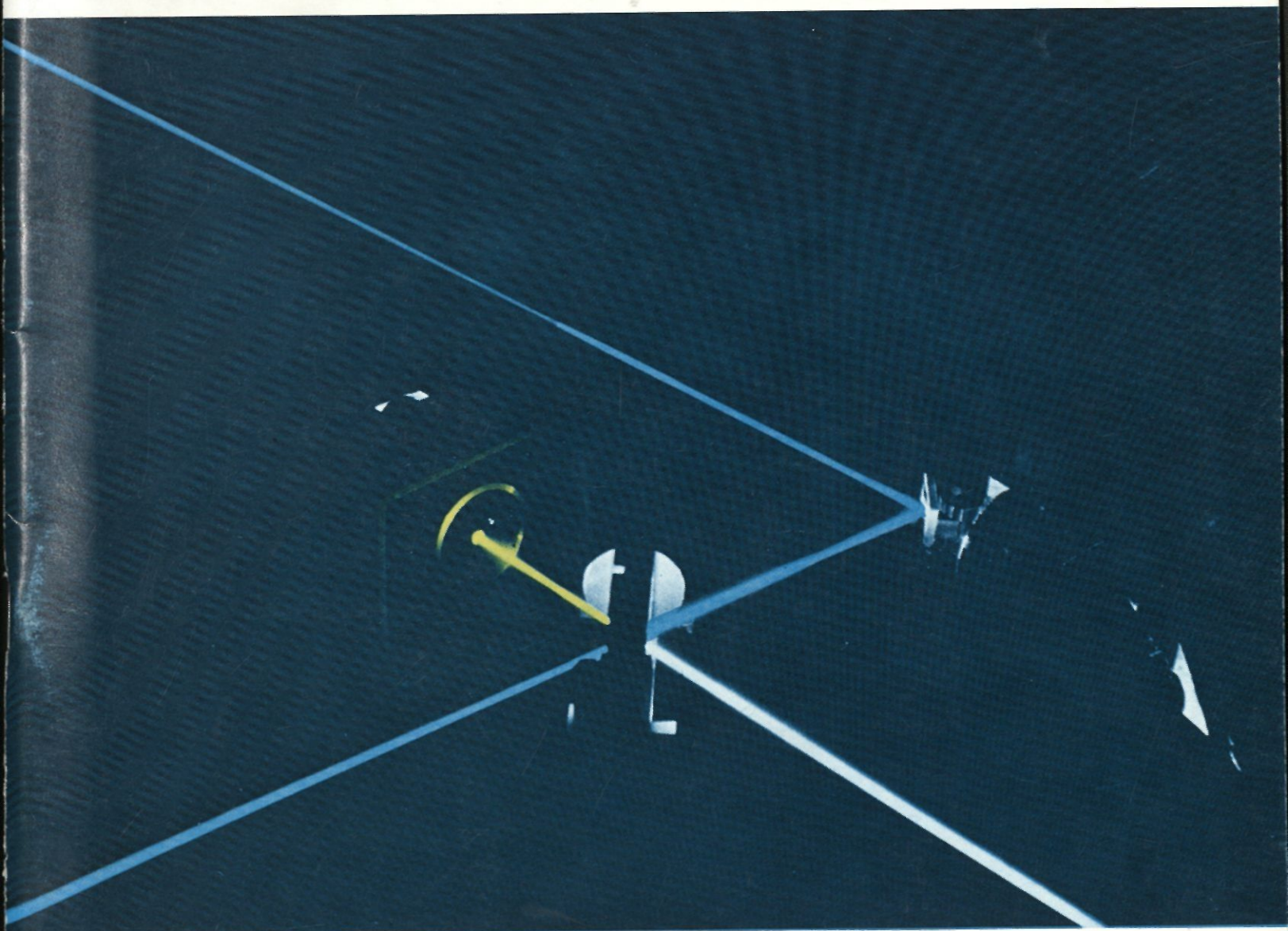


The
COLORADO
Engineer

November 1974



LASER RESEARCH

Some people are starving for more than a passing grade in English.

Many people we know couldn't stomach what some college students eat in one day.

Luke warm coffee.

Peanut butter on crackers.

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sugarcane.

