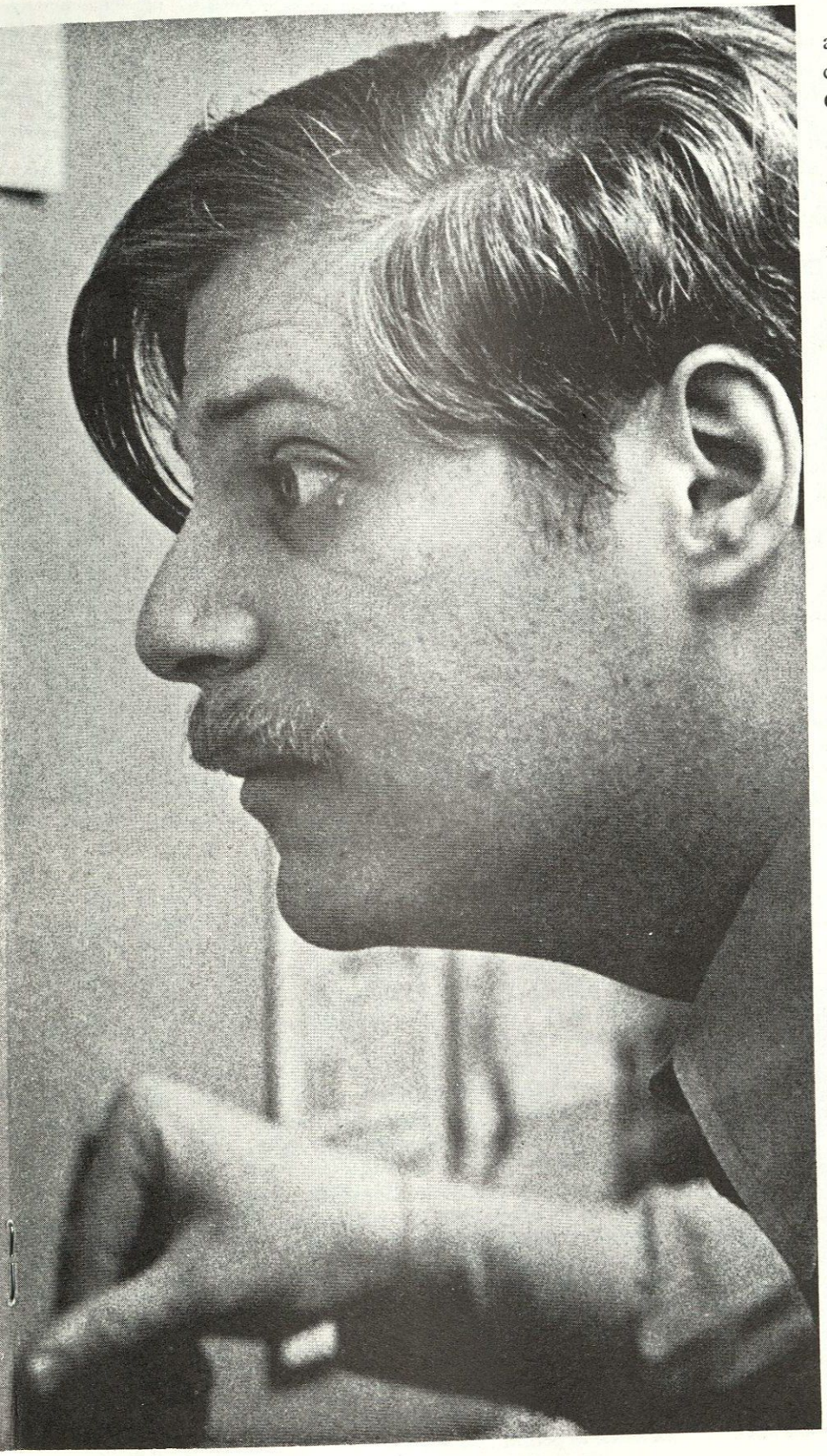
There is no pre-med student, lawyer or engineer-to-be, or indeed anyone who will not learn more about himself from a study of *Hamlet* or Dante's *Divine Commedia* or the *Book of Job* or any other great piece of literature. These works embody the great ideas, the great visions, the great dreams, the profound observations of the physical world in which man is privileged to live, and the appreciation of its manifold beauties. These works explore man's relationships with man, his thoughts about God and the universe. They encourage his self analysis in terms of all of these which, Montaigne says, is education – not the compartmentalized kind, but true education.

It is no new thing to question. Socrates, Job, Christ – all asked some of the best questions ever put to man or the

Continued on page 18

Don't let our name confuse you.





On some campus in the U.S. this year a well-intentioned interviewee is going to confuse us with the Foremost Machine Company or some other FMC.

We'll understand.

Having only letters for a name might be sophisticated in some circles.

But sometimes it's just plain hard to remember.

Perhaps we should explain how it came about.

FMC doesn't mean Ford or Foremost or anything else but FMC. Way back long ago it used to mean Food Machinery Company. And later on, it stood for Food Machinery and Chemicals.

But 10 years ago because we'd become so diversified, we dropped the name, although for obvious reasons we kept the initials.

It makes sense. We became the nation's largest producers of rayon. We built Deep Dive for the navy's underwater salvage teams. And we continue to turn out such diversities as railroad cars, printing presses, cranes, barges, compact tractors, automated food plants, and dozens of industrial chemicals. The list goes on and on.

Most of what we produce never gets seen by the public, so our name is seldom visible. Worse, it sometimes gets confused.

So remember: FMC means FMC. If that still doesn't do it for you, write us at Box 760, San Jose, California 95106 for our free brochure "Careers with FMC." Or see your placement director for an interview. We're an equal opportunity employer.

fmc CORPORATION ®

FMC CORPORATION
Remember us by our initials.

