

The **COLORADO** *Engineer*

JANUARY, 1964

TIMMERHAUS
CHUM 129
PUS

**HIGH SCHOOL
ISSUE**

Westinghouse



Even at 3 in the morning...commuter service every 2 minutes

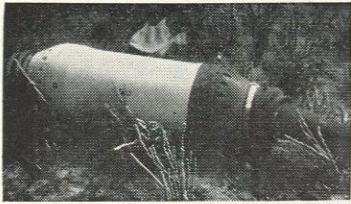
Urban planners figure the only way to solve the big-city traffic jams is to develop some method of mass transit that will be so frequent, so fast, so convenient that people will turn to it as their No. 1 choice, as they did years ago. The key to this kind of rider convenience is a computer-controlled system.

Westinghouse has developed such a system. It is called the Transit Expressway. It looks so promising the government has approved a demonstration project near Pittsburgh, through the Port Authority of Allegheny County.

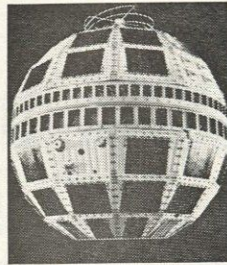
The system uses its own private roadway. Silent, rubber-tired, comfortable vehicles will operate on the two-minute schedule, day and night. A computer will schedule as many as 12 of these cars together into a train during peak periods. You can be sure...if it's Westinghouse.

For information on a career at Westinghouse, an equal opportunity employer, write to L. H. Noggle, Westinghouse Educational Dept., Pittsburgh 21, Pa.

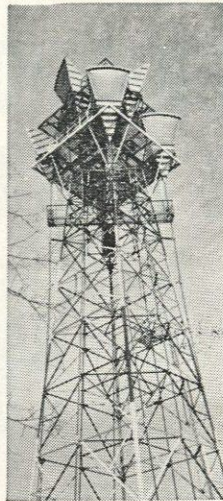
Progress in the Bell System...



SWIMS...



ORBITS...



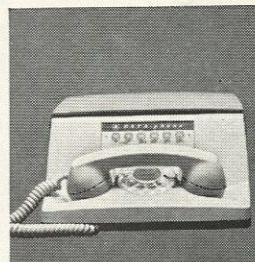
BEAMS...



FLASHES...



PUSHES...



PULSES...



TALKS...



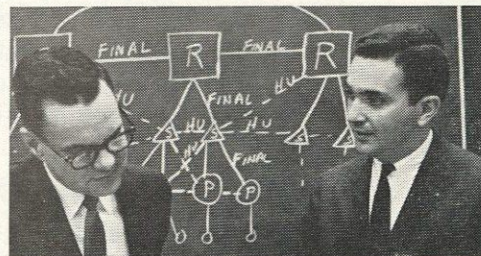
BURROWS...



WINKS...



BLINKS...



AND LIVES AND BREATHES...

Progress takes many shapes in the Bell System. And among the shapers are young men, not unlike yourself, impatient to make things happen for their companies and themselves. There are few places where such restlessness is more welcomed or rewarded than in the fast-growing phone business.



Bell Telephone Companies

ARE YOU INTERESTED IN...

CONSTRUCTION... WATER RESOURCES DEVELOPMENT...

IN THE GEOGRAPHICAL AREA OF YOUR CHOICE
WITH THE CORPS OF ENGINEERS



DIVERSITY OF ACTIVITIES

The Corps of Engineers embraces virtually the entire range of modern engineering in the construction field. Projects include research into basic science, engineering investigations and regional planning; design, construction, operations, maintenance, and management of hydro-electric power dams, flood control facilities, harbors and navigable streams; design, construction and maintenance of family housing, runways, hangars, roadways, hospitals, and nuclear power installations; and construction of intercontinental ballistic missile and space launching sites. In addition are the allied fields of cartography, geodesy and engineer intelligence.

OPPORTUNITY

Opportunity is provided for progressive movement toward top positions for men with ability. You learn from top calibre professionals who have had many years of high quality experience.

LOCATION

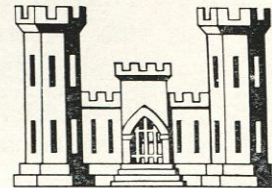
Projects are located in every State and in many foreign countries.

A CAREER NOT A JOB

The Corps offers a well defined 18-month rotational training program for young graduate engineers covering all facets of the varied work program. This is followed by planned career development assignments. These assignments enable a young man to develop his special aptitudes in the engineering field. As he progresses, special attention is given to the development of managerial and executive abilities.

ADVANCED EDUCATION AVAILABLE

Attendance at special seminars, symposiums, and university courses and participation in professional societies and activities are encouraged, and sponsored when possible. Fellowships for advanced study and awards for outstanding achievement are also available.



**CORPS OF ENGINEERS
DEPARTMENT OF ARMY**

AN EQUAL OPPORTUNITY EMPLOYER

FOR ADDITIONAL INFORMATION... and an illustrated brochure "Your Career", write to the Chief of Engineers, Department of the Army, Washington, D.C. 20315



Now the Monsanto man...

also represents...



He's ready to answer your career questions about
any or all of these outstanding organizations

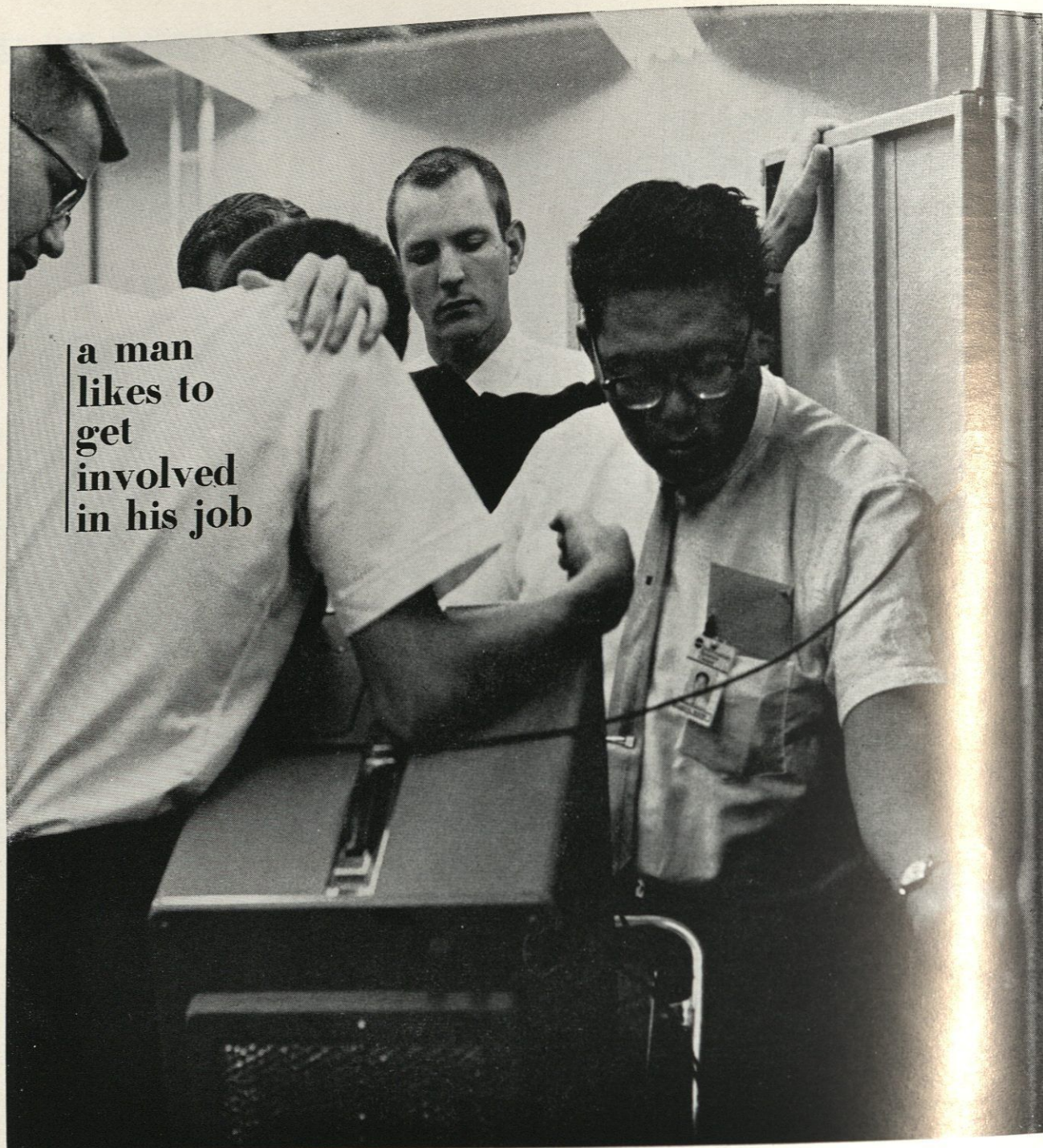
Their products range from chemicals to chemical fibers...from plastic bottles to nuclear sources. Their diverse activities create opportunities in research, development, engineering, manufacturing, and marketing. Yet, because each is an important member of the Monsanto corporate family, the Monsanto Professional Employment representative coming to your campus is fully prepared to give you complete facts on *any* or *all* of them... show you where *you* may fit in.

You will have a better opportunity to learn more about *us*...in a single interview. See

your Placement Director now to set up that interview when we visit your campus soon. Or, write for our new brochure, "You And Monsanto," to Manager, Professional Recruiting, MONSANTO, St. Louis, Missouri 63166.



AN EQUAL OPPORTUNITY EMPLOYER



**a man
likes to
get
involved
in his job**

Involvement is what you are offered at Collins. A chance to work on projects you can get your teeth into. A chance to work with some of the best engineers in the business. A chance to learn, to develop your talent and ability with guidance from experienced, creative professionals.

This involvement is demanding—but we are looking for the graduate who won't settle for anything less...who won't be satisfied unless he puts something of himself into everything he does. We

want the man who can come to grips with a problem and solve it. Sometimes alone. Using his knowledge, his initiative, his imagination, his creative talent.

The scope of our work—Data Processing, Space Communications, Avionics, Microwave, Antenna Systems and HF, VHF and UHF communication—offers graduates of this caliber every opportunity for growth, involvement, job satisfaction.

Contact your college placement office for full information.

COLLINS RADIO COMPANY
Cedar Rapids, Iowa • Dallas, Texas
Newport Beach, California



An equal opportunity employer

The COLORADO Engineer

UNIVERSITY OF COLORADO, BOULDER, COLORADO

VOLUME 60

NUMBER 2

CONTENTS

FEATURES

<i>Creative Environment</i>	Charles Boyd, Robert L. Carper, Steven Miller, Darrell Brooks Smith	9
<i>High School Special</i>	College of Engineering Faculty	9
<i>What Are You Breathing?</i>	Mark Sheridan	24
<i>Energy</i>	Ellen Harris	29
<i>Urban Traffic Studies</i>	Larry L. Huston	35
<i>Air Collisions</i>	Gary O'Keefe	41
<i>The Engine²r</i>	Rick Cys	47
<i>Interview: The Final Exam</i>	Northwestern University	53

SECTIONS:

<i>Editorial</i>	Larry Huston	7
<i>Dean's Column</i>	Dean M. S. Peters	44
<i>Book Reviews</i>	Joann Cram	49
<i>This Today</i>	Robert Barry	51
<i>Colorado Industries</i>	Larry Fowler	54
<i>Alumni News</i>	Chuck Hansen	57
<i>About the Authors</i>	Staff	58
<i>Puzzles</i>	Larry Hill	59
<i>Chips</i>	Larry Huston	60

This month's cover is Judy Becker's representation of a Colorado City.

Member of Engineering College Magazines Associated, J. Chumley, Chairman, Louisiana Polytechnic Institute, Ruston, Louisiana.

Circulation: 1300 by mail; 600 by sales; 1300 free; total press run 3200. Published four times a year on the fifteenth of November, January, March, and May by the students and faculty of the College of Engineering, Larry Huston, Editor; Ross Fraker, Business Manager. Offices located in Room 20 Ketchum Building.

Publisher's representative—Littell-Murray-Barnhill, Inc., 369 Lexington Avenue, New York 17, N.Y., and 737 North Michigan Avenue, Chicago 11, Illinois.

Entered as second-class matter March 9, 1916, at the Post Office at Boulder, Colorado, under act of March 3, 1879.

In just a few short months, those new graduates spanned the distance from the classroom to the space age. They joined with their experienced colleagues in tackling a variety of tough assignments. On July 20th, 1963, their product went off with a roar that lasted two solid minutes, providing more than 1,000,000 pounds of thrust on the test stand. This was part of the USAF Titan III C first stage, for which United Technology Center is the contractor. Two of these rockets will provide over 80% of all the thrust developed by the vehicle. Some of you now reading this page may soon be a part of that program...or a part of other significant, long-range programs.

■ UTC now offers career opportunities for promising graduates at the bachelor's, master's, and doctoral levels in EE, ME, AeroE, and ChE. Positions are important and offer personal and professional reward in the areas of systems analysis, instrumentation, data acquisition, preliminary design, aerothermodynamics, stress analysis, structure dynamics, testing, propellant development and processing. ■ If your idea of a career in the space age includes joining a young, vital, aggressive company...then get in touch with us now! If you want to work with men who can develop and build a wide variety of sophisticated propulsion systems, see your placement officer for a campus interview or write Mr. Jay Waste.

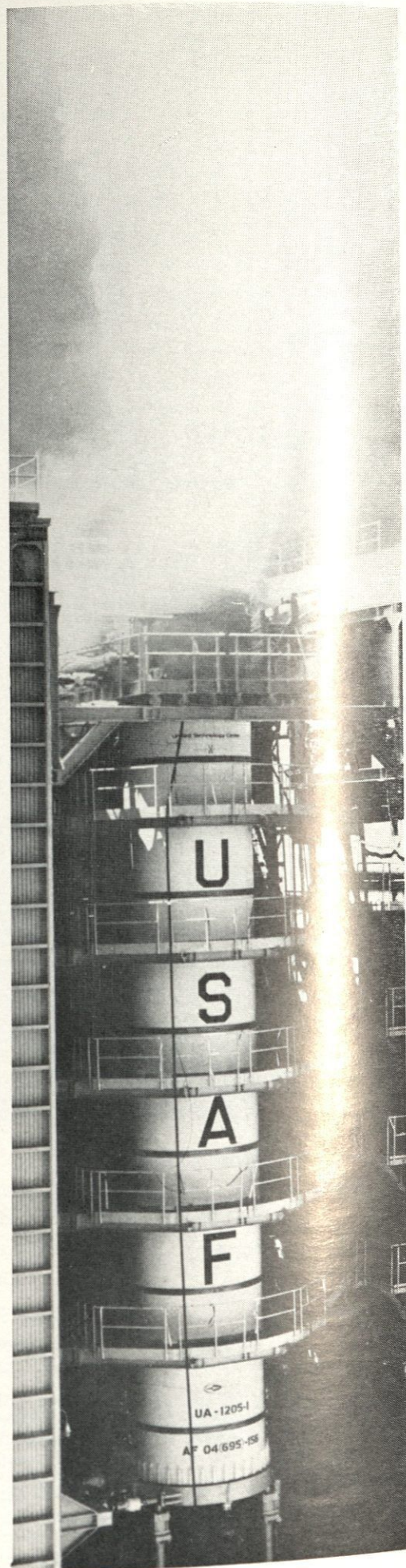
**SOME OF
THE MEN WHO
WORKED ON IT
WERE IN
COLLEGES
LIKE YOURS
A YEAR AGO**

**UNITED
TECHNOLOGY
CENTER**



DIVISION OF UNITED AIRCRAFT CORPORATION

P. O. Box 358 - Dept. E, Sunnyvale, California
U.S. Citizenship Required - Equal Opportunity Employer



COLORADO ENGINEER—January, 1964

The City

is complex. It is a complex of functions that work for and against each other. It is also a complex of ideas. Cities were made possible several thousand years ago when someone found a way to make one man produce enough food for several others. The herd instinct, wars, political and industrial revolutions did the rest. So, the city is here to stay as long as the atom allows man to stay. Where else could all those people go, where else could all those various things be done? Nowwhere!

There's just one major problem—Man. For some reason, or rather, lack of that, he insists on littering his housing, working, playing—living—grounds as no animal does. He litters the street with his trash, and even garbage. He clutters his views with edifices that have only function. He even litters the air he breathes. In an even more subanimal fashion, he annually assassinates or mutilates thousands of his brothers on the streets and highways. Even children are punished for behavior that is similarly antisocial.

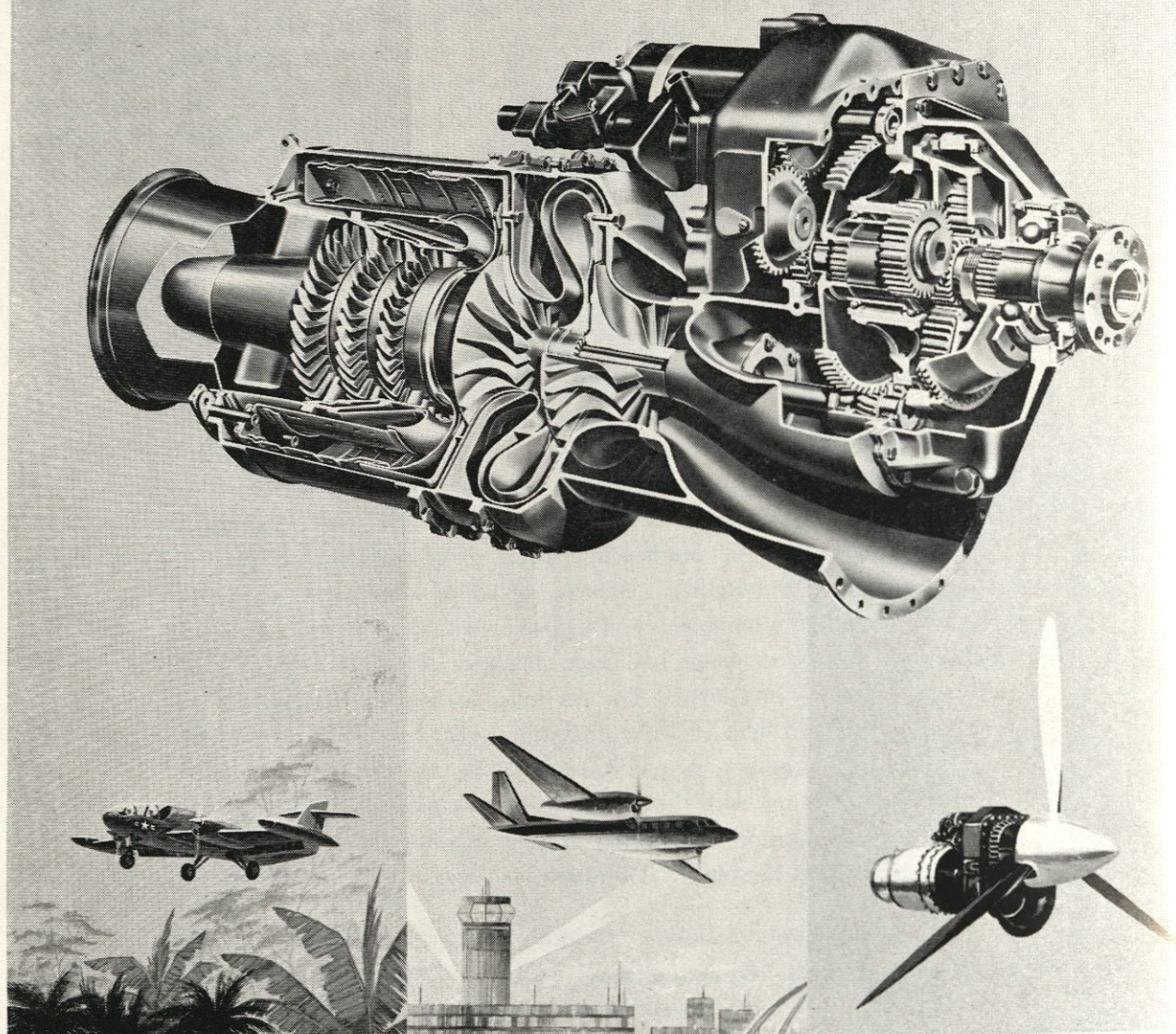
What to do? Take all man's harmful toys away. No, for he is too strong. Punish the offenders. Perhaps, but slapping hands is also a game. Try reason as a last resort. That hasn't worked well so far. The only solution seems to be to so design his surroundings that man can't hurt himself. As engineers, we can or will design automobiles and highways to keep the death toll down, design depollutant devices, design buildings, complexes, cities that are esthetically refreshing as well as functional. We can learn to help the society that we belong to and we *can* help it. The difficulty is that too often we *may* not. We are restricted by money, by political footballing, by time, by law, and by "other people". Dealing with these other people is a large part of each design problem. If your solution is approved by your supervisor and your boss, you still have to sell it to the buyer. Ultimately, the buyer is the rest of society.

That requires public relations. Illogically, people don't want to be told what is best for them. Or is it illogical that people should want to be told to do only what they already want to do? A not too distant example is the one-way street system on two downtown streets here in Boulder. All the logic, past experience, and future possibilities were in favor of the proposal, but the people wouldn't buy it. They weren't stupid; they didn't want it, so they didn't buy it. What may have been a good engineering solution was lost. Perhaps better public relations would have helped.

Public relations requires a knowledge of people, not just the people you meet in class, at home, or in your societies, but all the people with whom you are dealing. You must know something about society before you can help it. Where do you learn? The liberal arts are a good start!

—LARRY L. HUSTON.

TURBOPROP ENGINE FOR LIGHT AIRCRAFT



This 600 horsepower turboprop engine is designed to power the new generation of light, fixed wing aircraft for both civil and military applications. • The Garrett-AiResearch TPE-331 has a specific fuel consumption of .62 pound per shaft horsepower-hour, and a weight to power ratio of .45 pound per horsepower. The engine has a response rate from flight idle to full power of approximately 1/3 of a second. A military version has been designated the T76 by the U.S. Navy. • Designed specifically as a prime power plant, the model 331 is backed by the company's experience in producing over 10,000 gas turbine engines. • The Model 331 engine is programmed for additional performance growth. The turboshaft version (TSE-331) has been flight tested as a power plant in rotary wing and vertical lift vehicles.

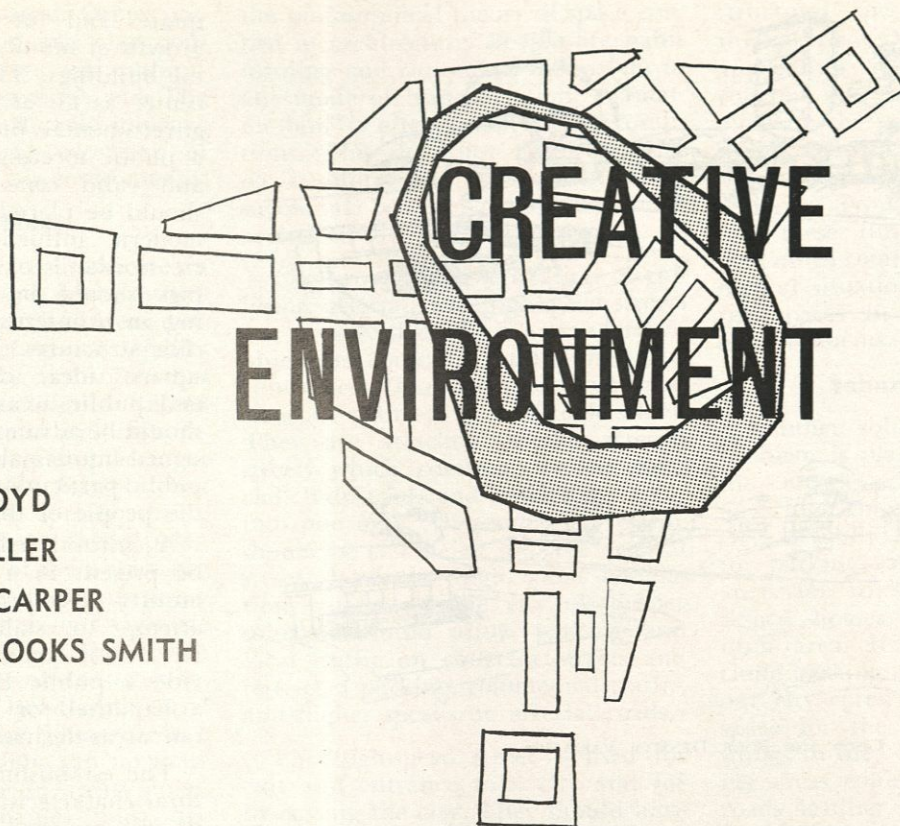
For further information about many interesting project areas and career opportunities at The Garrett Corporation, write to Mr. G. D. Bradley at 9851 S. Sepulveda Blvd., Los Angeles. Garrett is an equal opportunity employer.

THE FUTURE IS BUILDING NOW AT



AIRESEARCH

Phoenix • Los Angeles



CHARLES BOYD
STEVEN MILLER
ROBERT L. CARPER
DARRELL BROOKS SMITH

Organisms exist in an environment. Man should live in a creative environment, an environment created by him for his own well being. The city is man's most complex, dynamic, and important environment. The dynamics of a city are the people. But, in so many ways, our cities fail to fulfill the needs for the well-being of these people.

Unfortunately, our cities today seem only to be a collection of large masses of people who identify themselves with only two primary points, home and work. Everything between these two points is something to overcome in their everyday lives: congestion, traffic, uninteresting city surroundings.

What city are you from? Personal identity with a particular city is weak in one's own mind as well as in the minds of others. If one states that he is from Denver, the mental image formed may be the same as that of Columbus, Shreveport, or Helena, or one of countless numbers of American cities and towns.

What should a city be, and what should it do for its people? It should impart to its citizens and to visitors an image of character which belongs to no other city. A person ought to feel that he is a part of his city and its people and have understanding and pride for his environment.

We have lost the close interrelationship between people. The American

has made his house a hiding place from other people and uses the streets only for transporting himself from one place to another. The street and cityscape no longer provide the atmosphere in which people can live, see, gather, exchange ideas, and be a city of people.

The prime objective of planning the environment is to create a safe, healthy, convenient, and enjoyable place for people to live and work. This objective can be met by solving the problems of land use, public facilities, and transportation.

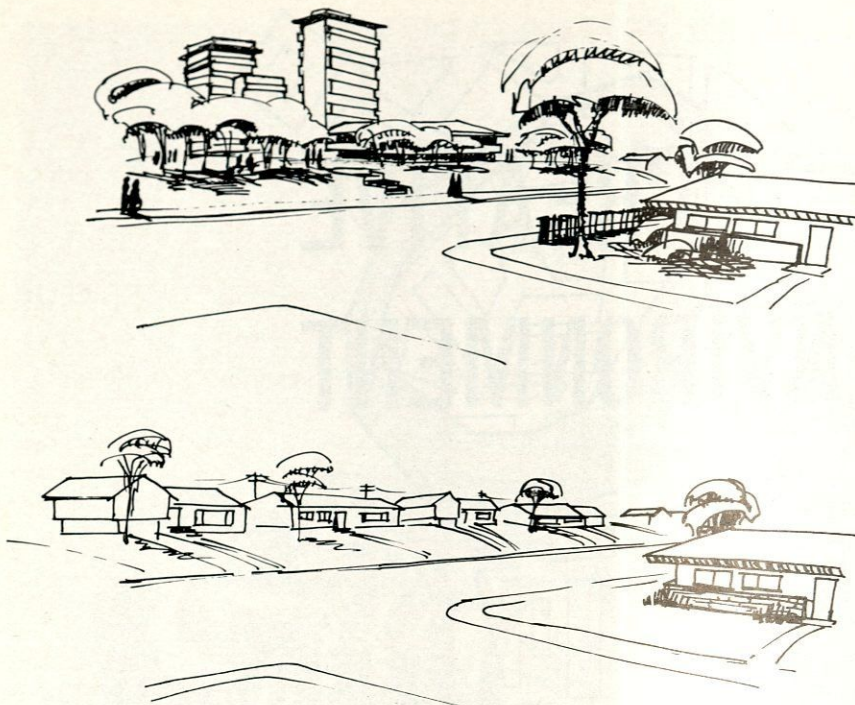
Land Use

The land use in a city is the actual expression of that city's environment. The control of land use, mainly in the form of zoning, has a terrific effect on the environment of a city. In some cases zoning has provided the guidance to create environments which are definitely for the well-being of the inhabitants. Unfortunately, this is more of an exception than a rule.