Atomic Power Co

The Fort St. Vrain

By Ron Fattor

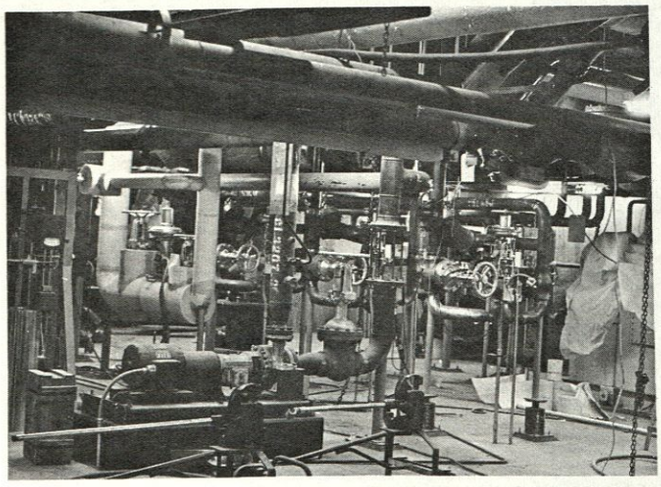
In 1945, the means of killing people in terms of mega deaths became a reality. War took on a dimension of horror hitherto unimagined; and peace born out of fear of conflict, rather than love of mankind, was instituted. The cause of this state of affairs, as everyone knows, was the atom, whose unleashed power was the sword over hostile heads at the peace table. But that which had the power to make peace out of fear also had the capability to make peace out of love, as well as being a pollutionless source of energy in a land already choked with pollution and threatened by fast depleting natural resources.

As William C. Gough and Bernard J. Eastlund ("The Prospects of Fusion Power," *Scientific American*, Feb. 1971) have pointed out, a nation's ability to grow is in direct proportion to the power available to it – and today this refers to electrical energy. If smaller and poorer nations can make use of nuclear power (lack of natural resources has been the most common stumbling block in obtaining electrical power), then our world will have taken a giant leap in the direction of erradicating poverty and instilling pride in poorer nations. (While this idea was expounded in an article concerning fusion power of the future, it applies equally well to the fission power of the present.)

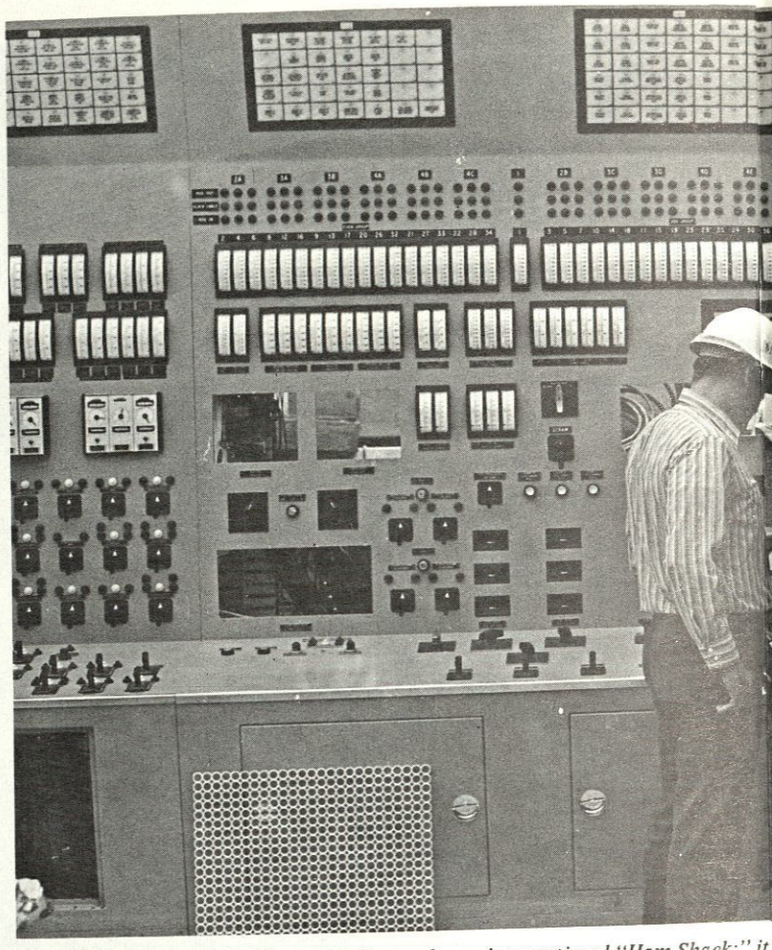
On a more domestic level, nuclear power opens new avenues of supply for our power-hungry nation and may save us from facing severe power shortages in the future – besides being nearly pollution-free in operation. This is the scope of modern nuclear generation of power – such as is exemplified by the Fort St. Vrain Nuclear Generating Station, located near Platteville, Colorado.

Since Colorado seems destined to be the innovative leader in such diverse fields as abortion and art museums, there is no reason why it shouldn't alos take the lead in nuclear power. The Public Service Company seems to agree. In conjunction with Gulf General Atomic they are building what is, without question, the most modern and efficient nuclear generating plant in the world. Its progress is being watched by countries from every part of the globe, because – in its field – it is an advanced "first".

The plant is capable of a 330-megawatt output – about the same as the largest power plant in Denver. The power from the Fort St. Vrain plant will be fed into a general grid network which feeds many areas – Denver included.



No, this is not a microscopic tour of a dish of spaghetti: it is a representative picture of the pipe work in the Fort St. Vrain plant.



In spite of its appearance, this is not the employees' recreational "Ham Shack;" it featuring the latest in automatic control.

The plant is "conventional" in that steam turbines turn generators, which produce electrical current. It is "unconventional" in that the heat for producing the steam is supplied by a fission reactor, utilizing uranium 235 and inexpensive thorium as fertile material.