The most pronounced problem in the area of land use is the lack of variety. This is particularly obvious in residential land use. There is a definite need for some variation in the type of dwelling and density of development in the present-day urban residential area. This variation must take the proper direction. For instance, density should be based upon drainage, topography, circulation,

and convenience to schools and commercial areas; it should be controlled by zoning. Today's zoning results in monotonous tract-type residential developments with little visual interest. The high density areas today are often not even related to schools, shopping, recreation facilities or the adequacy of sewer, water and/or street systems. The tract developers proclaim that they have a house just for you—the Alpine, the Westerner, the Coloradoan, or the Cape Cod. After picking the model just for you, which occurs only three times in your block, your special model is built, with little or no respect for the topography, or the community's unique amenities. This creates nothing but monotony. It is a fact that every community has some unique amenities which are provided by the natural setting of its area. These should be enhanced and complimented by the man-made environment, not destroyed. All of the above problems can be controlled for future building with the passing of effective zoning ordinances. The destroying of all the present conditions is unfeasible. However, these present conditions can be reminders of the need for effective zoning.

Another area which is becoming more of a detriment than an aid to the well-being of the people is the growth of commercial enterprises. Large shopping centers are popping up on the outskirts of practically all



GOOD AND POOR DENSITY VARIATION

cities. These centers try to provide all the needs of any individual and are in turn creating slum environments in old downtown business districts. This creating of slum environments is a definite detriment to society. This is caused by the attempt to create several centers to provide the same facilities for the people. It would be much better to limit these centers to one focal center, either a new center or renovation of the old one, always keeping it up to date to the needs of the people. This focal point could be supplemented by outlying neighborhood centers, which would satisfy daily needs. This would reduce the waste of duplication and provide a major commercial facility to add to the excitement of the individual's environment. The small supplementary areas would also help provide variety for the residential areas discussed previously. Three important items in commercial centers are convenience, accessibility and appearance. The focal point, probably called a central business district, definitely must contain the three above items. The best approach to the control of commercial environment is again the establishment of farsighted and effective zoning ordinances.

The placement of industrial facilities with respect to community is an area which always seems to occur with complete neglect to the well-being of the inhabitants of the community. Many communities depend upon industry for their existence, but

in turn, the industry also needs the community. A good example of the need to control the placement of industry is air pollution and odor. If an industry is placed in such a manner that the prevailing winds blow odor and air pollution across a community instead of away from it, it is possible to make the community an undesirable and even unbearable place to live.

In all the above cases the best weapon to provide for the well-being of the people is controlled growth (zoning).

Community government has provided immediate opportunity to improve civic environment in the areas of public facilities and utilities. Parks, schools, civic and cultural centers must meet the needs of creative surroundings.

Recreation

Many cities suffer from inadequate or poorly placed parks and playgrounds. The most important aspect of park planning is location. It must serve a portion of the community without inconvenience or hazard. A well placed park is central in location and safely accessible to the families in its neighborhood. School grounds are usually well located and should be promoted as community recreational areas.

Civic buildings are characteristically poorly planned and situated. In general, cities fail to supply future civic needs and seldom acquire ade-

quate land for orderly, centralized growth of municipal and governmental buildings. The idea of the civic center as an accumulation of related governmental buildings surrounding a public meeting area is an ancient and valid concept. More emphasis should be placed on this in terms of modern influences. Streets, which create islands of governmental buildings should be discouraged, allowing an uninterrupted composition of civic structures. The forum or "town square" idea, which provides informal public areas between buildings, should be advanced. The properly designed municipal complex encourages public participation and characterizes the people of the region it serves.

A cultural center may or may not be present in a city, but any community of respectable size makes an attempt to establish some civic center. Rural communities usually provide a public library, larger towns a bandshell or museum, metropolitan areas-theatres, concert halls, etc.

The establishment of regional cultural characteristics is important, but no less important are the locations of their facilities within the community. Small cities may find advantages in grouping these buildings within the civic center, thereby sharing certain public facilities, while large communities may find separation of civic and cultural activities a better arrangement. The center idea is a pleasing concept, but may become inconvenient when a community reaches metropolitan proportions. A distribution of activities, perhaps several cultural centers, may better serve the citizens. The proper arrangement is the one which best meets the requirements of convenience and facilities.

Schools attempt to meet the demands of community growth and are probably the best planned aspect of the city. Locations are based on population characteristics and city growth trends, and land is made available by land developers. Traffic hazards to children, however, still exist in too many areas. The successful location is one, central to the neighborhood and removed from heavy vehicular traffic. This is most important in elementary schools.

One aspect of school planning that should be exploited is that of community use. Too many cities attempt to provide facilities for education and recreation that are duplicated in the public schools. This repetition arises from the fact that schools and recreational departments are separate organizations. Mention has been made of the use of school playgrounds for public use outside of school, but this

idea is often discouraged. Other possibilities include shop and classroom use for adult education, and auditorium use for civic theatricals, etc. The facilities for the citizen could improve tremendously with the extension of school facilities into his environment.

Utility Poles

Probably the greatest eyesore on the American cityscape is the utility pole. This forest of plucked trees towering above the rooftops of equally appealing tract houses constitute what amounts to instant blight. Recent advances in equipment and installation make underground placement of cables economically feasible, but most developers still specify utility poles. That we ignore these poles, that we are unaware of their existence when observing a more distant scene is not a truth. One may but visualize the Colorado University campus with utility poles, 125 feet on center, ringing the Farrand quadrangle and piercing Mary Rippon Theatre. Since economic considerations can no longer be argued in favor of utility poles, public utility companies must dissuade their use and provide a significant step toward better visual environment.

It must be obvious that civic governments play an important and initial role in environmental improvements. Response to these obligations is necessary if government is to instill civic pride and inspire community betterment.

Environment is effected by traffic and transportation flow as well as

the philosophical theory of space control in architecture. People are habit forming and can adapt themselves to any mode of transportation, no matter how it effects their living conditions. This does not mean that today's solution of traffic control is successful because people accept it as part of their everyday existence.

The problems of separation of collector, arterial, and high-speed streets can be solved easily if a standard of objectives could be set for these circumstances. The street on which you associate yourself is a collector street. They are attached to the arterial streets which combine the commercial, industrial, and residential areas into one unit. All commercial traffic should be channeled into the arterial streets from the high speed circulation pattern of the city. A proper solution should allow parking and local traffic on collector streets and restricted parking, commercial traffic, and higher speeds on arterial roads.

The high-speed street is used for exit and entrance to a city and for by-passing the city. They should have limited access to the city and should only connect to arterial streets. A proper location of these highways would be on the edges of the city where noise can be reduced and the proper controls can be introduced.

Pedestrians

By separating the functions of the various streets in a city, the fundamentals of urban planning can be advanced to a point where an environmental control can be solved. Not only is the solution of combining various vehicular problems needed, but the pedestrian has to be introduced into the scheme. Today the pedestrian walkways are combined with the vehicular lanes of traffic. Using this system we have distorted our views of the city architecture around us and have helped to reduce our population in a very barbaric way. The proper solution would have to be complete separation of the automobile and man. The lanes of automobile traffic could be depressed, elevated, covered, or combined in any number of ways. By doing this the cityscape would be enhanced, and the living areas of our city would be free of mechanical devices to allow a pleasant and exciting environment.

A solution to parking problems also arises from this separation of vehicular and pedestrian circulation. The large areas of parking created in a downtown area of a metropolitan city could be depressed below the streets and buildings or fitted into

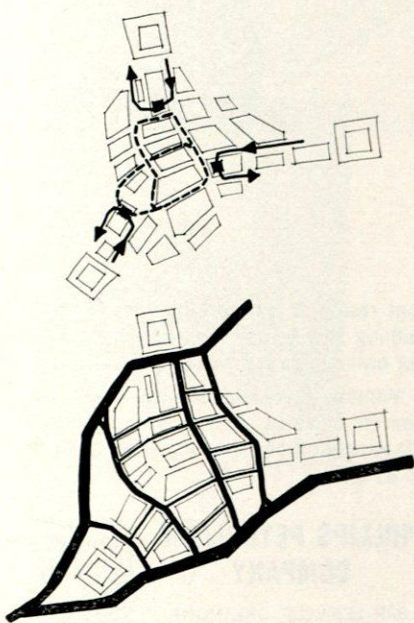
structures specifically designed for this purpose. Not only would these approaches reduce large areas of concrete and asphalt, but they would alleviate the spaces needed for parking, which then could be utilized for other public functions such as parks and civic groupings. In our lives today these functions are more important to complete our total environmental situation than paralled parking spaces in front of commercial establishments.

Suburban Parking

Another solution to this parking problem is placing parking areas on the outside edges of a commercial and high population section of a city: actually create suburban areas for parking rather than using these areas for rows of ugly, poorly designed homes to become our next slum area. If we could totally exclude parking devices and roads from our city cores, there would be more space for the finer, more desirable things in life. The surrounding parking areas could be located on main roads leading to the centers of the city. They could be connected by public transportation facilities.

The public carriers could range from buses to monorails. They could function over, under, or on the surface of the city. Their effect on the urban design would be one of interconnection of parts and a combination of areas to create a total environment.

The above statements of land use, public facilities, and transportation are what have been brought about by the present patterns of community development. It is obvious that in most cases these patterns must be modified in order to achieve a more attractive and workable living environment. When developers, investors, planners, engineers, and architects disregard the visual, three-dimensional effects of planning and development proposals, the results are chaotic monotony. Too often the decisions affecting the physical nature of the community are based solely upon short term economic and functional considerations. When speculators learn that community appearance, as a planning consideration, is just as important as functionalism and economy, the prime objective of city planning, which is to create a safe, healthy, convenient and enjoyable place for people to live and work, shall be achieved. This will be a Creative Environment.



RAPID TRANSIT (ABOVE) AND COLLECTOR-ARTERIAL TRANSIT SYSTEMS



You get one... then what?

Your first job after college can be a good beginning. Or it can be the first step in a succession of disappointments. That's why it's so important that you make the right career choice now. But how do you choose?

You're young, enthusiastic, eager... and you've worked hard to earn your degree. You want to make the most of your capabilities. You want plenty of room to grow...yet with it all you'd like a good sense of security.

So take a look at us—Phillips Petroleum Company. By industry standards,

we're young. We, too, are enthusiastic—and we've been growing rapidly. This enthusiasm, plus curiosity, and, sometimes just plain hard work have led us *profitably* into many diverse fields—agricultural chemicals—atomic energy—plastics—rubber—specialized chemicals...with more coming to complement our line of conventional petroleum products.

We feel the success of our work rests with the dedicated people we have, including thoughtful young men like yourself—with plenty of ambition and a good grasp of their basic discipline. Men like

that really enjoy working for us. And nothing pleases us more than promoting our own people from within.

Whatever your specialty—from research to sales—check your campus placement office for an interview or write to us today.

**PHILLIPS PETROLEUM
COMPANY**

BARTLESVILLE, OKLAHOMA



An equal opportunity employer

COLORADO ENGINEER—January, 1964

Engineering at the University of Colorado



Max S. Peters, Dean,
College of Engineering,
University of Colorado

On our visits to high schools throughout the State of Colorado, we have had a chance to talk with students facing a career choice and to see the kind of questions which are uppermost in your minds. In the following pages we would like to answer some of these questions and, at the same time, explain what the College of Engineering at the University of Colorado has to offer students who wish to enter its undergraduate curriculum.

One very natural question always is: What are the opportunities for graduates? Recently the Engineering Manpower Commission predicted that there will be an increase in job opportunities of 45% within the next decade. Dean G. R. Fitterer, President of the Association of Engineering Colleges of Pennsylvania, conducted a survey of graduates of a typical engineering college and found that about half of each 1,000 group of graduates were presently engaged in the following capacities: 2 as chairmen of corporations; 23 as presidents of companies; 31 as vice-presidents; 37 own their own companies; 42 are general managers; 48 are assistant general managers; 75 are chief engineers; 38 are division heads; 22 are sales managers; 14 are directors of research laboratories; 150 hold research positions. The other half, or the younger engineers, eventually are expected to fill similar positions proportionately.

Such figures speak well for both the students who have the determination to succeed in engineering and the engineering curriculum that prepares them for the positions that they occupy. With our projected Engineering Center on the University of Colorado campus and our fine engineering teaching faculty we feel we offer ideal conditions for an education leading to a rewarding career in engineering.

What is the College of Engineering at the University of Colorado doing that is of particular significance? Principally, we are complementing the growing scientific and technological activity in the State of Colorado as well as in the nation.

Accomplishments during the past year in our undergraduate curriculum in-

clude the development of a new instrumentation laboratory in Electrical Engineering, a special measurements laboratory through our Superior Students Program. We have expanded our undergraduate research programs and have introduced a new and advanced mechanics sequence for our Mechanical Engineering undergraduates and a new series of courses designed especially for Architectural Engineering students. We have expanded our undergraduate education in the Aerospace Engineering Sciences Department by means of special courses in Theoretical Aerodynamics and Foundations of Propulsion. Also, we have experimented with new teaching methods, particularly in applied mathematics and are making it possible for students to gain experience with digital computation methods that will be an asset to them in their careers. Finally, the College has started a highly successful television course in mathematics to experiment with more effective faculty teaching.

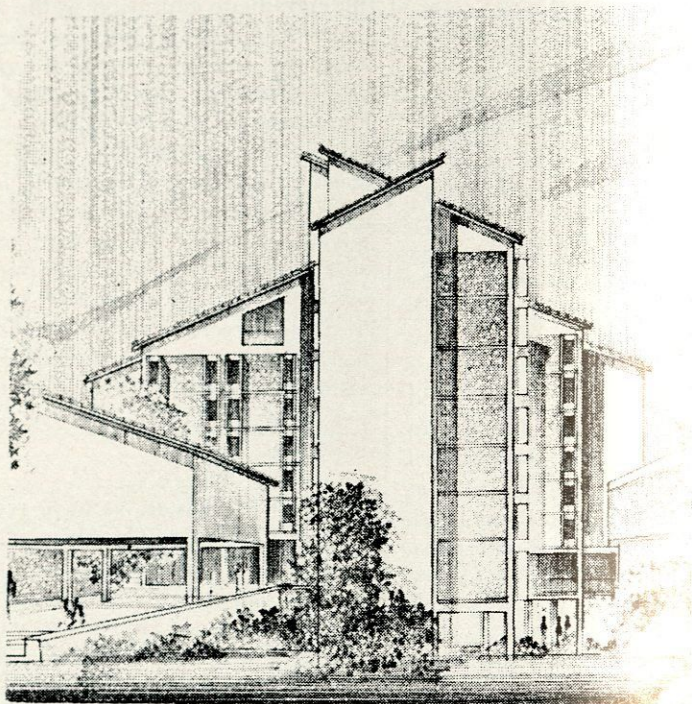
Many of our programs have received important foundation support. Our efforts in the major updating of the undergraduate curriculum and the attraction of prominent teachers and researchers to our campus are now gaining national attention for our College as an important educational center in the United States.

What about scholarships for students? In the area of scholarships during the past year, thirty were awarded to students by industry, twenty-eight through the Development Foundation; other aid was administered by the University of Colorado through the Office of Financial Aid.

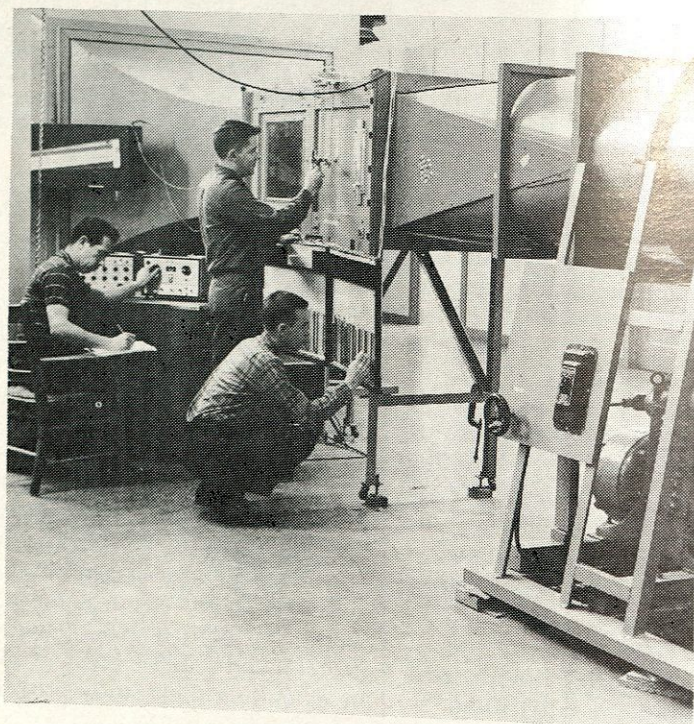
What about exceptionally well qualified students? In addition to its regular courses, the College of Engineering conducts a more intensive and special program for exceptional students to provide them with a firm foundation for eventual graduate study in science and engineering.

Is there a combined business and engineering curriculum? Undergraduates in the College of Engineering with career interests in administration may complete all of the requirements for both a B.S. (engineering degree) and a B.S. (business degree) by extending their study programs to

Architect's drawing of the \$9 million Engineering Center under construction.



Aerospace Sciences students using the wind tunnel.



five years. Combined business and engineering programs are available for students in aerospace, applied mathematics, architectural engineering, chemical, civil, electrical, engineering physics, and mechanical engineering.

You may have questions about the departmental areas of study which we have at the College and we hope that the information which we have gathered for you will be of help.

Max S. Peter
Dean

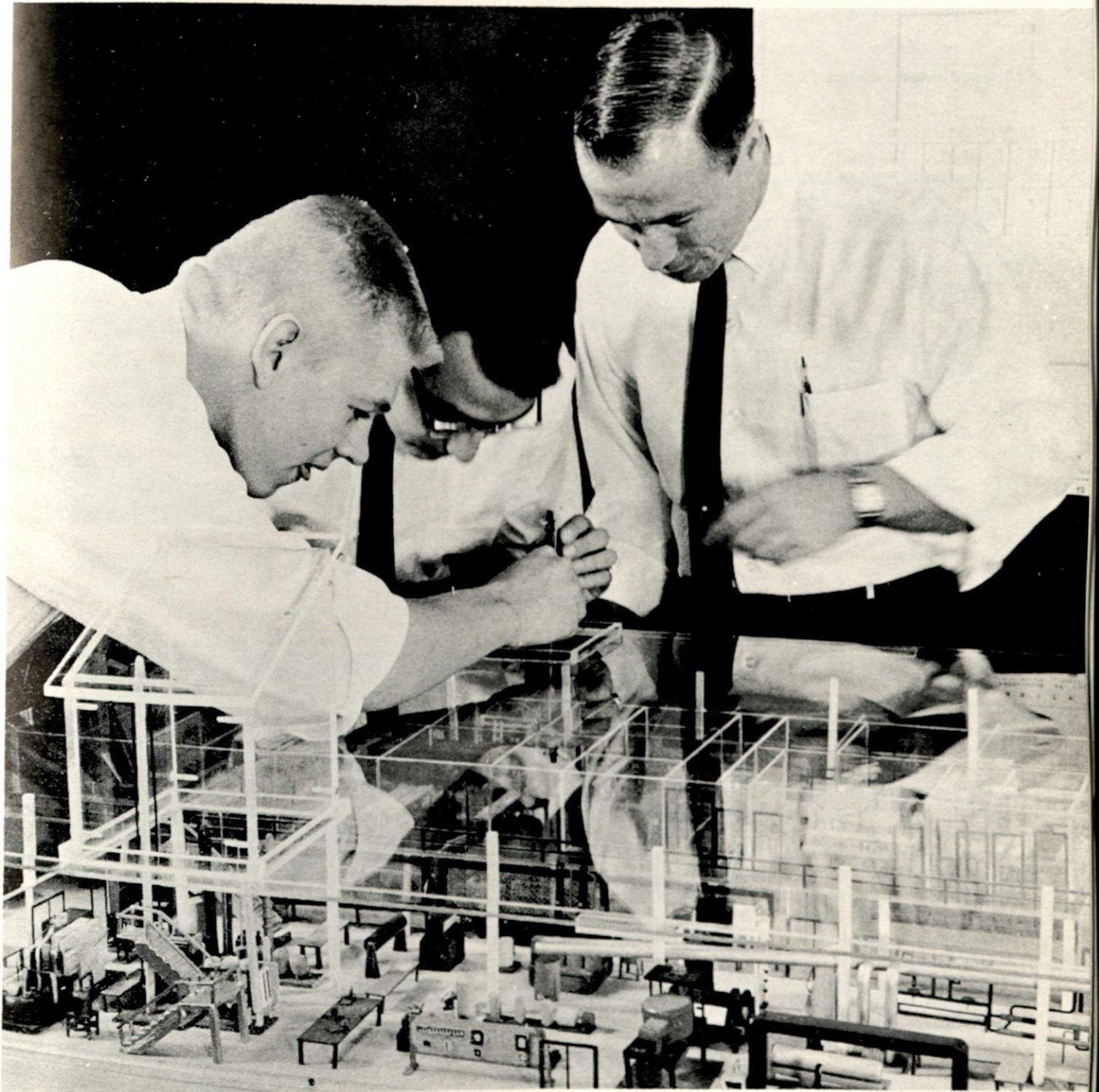
Aerospace Engineering Science

What does the department offer? The Department of Aerospace Engineering Sciences plays a unique role in the education of the engineering students because it is the only department of its kind in the State of Colorado. Instruction centers on fields of aeronautics, propulsion, astronautics and space sciences, guidance and controls, and materials. Undergraduate courses in theoretical aerodynamics, foundations of propulsion and space flight have been added recently. A major portion of the first three years is devoted to mathematics, physics, graphics, mechanics, chemistry, composition, literature, economics, and other subjects. In the fourth year the student specializes in some field of aerospace such as design, propulsion or controls.

What careers are open to aeronautical engineers? The aircraft industry is one of the largest employers of technically trained men and women. There is need for engineers who are able to design, develop, and manufacture airplanes, helicopters, missiles, and other space crafts. Aircraft companies employ aeronautical engineers in the fields of structures, aerodynamics, vibrations, and flight testing. Commercial airlines use aeronautical engineers to improve safety of aircraft operations and to keep airplanes in good flying condition.

The aircraft engine industry uses many aeronautical engineers in the design and testing of rockets and jet engines. Research organizations, such as the National Aeronautics and

Undergraduates in a plant design class put final touches on a model of a wing for the new Engineering Center.



Space Administration, employ many aeronautical engineers to study advanced aeronautical problems.

Students in the department will have an opportunity to study and come in contact with faculty members who have national and international reputations. This year, for example, we have on campus Professor Adolf Busemann whose swept back wing design was developed in the 1930's. Every high speed commercial airplane flying today uses this design.

Applied Mathematics

During the past several years, the field of applied mathematics has achieved a new kind of importance. A large portion of the research done today is theoretical, and applied mathematics is its cornerstone. Applied mathematicians are in demand in research and development departments throughout government and industry. Jobs vary from digital computer programming to extremely high-level mathematical analysis. Much of the need is for well-trained people with a broad background in fundamental mathematics and science and with the ability to bring original ideas to bear on interesting and important but quite difficult problems.

Keeping in step with the new technological demands, the Applied Mathematics Department has almost completely revised its entire curriculum. The freshman and sophomore courses now consist of a unified sequence of material designed to put somewhat more stress on fundamental understandings and to present topics in an order that more nearly coincides with the needs of concurrent courses in physics and engineering.

Of all the developments in modern technology, the electronic digital computer is probably the one that has made the greatest impact. Not only have many of the routine problems of science, government, and industry been relegated to automatic digital computer solution, but also many problems that were impractical to solve because of the enormous computational burden have become amenable to computer methods.

Students in applied mathematics have for many years been taking courses in

numerical methods and computer programming. A new one-semester-hour course on the sophomore level is being offered for all engineering students. This, or its equivalent, will eventually be a requirement for the Bachelor's degree in the College of Engineering. At the present time the programming language taught is MAD (Michigan Algorithm Decoder) in order to enable the students' problems to be run on the University's IBM 709 computer.

The undergraduate program in applied mathematics is designed to give training in mathematics and in the technical ideas of engineering. The first two years include basic courses such as English, chemistry, mathematics, and physics; the third and fourth years include mechanics, electricity, and thermodynamics as well as advanced courses in mathematics. In the advanced courses the students learn how to put practical problems into mathematical language (or, in modern terminology, how to build mathematical models) as well as how to handle the resulting mathematics.

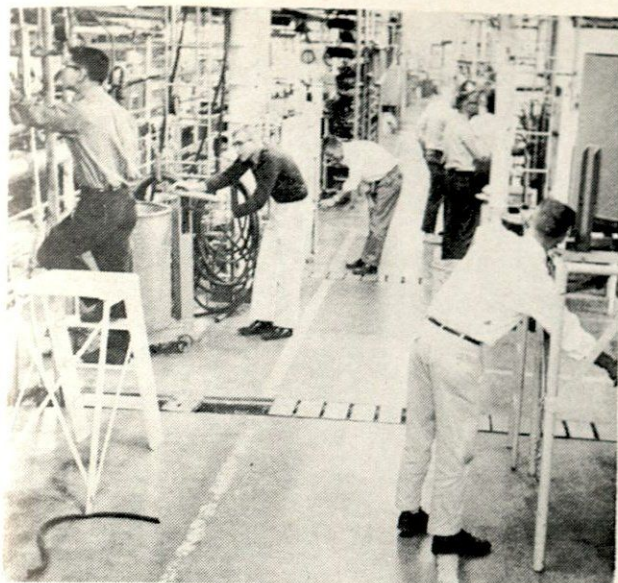
The Department also has a graduate program leading to the degrees M.S. and Ph.D. Much of the graduate program is recent in development and many highly qualified and distinguished faculty members have been acquired in recent years. The University of Colorado is now one of the few universities in the United States which grant a Ph.D. degree in applied mathematics.

Architecture and Architectural Engineering

The professions of architecture and architectural engineering are concerned with the building industry—with providing society with its homes and shops, its dams and schools. The services of the industry begin with evaluation of a proposed project—its relationship to the needs of its social and physical community—and continue through the creation of a three-dimensional solution which gives concern to the shape, form and quality of space within and around the building; analysis of soil conditions; understanding of construction processes and the necessary business activities which these require; development, manufacture and distribution

A student discusses a thesis project with his faculty adviser.





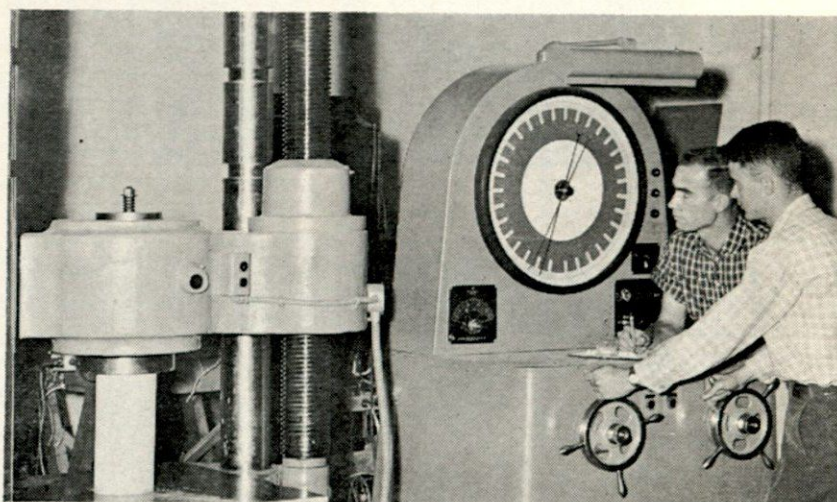
*Activity in the
Chemical Engineering
shops and laboratories.*



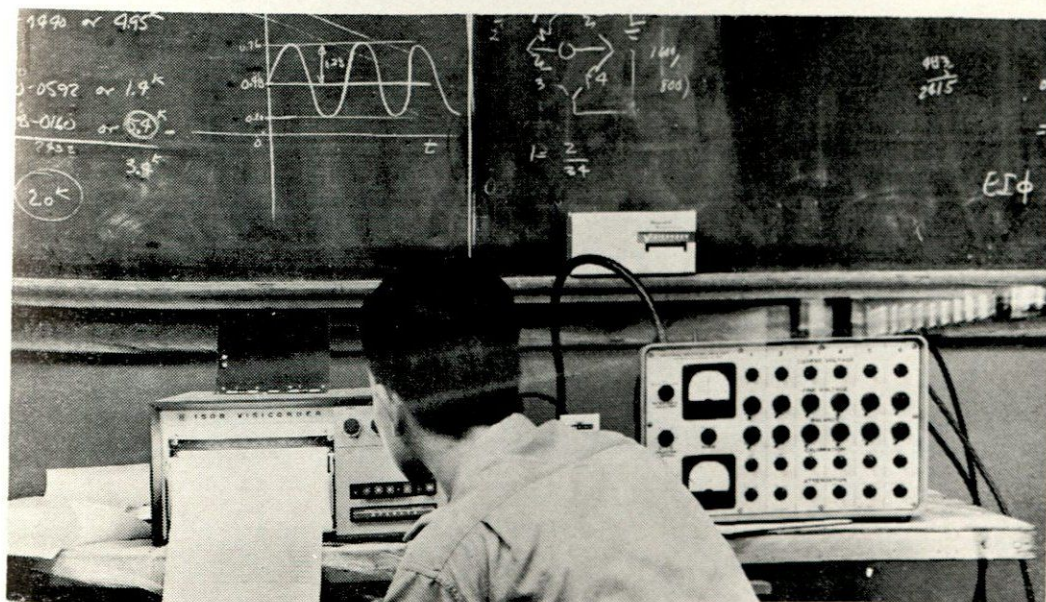
*An Engineering Physics
student attentively watches
his measurement experiment.*



*Civil and Architectural Engineering
students learn about
actual community needs.*



*Students operate a
structural testing device.*



*A visirecorder graphically
presents experiment data.*



*Electrical Engineering students
and faculty member
fire laser light beams.*



*A view of Ketchum, one of
the present Engineering buildings.*

of the products from which buildings are formed; and supervision of the actual unifying of these products into the building. The urban planner, landscape architect and the interior designer are additional members in the team of builders.

Academic background for careers in this facet of society is provided through curricula in architecture (School of Architecture), architectural engineering (College of Engineering and School of Architecture) and a combined program in architectural engineering and business administration (Engineering, Architecture and the School of Business).

The architectural engineer serves the building team in the technical and scientific aspects of the industry with special emphasis on the design of systems which serve the structural, heating, air-conditioning, lighting and acoustical needs of the building. His course of study must include the fundamental sciences necessary to an understanding of these technical areas. His interests carry him into the development of new materials and methods.

The architect concerns himself with evaluation of the basic building need and creates a design which provides proper physical and esthetic environment for that need. His responsibilities require extensive study in social sciences and the humanities in addition to creative and technical courses in architecture.

The combined engineering and business program complements architectural engineering background with further understanding of business processes and is particularly beneficial to the individual who will concentrate on contracting, personnel management, sales and similar specific facets of the industry.

Chemical Engineering

Courses of study in chemical engineering are concerned with those principles of physics, chemistry, and general engineering which are basic to industrial manufacturing processes. Chemical engineers turn chemical discoveries into the actual machinery of industrial production and few pro-

fessional men have contributed more fundamentally or more widely to the success of the vast American industrial complex.

Many American corporations which manufacture chemicals, paper, paint, motor fuels and lubricants, rubber products, metals, plastics, food products, glass, cement, detergents, and numerous other products owe their existence to the talents and efforts of the people in this profession. Chemical engineers also work for organizations that produce and use nuclear energy and liquid and solid rocket propellants. They are employed as technical experts in research and development activities, engineering design and construction, manufacturing, sales, and in management and administration.

The first two years are devoted mainly to basic course work in physics, mathematics, chemistry, and English. In the third and fourth year professional courses such as unit operations, unit processes and thermodynamics and their universal application to chemical engineering problems are presented. Technical subjects are supplemented with studies in literature, social sciences and the humanities.

Civil Engineering

Our Civil Engineering Department offers several broad areas of study: *Structural Engineering*—the design and construction of buildings and projects like tunnels, transmission-line towers, subways; *Transportation*—design of highways, streets; creation, operation of air terminals, ports and harbors, railroads, and other systems; *Hydraulic Engineering*—systems of water transmission and characteristics of flow through open channels or pipes, reclamation and dam design; *Sanitary Engineering*—design and operation of water treatment and distribution systems; *Municipal Engineering*—city planning, zoning, and land use in relation to services provided by a municipality; *Soils and Foundation Engineering*—study of the supporting capacity of soils and an understanding of geology. Because the fundamental goal in each of these areas is to create the most suitable environment for our society, the civil engineer perhaps can be characterized as an environmental engineer.

In addition to the traditional functions of the civil engineer, today he must solve new and complex problems, with sophistication and skill. The civil engineer, for example, is becoming increasingly concerned about entire new systems of transportation such as monorails and the concepts of moving highways rather than moving vehicles. Reclamation projects now are being planned on a scale that pales anything ever done. Conversion of salt water to fresh water for use in our communities is in part already entirely feasible. Many new materials for housing and other types of structures are daily being created as well as exotic design plans for lunar housing for survival of people we expect to land on other planets. Within the next twenty years our population will increase by approximately fifty million people, almost all of whom will choose to live in a major urban area, posing challenges for the civil engineer engaged in urban engineering.

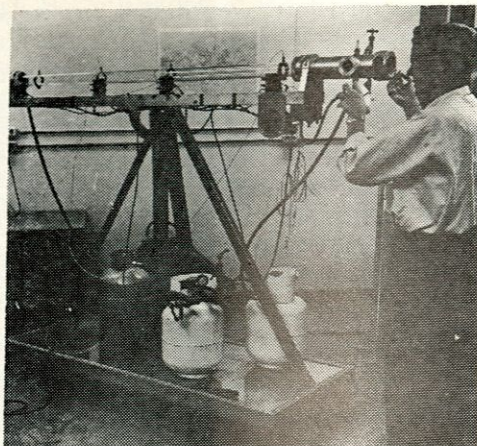
A large number of the people graduating in civil engineering at the University of Colorado continue on in graduate programs leading to a Master of Science or a Ph.D. Of those who seek direct employment, a number find positions in consulting engineering offices. After a time, one may decide to obtain a license to practice engineering and even may choose to establish one's own office. Other graduates choose employment with some branch of the government—federal, state, or local. A large group selects employment with industrial firms and in many cases eventually reach the objective of working at management levels.

Electrical Engineering

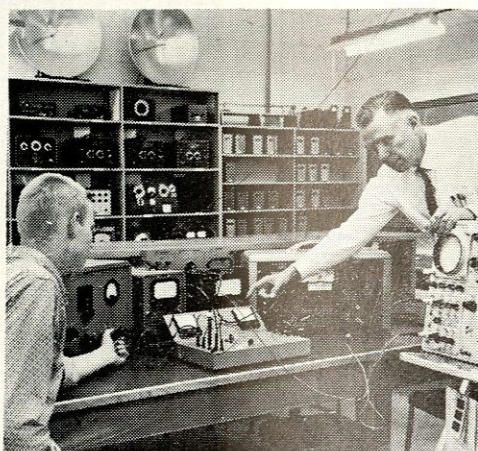
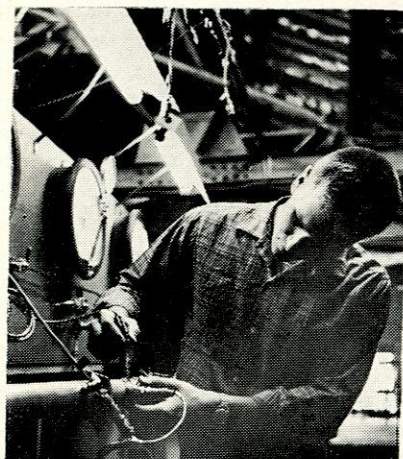
What does an electrical engineer do? His professional activities in society are covered by a very wide span of possibilities. In a broad sense, he might be active in one of four possible areas: in teaching and research at a university; in research or development of new electrical or electronic devices, instruments, or products; in production and quality-control phases of electrical products for private industry; or in the sales or management division of a private firm.

The student in our Electrical Engi-

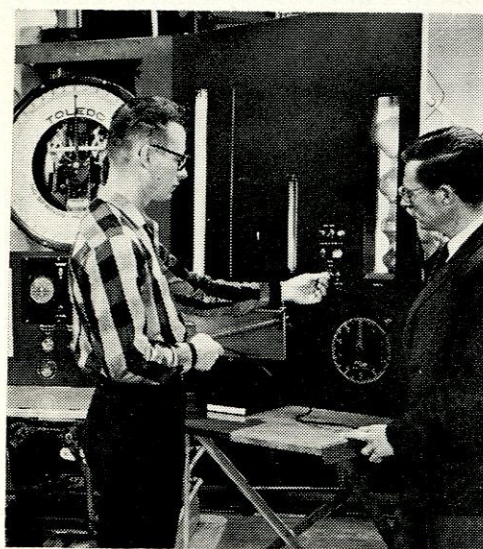
Igniting a combustible mixture in a flame tube part of the Aerospace laboratories.



Calibrating flow measurements.



Performing experiments on a transistor test set-up.



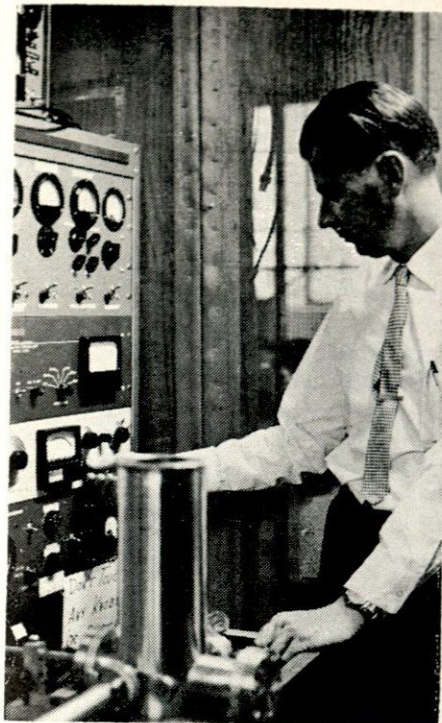
Determining the fuel consumption rate on a spark ignition engine loaded by a dynamometer.

Performing an Orsat analysis of gases by means of chemical actions.

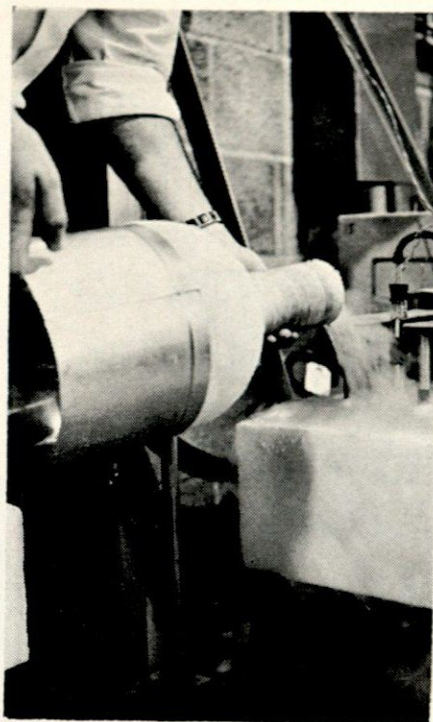


neering Department receives a sound background based on time-tested principles of physics, chemistry, and mathematics as the core of his first two years. An early, intensive training in the theory and laboratory application of electrical circuits is covered in his sophomore year. In his third year, the student learns more fundamentals in electronic circuits, electromagnetic and transmission theory, electrical machines and transformers, heat, and mechanics. In the summer between the junior and senior years, many students find an opportunity to put their knowledge to work with jobs in industry or research projects being conducted at the University. The senior year is devoted to more advanced courses in electronics and to certain more specialized courses.

As part of their studies on the nature of coherent light emitted by lasers, a team of juniors under faculty direction recently sent what were believed to be the longest laser shots from one point on the earth to another. The study is illustrative of the many ways in which electrical engineering students complement the theoretical with the practical.



Taking a molecular beam reading on a frequency standard tester built by a faculty member.



Conducting low temperature experimentation necessary in many fields of engineering.



Preparing a micrograph for a metallurgical studies.

Engineering Physics

The courses in engineering physics are designed to give students a thorough foundation in physics and in the application of physics. The freshman and sophomore years are devoted to general courses. In the junior and senior years, physics is studied in the kind of detail that represents the versatility of the physicist's profession, leading to a knowledge of various branches such as nuclear and atomic physics, electronics, thermodynamics, mechanics, electricity, and magnetism. The training received prepares the student for a career with vast opportunities in development work and research for government, industry, and in academic areas.

The mechanical engineering curriculum is designed for preparing the graduate to obtain meaningful pro-

Mechanical Engineering

fessional employment in an extremely wide range of engineering positions and to equip the student with the necessary basic tools of his chosen profession so that his education will not become outdated as new concepts and techniques are introduced. Through constant close contact between a member of the faculty and the student, each student is insured that his four years of training will be of as great a benefit to him as possible.

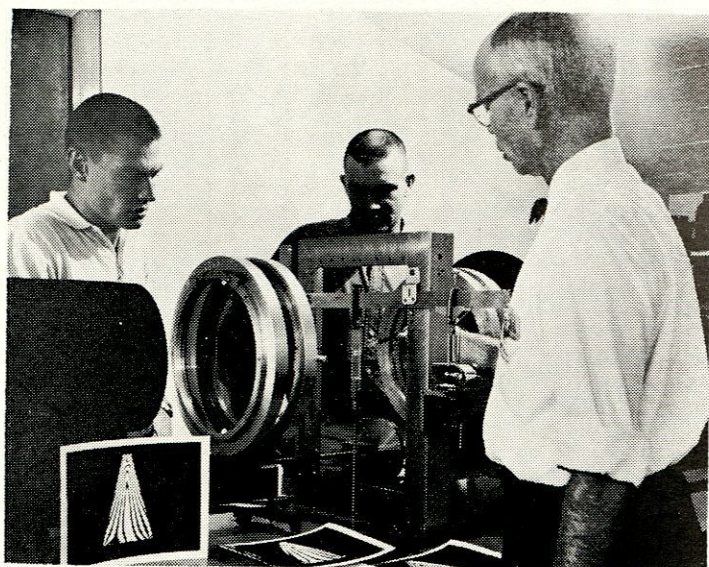
The demand of industry (chemical, aerospace, heavy equipment, automotive, consulting, electronics, research, and others) for the properly trained mechanical engineer is increasing much more rapidly than the supply, and all indications point to this gap widening at the bachelors, masters, and Ph.D. levels. The

Mechanical Engineering Department at the University of Colorado has the physical facilities and teaching staff to provide this type of training for the undergraduate student. In order to better fulfill the great demands of industry on the mechanical engineering graduate, after his second year, and after the student has determined his interests and areas of capability, two options are available within the department. These are the professional option and the more highly theoretical engineering science option. Both options are extremely valuable and the choice would depend primarily on which direction of professional activity the student would wish to pursue upon graduation. Prospective students and their parents are encouraged to talk with members of the mechanical engineering faculty.



Taking oscilloscope readings in the electrical engineering laboratories.

Undergraduates conduct stress analysis by means of polarized light processes.

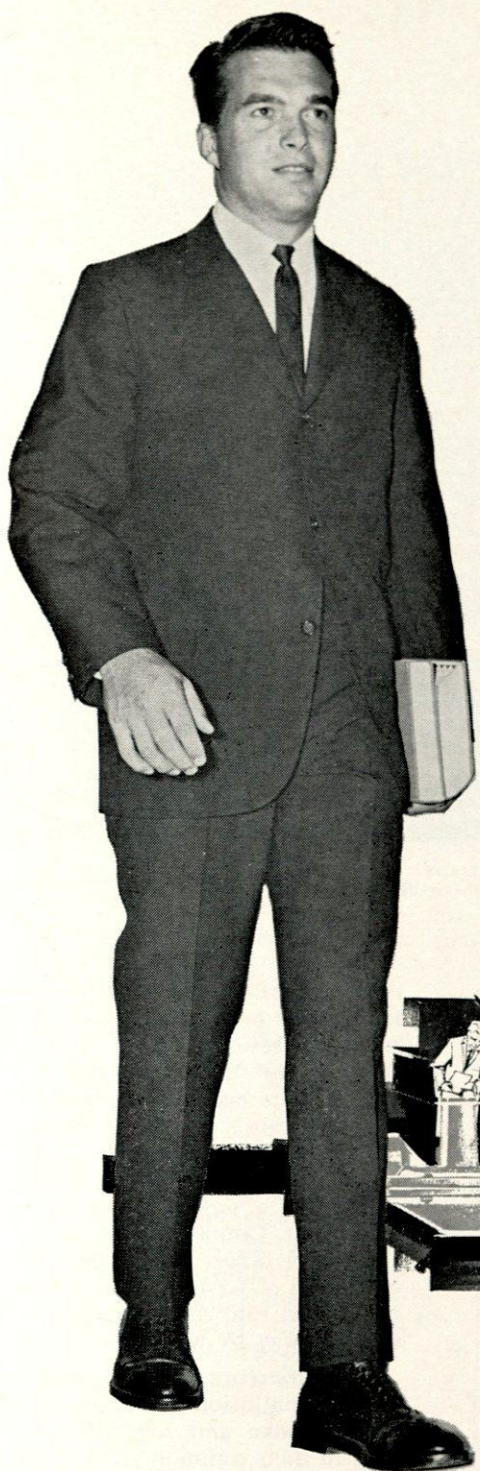


English in Engineering

The courses offered in the Department of English in Engineering are essentially the same as those offered in other colleges, but they are adapted to the needs of students who do not intend to major in English. The aim of the department is to teach students the fundamentals of acceptable usage, to give them an opportunity to improve their skill in communicating facts and ideas, and to assist them in developing their understanding and appreciation of literature. Electives in poetry, fiction, and drama are open to all students.

Engineering Graphics and Machine Design

The Department of Engineering Graphics and Machine Design offers instruction in engineering graphics to freshman engineering students and machine design and allied subjects to upperclassmen. Studies are under way to create an undergraduate program called Engineering Design and Economic Evaluation. The curriculum will include conventional engineering courses and then concentrate predominantly upon creating design, economic evaluation, and cost analysis.



Engineers

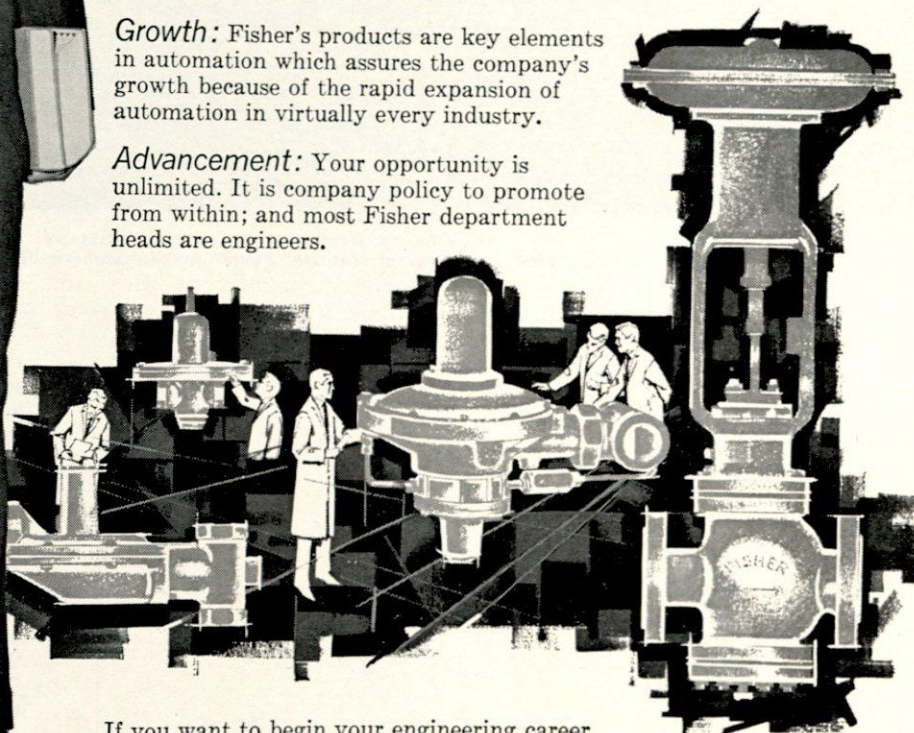
*In Choosing a Career,
Consider these
Advantages—*

Location: Fisher is basically an "Engineering" company with 1,500 employees located in a pleasant midwest community of 22,000. It's less than 10 minutes to the Fisher plant from any home in Marshalltown.

Type of work: You'll become a member of an engineering team that has produced some of the outstanding developments in the field of automatic pressure and liquid level controls.

Growth: Fisher's products are key elements in automation which assures the company's growth because of the rapid expansion of automation in virtually every industry.

Advancement: Your opportunity is unlimited. It is company policy to promote from within; and most Fisher department heads are engineers.



If you want to begin your engineering career with one of the nation's foremost research and development departments in the control of fluids, consult your placement office or write directly to Mr. John Mullen, Personnel Director, FISHER GOVERNOR COMPANY, Marshalltown, Ia.

*If it flows through pipe
anywhere in the world
chances are it's controlled by...*





AIR VIEW OF DENVER FROM 7TH AND WILLIAMS
All photos courtesy of National Center for Atmospheric Research

WHAT ARE YOU BREATHING?

MARK SHERIDAN

Anyone who actively supports FAC at the Tule or the Sink has seen and felt the results of air pollution. Students rub their eyes and cough; their throats become dry and parched. The cause of this pollution is the same as the cause of air pollution in our large cities: too much airborne garbage in a stagnant, confined volume of air. Contamination of a city's air supply occurs when the millions of pounds of waste materials that are introduced into the air daily are not carried away by winds.

The difference between smoke, fog and air pollution should be understood. Smoke and fog will be used here in their common sense; smoke is the product of incomplete combustion and fog is water spray suspended in the air. Community air pollution is defined by a federal committee as "... the presence in the ambient atmosphere of substances put there by the activities of man in concentrations sufficient to interfere directly or indirectly with his comfort, safety or health, or with the full use and enjoyment of his property..." In short, this is floating rubbish.

Polluted air can contain any number of impurities. Different cities have

different types of pollutants because the factories, geographic conditions, size and activities of the communities differ. For instance, Birmingham and Scranton have impurities in their air from burning solid fuels. Pollutants from petro-chemical plants near Houston and New Orleans affect the atmosphere near these cities while other communities are concerned with dust from cement factories and some large cities might contain almost all types of pollutants. In New York City, for example, health officials have measured the contribution to pollution of dried pigeon droppings from wild pigeons.

Sources

Unfortunately, there is no single impurity in the air of our cities that can be filtered out, thereby eliminating air pollution, because there is no single source of the impurities. Pollution is the result of the total activities of a community. Dirt from vacant lots, dry cleaning liquids, evaporated gasoline, barbecue pit smoke, factory metallic dusts, and cigarette smoke all contribute to a city's pollution dilemma. Naturally, some sources are greater problems than others. It is with these sources that pollution control centers are most concerned. To determine the prime origins of impurities, scientists and engineers must first determine the most prevalent ingredients in impure city air. Since the pollutants of a city's air are determined by the activities of the area, no two cities will have exactly the same impurities. Nevertheless, some compounds are common to all polluted urban air.

Sulfur dioxide was originally thought to be the major contributor to the Los Angeles smog problem. It is produced in the combustion of coal, although not usually in concentrations which are harmful to human beings, but in moist air some of the sulfur dioxide combines with water to form sulfuric acid. These sulfuric acid traces are particularly harmful to people with respiratory or heart ailments.

Formaldehyde is a product of all incomplete combustion from home incinerators and automobile engines, especially diesel engines.

Nitrogen oxides result from all combustion processes. These oxides react with oxygen from the air to form NO_2 . The concentration of nitrogen dioxide in the air has never been known to be a hazard by itself. However, this gas reacts with olefins (unsaturated hydrocarbons) to produce the eye-burning smog found in the Los Angeles area. The olefins

come from the combustion of petroleum products.

Carbon monoxide from automobile engines and ozone from electrical machinery are usually found in polluted air, also. Both of these gases are poisonous, but their concentrations seldom, if ever, reach a level in the open atmosphere that is lethal.

These impurities alone are not enough to produce the type of smog found in southern California. The meteorological and topographical conditions of a city must also be conducive to stagnant, warm air. The peak smog seasons of both Los Angeles and Denver are in the winter. During this period air turbulence in both areas is at a minimum. The Los Angeles smog problem is much more acute, however, than that of Denver. The main reason for this difference is the difference in temperatures of the two cities. Nitrogen dioxide and the olefins need temperatures of 70° or higher to produce eye-burning smog. Los Angeles' climate has these high temperatures, but Denver's does not. Although the Los Angeles atmosphere would still be hazy in the wintertime, its smog would not have the irritating effects that it has when the climate is warm.

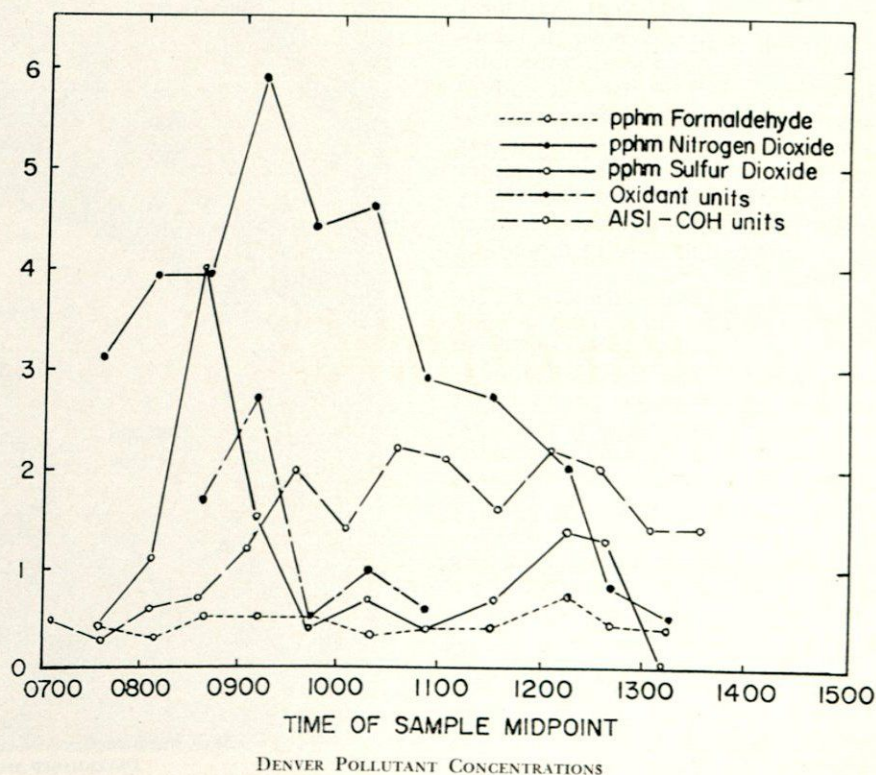
The consequences of air pollution are hard to evaluate. Exposure to smog over a prolonged period of time is quite certainly detrimental to man's health, but no one knows exactly how

detrimental. The harm air pollution does to our bodies is extended over years of time; the effects are subtle and, at present, the results can only be estimated. People with respiratory and heart ailments have found relief from these troubles by moving from an area of high pollution to one of cleaner air. Conversely, the death rate of people with respiratory problems does increase in an area when the degree of air pollution is high over extended periods of time. In December, 1952, five thousand deaths in London were attributed to the effects of a five day smog period.