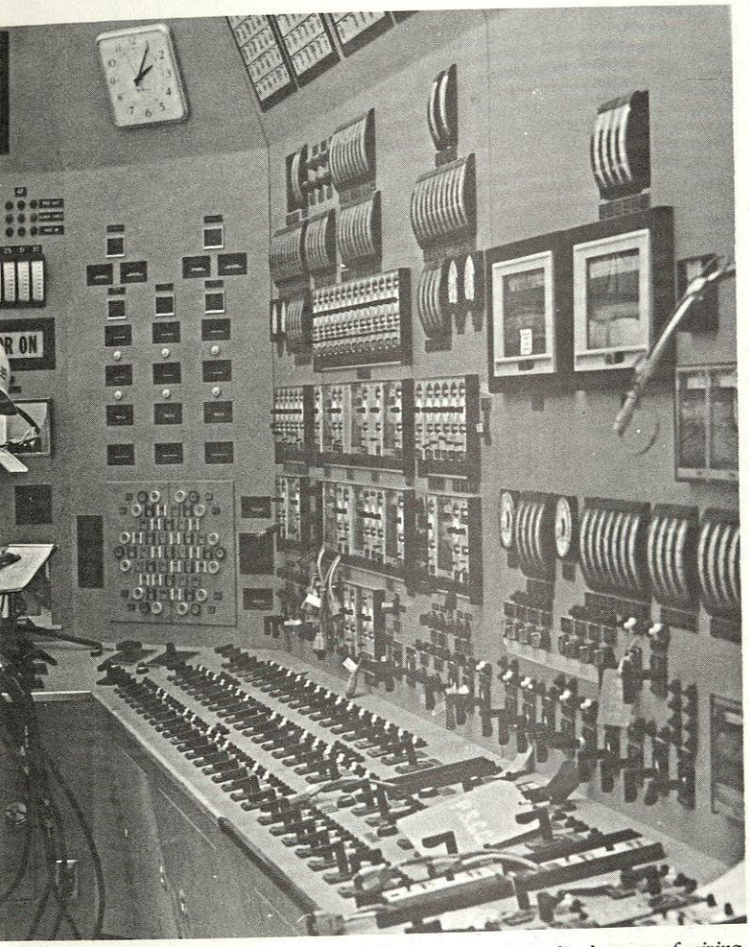
The "fuel" is contained in pellets about the size of poppy seeds, and these are used to fill holes in the graphite blocks of the reactor proper. Thorium is present, because the Fort St. Vrain reactor is a "converter reactor." Through the fission of the uranium, thorium is converted – via neutron bombardment – to uranium 233, which is also fissionable, and its birth is simultaneous with its use – it does not have to be removed and processed – it starts fissioning as soon as it is produced. Therefore, the reactor helps create its own fuel.

The reactor is operated in a manner so that one-sixth of the fuel is replaced each year (the fuel is removed and loaded in an automatic fashion and at any time, a fuel rod can be "pulled" for examination if necessary).

The reactor chamber is of prestressed concrete, lined with carbon steel. It is 106 feet high and 68 feet corner-to-corner. Its walls are post-stressed with 448 one-quarter inch steel tendons – each tendon was stressed to an average of 1,350,000 pounds. The walls of the reactor shell are 9 to 15 feet thick and are lined with sensors of all varieties, to permit monitoring of the reactor vessel when in use.

mes to Colorado

Nuclear Generating Station



is the main control room of the Fort St. Vrain reactor, it its final stages of wiring.

So far as concerns pollution, the Fort St. Vrain Atomic Power Station in operation puts out less pollution than a TV showroom. There is no smoke produced by the plant of any type.

The water used to cool the turbine steam for condensing is itself a closed system: the water used to cool the cooling water is drawn from the river (some of it is turned to steam and discharged to the atmosphere); the vast majority is cooled via a cooling tower and returned to the river with **zero degree** temperature as regards input and output temperature of the water.

The radiation contributed to the environment by the plant is on the order of 5 millirems – the equivalent output of 5 well-adjusted, color TV sets. Actually conventional, fossil, fuel power plants give off more radiation to the atmosphere (in the form of fly-ash, which contains carbon-14) than will the Fort St. Vrain power station.

The reactor is protected from accidental runaway by a power independent "Scram" system, which gravitationally lowers all control rods should the reactor get too "hot"; the system is automatic, with manual override if necessary. In addition to these safety precautions, the Fort St. Vrain plant has computer controls, the utmost in modern equipment and plant design, experienced and highly trained personnel; and in fact, the plant in operation is so safe that – by comparison – cooking hamburgers is a hazardous experience.

It also should be mentioned that **education** is the keynote concerning employees: **all** employees, from supervisor to laborer, are required to attend classes. The **average** training is 2 hours a day, per working day, in class; and many employees have been at this schedule for two or more years and are still going strong.

There are many sides to all issues; and one tries to see the bad, as well as the good, regarding the application of nuclear power. When looking at the Fort St. Vrain nuclear generating plant, however, it is hard to come up with any "cons", and the few that do exist are minor and are vastly outnumbered by the "pros".

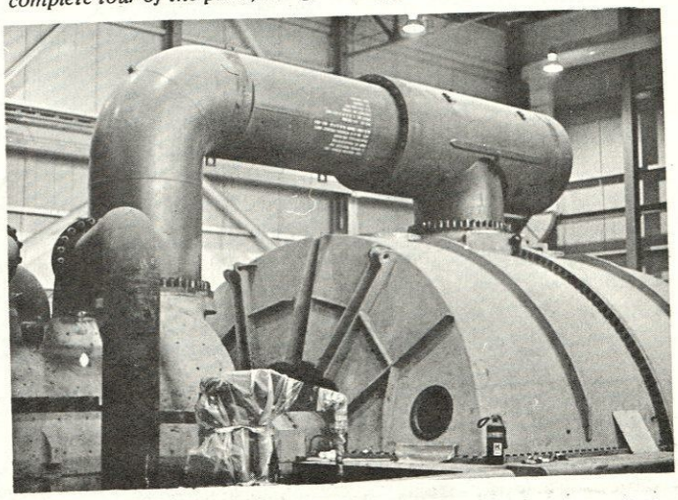
As of this writing, the Fort St. Vrain project is entering the final stages of construction, 3 months ahead of schedule, and is planned for initial fuel insertion ("fire-up") approximately one year from now – Right On, Baby!

The heat transfer, from reactor core to the water needed for steam is accomplished in a unique manner (previously proven at the Peach Bottom Atomic Power station, which has been operating since 1967), utilizing helium, which passes through the core of the reactor and is thereby heated to a temperature of 1,430 degrees F. Helium is used due to its inert properties; but to insure purity, after each heat exchange cycle with the water, 15% of the helium is continuously side- tracked to a purification system (before returning to the core), which removed tirtium (the radioactive isotope of helium produced in minute quantities due to the reactor), carbon monoxide, carbon dioxide, water, and dust, by means of nitrogen-cooling and high-temperature charcoal, along with various filtering devices to insure that the impurities are held to 10 ppm.