Psychological Effects

Psychological effects of polluted air and smog are also very important. With the irritation of one's lungs and eyes comes the irritation of his mind. With this irritability comes discontentment, ill temperment and mental depression.

The dollar value of clean air is hard to assess due to the slow action of the pollutants. It has been estimated that dirty air costs the United States between \$10 billion and \$15 billion annually. This cost results from metal corrosion, building depreciation and deterioration, crop and livestock damage, real estate depreciation, extra cleaning and laundry bills and many other results. This estimation does not include the indeterminable dollar value of human health and happiness.



More and more communities are becoming dissatisfied with their air pollution problems. Leaders of communities are studying the situations, editors are writing editorials, state legislators are voting appropriations, and some are even passing a few laws.

Actually, the problems are not new ones. Leaders have been studying, writers have been writing and legislators have been passing laws about air pollution for centuries. Back in 1306 King Edward I proclaimed the use of sea coal illegal because of the filthy smoke it produced while burning. In 1307 one freedom-minded individual broke the law and was consequently condemned and executed. Edward may not have been diplomatic, but he was effective. As it turned out though, the King's revolutionary air pollution reforms were cut short by another revolution—religious and political. Edward's control over the pollution problem was removed with his head.

The people of London did not allow the revolution to distract their attention from air pollution. A short time later, in 1661, John Evelyn impatiently wrote that London was submerged "... in Clouds of Smoke and Sulfur, so full of Stink and Darkness." Of course London did not then have the smog problems that it has now. Legal control of air pollution has become necessary in many industrial cities throughout the world.

One of the biggest legal barriers of air pollution controls in the United States is deciding what level of government should have that control. In many cases the air contaminants originate in one city and pollute the air of surrounding cities and suburbs which have no legislative power to control the pollution. On the other hand, rural dwellers argue that they should not have to pay state taxes that are to be used to solve this urban problem.

Some states have found a workable solution in the establishment of an inter-county board that is able to consider the difficulties of an entire region having one common pollution problem. With the regulatory powers given to these boards usually come enforcement powers, also. California recognized the common pollution difficulties of the entire San Francisco Bay area and in 1955 established a six county control board to regulate the pollution over that area.

In some few instances states have felt the need for statewide legislation to adequately control general pollution. California passed a law

requiring all new car owners to have exhaust filters installed in their cars' exhaust systems within one year of the date that the state government approves two of these filter systems.

States have spent their appropriations mainly for the establishment and enforcement of pollution laws, while the basic research on atmospheric impurities has been financed largely by the federal government. The Robert A. Taft Sanitary Engineering Center in Cincinnati is the largest organization studying air pollution under federal grants. Its budget is roughly one million dollars a year.

College Research

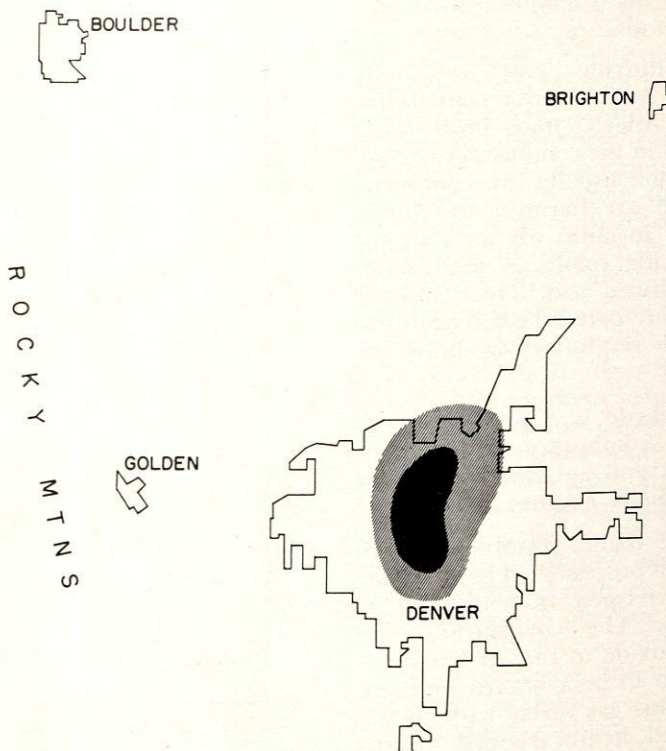
Approximately two or three million dollars a year is given by the federal government to colleges and universities throughout the nation to study atmospheric pollution. Many of the California universities, e.g. University of California at Berkeley, USC, Cal Tech and the University of California at Riverside have pollution programs. These are also sponsored by the state and a citrus growers co-op. The University of Utah is studying the agricultural effects of pollution, LSU is involved in finding methods of determining the less common substances in air pollution, and the University of Wisconsin is studying the economic effects of pollution. Colorado State University has undertaken two programs: one of these is the simulation of air flow, and the

other is an evaluation of meteorological effects of air pollution. Other schools are currently studying other phases of pollution control.

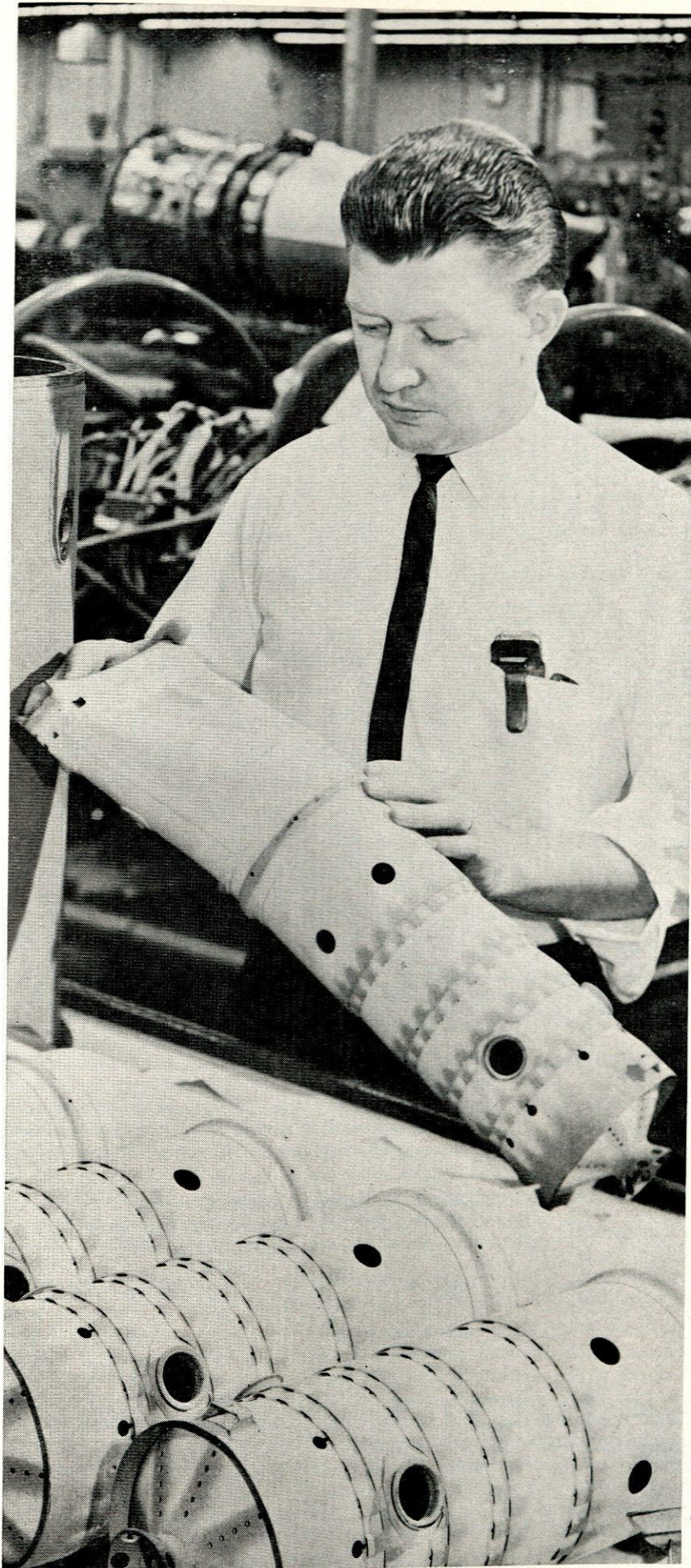
In Boulder, the National Center for Atmospheric Research has three groups that have undertaken pollution programs. Dr. James Lodge is establishing analytical methods of measuring some common pollutants. Dr. E. A. Martell is conducting research in the field of pollution fallout. Dr. R. D. Cadle is studying the reactions of trace materials in the atmosphere.

The American Association for the Advancement of Science is sponsoring a broad report on pollution which the Air Conservation Commission is putting together. Professor Howard Higman of the C.U. sociology department and Dr. Lodge are contributing to this report. Its purpose is to state the facts known about atmospheric pollution, identify the public policy issues that will arise from the effects of pollution, express ideas about who should bear research responsibilities, and point out the areas where scientific knowledge is lacking.

The report should collect much information that is badly needed. Nevertheless, the problems that cities face in effectively reducing their levels of air pollution are complex, and it will take a great deal of time, money and effort to eliminate them.



MAP SHOWING EXTENT AND SEVERITY OF POLLUTION AS DETERMINED THRU AIR PHOTOGRAPHY



■ Reuben C. Gooderum, BSME Wisconsin, 1962, is shown examining combustion liners after a thermal paint engine test at Allison Division, General Motors, Indianapolis, Indiana. Thermal paint, developed by Allison, is used to determine temperature gradients existing on engine parts.

Gooderum is one of the young engineers at Allison assigned to design and development of air-cooled turbine engine hardware. This work involves rig testing of turbine engine parts to determine optimum configurations. Parts later are endurance-tested on engines to prove the design.

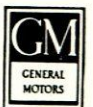
New, air-cooled turbine blades developed by Allison engineering have permitted more than 250 °F higher turbine inlet temperatures on turbo-prop engines, providing as much as 63% increased horsepower for the same engine envelope.

We think you, too, will like the creative climate at Allison, as well as the advantages of being associated with a long-established leader in the design, development and production of high performance aircraft engines. Talk to our representative when he visits your campus. Let him tell you what it's like at Allison where Energy Conversion Is Our Business.

An equal opportunity employer

Allison

THE ENERGY CONVERSION DIVISION OF
GENERAL MOTORS, INDIANAPOLIS, INDIANA

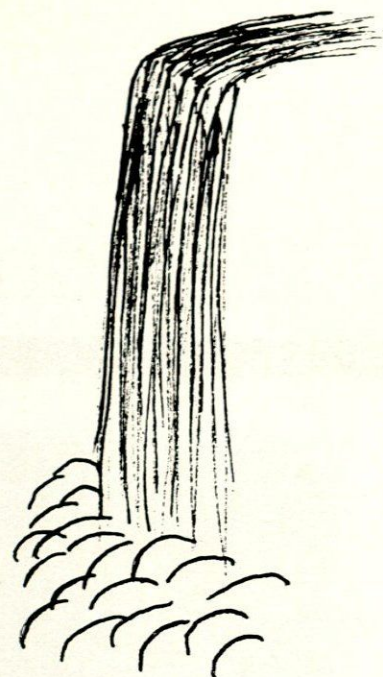


FROM 412 ACCREDITED COLLEGES AND UNIVERSITIES (IN 48 STATES AND 8 FOREIGN COUNTRIES)

CHOSE SANDIA CORPORATION

ENERGY

ELLEN HARRIS



The coming of cities, which accompanied industrialization and increases in population has brought an increasing demand for energy in a world whose fossil fuel reserves are limited. In order to conserve these fuels for purposes for which they alone can be used, it is desirable to find substitute sources of energy for everyday uses—heat, operation of machines and appliances, light, communication. Several alternative sources of useful energy are being investigated, among them solar energy, tidal energy, geothermic energy, and the thermal energy of the seas.

Also, electricity is by far the most important modern form of energy, since it can be transported over large distances and then be readily converted into other forms such as heat and mechanical energy, much research is being done to convert atomic, thermal, and chemical energy into electrical energy. Some of the newer methods of conversion being developed include thermoionics, thermoelectrics, magnetohydrodynamics, fuel cells, and nuclear fusion.

The following will be a brief discussion of these new sources and new conversation methods.

Solar Energy

Solar energy is essentially inexhaustible. No harmful fallout, smoke, or other health hazard results from its use. One country cannot restrict another country's use of it. On the other hand, it is difficult to utilize because of its low intensity. Another problem is its intermittency (both periodic, due to the rotation of the

earth, and non-periodic, due to varying cloud and weather conditions).

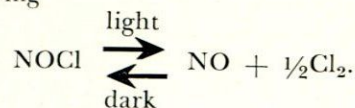
There are two groups of processes for converting solar radiation into useful energy—those related to heat and those related to light.

The processes related to heat can also be subdivided into two groups—low temperature processes and high temperature processes. Low temperature processes (less than 100°C), used mainly for distillation and water heating, use simple collectors—flat plate, or even simply the pipes used for transporting the water. Higher temperature processes employ lenses and/or strategically shaped reflectors. Temperatures as high as 3500°C have been obtained experimentally. The disadvantage of this type of collector lies in the fact that its orientation must be changed as the sun moves. Solar cooking is the simplest application of a reflector and is accomplished by focusing the radiation on the black bottom of the cooking utensil. Other applications requiring more complex devices are house heating, refrigeration, air-conditioning, heat pumps, and industrial furnaces. One especially ingenious home heating idea was developed by Dr. Maria Telkes. The house had a vertical collector 800 square feet in area. The solar radiation passed through glass plates and was absorbed by a blackened metal surface placed a few inches behind the glass. This surface heated the surrounding air, which in turn was circulated over metal containers filled with $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ which changes to Na_2SO_4 when heated above 91°F .

The heat absorbed in this reaction is given off when the temperature falls below 91°F , and thus it is possible to store heat for several days. The experiment was quite successful.

The processes utilizing the light part of the solar spectrum are either photochemical or photoelectric in nature.

A photochemical process, in order to provide useful energy, must involve reactants or photocatalysts which can absorb appreciable quantities of solar energy. This energy must then be able to be recovered during the reverse reaction; thus it is necessary to use a reaction in which the reverse reaction can be strictly controlled. Photosynthesis is a good example of this type of reaction; it is about 30% efficient, and is especially promising in the laboratory production of algae for fuel and food. Another reaction which appears favorable and is being studied by Dr. Otto Nieuwirth at the University of Wisconsin is the following



Photoelectric conversions are more fully developed than are photochemical. The most striking success has been in the development of the silicon "solar cell" by the Bell Telephone Laboratory. The silicon is grown as a single crystal, and at a definite level, a little arsenic is introduced and the crystal is exposed to a gas containing boron to add a thin layer of boron. As the five-valent

(Continued on page 32)

room for



Like everyone else who must meet the expanding challenges of science and industry today, IBM banks heavily on initiative. By initiative, we mean the desire to forge ahead. We believe this kind of initiative benefits not only a corporation and its customers, but the individual as well.

For IBM, the exercise of initiative results in an expanding line of products ranging from electric typewriters to complete computer systems. It is evident, too, in the advanced systems for space programs and national defense which IBM also produces.

For our customers, it brings new methods, new efficiencies, and new directions for expansion in step with the growing economy of our nation.

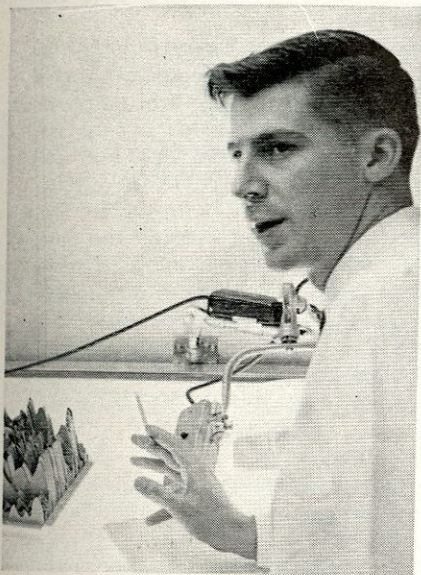
For the individual, encouragement of initiative means the fullest possible growth of personal talent, ability, and stature. In the course of building their professional careers, IBM's engineers and scientists are given all the responsibility they are ready for. In fact, IBM encourages each individual to tackle progressively tougher problems by providing the stimulating associates, professional atmosphere, and educational

opportunities that form a sound basis for career growth. There are no barriers to individual achievement at IBM.

For example, the story of Oliver W. Johnson, the young engineer pictured here, demonstrates how an individual can apply his full range of talents and interests at IBM to further his professional career. Since he first joined IBM, he has been assigned to several different project areas, including: special



initiative...



transistor circuits, cryogenic development, experimental studies on voice output from computers. He is now being recognized for his success in developing a new method of compressing speech by which time might be saved in voice transmission of data.

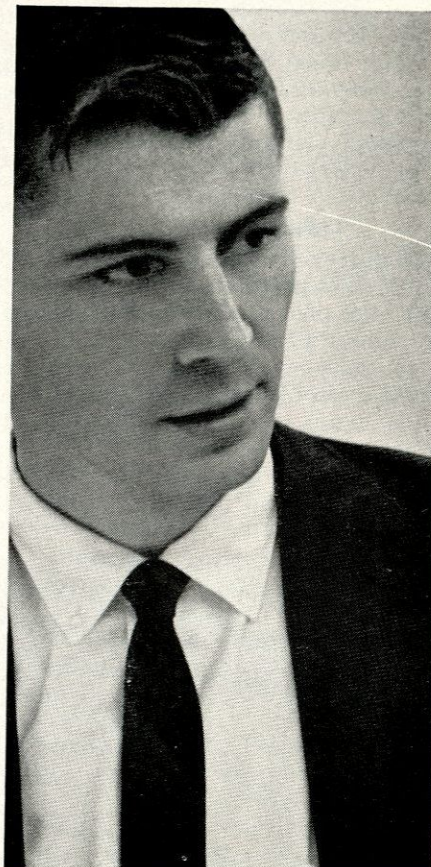
His colleagues in development, research, and manufacturing are making the same kind of individual progress,

for at IBM the accent is on initiative—no matter what type of work, or what field of interests. Broad education programs, among the finest to be found in industry, enable each individual to study in his field of specialization or range beyond it as he desires. These educational programs are designed for the individual's personal satisfaction as well as professional advancement.

IBM offers graduates with degrees in Engineering, Mathematics, and the Sciences exciting assignments with room to move ahead. IBM is an Equal Opportunity Employer.

Education programs are conducted along the following lines: initial training; continuous education to stimulate development and help prepare for advancement; master's and doctoral study with company support.

See your college placement officer to determine when we will be interviewing on campus. We will be glad to discuss typical openings and opportunities at IBM. If you prefer, you may write, outlining your education and interests, to: **Manager of College Relations, Dept. 915, IBM Corporation, 590 Madison Avenue, New York 22, N. Y.**



IBM®

ENERGY

(Continued from page 29)

arsenic is a misfit in the four-valent silicon lattice, the extra electron is free to migrate, resulting in a negative charge. Similarly the three-valent boron acquired a positive charge. The two layers touch each other, forming a p-n junction. Light provides enough energy to cause the electrons and positive moles to migrate to electrodes attached to the crystal, resulting in an electric current. If the light is then removed, the crystal returns to its original condition. The cell has no moving parts and consists of no substances which are used up during the process. Its efficiency is close to 15%.

The many uses for the battery include temperature control switches and remote control for machines. Solar batteries powered the Vanguard satellite's radio transmitter.

Tidal Energy

Tidal energy simply uses the power from falling water. Water is trapped at high tide, then allowed to fall and run turbines. The supply is periodically intermittent, but in this case the storage problem is easily solved. Multiple basins can be used so that while water is being trapped in one basin an already full basin can still generate power, and part of the turbines can be operated as pumps during low tide to replenish the water supply. The most difficult limitations are geographic; there just aren't many locations suitable for an efficient tidal power plant. France is most favorably endowed and actually has a plant nearing completion, with an expected annual output of 820×10^6 kw-hrs. Several other countries also have considered tidal power plants.

Multipurpose schemes are also quite intriguing; these would combine construction of a power plant with flood production, construction on a harbor, or swamp reclamation. Under present conditions, however, these schemes are unrealistic.

Geothermal Energy

This type of energy comes from natural steam or hot water, plus certain gases and chemicals, under pressure. A steam turbine is used to drive a generator and thus produce electric power. Often the chemical by-products are also extremely important.

Utilization of geothermal energy is greatly limited by geography and by the fact that the various regions of the world in which geothermal action having industrial possibilities is to be found exhibit substantial phenomenological and geological differences.

Italy has quite a highly developed system of power production dating

from the first successful experiment in 1904. In the area known as the Larderello boraciferous region, steam jets are the characteristic natural phenomenon. The heat energy of the superheated steam is released merely through its expansion; no additional agent is required. From 160 active wells 2.66×10^6 kg of steam per hour are produced. This figure is the yield. The value of the recoverable energy depends on the yield, the pressure and temperature of the steam, and the mineral characteristics of the field, thus involving both thermodynamic and mineralogic considerations and can only be determined empirically. The extracted boric acid, ammonia, and other substances, while secondary, are important by-products of the Larderello power production, especially since boron compounds are becoming more and more important.

Iceland utilizes the thermal energy of its natural steam fields for heating. New Zealand, Japan, and Katanga also have small power stations operating. In the United States, some heating projects have been successful in Steamboat Springs, Colorado, and the Pacific Gas and Electric Company is operating a power plant in California utilizing steam geysers.

Thermal Energy of the Seas

This type of energy utilizes the temperature difference between two large bodies of water, for example, warm surface water and cold deeper water. To be effective for power production, the temperature difference must be at least 20°F .

The process operates as follows: warm salt surface water enters a low pressure vessel in which a vacuum is created with an air gas extraction and part of the warm water flashes into vapor. On its way to a condenser cooled by water from the cold reservoir, the vapor drives a low-pressure turbine.

A plant has actually been constructed on a small island off the coast of France, and although its value is largely experimental, it exhibits some of the possibilities of utilization of thermal energy from the ocean.

The process could be improved by using solar energy to increase the temperature of the hot source, or by using the water coolant from an atomic reactor as the hot source.

Fresh water and salt are important by-products of this process, as may be deep sea organic materials.

Energy Conversion

Thermoelectrics operates on the principle that heat applied to one junction of a circuit containing dissimilar metals induces a small amount of electric current to flow in the con-

nected circuit. Until recently, the only practical application has been in thermocouples to measure temperatures. Possibilities for power generation have only come with discoveries in the field of semi-conductors which resulted in substantial improvements in thermoelectric conversion efficiency.

The reverse effect also shows promise in refrigeration, since an induced current results in a temperature difference. Since the high temperature can be made the low temperature simply by reversing polarity, an automatic temperature control can also be set up.

Another type of converter, thermionic, consists of a metal vapor (cesium)-filled device with a hot electron emitter insulated from a cold collector, a gas-tight envelope and two electrical leads. Thermoelectrons furnish the current by being accelerated by cesium ions just outside the emitter. A few of the electrons help create the Cs^+ ions, but most flow through the plasma to the collector. The thermoionic converter is a low voltage, high current device. For example, a flat converter designed to be heated by solar energy developed 1.3 volts at 64 amps.

Magnetohydrodynamics (MHD), another new conversion method, relies on the principle stated by Faraday that current is produced when a conducting, ionized gas is forced through a magnetic field. (See diagram.)

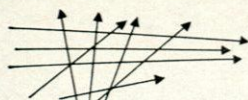
The first modern interest in MHD stemmed from work on the behavior of layers of ionized air which form on the front of nose cones during re-entry.

One suggested use of the MHD generator is that it be operated in a closed cycle which tops a conventional gas or gas plus steam turbine cycle. Some estimates indicate that the efficiency of the conventional cycle might be raised from 40% to 55%.

While MHD research and engineering is only in the laboratory stage at present, MHD energy conversion appears to be an exciting new means of increasing efficiency of power generation.

Conclusion

The age in which we live could well be called an age of energy. Sources of energy exist which are essentially inexhaustible, the only limitation in their utilization being prohibitive initial costs for plant and equipment. In most cases, once the plant is in operation, maintenance costs are very low. In the future more and more utilization will be made of unconventional sources until they become no longer unconventional.



EXCITING THINGS HAPPEN AT FORD MOTOR COMPANY!

THE 100,000-MILE ENGINEERING TEST THAT SET OVER 100 NEW WORLD RECORDS

It began September 21 in Florida, when a team of four 1964 Comets, specially equipped and prepared for high-speed driving, set out to do the equivalent of four earth orbits at Daytona International Speedway—100,000 miles at speeds well over 100 miles an hour, round the clock for 40 days, through weather fair and foul.

They did it, all four of them, and they made history! They did it in the full glare of publicity. In semi-tropical heat. In the teeth of torrential squalls that fringed two hurricanes. Including time out for refueling and maintenance, the lead car averaged over 108 miles an hour, toppling over 100 national and world records!*

For all practical purposes this was an engineering trial—the most grueling test of staying power and durability ever demanded of a new car. Only near perfection

could stand the punishment dished out to parts and components hour after hour, mile after mile. Brakes, engines, transmissions, ignition systems—every single part a pawn in a grim game of truth or consequence, with *total* product quality the stake. And they all came through hands down!

Now that it's over and in the record books, what does it mean? New proof of Ford-built stamina and durability! New evidence that Ford-built means better built! Yes—and more, it is a direct reflection of the confidence and creative know-how, the spirit and spunk of Ford Motor Company's engineering, styling and manufacturing team—men who find rewarding adventure in technical breakthroughs.

More proof of the exciting things that happen at Ford Motor Company to bring brighter ideas and better-built cars to the American Road.

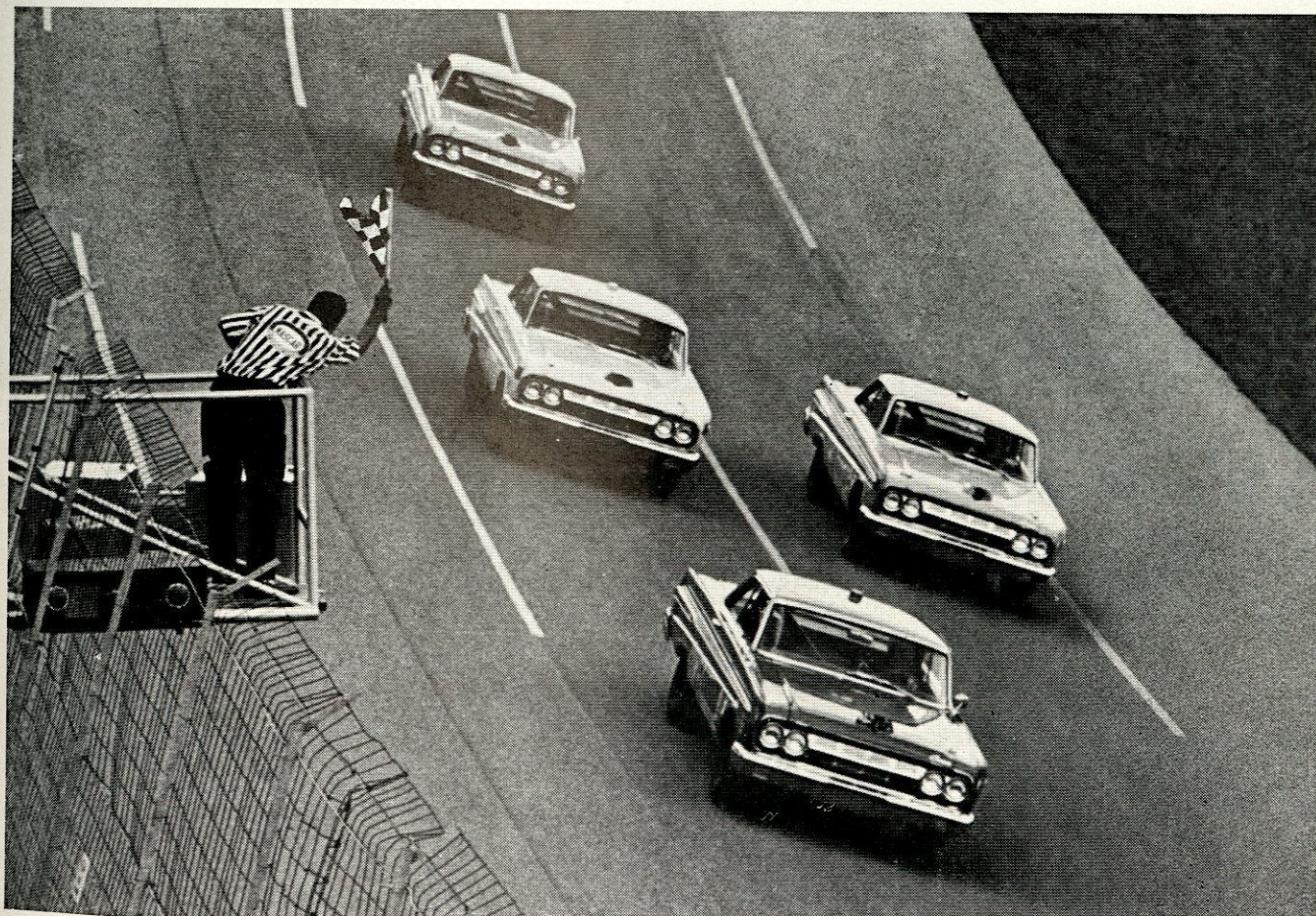
*World Unlimited and Class C records, subject to FIA approval

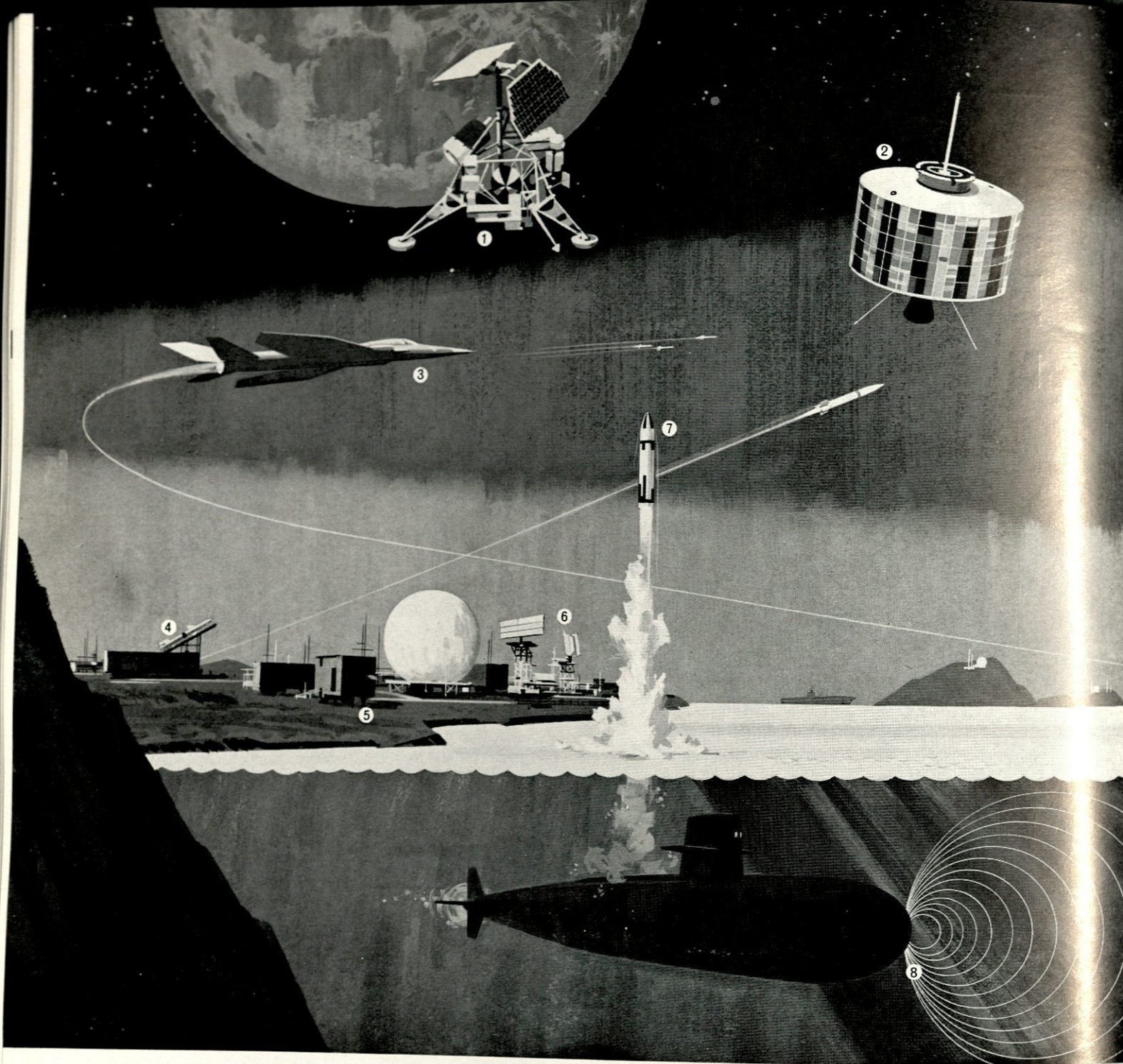


MOTOR COMPANY

The American Road, Dearborn, Michigan

WHERE ENGINEERING LEADERSHIP BRINGS YOU BETTER-BUILT CARS





Opportunities at Hughes for EE's—Physicists—Scientists:

from the ocean floor to the moon...and beyond

Hughes sphere of activity extends from the far reaches of outer space to the bottom of the sea... includes advanced studies, research, design, development and production on projects such as: ① **SURVEYOR**—unmanned, soft-landing lunar spacecraft for chemical and visual analysis of the moon's surface; ② **SYNCOM** (Synchronous-orbit Communications Satellite)—provides world-wide communications with only three satellites; ③ **F-111B PHOENIX Missile System**—an advanced weapon system designed to radically extend the defensive strike capability of supersonic aircraft; ④ **Anti-ICBM Defense Systems**—designed to locate, intercept and destroy attacking enemy ballistic missiles in flight; ⑤ **Air Defense Control Systems**—border-to-border control of air defenses from a single command center—combines 3D radar, real-time computer technology and display systems within a flexible communications network; ⑥ **3D Radar**—ground and ship-based systems give simultaneous height, range and bearing data—now in service on the nuclear-powered U.S.S. Enterprise; ⑦ **POLARIS Guidance System**—guidance components for the long-range POLARIS missile; ⑧ **Hydrospace**—advanced sonar and other anti-submarine warfare systems.

Other responsible assignments include: TOW wire-guided anti-tank missile, VATE automatic check-out equipment, Hard Point defense systems... R & D work on ion engines, advanced infrared systems, associative computers, lasers, plasma physics, nuclear electronics, communications systems, microwave tubes, parametric amplifiers, solid state materials and devices... and many others.

B.S., M.S. and Ph.D. Candidates
Members of our staff will conduct

CAMPUS INTERVIEWS

February 4 & 5, 1964

Learn more about opportunities at Hughes, our educational programs, and the extra benefits Southern California living offers. For interview appointment and literature, consult your College Placement Director. Or write: College Placement Office, Hughes Aircraft Company, P. O. Box 90515, Los Angeles 9, California.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

U. S. CITIZENSHIP REQUIRED

An equal opportunity employer.

URBAN TRAFFIC STUDIES

LARRY HUSTON

The urban transportation problem has existed since mankind began to live in a community large enough to call a city. For the most part it has been ignored until this century. In ancient times the ruling classes, who controlled the building materials for streets and roads, apparently felt that intraurban roads were less important than interurban roads. In America today, the ruling class is the voters, and they are showing an ever-increasing interest in city streets. The streets that carry the heaviest traffic in major cities were, more often than not, built for the horse and wagon, and people, not for 200 horsepower wagons.

During the past 30 years, the population growth of the cities, the migration of rural workers to the city, and the ever-increasing utilization of automobiles, have worked together to complicate an already bad situation. Even with the hindsight available from European and the older Eastern cities, planners were not able to predict either the direction of growth, the magnitude of the growth or the eventual impact of the automobile. That is, they could not even where there were city planners. So, the problem of correcting past mistakes, or oversights falls to the modern civil engineer as well as the problem of making his own predictions. In few phases of civil engineering is the urgency of correction and proper planning as apparent as it is in traffic control. The increased use of the automobile has often clogged city streets far beyond reasonable limits, resulting in accidents, injuries, financial loss, and many bad tempers. In many instances, cities have improved their streets system since the advent of the automobile only by placing a good wearing surface on a horse and buggy sized street. In addition to this problem, there are difficulties which are unique to the automobile.

With hope of finding these unique

difficulties, the Bureau of Public Roads in 1959 began an in-depth study of a single street in Washington, D.C. and a study of driver reactions. The study encompassed nearly every facet of traffic on a 4 mile stretch of Wisconsin Avenue. Realizing that most cities, particularly small ones, could not afford the time, personnel, or money to make a similar study, yet also realizing that even the small cities could not afford not to make the study, the Bureau of Public Roads financed a short-term, low-budget, depth study of a street in a small city, to see if, using the Wisconsin study as a basis, the small city could profit by a quick but thorough look at its streets. The contract for the study was awarded to CU's Civil Engineering Department with the cooperation of the State Highway Department Research Board and the City of Boulder.

To arouse this much interest, there has to be some tangible benefit. Traditionally, items of only academic interest get little support from political bodies. The advantages of properly engineered traffic are becoming more apparent to governmental bodies as the economics show that it is cheaper to have a properly run street system.

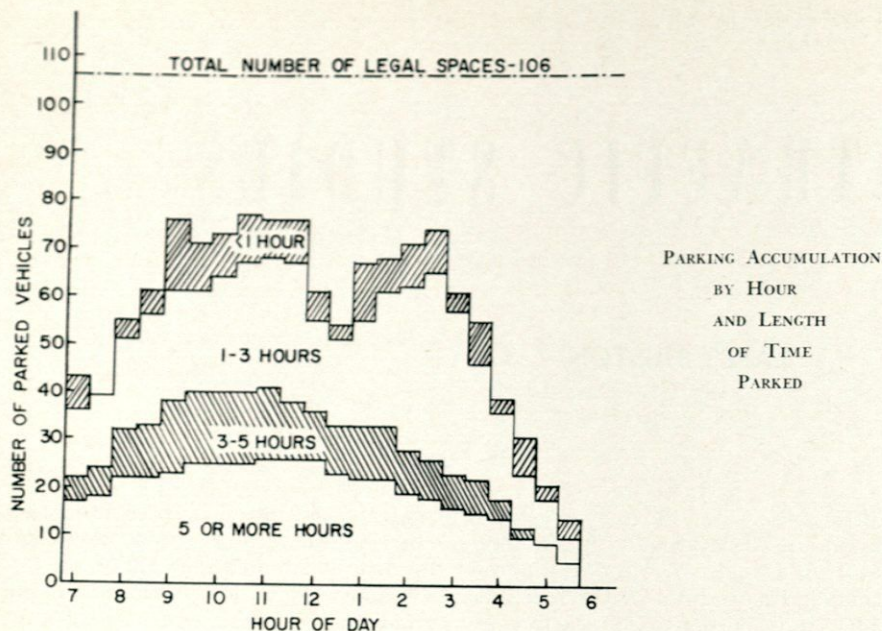
Benefits

If the flow of traffic can be smoothed and at the same time increased, two groups of people benefit. First of all, the individual benefits; because he has to make fewer unwanted stops, he saves gas, wear on the automobile, time, wear on his nerves, and most noticeably, he saves money on insurance rates because of the accidents that he and his fellow citizens did not have. Because of fewer accidents, he saves not only the money in automotive repairs, but lost time and cash involved in human repairs.

These same benefits, though small in most individual cases, except for

repair costs and insurance rates, accrue to the second group, the community which includes all of the individuals. Here the benefits are far from small, for the sum of all the individual benefits is indeed large. In addition the community saves by not having to investigate as many accidents or process them through both police and judicial files. Smoother flowing traffic, say in a downtown area, will encourage people to use the downtown area more, for instead of simply pushing more cars *through* the shopping districts, the smoother traffic will make it more pleasant for people to shop there. Shoppers in a community will shop in a certain place for, generally speaking, two reasons—they want to or they have to. If they have to, they will shop regardless of opposition, but they will want to only if it is most convenient, as well as desirable, to shop there. Thus, the business community within a city would benefit from a better traffic system and the city would benefit from the additional taxes received. Thus, it appears that both individuals and the whole community would benefit from a properly engineered traffic control. How does one get the necessary information about a city street system, what can be done with it, and specifically, why does Broadway Street in Boulder function as it does.

Last summer, the study group attempted to learn all it could about the physical and traffic characteristics of Broadway from the Marshall Road Animal Clinic south of town to the junction with the Boulder by-pass north of town. The group counted and analysed vehicle and pedestrian movements at intersections, made studies of the theoretical capacity of each signalized intersection, analyzed accident reports, made and analyzed speed and delay studies, as well as recording the usage of available on street parking and physical



characteristics of the entire street.

Omitting most of the details of operation, which can be found in the Wisconsin Study if desired, the study group found that Broadway's greatest problems were lack of real or effective signal coordination and inadequate street width. These problems were readily apparent before the study began, so their confirmation statistically was not surprising. However, the degree of the problem was surprising, and simply finding the degree of a problem is itself an engineering function. It doesn't take an engineer to recommend some improvements in a city streets, but it does take an engineer to determine whether or not the improvement will have an effect significant enough to warrant consideration. Traffic is by nature highly variable, and shows random fluctuations superimposed on daily and weekly patterns. Any given improvement might make the pattern more predictable, but the worth of the improvement is in the degree of change relative to previous conditions.

Thus, the study group had not only to accumulate enough information to find out what was wrong with Broadway, but also enough information to show that it is not only feasible to make certain improvements but also justifiable economically. In addition, for this study, the group had to have enough data to show after the improvements have been made, that a real improvement has been made, indeed.

The study group used all existing data on Broadway and made every feasible attempt to collect enough information to insure reliability both

for the recommendations and for later checks. The Colorado Department of Highways provided the automatic counters and personnel to operate and maintain them. These counters gave a 24 hour record of traffic volumes for each of 18 locations in the city. This allowed the study group to see the traffic flow pattern within the city, find the peak traffic periods (12:00-1:00 P.M. and 4:00-5:00 P.M.), and determine the directional distribution of traffic. The major direction of flow in the morning is toward the university, but about mid-morning the traffic flow is nearly equally distributed, and remains so throughout the day. This immediately eliminated any hope of smoothing traffic flow by favoring one direction of traffic in signal progression.

Intersection Counts

While the machine counters were recording the total traffic picture, manual counts were made at each signalized intersection during the peak periods to determine the number and type of vehicles going through the intersection and what movements each made. This phase of data collection was by far the most pleasant, especially when pedestrian movements were also recorded (notably near the University). Pedestrian and traffic movements on the Hill were compared to see how they affected each other, and traffic movements at all intersections were compared to the existing street size and signal timing to check for consistency.

After the greater percentages of these two studies were completed, the group initiated several specific studies. Using accident reports from the files

of the State Highway Department, the group recorded and plotted the number, type, and cost of accidents that occurred on Broadway during 1962 and the first quarter of 1963. This study indicated which intersections should be specifically studied for characteristics which could cause accidents. For instance, at both Walnut and University intersections, which had the highest accident rates, there was a high incidence of accidents involving vehicles making left turn movements as well as the normal incidence of rear end collisions that typified Broadway. The left-turn accidents indicate that some extra provision should be made for those movements. The rear-end collisions seemed to indicate too high a rate of stoppages. Investigation of the individual accident reports showed that the stoppages were almost totally signal caused. Theoretically, it would be possible to eliminate this kind of an accident by not having any vehicle stopping for signal lights. Therefore, improved signalization is indicated.

Other Accidents

The accident reports showed that the only other predominate type of accident was that involving parked vehicles. A study of the individual cases showed that people felt pressured by traffic to move to the right or else that they simply misjudged the distance. Either situation would indicate that wider lanes should be used. The only other frequently recurring type of accident, that of someone opening a door into traffic, could only be improved by a driver-education program. The rest of the accidents were more or less unique, such as the case of the driver who sideswiped a policeman giving a ticket to another driver.

Another specific study was a short, hard look at the parking problem. Three men, one driving, one calling license plate numbers, and the third recording the numbers, drove by the parked cars once every half-hour. By noting the number of recurrences of a license number in a specific location, the study group was able to determine the approximate duration of parking for each vehicle. This study showed that except where specifically prohibited, and even occasionally there, long-term parking predominated. Throughout those sections where parking was permitted, utilization was high enough to prohibit parking removal as a means of widening the street. Barring extreme conditions then, some other means of increasing the capacity of Broadway had to be found.

In line with this, a study was made

of the theoretical capacity of each intersection as it existed. Using data from the intersection counts and following the procedure given by Bureau of Public Roads as modified by the Denver Metropolitan Area Transportation Study, a theoretical capacity was found for each intersection. These values were checked against a typical intersection and found to be essentially accurate. The values were then compared with traffic volumes during the peak hour. In the downtown area, the volume of traffic exceeded the practical capacity. These capacity values served as a basis of comparison for later use. Any conceived improvement that would affect the street capacity was compared with existing conditions to see if the improvement could, theoretically at least, increase the capacity.

Additional Proof

These capacity calculations also served as a basis for judging the sequence of improvements so that the capacity of various sections could be increased most economically without causing the rest of the street to suffer. In general, the capacity study indicated that the most significant immediate improvement could be made by rephasing the signal lights. This was additional proof for the observation made before the study began, that is, that the signal lights needed reworking.

So far, all the evidence showed signal lights to be the main culprits. The next stage was to find out how much the signal lights really did affect the flow of traffic and what other factors, if any, should be considered. Using six "average" drivers and a 10-channel paper-tape recorder, the study team simply drove the length of Broadway. The amount and cause

of each vehicle delay was recorded along with the time, driver, weather conditions and other pertinent factors. Since the length of various sections of street were known, not only the amount of delay but also the speed could be found. Predictably, the study showed that the greatest portion of delay was of signal origin, that the average speeds through any given section of Broadway were far below the speed limit, but that the running speeds in nearly all cases exceeded the speed limit.

Downtown Delays

The implications of these findings were probably the most significant of the study. Prior to this study the individual intersection had been the primary focus of attention. The speed and delay study confirmed that the signal phasing should be changed to allow more cars through per cycle at each intersection, as the intersection count observations and the accident reports had indicated. What the other studies could not show, however, was the amount of delay that would normally be encountered in any one trip. In the outlying areas, of course, the delays were negligible, but in the downtown area they were impossible to ignore. The results of 116 trips showed that an average car was standing still 32% of the time it was downtown and that 95% of this was directly caused by signal lights. This of course explained why the average speed was as low as 12.2 m.p.h. while the average running speed was 20.8 m.p.h. No attempt was made to record the peak speeds for each block, but if the average running speed, which in most cases included an acceleration time on each end of the block, exceeded the speed limit, it seems reasonable that most of the traffic was well over the speed limit.

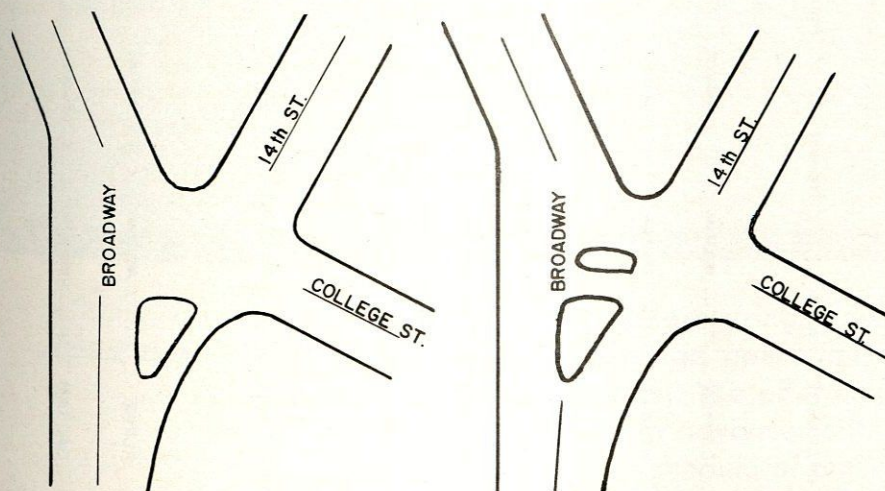
The second item noted by the speed and delay crews was that frictional resistance greatly impeded traffic flow. The eight foot wide lanes were too narrow for the street to function as a four-lane arterial. The parked cars seemed to close for many drivers, who shied away from any obstacle. This, plus the possibility of someone opening their door into traffic, caused Broadway to operate as what has been called a one and a half lane street. These conditions caused very little actual delay time, but they effectively narrowed the street between intersections.

The speed and delay crews also observed that too much of the driving on Broadway was of the slow-and-go type. For instance, in the downtown area a group of cars would speed up to make a light and then slow down to make the next one. In the process several cars in the group might be stopped at the first light to become the lead cars in the next group. These vehicles then slowed the lead cars in the following group. During peak hour traffic this was disastrous, since a new group was forming at each signal light instead of passing through several lights in a row. This sort of operation cuts the efficiency of the street far below its potential.

Traffic Analogies

Traffic flow can be considered in two fashions. One view is that traffic is analogous to a compressible fluid in which the individual unit is not significant. The analogy may seem valid since the rate of flow increases with the concentration up to a point but decreases with an increase in density after that point. The second point of view is that the individual units are similar to molecules of a gas—alone at times and interacting with other molecules at other times.

The molecular analogy seems most appropriate to Broadway. For light traffic, the individual vehicles act independently for the most part. As the density increases, the number of interactions, which frequently are very much like molecular collisions, also increase. At peak hour density the molecular reactions approach those of a compressible fluid. Here, although the individual units have some freedom of movement the degree of movement is severely restricted. In this kind of a situation, any disturbance is propagated through the fluid. If the disturbance is frictional, such as a car pulling away from a parking place or a car kept from making a right turn by a pedestrian, the street is effectively narrowed to one lane, thus decreasing the capacity. If the flow of traffic



AN EXAMPLE OF INTERSECTION REDESIGN (LEFT)
FOR SMOOTHER TRAFFIC FLOW

is stopped for any reason, a shock wave of stopped and slowing cars propagates through the traffic stream.

One of the most effective methods of combating these undesirable effects has been to release the traffic stream in spurts. In all probability, the disturbances that affected one wave will have died out before the next wave of vehicles arrives. This procedure is called platooning, that is, forcing most of the vehicles to travel in closely knit groups. At first glance this would not seem to have any net effect on the traffic, since the same number of cars are going to go through the same section anyway and in probably the same amount of time. What changes this is that frictional events effect only one or at worst two platoons at a time. These platoons would progress at the same speed as before. However, the other platoons would not be affected, and could move faster.

Efficient Platooning

To make platooning work, the group must remain intact. Ideally this implies that the first car in each platoon encounters a newly green light at each signal and that the green phase is long enough to allow all the cars in the platoon to pass through. If this cannot be achieved, time should be allowed to pass a platoon of a given size (assuming a 2.1 second space between cars in a single lane. If the signals are so spaced that neither of these two alternatives is possible, some compromise might be made to approximate efficient platooning. Besides the advantages already noted, efficient platooning allows the maximum time for cross-street traffic and at some locations may even eliminate the need for a signal.

By the time the speed and delay data had been analysed, there remained only a few minor studies. For example, an inventory of street signs had been made earlier in the summer. This inventory had to be studied for conflicting signs. In one case near the University, there was a "School Zone" sign one half block before a "30 MPH" sign and two blocks before a primary school. The observations of the field crews about certain details had to be checked against other more measurable evidence. A study of the geometric and traffic characteristics of a few problem intersections such as Broadway at 20th, College, Pleasant, University, Arapahoe, Canyon, and Pine was made and recommendations for improvement were noted. Possible improvements were compared by means

of capacity calculations to determine their effect and sequence.

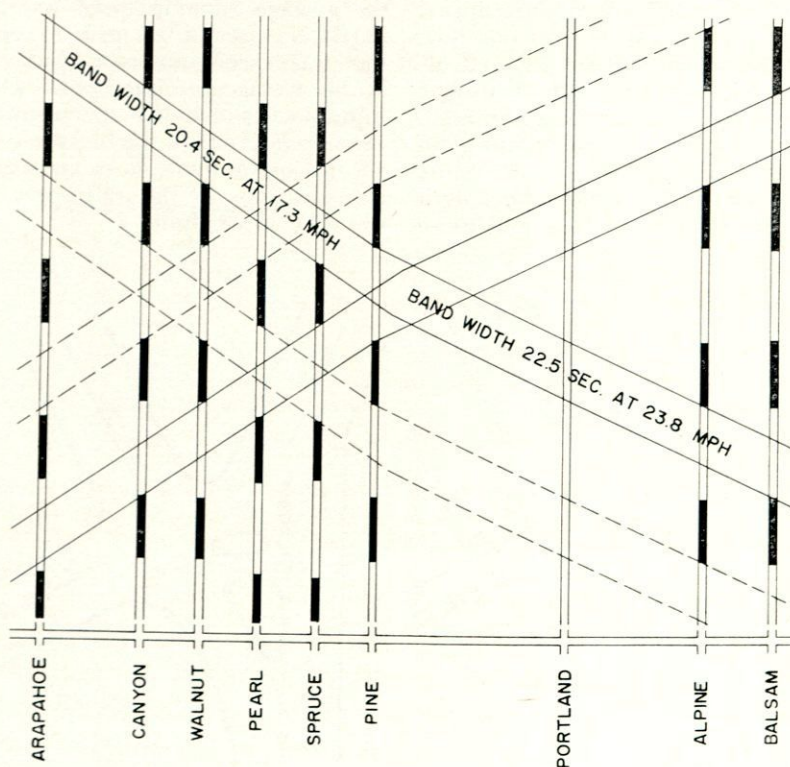
Signal Coordination

Traffic signal coordination was the subject of one of these final studies. The existing phasing and coordination, where it existed, were plotted against the distance between signals. This time-space diagram enabled the study group to find the speed and approximate platoon size in the downtown area, the only section where the signals were coordinated. By plotting a similar diagram with the distance as the abscissa and variable cycle length as ordinate, the group was able to determine the most efficient cycle length and signal offsets for two-way coordination. The speed that a platoon will progress through a series of signals is a function of the signal spacing and the cycle length. By using an unknown cycle length (100%), an efficient band can be found. The speed of progression can be adjusted to the desired speed by adjusting the cycle length. Since most signal lights can be adjusted by only five-second increments of a cycle length, the speed nearest the desired speed must be used. The problem can become exceedingly complicated if there are several sections with different desired speeds.

In addition to setting a desired speed, the time-space diagram can

establish the bandwidth. The width of the band is the minimum green time a platoon can use within any section of lights. It is also a function of the cycle length and must be made large enough to allow a platoon to form, besides being large enough to accommodate a given platoon. For instance, a platoon limited to only ten vehicles will probably not function as a platoon, but rather, will react as a loose group of ten vehicles. A larger platoon will tend to stay together, if given the opportunity, simply by the presence of the larger number of vehicles in much the same fashion that gas molecules in a group act on each other. The cars behind a vehicle act as a pressure. Although no evidence has been found that there is a certain minimum platoon size, it is felt that 10 vehicles is too small a number.

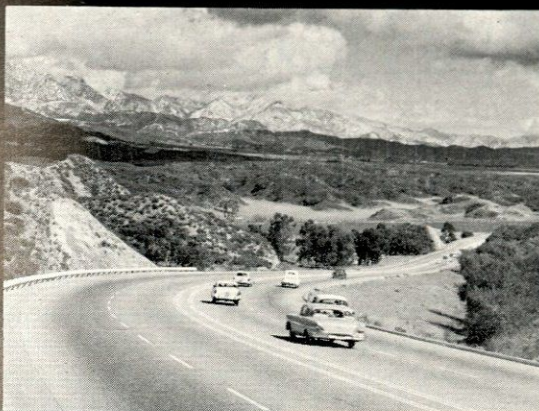
These are just a few, though the most important, of the studies that can be made in a short period to diagnose urban traffic sicknesses. As more of this kind of work is done, traffic engineering will continue to improve until a city of any size can benefit from a low-cost reasonable evaluation of its traffic problems. In all probability, traffic engineering will remain just a little behind what it must do, but then, it started several centuries late.