The heat exchanger raises the temperature of the water to 1,000 degrees F., in which form it exists as superheated steam and is passed through the turbines. (This is on par with the most efficient means and allows use of turbines, which take up only one-half the space of the old, "boiled water" range turbines.) The steam used for the turbines is cooled, using a closed, coolant water cycle (more of which later) and is rechanneled to the heat exchanger.

The Fort St. Vrain reactor proper is 39.23% efficient over-all – setting a new record of efficiency for atomic energy plants (previously at 35% efficiency).

Thanks for much of the information in this article must go to the assistant supervisor at the Fort St. Vrain power station, Ken Barnett, whose courteous and intelligent help, as well as his complete tour of the plant, was greatly appreciated.



A view of the superheated steam turbine which is under final construction.

Campus Development

The Asphalt Jungle

By Lee Gilbert

Dear Entering Freshman,

Congratulations on having been accepted to the University of Colorado. We hope your college career will be a successful one.

To help acquaint you with your new "home," we have enclosed a map of campus. Realizing that "getting around" is an important part of campus life (especially for the freshman), we have made sure that your car has a home here too. The spacious Farrand Field parking area provides convenient storage for your car, while easy access throughout campus is assured by our advanced road system. (Note especially Colorado Avenue, 18th Street, and 24th Street – All are 4-lane divided highways.) We are presently considering building a parking area in front of Norlin for added convience.

The dormitories . . .

Several people didn't think it should happen that way. We didn't think that the campus should be paved over. As a result, about a year ago, an alternative scheme was developed.* Over the last few months, the Joint Campus Planning Commission** has been working on the details.

The basic philosophy of the plan is simple. The campus should be a pleasant place for people to be, and it should be pedestrian (and bicycle) oriented.

A definitive final plan has not yet been developed, but tentatively speaking the final plan would include: (see Fig. 1)

1. The closing of all roads encircling Farrand Field and roads connecting Farrand Field with 24th Street. All parking in this area would be moved to peripheral lots. All general traffic would be eliminated. Access by car to the dorms would be allowed at certain specified times only.
2. The closing of Green Mountain. Parking Allowed.
3. The closing of 18th Street and Colorado Avenue as indicated. No parking allowed.
4. The closing of 24th Street and Regent Drive as indicated. No parking allowed.
5. The closing of the road behind Hale as indicated. No parking allowed.
6. Elimination of various other parking areas as indicated.
7. Development of new parking areas:
   (a) In front of Regent Hall
   (b) Behind Engineering and Business buildings
   (c) East Campus and other locations removed from campus
8. Modified access to Kittredge.
9. Conversion of closed roads and parking areas into pedestrian malls or open fields, as is reasonable.
10. Separation of pedestrian and bicycle paths.
11. Various other internal improvements such as redesigning the field south of the Fine Arts building.

The above tentative plan would not only improve the appearance of the campus, it would also improve its functioning. Most travel on campus is by foot or by bike. Both these forms of transportation conflict with automobile traffic. The result is less efficient movement for everyone. Under the above plan, pedestrian bicycle traffic would be separated from each other and from automobile traffic. Campus travel would certainly be improved and automobile traffic flow would follow the route specially designed for it, namely 28th Street and Baseline.

The tentative plan presented above will not go into effect immediately. The new parking areas must be developed before any large amount of cars can be removed from central campus. The lot in front of Regent Hall as well as the one behind the Engineering Center could be completed by Fall if funds are available. If they are built by then, it is possible that parking in the Farrand Field area could be eliminated by next Fall, or more resonably, by next Spring.

A much stickier problem centers around the closing of roads that are owned by the city (see Fig. 2). For example, 18th Street and Colorado Avenue were closed on a temporary basis while work was being done in that area. They will be reopened soon unless the University and the city can reach an agreement on closing them permanently.

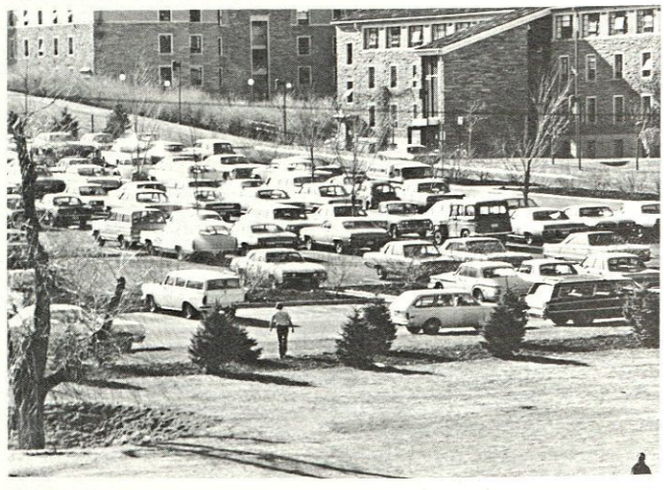
Realizing the difficulties involved in immediate implementation of a final plan, the Joint Campus Planning Commission developed a three-phase plan for developing the campus.

Under Phase I (see Fig. 2), through-campus traffic, i.e., traffic which has no final destination on campus, would be hindered. This portion of the total plan could be put into effect almost immediately and perhaps will be in effect by the time this article is published.

Phase II (see Fig. 1) centers around the development of peripheral parking areas and the closing of most campus roads with parking no longer allowed. As indicated earlier this portion of the plan is more dependent on funding, but could be in effect by next Fall or next Spring.

Phase III (see Fig. 1) would complete the plan. It would involved general campus improvement, the closing of remaining roads, the development of remote parking areas, and the development of a campus transportation system in conjunction with regional transportation planning.

It is my belief that the adoption of the above plan will make the University of Colorado a more progressive university, better serving the campus community.



* Actually two similar plans were developed. One was published in the *Colorado Daily*. The other was drawn up by Steve Workman and myself.

**Members: David Rowland, Planning Office; Richard Whitaker, faculty-Arch.; Walter Meyer, faculty-C.E.; Richard Richardson, student-Arch.; Robert Gray, student-C.E.; Lee Gilbert, student-E.E.

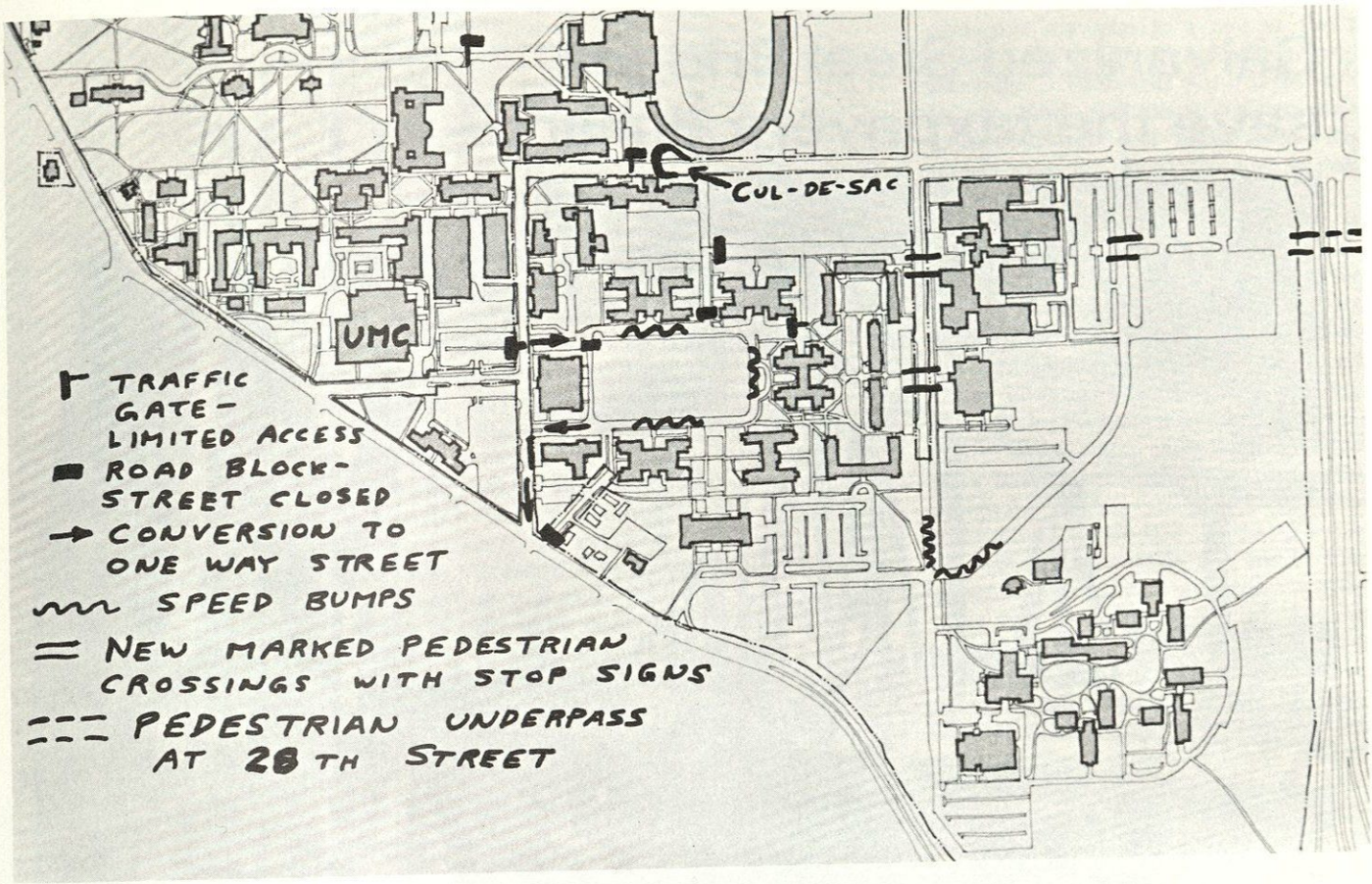


Fig. 1 Tentative final plan. Phases II & III

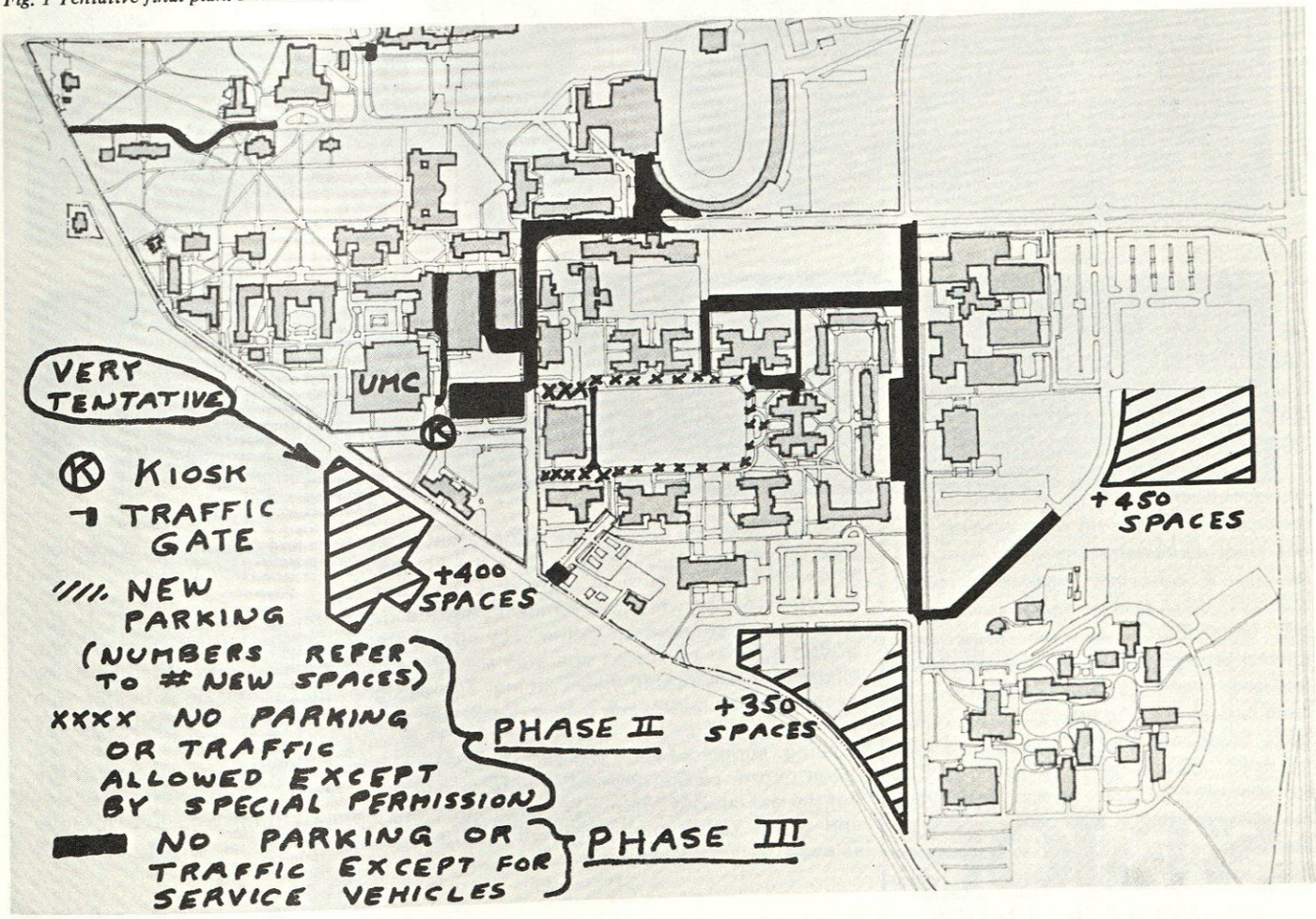
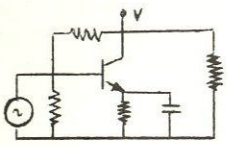