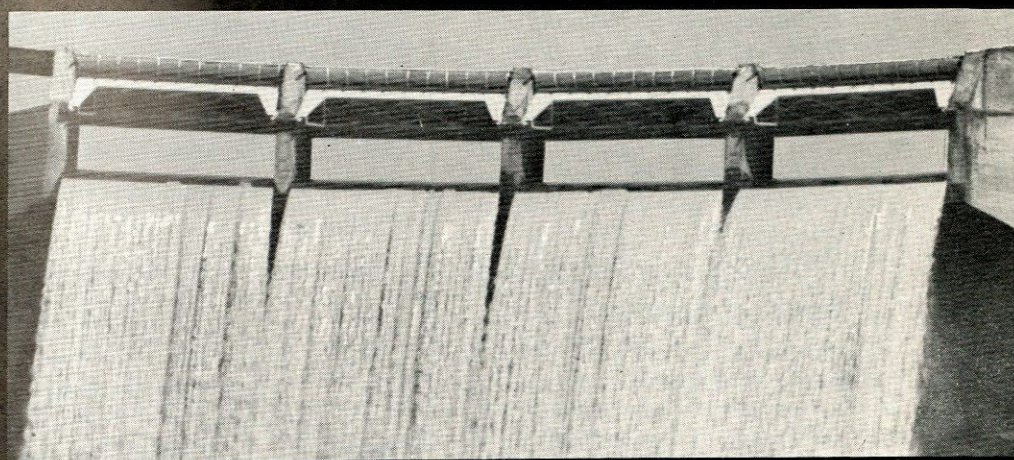
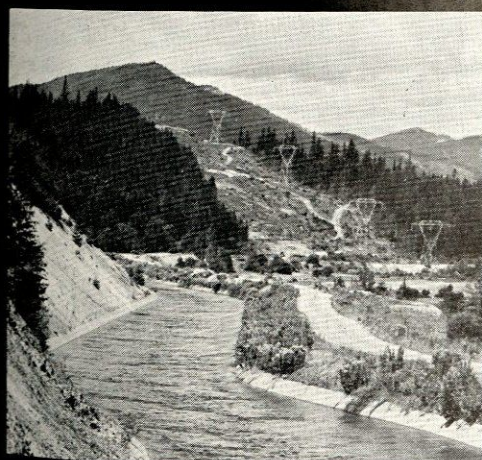
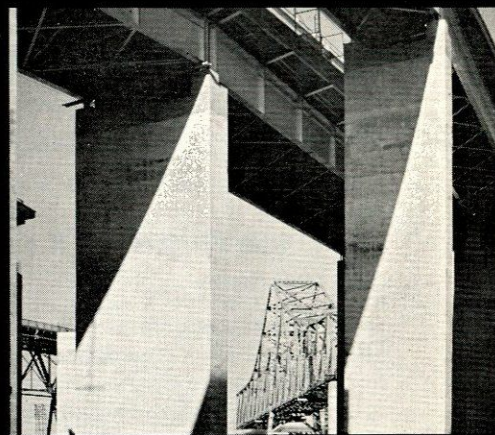
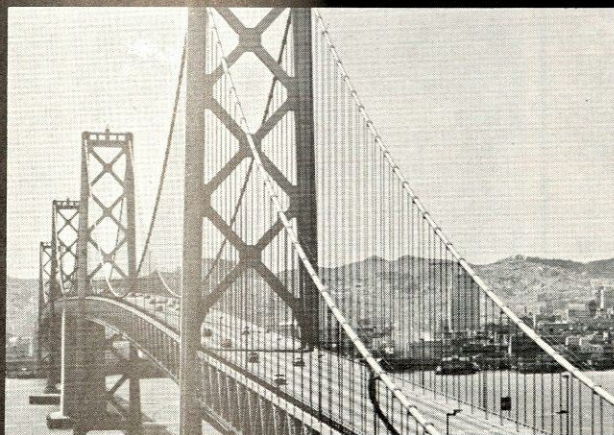
A TIME-SPACE DIAGRAM FOR SIGNAL COORDINATION. ONE BLACK-AND-WHITE SECTION REPRESENTS A 60 SECOND CYCLE LENGTH

CHALLENGE IN CALIFORNIA

IN ALL PHASES OF CIVIL ENGINEERING



HIGHWAYS
BRIDGES
STRUCTURAL
SANITARY
HYDRAULIC



California's far-flung state engineering projects are no boom-time enterprises. They are sustained, long-range operations planned to keep pace with the continued growth of the West. We offer employment stability, good salaries, job rotation and professional advancement. Let us send you illustrated literature and campus interview schedule of our representatives. Please state your field. State Personnel Board, 801 Capitol Mall, Sacramento, California: 95814.

Here are 6 reasons why you should spend at least the next four years with us...

You'll find that at least a few of these six advantages are exclusive with the civilian Navy generally, and especially with the world-renowned Naval Ordnance Laboratory because of its perennially powerful role in government weaponry research. No "Blue Sky" promises here—you'll soon see why these advantages make sense individually, and why collectively they represent a career development opportunity you really should consider.

1 Vital assignments of national importance

Whatever programs you may work on . . . missile guidance, weapons systems, re-entry components, underwater ordnance, fire control, sonar, fuzes, sonobuoys, nuclear explosives, propellants, solid state, acoustics, infrared . . . you see and follow the big picture, from initial concept to fleet acceptance. *More than 95 major weapons devices developed at NOL are in fleet use today.*

2 Training programs encourage Breadth of Experience

During your first year you will rotate through four assignments in research, engineering, and evaluation. This enables you to understand the whole and to help select a permanent assignment area.

3 Wholly- or Partly-Paid Graduate Education Programs

Various accredited graduate pro-

grams, both with local institutions or the university of your choice, permit you to attain your advanced degrees. Many courses are held right at NOL, and enable young professionals to work full time while participating. Most such programs provide for reimbursement of tuition. Stipends, in some cases, are available.

4 Professional Stature and Future Opportunity

NOL retains patents in the employee's name for professional purposes, and for commercial rights in some instances. Attendance at professional meetings is encouraged, and there is ample opportunity to conduct foundational research. At the end of these four years, many doors to the future will be open to you . . . as a professional engineer with an unusually strong R & D background.

5 Top-Flight Equipment & Facilities

Because so much in-house work

—\$30 MILLION annually—goes beyond the existing and known, NOL has many of the finest research and development facilities available anywhere. NOL headquarters spread over nearly 1,000 acres of suburban Maryland just outside Washington, D. C. (now one of the nation's leading R & D centers). You may also work at NOL test facilities elsewhere in Maryland, in Virginia, and Florida . . . as well as with the operating units of the fleet.

6 Reach the \$10,000 to \$12,000 level within 4 years

New and virtually unknown is the fact that the new government salary structure lets you earn more than \$10,000 within four years . . . PLUS all the benefits of Career Civil Service.

Watch for the NOL representative on campus

If you would like to contact NOL directly, write to Mr. Emil Kranda, Personnel Officer.

NAVAL ORDNANCE LABORATORY

NOL

WHITE
OAK

SILVER SPRING, MARYLAND

An Equal Opportunity Employer

CONTROLLING AIR COLLISIONS

GARY O'KEEFE



AIR ROUTE TRAFFIC CONTROLLERS OF THE FAA'S BUREAU OF AIR TRAFFIC MANAGEMENT
KEEP WATCH OVER THE MOVEMENTS OF INSTRUMENT FLIGHT RULE TRAFFIC

Air transport has risen to become a lifeline connecting our modern cities. Day by day the airplane and its needed facilities bring increasing promises and problems to the civilized world.

In view of this, the federal government, under the auspices of the Federal Aviation Agency, has had two special task forces working on future air transport problems under the code names of Project Horizon and Project Beacon. Horizon deals with overall national aviation goals, while Beacon deals specifically with air traffic control. Working in cooperation with various aircraft corporations, it has yielded many interesting observations on the issue and has

come forth with several policies which may well be put into effect in the near future.

The FAA expects that within fifteen years there will be a total increase in U.S. flying of 44% a 36% decrease in military flight being counterbalanced by about an 80% increase in general aviation and air carrier flying. They expect that "controlled flying," representing the load on air traffic control systems, will be subjected to a 300% increase within fifteen years. It is here where the real difficulty will lie.

At the time of Project Beacon's initial report to the President in late 1961, fourteen major airports were closing in on or had already passed

their handling capacities. It can be expected that dozens more will follow suit in the near future.

Shortcomings in adequate planning for landing fields lies partially in the separation of responsibility in operation and planning between the FAA and local governments. Eventually more federal controls in this area may have to be seriously considered for the interest of all parties concerned.

A basic area of concern to metropolitan areas, and perhaps the most obvious to the public at large, is the location of airport terminals. The rising growth of cities gives need to a directly proportional rise in airport facilities. These facilities, to be of practical value, need necessarily be located close to urban centers. And of course this necessity is hindered by the disturbances caused to normal life in densely populated areas by low-flying aircraft. Despite noise abaters and other such devices to protect the sanity of airport neighborhood dwellers, the increasing speed and power of new commercial transports are causing many understandable complaints.

All airway cities are facing this issue today or will soon be facing it. Many airport sites which have been in operation for years in the rural outskirts of cities are now surrounded by suburbia. And this suburban element is quite vociferous in making clear its attitude concerning loud, low-flying jets above homesites.

In such cases as this the airport's legal claim, boiling down to "we were here first", is of true judicial merit, but is a highly ineffective attitude in dealing with the tax-paying citizen.

DEAN'S COLUMN

DEAN PETERS



Engineering in its broadest sense consists of individuals and the services rendered by these individuals. The people involved are those engineers in practice rendering services to the city, government, and mankind plus those individuals in training to become engineers. A third group of individuals must be considered as vital to the future of Engineering. This group consists of those persons who are now in our secondary schools and who are considering Engineering as a career—the high school student.

This issue of **THE COLORADO ENGINEER** is dedicated to the high school students who are considering Engineering as a career. Our Engineering faculty at the University of Colorado has been very active in traveling to the various high schools in the state to discuss with the students the career opportunities in the major fields of Engineering and to point out the type of exciting career that exists for the modern Engineer. The fact that the present industrial demand for Engineers is far ahead of supply, combined with excellent starting salaries averaging about \$600 per month for B.S. Engineers and over \$1000 per month for starting Ph.D. Engineers, is one indication of the tangible benefits of an Engineering career; however, by far the most important benefit is the fact that modern Engineering is a challenging and exciting field for the person who has a strong interest in combining mathematics and physics with the practical aspects of applications to

benefit mankind. I would like to urge any high school student who has the necessary interest in mathematics, physics, and applications to decide in high school on Engineering as a career and enter a strong university as a freshman in the Engineering curriculum, even though he or she is not positive that Engineering will be the ultimate career. The reason for this advice is that it is possible to transfer from Engineering to other curricula with little loss of time; however, to transfer into Engineering after the freshman year requires making up a considerable course load. Although, after 25 years as an engineer, I am obviously prejudiced, I still think the following advice to any high school boy or girl is sound: "If you are interested in mathematics, physics, and applications, be an Engineer—you will never regret it."

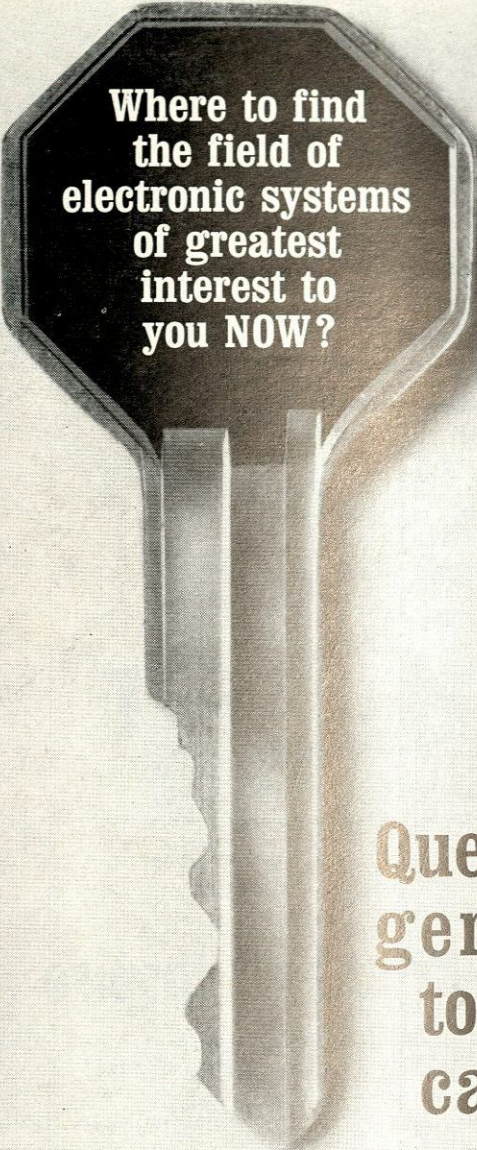
With reference to the services in Engineering, the effects of modern Engineering activities on city development is typical. One example is the change that has occurred in the Denver-Boulder area during the past five years. The tremendous influx of industry to the Denver area has been greatly enhanced by the impact of the surrounding universities. The Boulder community, only 25 miles from Denver, has developed and emerged as a major scientific research and development center. This has resulted because of the increased scientific activities at the University of Colorado including a modernized and expanded Engineering educational program. The location in Boulder of the National

Bureau of Standards, The Rocky Flats Atomic Energy Commission, Ball Brothers Research, Arapahoe Chemicals, Automation Industries, Beech Aircraft Research and Development, The Joint Institute for Laboratory Astrophysics, The National Center for Atmospheric Research, and many other industrial and research concerns, shows the direct impact Engineering can have on the development of a city.

The construction of the new Engineering Center on the Boulder Campus, an outstanding Engineering faculty of whom nearly half hold the Ph.D. degree, a modern undergraduate program in Engineering covering eight degree fields in Engineering, and a strong graduate and research program provide the ideal conditions for educating the Engineer at the University of Colorado. These same conditions permit the providing of Engineering services so vital to our cities in the state of Colorado and the nation.

To our high school students, I say "Engineering is a rich and rewarding career—consider it." To our students, I say "You have made the right choice of a career—be sure you make the most of it to be one of the best Engineers." To our alumni, I say "You have achieved the ultimate goal of being prepared to give outstanding service—keep up the good work."

Max S. Peters
Dean



Where to find
the field of
electronic systems
of greatest
interest to
you NOW?



How to plan
a course
leading to
career achievement
and satisfaction
3 to 5 years
from now?

**Questions
germane
to your
career**

At Sylvania Electronic Systems you can achieve both these objectives. To begin with, diverse programs give you a chance to enter practically any field in electronics: space-earth communications; electronic reconnaissance, detection, countermeasures; information handling; and complex systems for military command and control.

Here you can move about within the community of 20 interrelated research and advanced development laboratories located in a number of different locations including suburban Boston, Buffalo and San Francisco. Or you may prefer SES's Product Support Organization at sites throughout the world. Furthermore, three parallel advancement paths provide ample opportunity to further your career as a technical manager, technical specialist, or program/project manager—with equal rewards.

This major electronics division of Sylvania Electric Products Inc. coordinates for defense all technical personnel and facilities for General Telephone & Electronics Corporation.

For the talented young engineer or scientist eager to progress, career opportunities are now open. For further information see your college placement officer or write to Mr. Robert T. Morton.

SYLVANIA ELECTRONIC SYSTEMS

Government Systems Management

for **GENERAL TELEPHONE & ELECTRONICS**

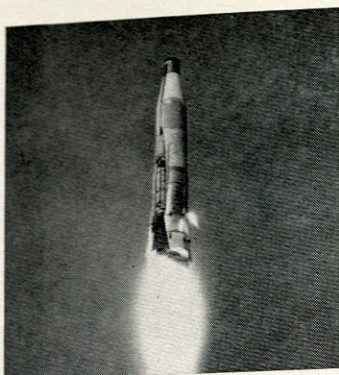


40 Sylvan Road—Waltham 54, Massachusetts

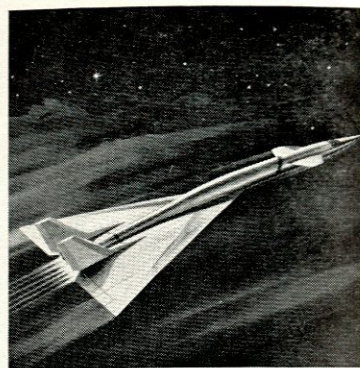
An Equal Opportunity Employer



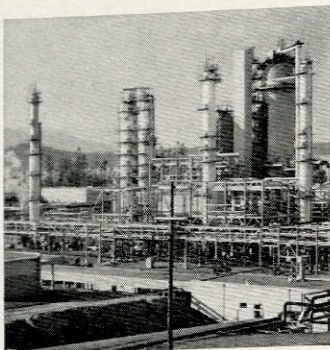
PROBLEM: Find new techniques and equipment to reach oil and gas now inaccessible under the oceans.



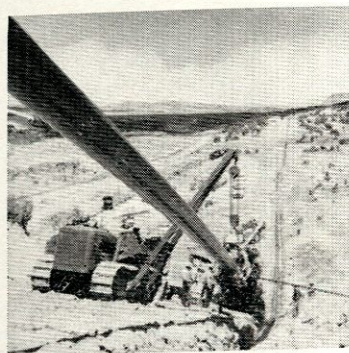
PROBLEM: Develop fuels and lubricants for space-age vehicles, such as greases to withstand 1000° F. temperature and almost absolute vacuum.



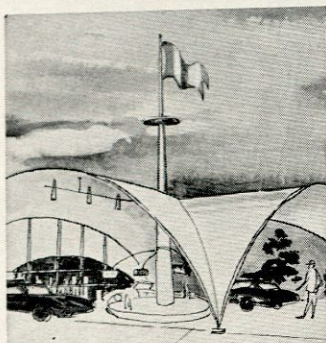
PROBLEM: Make chemical adhesives to bond wing structures of the 2000 mph Mach 3 plane of the 1970's.



PROBLEM: Improve the reliability and precision of automatic controls and new materials and equipment demanded by new oil and chemical processes.



PROBLEM: Engineer and operate tomorrow's petroleum transportation system to handle greater volumes faster throughout the nation.



PROBLEM: Brainchild the function, design, and locations of marketing outlets which future populations, cars and roads will demand.

Tough Problems Inspire Top Performance

The problems facing Shell are diverse and tough. And Shell's scientists, engineers, and other professionals prefer it that way. They know that their individual achievements and the success of the Company are determined by the size of the problems they tackle and solve. They have set for themselves the highest standards of performance.

These standards have enabled Shell to lead in advances in offshore exploration and production, new manufacturing processes, new products, efficiency in distribution and marketing, and to achieve a position as one of the nation's dynamic and progressive companies.

Shell's continuing dedication to excellence assures a variety of rewarding careers for graduates who also have set for themselves the highest standards of performance. Opportunities exist for graduates in engineering, chemistry, geology, geophysics, physics, mathematics and business.

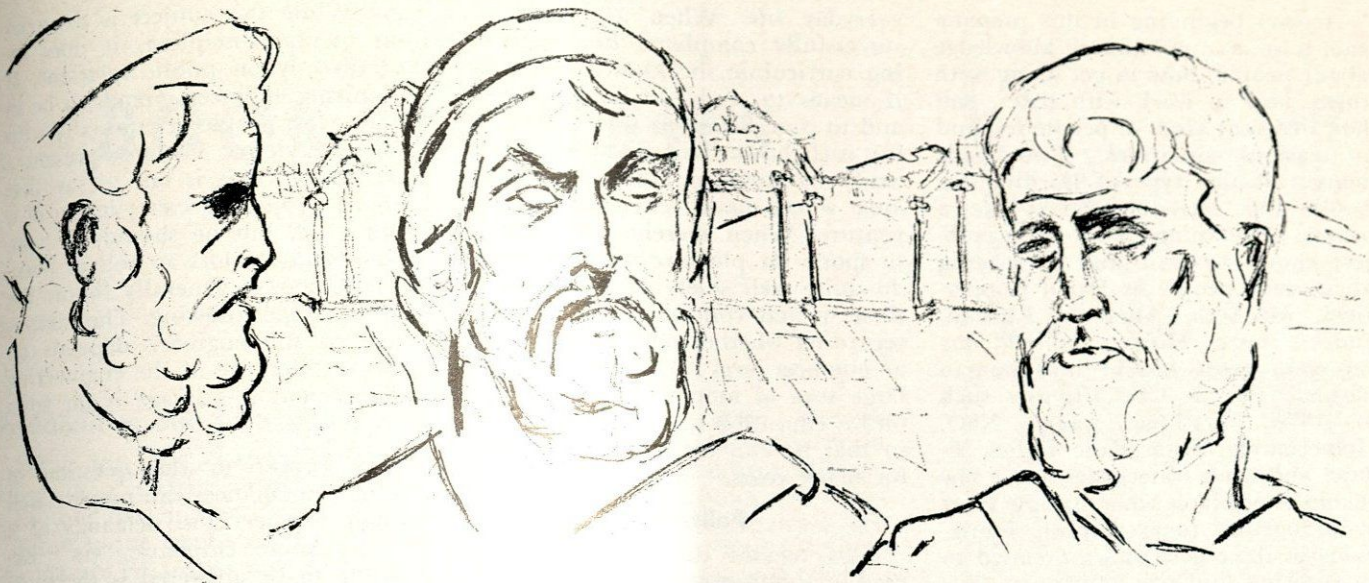
Shell Representatives will be pleased to tell you more about the Shell Companies when they visit your campus. Or a resume sent to Manager, Recruitment Division, Dept. E, The Shell Companies, 50 West 50th Street, New York 20, N. Y., will receive full consideration. Candidates whose qualifications and interests match Shell opportunities will be invited to visit Shell installations for interviews.

An Equal Opportunity Employer

The Shell Companies
Shell Oil Company
Shell Chemical Company
Shell Pipe Line Corporation
Shell Development Company



SIGN OF A BETTER
FUTURE FOR YOU



THE ENGINE²R

RICK CYS

The city; a conglomeration of people, machines, cars, buses, industries, nightclubs, and a never-ending atmosphere of "hurry-up and wait." Within a big city the cycle of consumption, supply, saving, and investment propagates continually to support the vast economy of the urban community. Businessmen run to the roof of the nearest skyscraper when the ticker tape reports a \$30 drop in their stocks while the local division of the Cosa Nostra meets to decide who the next mayor should be. Bricklayers, clerks, professors, lawyers, doctors, insurance salesmen, and every other kind of worker or professional person imaginable are cast into this complex machine. When the switch is thrown, these people will either succeed or lie on a psychoanalyst's couch talking about their early childhoods.

Of course, directly in the midst of all the activity are engineers. Every type of engineer has a role in a modern urban society. He may have a plush suite on the fifty-third floor of the Tycoon Building, or he may spend his days on the job supervising the construction of a new church in a nearby suburb. He may spend his time developing elaborate production methods, or he may have to con-

vince the public that his new soap has more suds, perfume, hand lotion, and, incidentally, cleaning power than any other on the market. Buyers will call on the engineer to supervise installation of new equipment or to teach the workers how to operate the machines. Chemical, mechanical, electrical, civil, aeronautical, and architectural engineers will all find a job and a challenge in the city.

Additional Duties

These engineers will not only have the daily grind at work, but also certain duties to their families and communities. Cub Scouts, Little League sports, Lions club, Rotary club, PTA, and local politics are just a few of the many activities the engineer, as a citizen, may participate in. As a family man he will frequently be asked to fix the plumbing, rough-house with his children or decide who should get the first shower. In meeting his responsibilities in these two areas, the engineer will perhaps be regarded as a leader, even in arbitrating the shower dispute. As a man who can appreciate the aesthetic beauty of science and mathematics, he is a respected and esteemed member of the community; it is logical that he can take the reins in many clubs and activities.

Can the average engineer with a Bachelor's degree meet these stringent demands of big city life? Each engineer must objectively answer this question himself. Some engineers will perhaps feel that not all of these requirements will apply to their roles in society; others will say that seeing the interests of science is enough of a contribution to society to compensate for missing the last election. The majority of young engineers, however, will feel that this question travels directly back to the old problem of the "narrow engineer" without passing "go" and collecting \$200. With such a tremendous curriculum of science, math, and engineering put before him in college, finding spare time to read even the evening paper could prove to be a major project for any serious engineering student. Despite the curriculum presented to the potential engineer during his college career, the duties of citizenship will nevertheless rest heavily upon his shoulders when he is thrust into competitive city business. All through his college career, then, he must prepare to meet these challenges by utilizing all the facilities of the university—academic, social and cultural and by utilizing every second of every day to the fullest extent.

A good beginning in this preparation is an accumulation of knowledge about people; how to get along with them, how to work with them, and how different kinds of people respond to various situations. Two basic sources of this type of learning are books and activities. Books are a source of learning about every subject known to man, and by reading about such people as David Copperfield, MacBeth, Abraham Lincoln, and, of course, Holden Caulfield one can gain great insight into human nature. Here at CU, activities such as ASUC, Freshman camp, NSO, Homecoming, Slide Rule follies, E-days, and even fraternities are a few examples of places where people must work together to accomplish a task. None of these activities are closed to engineering students; and yet too few participate. The physics lab report may have to be done first, the thermo problems worked next, but there is at least an hour or two each week that could be spent reading and at meetings if one would keep himself on a strict schedule.

A potential engineer might consider how to apply his strict, systematic method of problem solving to

everyday life. When a person has successfully completed his engineering curriculum, he knows well what it means to study 45 hours a week and to concentrate to the fullest during each hour. This discipline could easily be used in athletics, another area where many engineers fail to venture. When merely participating in sports for pleasure most engineers do quite well solely on the basis of their mental conditioning. Even disregarding whether one wins or loses, an engineer owes it to himself and the large sum of money and time spent on his education to protect his health so that he can contribute to society for many years.

Politics

This mental discipline could be used in almost everything an engineer does, in fact, it might even be of help in things such as politics. Herbert Hoover is one example of an engineer who applied his engineering methods to politics. Few engineers aspire to become the President, however, this is one example of an engineer who is indeed a leader.

Finally the engineer would do well to take a brief look at his mode of

dress. While this subject is divorced from mental discipline, it does reflect directly on public relations. If an aspiring engineer intends to be in contact with people or especially with a job interviewer, he must present a good image. This is not to say that he must project an exact image of a Playboy ad, but he should be neat, should match colors as well as possible, and should generally follow the rules of proper dressing. The campus image of the engineer depends on what outsiders see of the engineering students, and this image is far from good at C.U.

The answer to the question of whether an engineer can prepare well enough to meet the demands of a big city is an emphatic "yes." Remaining to be answered is the question, will the engineer take the time and trouble to get this preparation and will the schools and colleges help the engineer in this endeavor. Big cities and society as a whole will continue to demand a great deal of the engineer. This demand, it seems, is sufficient to warrant the attention of those involved in it.

CIVIL ENGINEERS:

The AASHO Road Test findings can help you build better highways... get the latest facts about DEEP-STRENGTH (Asphalt-base) pavements

Out of the AASHO* Road Test have come a number of important findings on the structural superiorities of DEEP-STRENGTH Asphalt pavements.

If your career is in Civil Engineering, you owe it to yourself to get the latest facts about modern highway design. Thirty-four states have already used DEEP-STRENGTH Asphalt pavements in their new heavy-duty highway construction. Prepare now for your future by sending for a free student library on Asphalt Construction and Technology.

*American Association of State Highway Officials.