Fig. 2b Phase I



FEEDBACK

"No man is an island entire of himself." So noted John Donne at the beginning of the 17th century. Since the beginning of intellectual thought, philosophers, poets, and mystics have realized this. Modern ecologists, who now include man as a part of the overall ecosystem, have likewise grasped this fundamental truth. With the Apollo moon flights we have all shared, at least vicariously, the experience of seeing the earth as a spaceship on a rather lonely journey of its own. The earth is now seen for what it is, a nearly-closed and finite system with a limited reserve of resources (or capital) that have been accumulated over aeons of geological time. Such a profound realization is only now beginning to affect modern intellectual thought and must permeate our educational system if we are to survive.

In designing an artificial space capsule a basic design criterion is that of minimizing the initial resources or payload for a given mission. Who could imagine designing a spaceship for an expanding population of astronauts, with an ever increasing rate of consumption? But this is precisely the condition that faces us astronauts of spaceship earth. Very few technologists question our current growth-motivated patterns. Where are those that ask how we can minimize our present extravagant consumption of energy and mineral resources? Minimizing resource consumption for a given standard of living is clearly a technical question. Closely related is the problem of pollution. While the pollutants introduced by many processes can be reduced, it is ultimately tied to our consumption patterns. What is obviously needed is an overall approach which can recognize various "trade off" and which has a goal of minimizing the overall impact upon our spaceship. This problem is further compounded when it is realized that we Americans who make up but 6% of our spaceship's astronauts, consume non-renewable resources at a rate of about equal to that consumed by the remaining astronauts. It is obvious that if those with second, third, and fourth class accomodations achieve first class status the soundness of the life support system may become questionable.

A wholistic concept in education is called for. For example, there is no question as to the undesirable pollutive effects of the automobile. Even if an emissionless automobile could be developed (a technological fix) the assault on the environment would continue and very likely such an improvement would lead to further congestion, more highways and more land utilized for storage of unused automobiles. This type of technological solution, a solution tied to moving a one or two ton automobile for one or two passengers, would lead not to an improvement but to a degradation of life. An overall approach is called for which questions why we travel in the first place. Is it not appropriate to ask to what extent travel could be reduced by applying new concepts of urban design? Should not the feasibility of new communication systems (low energy consumers) be considered? Could not an effective mass transportation system drastically reduce our dependence on the individually propelled automobile? We mgiht even discover that the design of environments which facilitate more walking might have profound effect both upon energy consumption and our psychological well being.

Advocates of sophisticated technology ("it's really fun) will undoubtedly remain with us. Both the doomed SST and space exploration have marginal utility relative to terrestrial problems. When I listen to the proponents of such technology I often wonder if these people would be equally sure of these "needs" if it was proposed that they work at a subsistence wage like a Peace Corps or VISTA volunteer. How many SST proponents would we then have?

The problems facing our global, spaceship society, call for a new Renaissance Man, one who understands not only the latest technology but who is also an intellectual of the highest order. The new man must not only understand the mechanisms of social organisms as treated in sociology, anthropology, political science, history, and economics, but must also possess a value structure based upon a deep understanding of man. Such an individual needs to be capable of experiencing art and music. He needs an awareness of self that can be obtained only through deep and meaningful

Continued on page 20

PROF'S CORNER

Continued from page 9

universe. As the *Book of Job* makes clear man was given an intelligence to use: to ask questions. It little matters that there often are no answers. So our being prone to question in this, the latter half of the twentieth century – to borrow from Ecclesiastes once more – I repeat is no new thing. True, the phrasing of the question may be a little weary: Is it relevant to me?

I have found that most of our students are really very intelligent. Only occasionally does a student ask, "What can the Humanities offer me?" If he is no longer a member of the human race, nothing! If he wants to become more aware of himself and the world in which he lives, then everything!

The humanities are a rich part of everyone's heritage. It is one's responsibility and privilege to make a part of this great wealth his own.

The humanities deal with the universalities, the greatest of which is love – love of life, of mankind, of family, of God, of trees and flowers, of mountains and seas, of sun and moon and stars; of those things we understand and those things we don't understand.

We turn to Aeschylus and Plato and Shakespeare and Keats; to Michelangelo and El Greco; and to Bach and Mozart; and all the great artists because they have given of their aesthetic and intellectual experience, in forms incomparable, to the ages. Yes, oh yes, the humanities are important, important to enlarging our vision, to deepening our comprehension and appreciation, to enriching our lives. They are important to our very being. If I can convince you of this and you, in turn, can convince someone else, then our mission is being achieved.

But to return to the point at which I started, please let me emphasize that if we are to avoid that infernal circle the existence of which I do not doubt, despite Dante's not having charted it for us, we must know what education does. Certainly it should have as its primary aim to assist us to find what we are best able to do and to teach us or to help us teach ourselves to do that work as best we can – a work from which we derive pleasure and satisfaction. It should point us in the right direction. But even that is incomplete, or perhaps we should say it hardly fulfills responsibility to self and to life. There are, after all, the living arts; they belong to us. We are fools if we turn our backs on them. As Robert Frost says,

My object in living is to unite
My avocation and my vocation
As my two eyes make one in sight.
Only where love and need are one,
And the work is play for mortal stakes
Is the deed ever really done
For heaven and the future's sakes.

POPULATION

Continued from page 7

The problem now in defining a model for projections is centered around correlating the net immigrations to the model. It is evident from a glance at tables 1 and 3 that the growth of the University of Colorado follows or leads a similar growth in the size of the community. If the net immigrations are divided into an increase in university enrollment and an increase due to business and industrial development, such a correlation can be made. (It should also be noted that an increase in university enrollment also involves an increase in the business expansion of the community.) If (as for the birth and death rates) CU and BI are defined as the rate of increase per 1000 inhabitants per year for university enrollment and business and industrial expansion, the model becomes;

dp/dt = Bp - Dp 3CUp 3 BIp

Because of the simplifications and assumptions involved in defining this model, the projections cannot be stated emphatically. For this reason the terms BI and CU will be derived based only on Boulder's growth from 1960-1970. In other words, most projections and conclusions will contain the stipulation that if Boulder continues to grow as it has during the sixties, then . . . . . .

In trying to calculate the number of migrants that arrived in Boulder in the sixties, a few assumptions must be made. It is impossible to use the stable population model (dp/dt = Bp - Dp) to somehow derive the number of immigrants. That is, you cannot calculate dp/dt for the sixties and then conclude the difference is the number of immigrants, because dp/dt is proportional to the size of the population which is definitely affected by immigrations. Therefore a mean population for the decade will be defined to make the computations possible.

It might be worthy of mention here to note the major reason that it is difficult to model Boulder's population. For the past 30 years the increase in Boulder's population has been influenced to a greater extent by net immigrations rather than births. It is undoubtedly harder to predict the number of people who will move to Boulder than it is to predict the number of people who will be born and die here.

The mean population for the period 1960-1970 = [37,718 3 65,789]/2 or 51,753. Assuming that for the sixties B = 20.0 and D = 9.0 you could expect the population in 1970 to be (disregarding migrations) . . . p(1960) + [Bp(mean) - Dp(mean)] X 10. Therefore, the net migrations would be 65,789 - 43,408 = 22, 381. In this model, it is assumed that this 22, 381 increase is a result of either an increase in the size of the university or an increase in the size of the business and industrial community. If Migration = CUp + BIp, then from 1960-1970 CU increase (table 3) = 9,385 or 938.5/year, and BI increase = 12,996 or 1,299.6/year. Therefore, the CU rate/year/-1000 inhabitants = 938.5/51.753 or 18.0. The BI rate is, similarly, = 1300/52 or 25.0. Checking this model of growth for the sixties . . . .

dp/dt = Bp - Dp + CUp + BIp.

dp/dt = .018p - .007p + .018p + .025p.

When applied to the past decade, it is found that this model is within the 95% confidence interval. It is now possible to project Boulder's future growth based on its growth for the past decade.

A model of Boulder, Colorado's population was devised and implemented. Due to the innumerable factors that influence population variation, a simple model was developed so as to allow its use.

According to this model, Boulder can expect a population of 1,000,000 in about 50 years if it grows at the same rate it experienced during the past decade. This, of course, is quite startling and seems highly unlikely. In actuality, it would be extremely difficult for Boulder to meet even the physical demands, such as housing, to accommodate this growth rate. It is interesting to note, however, that even today this problem of housing seems to plague Boulder more and more each year. It would seem that since Boulder cannot possibly keep up with its present growth, it must look for solutions to control this expansion.

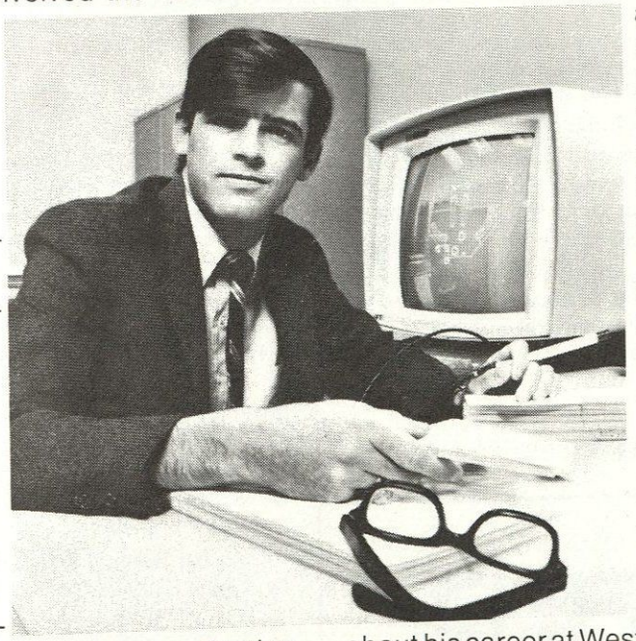
Continued on page 20

"I can do my kind of work here...there's always a lot of variety."

Bob Sedgewick, Western Electric.

And his achievements that first year at Western Electric are proof.

Bob's major project involved the use of the computer to develop ways of producing integrated circuit masks for the future with even smaller features than those used today.



He also worked out a job-shop scheduling program that uses computer graphics, a two-dimensional representation of computer data. This may well replace the traditional push-pin type of wall chart method for analysis of job operation.

Another contribution during that first year was his work evaluating computer performance. This involves communication between computers, where a small computer extracts information from a big one. The goal of this project was to optimize computer operation.

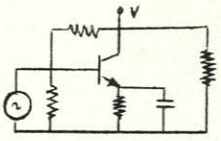
It was this project which led to the development of a paper on evaluating computer performance which Bob presented at the Fall Joint Computer Conference in Houston, Texas. His paper won the respect of his peers and was reviewed by a computer trade journal.