THE ASPHALT INSTITUTE

College Park, Maryland

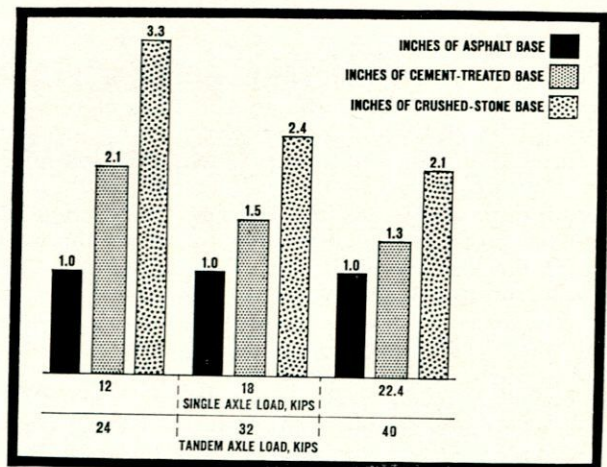


Chart based on data in Highway Research Board Special Report 61 E shows greater effectiveness of Asphalt bases in terms of relative pavement thicknesses to support typical single and tandem axle loads (12 kips = 12,000 pounds).

THE ASPHALT INSTITUTE College Park, Maryland

Gentlemen: Please send me your free student library on Asphalt Construction and Technology.

NAME _____ CLASS _____

ADDRESS _____

CITY _____ STATE _____

SCHOOL _____

BOOK REVIEWS

JOANN CRAM

Probabilities and Life

What are your chances of being killed in a traffic accident if you spend one day in New York?

What is the probability of drawing the ace of spades out of a deck on the first try?

What are your chances of catching a bus within one minute after reaching the stop if the buses arrive alternately at 10 and 30 minute intervals?

By Emile Borel, 87 pp., Dover Publications, Inc., 180 Varick St., N.Y. 1962, Paperbound \$1.00.

This book by the great French mathematician Emile Borel is a very clear, very easily followed introduction to aspects of probability, yet it does not demand any special knowledge of mathematics to understand it. Professor Borel's exposition is unusual among elementary statements of probability in concentrating upon situations of every day life. It covers problems like those listed above, problems which you have seen arise in life, and may have thought about, without realizing that accurate answers were possible. Stress is placed upon such matters as accidents, jobs, medical matters, weather, and a few simple phenomena of gambling. Among the topics covered are the single law of chance, the psychology of gamblers, roulette series, law of variations, investigations of Bernoulli and Bertrand, the wager and auction concepts in probability, Poisson's law, consecutive series, probabilities of waiting, death, diseases, accidents, heredity, etc. Detailed mathematical appendices cover roulette, Poisson's formula and mortality tables. This is the first English translation of this book, and it is highly recommended.

Error Propagation

By Peter Henrici, 73 pp., John Wiley & Sons, Inc., 1963, \$4.95.

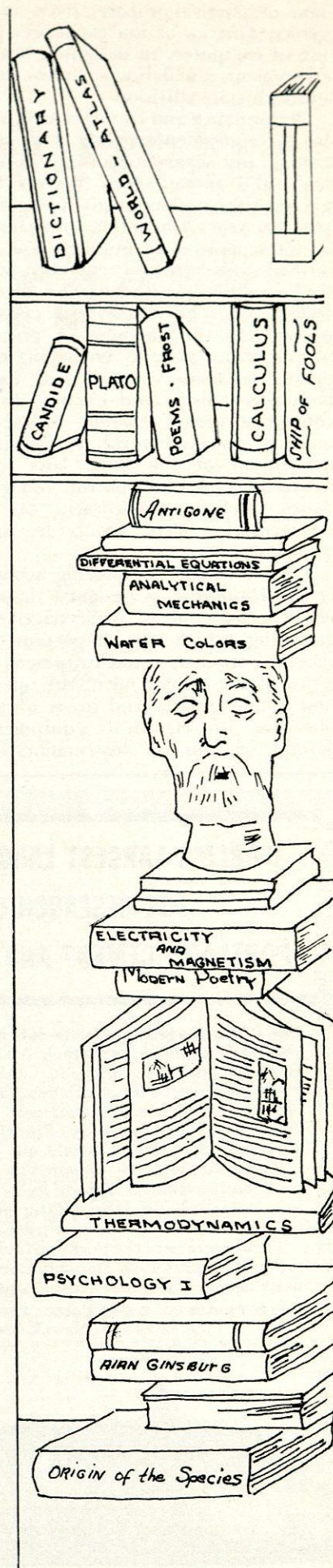
Here is a rigorous study of the laws governing the propagation of errors (both systematic errors due to

discretization and "noise" due to rounding) in the numerical integration of systems of ordinary differential equations. It includes an exhaustive discussion of an idealized problem in orbit theory. This volume is a sequel and companion to the author's earlier work—*Discrete Variable Methods in Ordinary Differential Equations* (Wiley, 1962)—in which treatment of systems of differential equations is restricted to methods of the one-step type. Together, the two volumes present the theory of error propagation as a whole—a significant achievement of modern applied mathematics. The results of the book were presented, in part, at the Annual Meeting of the Association for Computing Machinery in 1961 and, by invitation, at the 1961 Meeting of the Mathematical Association of America and the International Congress of Mathematicians in Stockholm in 1962. Contents: Introduction; Basic concepts; Stability, consistency, and convergence; Asymptotic behavior of discretization error; Asymptotic behavior of round-off error; Application to two problems of circular motion.

Chemical Engineer

Prepared by a staff of specialists under the editorial direction of Robert H. Perry, Chairman, School of Chemical Engineering, University of Oklahoma; 1802 pp., 1974 illustrations; McGraw Series in Chemical Engineering, 1963; \$29.50.

The Fourth Edition of the *Chemical Engineers' Handbook* has been completely revised and reorganized to reflect current advances in chemical engineering principles and practices. The special emphasis on fundamentals makes the *Handbook* more than ever applicable to problems in such rapidly developing fields as missiles and neucleonics. Among the many new topics covered in the twenty-six sections of the *Handbook* are: The dynamics of falling films and fluidized beds; prediction and extrapola-



tion of physical-property data; cryogenics; kinetics of ion exchange; the use of computers in designing multi-component distillation columns; and unsteady-state diffusion.

Performance and cost data are given for all equipment dealing with contacting and separation of gas, liquid, and solid phases. New devices for gas separation developed during the past ten years (including those needed for separation of isotopes) are described. The process engineer will find a comprehensive summary of the technology of process control encompassing the fundamentals of process measurement, primary measuring elements, automatic control and feedback mechanisms and circuits, final control elements, current telemetry used in process control, a complete description of the basic laws and nature of automatic control, and guidance in the establishment of instrumentation departments in process plants.

The electrical engineering section of the *Handbook* is designed to present the basic ideas of electrical engineering which are important to chemical engineers, and to present in terms of these basic ideas, the operation characteristics and areas of application of electrical equipment. Several sections on instrumentation

are included, with application notes indicating correct and incorrect applications, important characteristics of various instruments, proper interpretation of instrument indication, and typical applications.

The section on "Mechanical, Plant and Project Engineering," was prepared by the top consulting staff of one of the largest engineering organizations in the chemical process industries. New in concept, its purpose is to provide the chemical engineer with a sufficient working knowledge of mechanical design to guide him in the selection, application, and maintenance of pressure vessels and process equipment.

The *Handbook* is a comprehensive, authoritative, practical reference work for the chemical engineer.

Mathematical Theories

By Itto Dziobek, 294 pp., Dover Publications, Inc., Paperbound \$2.00.

The determination of the motions of the heavenly bodies is the basic problem of astronomy and has exerted tremendous influence on the development of mathematics. This book sets forth the principles of mathematical astronomy in a remarkably simple, yet strictly scientific form.

In the first half of the book, the author covers elliptic, parabolic and hyperbolic orbits; the solution of Kepler's equation; the problem of n bodies and the important special case of three bodies; Poisson and Lagrange's formulas for the elliptic elements of the orbit of a planet, the partial differential equation of Hamilton and Jacobi; and other topics. Under the general heading of perturbation theory, which forms the latter half of the book, the author considers the theory of absolute perturbations; analytical development of the perturbing function; the variation of elements; the secular variations of the mean longitude; the stability of the solar system; the invariability of the major axes; and many other closely related matters. Pertinent and interesting historical sketches accompany each important subdivision, and references to original sources of information are faithfully given.

Workers in celestial mechanics, graduate students in mathematics who would like an insight into the creations of master mathematicians in this field, and engineers and scientists interested in space technology will find this a reliable and readable account.

WORLD'S LARGEST LABORATORIES FOR RESEARCH ON PORTLAND CEMENT AND CONCRETE

How PCA helps keep you up-to-date on concrete after you leave engineering school. At the \$10,000,000 Research and Development Laboratories of the Portland Cement Association is the world's largest assembly of scientists, engineers and equipment devoted solely to the study of portland cement and concrete. The findings benefit all.

Technical literature, prepared by other PCA engineers and specialists is made freely available. PCA field engineers regularly inform project engineers on advances in concrete construction.

These services of the Portland Cement Association are made possible by the voluntary support of its more than 75 member cement companies.

PORTLAND CEMENT ASSOCIATION
721 Boston Bldg., Denver 2, Colorado

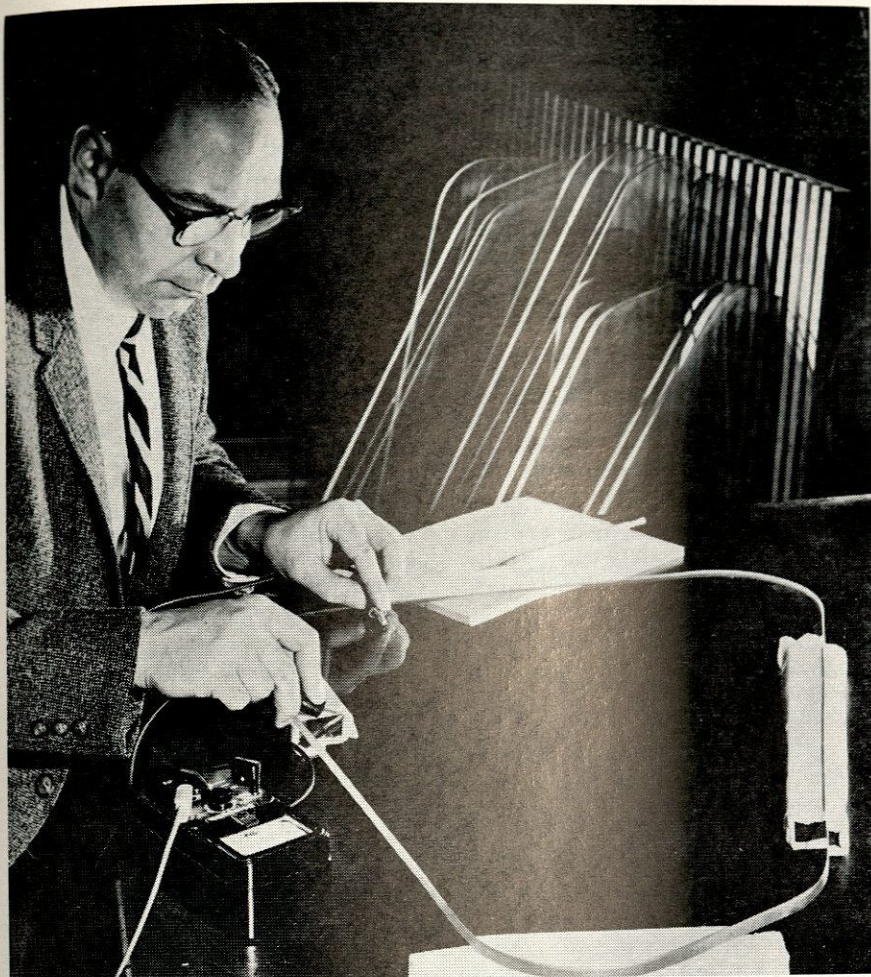
A national organization to improve and extend the uses of portland cement and concrete



the BOULDER DAILY CAMERA

COMMERCIAL
PRINTING
DEPARTMENT

FOR ALL YOUR PRINTING NEEDS
PHONE HI 2-1202



CHECKING THE RESISTANCE OF THE NEW HEAT-REFLECTING COATING

THIS TODAY

ROBERT BARRY

WINDOWS FOR THE DYNA-SOAR

A special combination of glasses is being supplied by Corning Glass Works for the windows on the Dyna-Soar space ship. The fine windows on each ship will contain a total of 12 glass panels. Each window will have an outer panel of fused silica and an inner panel consisting of two sheets of aluminosilicate glass, laminated with a silicone type interlayer. Two of the windows will have a third panel, also made of fused silica. Except for the outer surface of each window, the surfaces of the panels will be coated with a special transparent film which will reflect infrared radiation.

The space craft will have three windows for forward viewing and two for side viewing. The three forward-viewing windows will be protected by a metal shield until the craft has completed the high-temperature phase of re-entry. The shield will then be jettisoned to provide visibility for the airplane-like landing for which the

Dyna-Soar is designed. The two side windows will provide visibility throughout the mission. Because of their exposure these two windows contain the extra panels of fused silica.

Fused silica will provide resistance to the high temperature and thermal shock of re-entry. It was used for a camera window in the X-15. The softening point of fused silica is 2880° F. Its modulus of rupture is 8×10^3 psi and the coefficient of linear expansion between 77 and 572° F. is only $3.0 \times 10^{-7}/^\circ\text{F}$.

Aluminosilicate glass, one of the strongest optical glasses known, will provide an extra safety factor in mechanical strength. It has been used previously for the windows of the X-15 and the Mercury spacecraft, and is being used in the Gemini spacecraft. Its softening point is 1674° F.; its modulus of rupture is 9.3×10^3 psi; and its coefficient of linear expansion between 77 and 572° F. is $25.2 \times 10^{-7}/^\circ\text{F}$.

SECOND LARGEST SHOVEL

Bucyrus-Erie Company, South Milwaukee, Wisconsin has recently completed the erection of its new 90 cubic-yard stripping shovel for the Pittsburg and Midway Coal Mining Company. Located at the Pittsburg and Midway's mine, near Hallowell, Kansas, the shovel is the second largest mobile land machine in the world. The only larger machine is a Bucyrus-Erie shovel which has a capacity of 115 cubic yards.

The basic justification for these huge shovels is their ability to strip overburden from deeply buried coal reserves which it would not be profitable to strip mine with smaller equipment. For this type of job the efficiency of these shovels far surpasses that of smaller machines. A single operator has complete control, with only two levers and two pedals. The electric powered shovel picks up 175 tons of overburden in each bite and completes a dig-and-dump cycle in less than one minute. A full dipper

load can be accelerated from 0 to an 18 mph speed in 8 seconds and decelerated to a stop in only 6 seconds.

The big shovel benefits from the latest advances in materials, construction and design. Lightweight, high-strength steels were used extensively and its dipper lip was cast from an alloy developed specially for it. The shovel's lubrication system is almost entirely automatic and operates from a fully instrumented lubrication center on the machinery deck.

Almost everything about this shovel is gargantuan. More than 150 railroad cars were used to ship the shovel's components to the mine site where a team of erection specialists spent almost a year assembling it. It has a total reach of more than 300 feet and a maximum dumping height of better than 100 feet. The shovel stands over 130 feet tall and weighs about 10 million pounds. It has a maximum power capability of about 7000 horsepower.

DETECTORS FOR TOXIC GASES

Many potentially deadly gases and dust particles, a number of which are used extensively in NASA and Air Force rocket propulsion research, can now be safely monitored by two new instruments developed for the Air Force by IIT (Illinois Institute of Technology) Research Institute. Both monitors were developed by Dr. Robert S. Branman, IITRI research chemist.

According to Dr. Branman the first of these devices was designed to detect poisonous boron compounds but can be adapted to detect minute quantities of other toxic or flammable gases including chlorinated hydrocarbons, nitrogen dioxide, and petroleum fuels. This monitor will sense immediately a toxic level for pentaborane which, in an eight hour period, is lethal at concentrations of ten parts per billion parts of air.

The principle on which the device operates is simple. The monitor pumps air through a gas pilot light which has a colorless flame until a contaminant passes through it. When a contaminant is present the flame has a characteristic color, in the case of pentaborane a faint green. A photomultiplier measures the intensity of the color and transmits this information to a meter display. When the intensity of the color indicates a hazardous concentration of toxic gas the monitor activates an alarm system.

Beryllium oxide, another poisonous compound, is monitored by a second instrument designed by Dr. Branman. Beryllium compounds

which cause a respiratory disease known as berylliosis, are used as rocket fuel additives. The monitor can detect as little as two micrograms of beryllium dust in a cubic yard of air and sound an alarm before the concentration becomes lethal. The device operates by bombarding air-borne dust samples with alpha rays. If beryllium atoms are present in the sample, a nuclear reaction occurs which re-

BRIGHT-ANNEALED STAINLESS STEEL

Allegheny Ludlum Steel Corporation has recently expanded its facilities so that it can now produce bright annealed stainless steel sheet. The company has been a large tonnage producer of this product in strip form since 1960. In the steel industry, thin flat-rolled products which are less than 24 inches wide are known as strip, while those wider than 24 inches are referred to as sheet. The company's new facilities make it possible for the firm to produce 48 inch wide sheets with a bright-annealed finish in gauges from .010 to .062 inches.

The high-luster stainless steel is now being purchased primarily by the automotive industry, where it is popular for exterior and interior trim. The thin gauge sheets are also in demand for cladding to other materials when aesthetic qualities or high corrosion resistance are desired. In architectural design the high luster finish of the bright-annealed stainless steel serves as a background for

pattern designs that are rolled into the sheet at the mill. The smaller gauges of the steel sheet are becoming popular for use as lithograph plates. These plates are used in the offset printing process.

Bright-annealing is a method of preserving the high luster, high corrosion resistance and extreme density of finish obtained on stainless steel during processing. In the stainless steel manufacture process, the material is cold-rolled to the desired gauge from a hot-rolled coil. While it is being rolled the material hardens and becomes very smooth and dense. In this form it can not be worked. Therefore, it is necessary to heat the material to a high temperature to put it into its most workable form. The usual technique is to heat the stainless steel in an air or oxidizing atmosphere furnace. The reaction of the surface of the material with oxygen causes a heavy scale to form. This scale is removed by running the steel through pickling tanks. The pickling process causes the stainless material to take on a light gray color and to lose the high luster obtained during the cold-rolling process.

To obtain bright-annealed stainless steel the heating process is done in a furnace which has a controlled non-reacting atmosphere (either hydrogen or cracked ammonia). Since no scale forms under these conditions, there is no need to pickle the material and the high-luster finish is retained.

THE
NEW
48-INCH
PRODUCT.



INTERVIEW: ***THE FINAL EXAM***

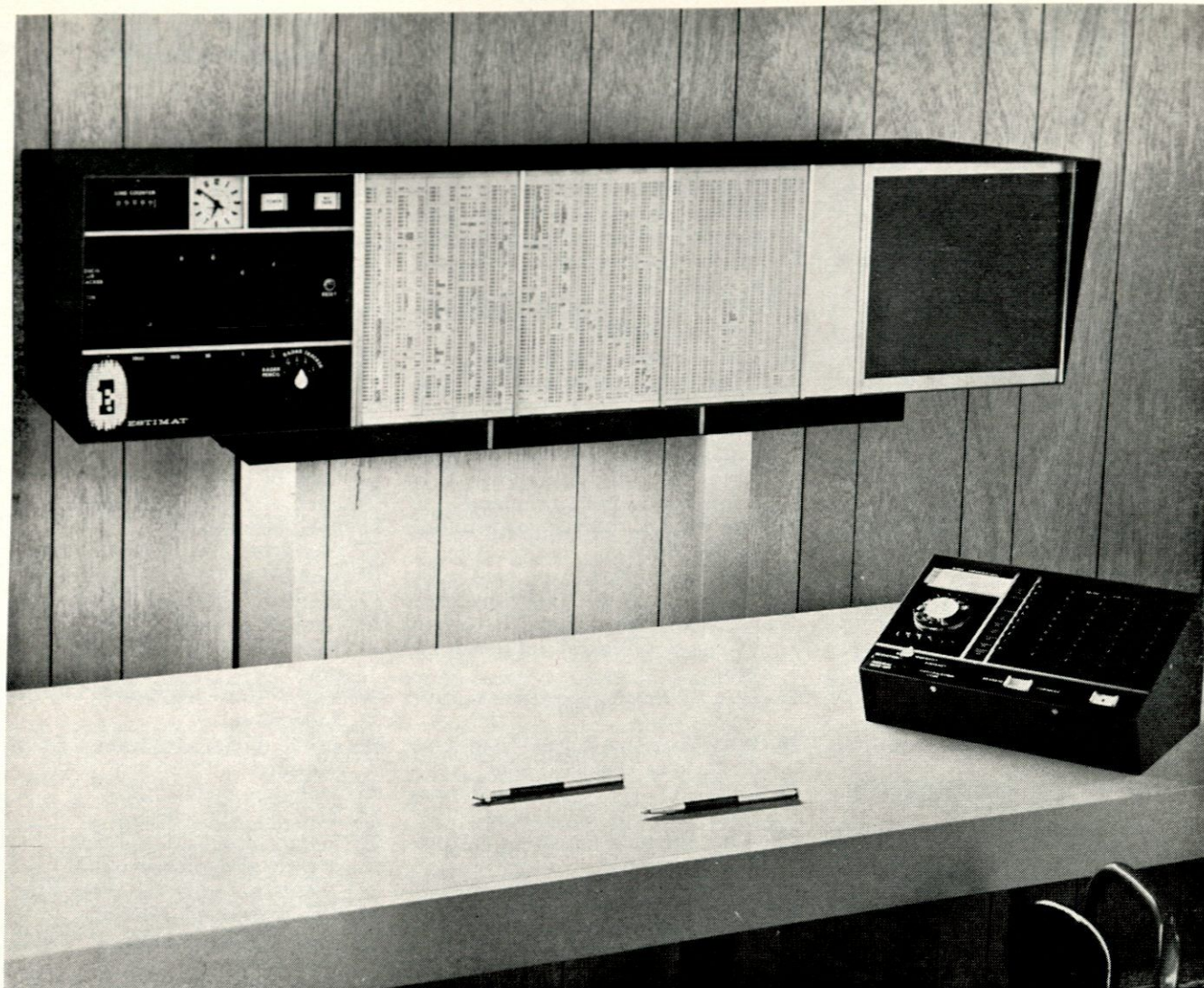
FURNISHED BY NORTHWESTERN UNIVERSITY

Questions most frequently asked by college recruiters in interviewing college seniors.

1. What are your future vocational plans?
2. In what school activities have you participated? Why? Which did you enjoy most?
3. How do you spend your spare time? What are your hobbies?
4. In what type of position are you most interested?
5. Why do you think you might like to work for our company?
6. What jobs have you held? How were they obtained and why did you leave?
7. What courses did you like best? Least? Why?
8. Why did you choose your particular field of work?
9. What percentage of your college expenses did you earn? How?
10. How did you spend your vacations while in school?
11. What do you know about our company?
12. Do you feel that you have received a good general training?
13. What qualifications do you have that make you feel that you will be successful in your field?
14. What extra-curricular offices have you held?
15. What are your ideas on salary?
16. How do you feel about your family?
17. How interested are you in sports?
18. If you were starting college, what career would you take?
19. Can you forget your education and start from scratch?
20. Do you prefer any specific geographic location? Why?
21. Do you have a girl? Is it serious?
22. How much money do you hope to earn at age 30? 35?
23. Why did you decide to go to this particular school?
24. How did you rank in your graduating class in high school? Where will you probably rank in college?
25. Do you think that your extracurricular activities were worth the time you devoted to them? Why?
26. What do you think determines a man's progress in a good company?
27. What personal characteristics are necessary for success in your chosen field?
28. Why do you think you would like this particular type of job?
29. What is your father's occupation?
30. Tell me about your home life during the time you were growing up!
31. Are you looking for a permanent or temporary job?
32. Do you prefer working with others or by yourself?
33. Who are your best friends?
34. What kind of a boss do you prefer?
34. Are you primarily interested in making money or do you feel that service to your fellow men is a satisfactory accomplishment?
36. Can you take instructions without feeling upset?
37. Tell me a story!
38. Do you live with your parents? which of your parents have had the most profound influence on you?
39. How did previous employers treat you?
40. What have you learned from some of the jobs you have held?
41. Can you get recommendations from previous employers?
42. What interests you about our product or service?
43. What is your record in military service?
44. Have you ever changed your major field of interest while in college? Why?
45. When did you choose your college major?
46. How do your college grades after military service compare with those previously earned?
47. Do you feel you have done the best scholastic work of which you are capable?
48. How did you happen to go to college?
49. What do you know about opportunities in the field in which you are trained?
50. How long do you expect to work?
6. Lack of confidence and poise — nervousness—ill at ease.
7. Failure to participate in activities.
8. Overemphasis on money — interested only in best dollar offer.
9. Poor scholastic record — just got by.
10. Unwilling to start at the bottom expects too much too soon.
11. Makes excuses — evasiveness — hedges on unfavorable factors in record.
12. Lack of tact.
13. Lack of courtesy—ill mannered.
14. Lack of maturity.
15. Condemnation of past employers.
16. Lack of social understanding.
17. Marked dislike for school work.
18. Lack of vitality.
19. Fails to look interviewer in the eye.
20. Limp, fishy handshake.
21. Indecision.
22. Loafs during vacation — lakeside pleasures.
23. Unhappy married life.
24. Friction with parents.
25. Sloppy application blank.
26. Merely shopping around.
27. Wants job only for short time.
28. Little sense of humor.
29. Lack of knowledge of field of specialization.
30. Parents make decisions for him.
31. No interest in company or in industry.
32. Emphasis on whom he knows.
33. Unwillingness to go where we send him.
34. Cynical.
35. Low moral standards.
36. Lazy.
37. Intolerant—strong prejudices.
38. Narrow interest.
39. Spends much time in movies.
40. Poor handling of personal finances.
41. No interest in community activities.
42. Inability to take criticism.
43. Lack of appreciation of the value of experience.
44. Radical ideas.
45. Late to interview without good reason.
46. Never heard of company.
47. Failure to express appreciation for interviewer's time.
48. Asks no questions about the job.
49. High pressure type.
50. Indefinite response to questions.

Negative factors evaluated during the employment interview and which frequently lead to rejection of the applicant.

1. Poor personal appearance.
2. Overbearing — overaggressive — conceited "superiority complex"—"know-it-all."
3. Inability to express himself clearly —poor voice, diction, grammar.
4. Lack of planning for career—no purposes and goals.
5. Lack of interest and enthusiasm —passive, indifferent.



FROM STEEL TO BOWLING WITH A

COLORADO INDUSTRY

LARRY FOWLER

Assume that you are a cost estimator for an electrical contracting company. Your firm wants to bid on the electrical system of a modern skyscraper. You can easily imagine the complexity and tedium of counting, tabulating, summing, and estimating of cost for tens of thousands of items which architects call for in their drawings.

Again suppose you are with the contractor building the 46th Street

viaduct. You are asked to determine the total poundage, poundage by type, and footage by type of the steel required to complete the project. Call upon your imagination once more and you can see that the manual extraction of this data is a time consuming and boring job.

However, in this age of machines, neither of the tasks listed above requires the time you may have imagined. Through the "magic" of compu-

ters and complimentary instruments designed for specific applications the time required for these jobs is reduced to hours rather than days.

The development and production of accessories which provide a data-link between human and computer are major parts of Colorado Instruments Incorporated business. Colorado Instruments is located in Broomfield and owned and staffed by Coloradans.

Both of the jobs above have been considered by Colorado Instruments and have become considerably more manageable through development of data acquisition devices by the Colorado firm.

The first of these devices, known as the "Estimat," is a digital data acquisition machine which was developed by Colorado Instruments at the request of Sturgeon Electric Company of Denver.

The Code

Mr. Ralph E. Johnson of Sturgeon has developed a ten character alphanumeric code, called the Estimatic system, which allows material to be grouped by assemblies. Because of the mnemonic structure of this code, an estimator familiar with its use can usually from the code identify any particular item from memory. Material cost and installation man-hours for each particular assembly are constantly received and up-dated in a large digital computer which now contains some 45,000 items. The cummation of time and material required to do any construction job can be quickly determined whenever the quantity and identifying assembly codes are fed into the computer.

The tiresome task of taking off assembly quantities from architects' drawings became the chief obstacle to further improving estimator production. The design of a machine to aid the estimator in taking off items called out on the drawings and quickly transferring the data to the computer was undertaken by Colorado Instruments. The result is the Estimat.