We hired Bob right after he was graduated from Brown. Now, two years later, with one more degree and a full year on the job behind him, Bob is taking advantage of our tuition refund program—this time studying part-time for his Ph.D. at Columbia.

How does Bob feel about his career at Western Electric? "There's a lot of freedom here," said Bob. "I don't know where else I could have done as much in so short a time."

Western Electric

An Equal Opportunity Employer



FEEDBACK

Another spring rolls around and it's time for another episode of Engineering Days. A speaker or two speaks, students dance, and a picnic is held with carefree happiness being the order of the day. Certainly there's nothing wrong with all of this, but, somehow, there's something that's not quite right about it all. That was obvious last year, and it will probably be obvious again this year.

I'm not sure why E-days didn't appeal to students last year, so I can't lay down problems one, two, and three. The best I can do is relate my general feelings about the problems, which were greatly amplified by the student strike last year.

Somehow the E-days festivities are not real. We seem to be celebrating when there is nothing to celebrate. For those students who are concerned about graduation or simply the end of the school year above other things, this might not be a valid complaint. But for those of us concerned about the war, the ecosystem, and other problems, something like E-days simply strikes us as being totally irrelevant.

Perhaps there is also a fear of being stereotyped within me. When I think of an engineer I tend to think of a person who is hard working and fun loving in alternate cycles. E-days represents part of his fun-loving cycle, and there is nothing wrong with that in itself. The trouble is that there seems to be little room for concern within either of the two engineers basic activities. That does bother me, and I would hate to believe that I could exist that way. In a way E-days represents that kind of existence to me, so naturally there is an inward skepticism present.

For E-days to work, it has to appeal to at least the engineers, and hopefully to people in general. Aside from the vague and perhaps even singular complaints I presented above, there are a couple of more concrete problems that could and should be dealt with.

The dance strikes me as being useless. People just don't enjoy dancing anymore, especially formally. The E-days dance is only tradition; a refusal to change with the changing attitudes of the students. I would rather see a planned encounter session, open to all students, and held on the grass within or around the Engineering Center. Perhaps other people would like to see other things, in which case they should certainly pay a visit to the A.E.S. office.

The meanest professor contest, the beard growing contest, the softball games and the rest of the happenings during and before activities day are fun and certainly should be continued. They would probably be more attractive to more people, however, if they were better planned and advertised. They simply need some pride and some vigor. I think the same problem exists with the speech.

Maybe I'm all wrong about the reasons that E-days is failing. If you understand why it doesn't appeal to you, if it doesn't, let somebody in the A.E.S. office know what you want. That's the only way E-days can become something we can all sincerely look forward to.

An Engineer's View

H. Bruce Campbell

FEEDBACK

Continued from page 17

personal relations. These are the minimum criteria for the crew of our spaceship.

Obviously, a four-year educational scheme can hardly begin to touch on the real needs of a modern technologist. Present emphasis is almost entirely on technical expertise in narrowly defined fields. To fulfill the "humanities" aspect of the engineering curriculum, students are sent to other parts of the campus where they are exposed to educators who have little feeling for the technological basis of our present society. A similar gap exists on the technical side with the question of "technology for what" almost completely ignored. The two cultures of C. P. Snow do indeed permeate the educational system. If this gap isn't bridged, the advance of modern technology may prove meaningless and the bell may toll for us all!

Jerold H. Krenz

Director, Engineering Honors Program

WANTED

STUDENTS FOR A.E.S. – Open under new management effective May 5, 1971. Please come in and see us. We will appreciate your advice, suggestions, and help. There are positions of authority available for those who are interested. Contact Jim Mateyka (A.E.S. President) or Dave Szabados (A.E.S. Vice-President at ext. 7975 or come into the office ECOT 1-6.

POPULATION GROWTH

Continued from page 18

According to the Boulder planning board, the average number of persons per household is declining in Boulder. This would indicate hopefully a smaller family size in Boulder, but it probably indicates a lowering of the average age of a resident (table No. 5). At any rate, the town can only do so much to control its births and deaths. The two areas where Boulder can limit its growth are the University of Colorado and the business and industrial communities.

It is evident from the computer projected population curves how dramatically these two influences can slow down Boulder's growth. It will be interesting to see which direction the town turns in order to control its own destiny. It should go both ways (i.e. limit C.U. enrollment by pressuring whomever it takes and try to discourage any big business from coming to Boulder). Because of the way that cities are run, it would probably be safe to say that Boulder will get bigger, dirtier and less livable for the next several years.

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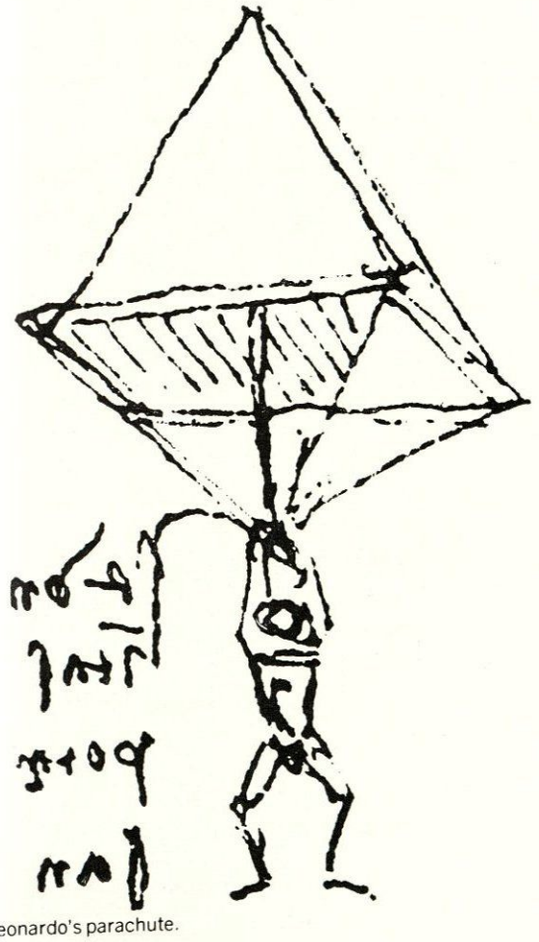

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