Input from the architects' drawings to the machine is achieved through instruments known as a radar pencil and radar rotometer. These devices are battery-powered transistor oscillators operating on a frequency of 500 kilocycles. They are completely self-contained and are hand-held instruments. The inductor of the tuned-circuit of the oscillators is wound around a ferrite rod which generates a substantial magnetic field and couples the signal to a tuned loop antenna located beneath the operating table.

The pencil point is coupled to a switch which is highly sensitive to pressure and causes the oscillator to pulse when it is closed. The rotometer emits a pulse for every 1/16 inch of peripheral travel of the wheel as it is moved along linear distances. These pulses are fed directly through pulse shaping networks to the counter register if the scale of the drawings is 1/16 inch equals one foot. Provisions

are included to handle scales of 1/8, 1/4, 1/2, and 1 inch equals 1 foot.

Since elevations do not appear in two dimensional drawings, provision for including the height of assemblies is made through a "riser" dial on the keyboard accessory. This dial also allows presetting or rearranging of data in the counter register.

The antenna input is rectified and then fed to the counter register through a thyatron pulse-shaping circuit. This circuit contains a discriminating network to prevent pulses caused by local noise from entering the counter.

Identification of the assembly must be accomplished prior to summing the data in the counter. Although the use of Johnson's Estimatic code readily allows identification of assemblies by estimators it is not useful for direct entry into computers. Therefore a system which allows this code to be translated into a five digit numeric code is provided. An index listing 650 items is mounted on the console and allows access to all 45,000 items in the Estimatic system through a keyboard-controlled, servo-driven microfilm viewer. The estimator is able to view all existing assembly codes and quickly locate the equivalent five-digit numeric code.

Pull Boxes

For example, in the Estimatic code pull-boxes are "BXP's." The console-mounted index shows that "BXP's" are on page 234 of the microfilm catalog. The estimator punches the number 234 into the first three rows of the keyboard. In a moment the servo-driven microfilm projector brings the page into view. As many as 100 different types of pull boxes are listed on this page. The estimator checks the five-digit code for the

specific box and punches the last two digits of the code into the remaining two rows of the keyboard.

As soon as the estimator has accumulated, through the radar pencil, the total number of these boxes, he presses the record button on the keyboard and the data is recorded on a punched tape in the language of the associated computer. Another feature of this tape is its adaptability to teletype communications. The tape may be fed directly into a teletype distributor and sent to the computer location in Denver.

Time

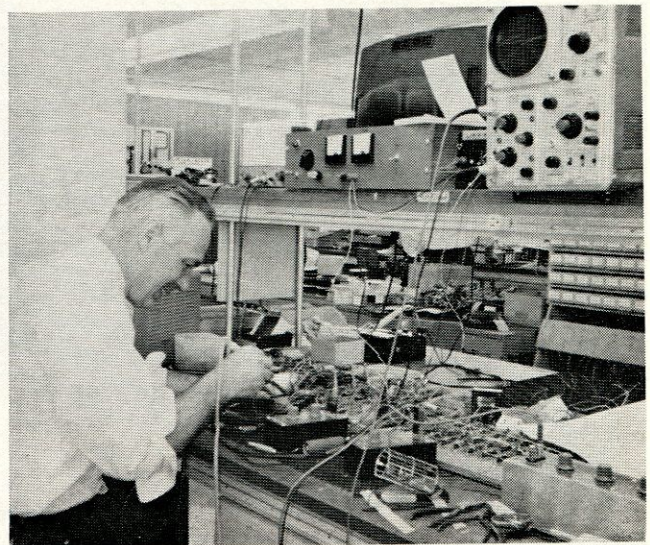
Colorado Instruments estimates that the time required to acquire data from architects' drawings has been reduced by from five to ten times. In conjunction with the Estimatic coding system, the overall estimator time has been reduced by four or five times over manual methods.

Although the instrument was developed for use in the electrical contracting industry, the extension to the other building trades is obvious.

The second of these data-link devices is the Computer-Data Entry Keyboard or C-DEK as it is called. This machine was designed to be used wherever quantities of numeric information must be organized and entered quickly for computer processing. Identifying codes, data, job number, and similar information as well as random numeric data, may be entered in orderly sequence and verified prior to punching paper tape records.

The C-DEK keyboard responds visibly through illuminated keys and makes word verification fast and accurate. A punched paper tape record is made on command after verification. The device is ideal for the pre-

A COLORADO INSTRUMENTS
INC. ENGINEER AT
WORK DESIGNING
ADVANCED ELECTRONIC
CIRCUITS FOR USE
IN THE FIRMS'
PRODUCTS.



paration of data to be forwarded to a computer via teleprinter transmission circuits.

Earlier keyboards were set up for specific customer requirements but the later models make use of overlays and are readily adaptable to a variety of uses. Some of the uses already in mind are in inventory control, payrolls, bowling, banking, and libraries. One of the first models was used to provide data on the steel poundage required on the 46th Street project in Denver. Twenty-four hundred line items had to be tabulated and summed. The job was accomplished with a computer using the C-DEK as a data-link between plans and computer. The time of computation was four and one-half hours but the designers feel that a job of similar complexity would now require only an hour of computing time.

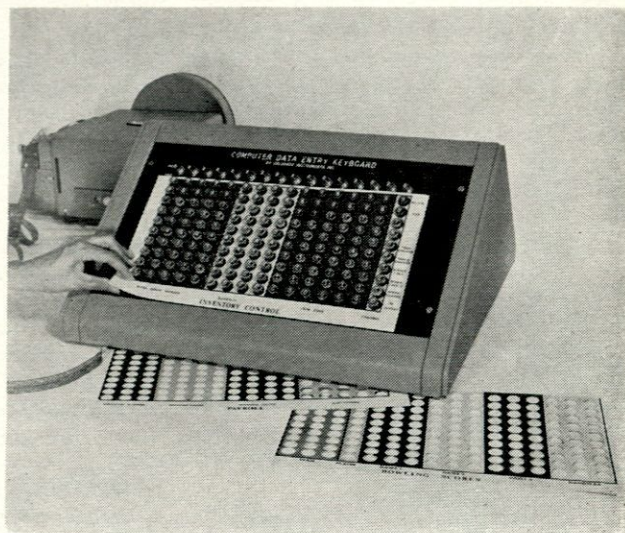
Colorado Instruments, Inc. was organized in May, 1961 by Dr. Richard C. Webb and a group of associates in the electronics industry. Since its founding, Colorado Instruments has developed in addition to Estimat and C-DEK, the "Multiple Formation Evaluator Readout System", a device used by the petroleum industry, which

provides surface recording in digital form of data from downhole instruments, and the CI² Teleflyter, a television picture synthesizer for display of airline "Arrival" and "Departure" information. Presently they have under development a "Power System Analyzer" which will simulate faults on electric power transmission systems and test the reaction of the system to the fault.

Additional activities of Colorado Instruments include manufacture of Nike-Zeus power supplies and solution of engineering problems through use of their computer system.

Further information on the services and products of Colorado Instruments may be obtained by inquiry to the firm at the Garden Office Center, Broomfield, Colorado.

LATEST VERSION
OF THE C-DEK
SHOWING OVERLAYS
WHICH PERMIT WIDER
ADAPTABILITY.



PROGRESS in Engineering

DENVER our central engineering office

**HEADQUARTERS FOR
DESIGN, CONSTRUCTION
AND MANUFACTURING
SERVICES TO INDUSTRY**

To customers from the Gulf Coast to the Canadian Northwest, Stearns-Roger provides every needed service through one responsible source...one contract.

Current projects include oil and gas plants, power stations, chemical and metallurgical plants, sugar factories and defense-related installations and equipment.

Stearns-Roger
CORPORATION

Denver Hilton Office Bldg., Suite 411,
1515 Cleveland Place, Denver 2, Colorado

DENVER
SALT LAKE CITY
HOUSTON

ALUMNI NEWS

CHUCK HANSEN

JOHN PARMAKIAN

John Parmakian, M.S. (C.E.) 1939; has retired after 33 years service with the Bureau of Reclamation. He has announced that he will serve as a private consultant on hydraulic transients and vibration problems at hydroelectric power installations.

Parmakian was named Associate Chief Designing Engineer in November, 1959. Earlier, he was Chief of the Technical Engineering Analysis Branch.

He joined the Bureau in 1930 as a Junior Engineer assigned to testing hydraulic structures at Hoover Dam, following his graduation from Massachusetts Institute of Technology. While with the Bureau, Parmakian has authored numerous technical papers, many of which deal with the special problems of water-hammer.

He is presently a director of the American Society of Mechanical Engineers, a Fellow of the American Society of Civil Engineers, a member of the International Association of Hydraulic Research, a member of the U.S. Committee on Large Dams, and is a registered Professional Engineer in the state of Colorado.

WILLIAM D. ROMIG

William D. Romig, B.S. (C.E.) 1936; has accepted a position in Washington, D.C., with the Agency for International Development. AID is the United States agency which administers foreign assistance. Romig will be a hydraulic engineer in the AID Bureau for Near East and South Asia.

ALFRED C. STIEFEL

Alfred C. Stiefel, B.S. (C.E.) 1921, was made of life member of the American Society of Civil Engineers at the annual dinner of the society. Stiefel is presently in the

Office of Program Development of the U.S. Geological Survey and is engaged in planning the National Typographic Mapping Program.

NEIL P. BAILEY

Neil P. Bailey, B.S. (M.E.) 1924; professor of mechanical engineering at the University of Utah at Salt Lake City, has been chosen for recognition in the teaching field by Mortar Board, senior women's honorary. Bailey was selected on the basis of questionnaires circulated to senior engineering students.

CHARLES V. SCHELKE

Charles V. Schelke, BSME '24; has retired from his position as a vice president of International General Electric after thirty-nine years of service. He will continue to assist in various company affairs and special assignments.

Schelke joined General Electric after graduation and was active in advanced engineering work for several years. His various assignments with IGE have sent him overseas many times. In 1927 he went to Japan where he served as an engineer in the heavy industrial field—power plants, railways, steel construction, etc. He returned to New York in 1931 and continued to work in the industrial equipment field.

In 1939 Schelke was assigned to IGE's London office where he remained until the outbreak of the war. He then returned to New York and became General Manager of General Electric's operations in the Philippines. While working in the Pacific, he and his wife were interned by the Japanese for a period of three years. They were released in 1945 and returned to the United States.

His next assignment took him to

China where he was president of the company's operations in that country. The Chinese Communist conquest of China in 1949 resulted in another year of internment in Shanghai for Schelke after which he returned to the U.S. He then became vice president of International General Electric Co. in charge of licensing and later in charge of overseas affiliated companies.

In 1955 Schelke became vice president of charge of all heavy equipment sales overseas. In 1960 he was appointed general manager of all international operations, and he became a vice president of the parent company, General Electric, where he served until his recent retirement.

Commenting on his career, Schelke states that his work "has been an expansion of the engineering training received at the University—first, theoretical engineering, then practical applications, field work, commercial and legal work related thereto, and finally management of all these aspects of engineering activity."



CHARLES V. SCHELKE

ADVERTISER'S INDEX

Allison Division of General Motors	27
American Telephone and Telegraph	1
Asphalt Institute	48
Boulder Camera	50
California State Personnel Board	39
Collins Radio Company	4
Corps of Engineers, Department of the Army	2
Eastman Kodak	Inside Back Cover
Fisher Governor	23
Ford Motor Company	33
Garrett Corporation	8
General Electric	Back Cover
Hughes Aircraft Company	34
International Business Machines	30-31
Montsanto Chemical Company	3
Naval Ordnance Laboratory	40
Phillips Petroleum	12
Portland Cement Association	50
Sandia Corporation	28
Shell Oil Company	46
Stearns-Roger Corporation	56
Sylvania Electronics Division	45
United Technology Center	6
Westinghouse	Inside Front Cover

The COLORADO Engineer

STAFF

LARRY L. HUSTON	Editor	LARRY HILL	Puzzle Page
ROSS M. FRAKER	Business Manager	POLLY HAHN	} Art Staff
CHERYL ANDERSON	Asst. Business Manager	MARY ANN MIKLICH	
BURTON DWYRE }	Faculty Advisors	JUDY BECKER	
SIEGFRIED MANDEL }		MARK SHERIDAN	} Staff Writers
JIM TOEVS	Associate Editor	RICHARD CYS	
DAVE PARKHURST	Assistant Editor	ELLEN CARR	
MARSHALL L. SILVER	Feature Editor	JOHN MELONE	
FRED IOVE	Sections Editor	BILL CHENWORTH	
RON BLACKWELDER	Production Manager	DENNIS LOTITO	Business Assistant
PAUL BUGG	Head Proofreader	GARY GOLDBERG	Finance Manager
DAVE PEERCY	Proofreader	GARY EMBLEM	Circulation Manager
ROBERT BARRY	"This Today"	WAYNE ENGSTROM	Circulation Staff
LARRY FOWLER	Colorado Industries	PING CHAN	Circulation Staff
CHARLES HANSEN	Alumni News	MITCH ALLIES	Circulation Staff
JO ANN CRAM	Book Reviews	SANDY PYLE	Office Manager
		ANDREA BIEL	} Office Staff
		CONNIE CHANDLER	
		DOROTHY CLARK	
		INA RAE GOFFSTEIN	

ABOUT THE AUTHORS

CREATIVE ENVIRONMENT

The authors of this article are all 5th year students in the School of Architecture. They represent 50% of the 1964 graduating class.

Charles "Chief" Boyd is one of the few dirty old Indians from Texas in the area. Besides being a half-breed, he is Vice-President of the student chapter of the American Institute of Architects and a member of Kappa Sigma. Presently he is working on his thesis which is a memorial to the Cherokee Indians. Outside interests include such things as skiing and spads.

Robert L. Carper, from Loveland, Colorado, is a member of the student chapter of the American Institute of Architects, and Vice-President of Delta Phi Delta Art Honorary. In the summer of 1962, he participated in the International Association for the Exchange of Students for Technical Experience program, working in an architect's office in Milan, Italy. His thesis project is a civic center for his hometown. Bob is a part time draftsman at the National Bureau of Standards, and his hobbies include painting, photography, and skiing.

Steven W. Miller, from New York City, is a member of the student chapter of the American Institute of Architects, Delta Phi Delta, and Phi Sigma Delta fraternity. He has been employed by the city of Boulder, Colorado for the last three years in the capacity of landscape designer and park planner. Experimentation in the combinations of metropolitan theatres for a large urban area is his undergraduate thesis. He intends to continue his studies of architecture in graduate school.

Darrel Brooks Smith is a member of Delta Phi Delta, and he is president of the student chapter AIA. In the spring of 1963, he was named designer of the year in the Senior Class and received the Monarch Tile Company Scholarship Award. His undergraduate thesis will be a National Headquarter Complex for a boy's organization. Darrel is from Littleton, Colorado.

AIR COLLISIONS

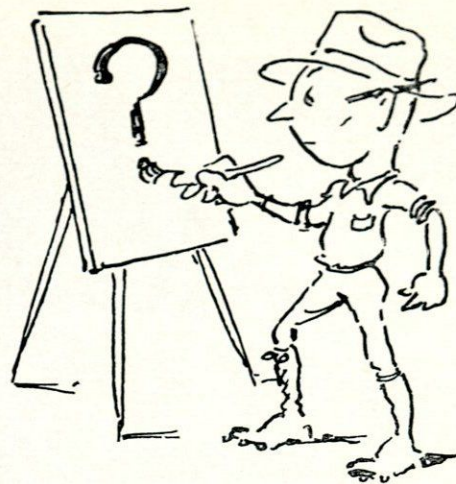
Gary O'Keefe is a transfer student in his first semester at the University of Colorado, having previously attended Long Beach, California. He is presently a junior majoring in Civil Engineering. Summers he is engaged in materials testing work with the California Division of Highways. Tennis and handball are among his favorite activities and he hopes to get in some skiing while in Colorado.

URBAN TRAFFIC STUDIES

1. *Increasing the Traffic-Carrying Capability of Urban Arterial Streets - The Wisconsin Avenue Study*, Bureau of Public Roads, Washington D.C., 1962 54 pp.
2. *Appendixes to the Original Wisconsin Avenue Study*, Bureau of Public Roads, Washington, D.C., 1962 143 pp.
3. *Denver Metropolitan Area Transportation Study, Capacity Report*, Colorado Department of Highways, 1962.
4. "Effective Use of Traffic Signals", Eager, W. R., *Colorado Municipalities*. V. 38, n. 9, Sept. 1962, p. 248.
5. "Vehicular Traffic Flow", Robert Herman and Deith Gardels, *Scientific American*. V. 209, n. 6, Dec. 1963, p. 35.

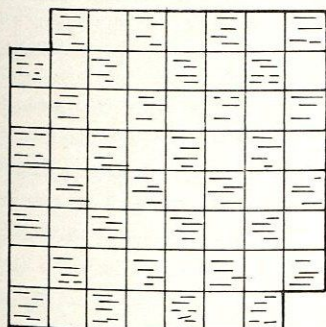
PUZZLE PAGE

LARRY HILL



Everyone has heard the old riddle which runs as follows: An explorer walks one mile due south, turns and walks one mile due east, turns again and walks one mile due north, arriving at the point where he began. He shoots a bear. What color is the bear? The time honored answer is "white" because the explorer must have started at the North Pole. Recently someone discovered that the North Pole is not the only spot on the globe from which one could walk a mile south, a mile east, a mile north and find himself back at his original position. Can you?

The mathematician Max Black published, in his book *Critical Thinking*, a problem involving a chess board and 32 dominoes. Each domino is of such a size that it exactly covers two adjacent squares on the board. The 32 dominoes therefore can cover all 64 of the chessboard squares. But now suppose that we cut off the two squares at diagonally opposite corners of the board and discard one of the dominoes. It is possible to place all 31 dominoes so that the remaining 62 squares are covered? If so, show how it can be done. If not, prove it to be impossible.



A carpenter, working with a buzz saw, wishes to cut a wooden cube, three inches on a side, into 27 one-inch cubes. He can do this easily by making six cuts through the cube, keeping the pieces together in the cube shape. Can he reduce the number of necessary cuts by rearranging the pieces after each cut?

In H. G. Well's novel *The First Man in the Moon* our natural satellite is found to be inhabited by intelligent insect creatures who live in caverns below the surface. These creatures, let us assume, have a unit of distance that we shall call a "lunar". It was adapted because the moon's surface area, if expressed in square lunars, exactly equals the moon's volume in cubic lunars. The moon's diameter is 2160 miles. How many miles long is a lunar?

Puzzles taken from:

Scientific American, Feb. 1960.

Scientific American, Feb. 1957.

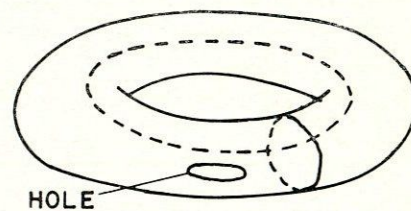
Riddles in Mathematics, Eugene P. Northrop, D. Van Nostrand Company Inc., 1944.

ANSWERS TO NOVEMBER PUZZLES

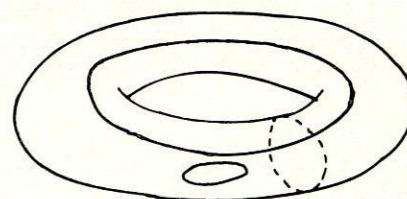
The welding job on the chain can be performed for forty-five cents; believe it or not. How? Take one piece of three links; cut them all. This will give you three links of chain with which you can put together the remaining four pieces. At five cents per cut and ten cents per weld you have:

$$3(15c) = 45c$$

The circles would no longer be linked in space. The one formerly on the outside would be on the inside, and the one formerly on the inside would be on the outside. A diagram is shown below.

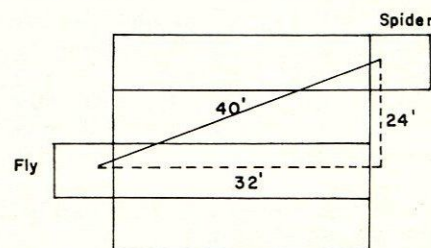


BEFORE



AFTER

The shortest path crosses five of the six faces of the room. One might think that a path across the top of the room would be shorter, but it isn't.





LARRY HUSTON

A Long Island Potato married an Idaho Potato and eventually the two became the proud parents of Sweet Potato. Sweet Potato grew up and one day announced her intention of marrying Gabriel Heatter. "But you can't marry him," her shocked parents wailed. "He's only a commentator."

He who laughs last has found a double meaning.

The scene is a dress rehearsal of "Noah's Ark." Hundreds of people and animals are running about. But above all the confusion can be heard the shrieks of the electrician: "What lights shall I use? What lights shall I use?"

And the heavens open and a voice comes to him: "The flood lights, you sap."

One of the questions asked in an examination on stockraising was, "Name four different kinds of sheep."

An inspired student answered, "Black sheep, white sheep, Mary's little lamb, and hydraulic ram."

Sign in a funeral parlor window: "We give Green Stamps."

After a freshman economics lecture, a student came up to the instructor. "Gee, Mr. Fieser," he said, "you've certainly got a swell vocabulary. Golly, all those big words."

"Well, thank you," the instructor said with an amused smile. "I have always considered it rather meager . . ."

"There you go again!" caroled the student.

A kiss is a noun because it's common and proper.

It's a verb because it's active and passive.

It's a pronoun because she stands for it.

It's an adverb because it makes an explanation.

It's a conjunction because it brings together and connects.

It's an interjection because it shows strong feeling.

It's a preposition because it has an object.

Our Favorite Cynic Defines For Us: Anatomy as something that everybody has, but looks better on a girl.

Both bigamy and marriage as having one wife too many.

Husband as an unfortunate who began by handing out a line and ended up by walking it.

Individualist as a man who lives in the city and commutes to the suburbs.

"You were a very tidy boy not to throw your orange peel on the floor of the bus. Where did you put it?"

"In the pocket of the man sitting next to me."

Then there was the ill-humored civil engineer who built cross roads.

A young husband received a telegram stating that his mother-in-law's body has been found floating at the seashore, a lobster attached to each toe. He was asked to telegraph instructions for disposition of the body.

He wired back: "Sell the lobsters and set her out again."

Editors call themselves "we" so the person who doesn't like the article will think there are too many for him to lick.

A driving school offers this sage advice: If your wife wants to learn to drive, don't stand in her way.

Circus Joke of the Year:

A certain animal trainer became bored with his act, and decided to search for something new. He pondered upon numerous ideas, and finally came up with a brilliant new act.

Going down to the river with a net, he caught about a half-dozen large carp, which he transported back to the circus. After the carp had become accustomed to their surroundings, he began to train them for his new act.

Three months later, the trainer had taught the carp an amazing trick. He would throw a rubber ball into the tank, and the first carp would catch it on his nose and throw it to the second carp, who would, in turn, throw it to the third carp and so on down the line to the last carp.

The trainer dashed to the circus manager's tent and summoned him to see the new act. The manager peered into the tank. Seeing nothing, he leaned over the edge for a better look. As he did, his wallet fell out of his pocket and into the tank.

The first carp picked up the wallet on his nose and threw it to the second carp. The second carp threw it to the third and so on down to the last carp, who flipped it back to the manager. And that, fans, was history's first carp-to-carp wallet.



We are the chemical company that an electromechanical designer might be operating some day

The chemistry of photography is far from being all of chemistry that concerns us. Actually, it is rapidly going into hiding inside such machines as these automatic x-ray processors for hospitals, seen here under construction.

We need **electromechanical engineers** to design all kinds of automatic photographic apparatus that we have ideas for—big ones, little ones, simple ones, super-sophisticated ones, inexpensive ones to sell by the millions, very expensive ones for maybe internal use only.

We need **process engineers**, by which we mean those who figure out the best way to make what the designers have dreamed up.

We need **industrial engineers**, who work out the most rational relationships between apparatus and people—the people who work in the plants and even on occasion the people who buy or use our products.

This is a great place for all categories of engineers. However, we think in categories largely for hiring purposes. There is such a thing as mobility, and it doesn't have to be geographical.

Incidentally, we still need **chemical engineers**. Maybe you are one and maybe you join us and maybe you turn out to be such a whiz at your profession that after a while we ask you to operate an electromechanical plant for us.

EASTMAN KODAK COMPANY

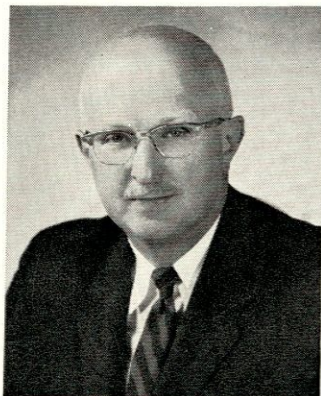
Business and Technical Personnel Department, Rochester, N.Y. 14650

An equal-opportunity employer offering a choice of three communities:

Rochester, N.Y., Kingsport, Tenn., and Longview, Tex.

Kodak

**An interview
with G.E.'s
Dr. George L. Haller
Vice President—
Advanced
Technology**



As Vice President—Advanced Technology Services, Dr. Haller is charged with coupling scientific knowledge to the practical operating problems of a Company that designs and builds a great variety of technical products. He has been a radio engineer, both in industry and the armed services (Legion of Merit for development of radar counter-measures); physics professor at Penn State and dean of its College of Chemistry and Physics; and a consulting engineer. With G.E. since 1954, he has been manager of its Electronics Laboratory, and general manager of the Defense Electronics Division. He was elected a vice president in 1958.

For complete information on opportunities for engineers at General Electric, write: Personalized Career Planning, General Electric Company, Section 699-09, Schenectady, N. Y. 12305

GROWTH THROUGH TECHNOLOGICAL CHANGE

The Role of R&D in Industry

Q. Dr. Haller, how does General Electric define that overworked term, Research and Development?

A. At General Electric we consider "R&D" to cover a whole spectrum of activities, ranging from basic scientific investigation for its own sake to the constant efforts of engineers in our manufacturing departments to improve their products—even in small ways. Somewhere in the middle of this range is an area we call simply "technology", the practical know-how that couples scientific knowledge with the engineering of products and services to meet customer needs.

Q. How is General Electric organized to do research and development?

A. Our Company has four broad product groups—Aerospace and Defense, Consumer, Electric Utility, and Industrial. Each group is divided into divisions, and each division into departments. The departments are like separate businesses, responsible for engineering their products and serving their markets. So one end of the R&D spectrum is clearly a department function—engineering and product design. At the other end is the Research Laboratory which performs both basic and applied research for the whole Company, and the Advanced Technology Laboratories which also works for the whole Company in the vital linking function of putting new knowledge to practical use.

Having centralized services of Research and Advanced Technology does not mean that divisions or departments cannot set up their own R&D operations, more or less specialized to their technical or market interests. There are many such laboratories; e.g., in electronics, nuclear power, space technology, polymer chemistry, jet engine technology, and so on.

Q. Doesn't such a variety of kinds of R&D hamper the Company's potential contribution? Don't you find yourselves stepping on each other's toes?

A. On the contrary! With a great many engineers and scientists working intensively on the problems they understand better than anyone else, we go ahead simultaneously on many fronts. Our total effort is broadened. Our central, Company-wide services in Research and Advanced Technology are enhanced by this variety of effort by individual departments.

Q. How is Advanced Technology Services organized?

A. There are three Advanced Technology Laboratories: Chemical and Materials Engineering, Electrical and Information Engineering, and Mechanical Engineering; and the Nuclear Materials and Propulsion Operation. The Laboratories do advanced technology work on their own, with Company funds, and on contract to product departments or outside customers and government agencies. NMPO works for the AEC and the military to develop materials and systems for high-temperature, high-power, low-weight nuclear reactors. ATS is the Company's communication and information center for disseminating new technologies. It also plans and develops potential new business areas for General Electric.

Q. So R&D at General Electric is the work of a great many men in a great many areas?

A. Of course. The world is going through a vast technological revolution—in the ways men can handle energy, materials, and information. Our knowledge is increasing exponentially. In the last five years we have spent more than half the money ever spent for research and development. To keep competitive, and to grow, industry must master that mountain of new knowledge and find ways to put it to practical use for mankind. Only by knowing his field well and keeping up with the rush of new developments, can the young engineer contribute to the growth of his industry—and society as a whole.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

An Equal Opportunity Employer

K
KET
CAN