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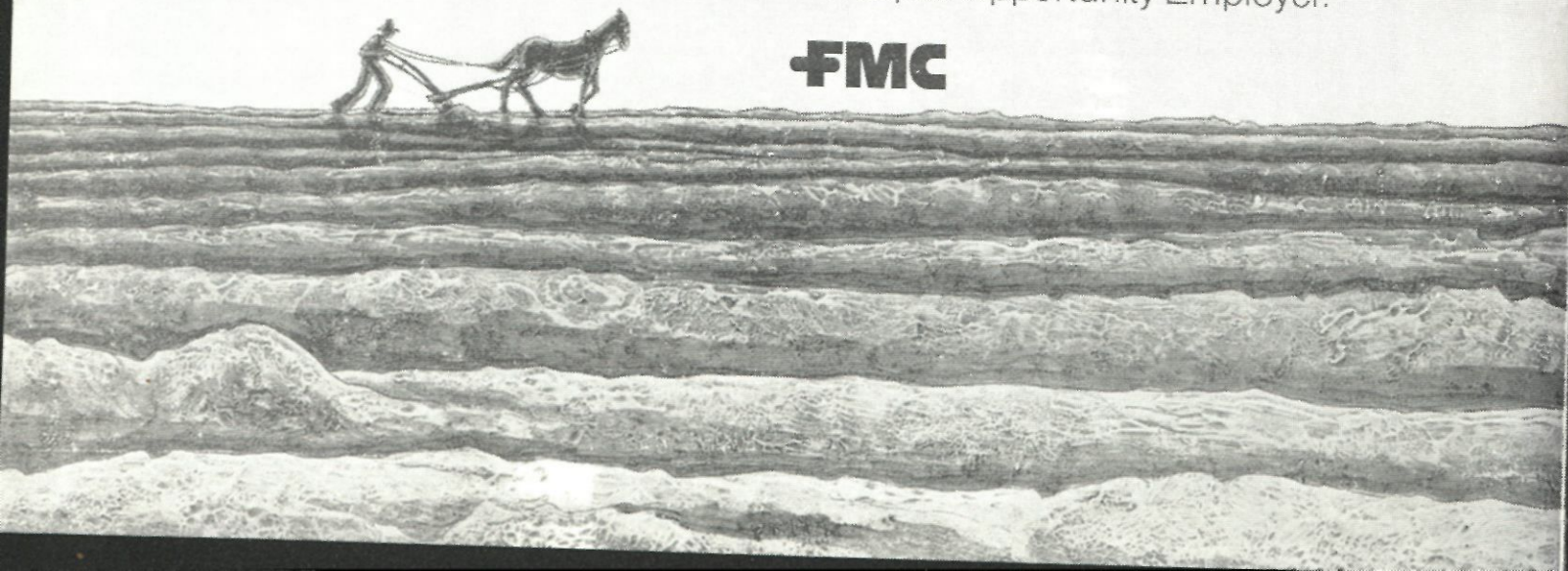
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Cover

The photograph on the cover shows part of the apparatus used in an experiment on spin-flip scattering of laser light. The blue (4880 Å) laser beam at the top of the picture is being produced by an Argon ion laser. This blue beam is reflected by and transmitted through a beam-splitting mirror where it is joined by the yellow (5682 Å) beam which is produced by a krypton ion laser. The resultant "white" beam is used to study the laser properties of semi-conductor materials in a high magnetic field. See article on page 18.

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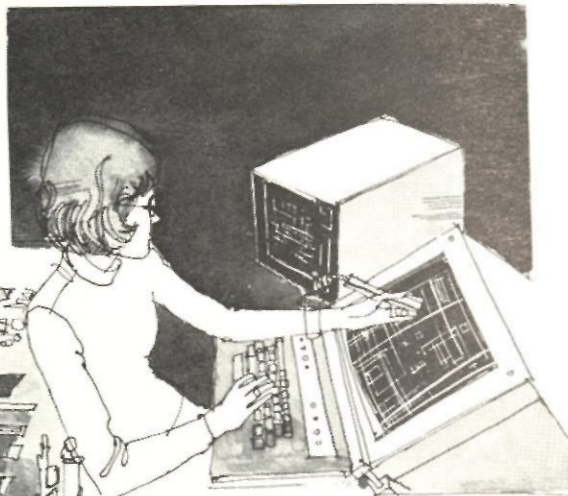
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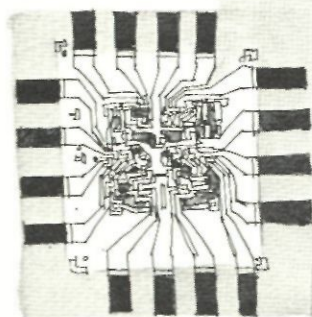
At Western Electric, we put science to work.



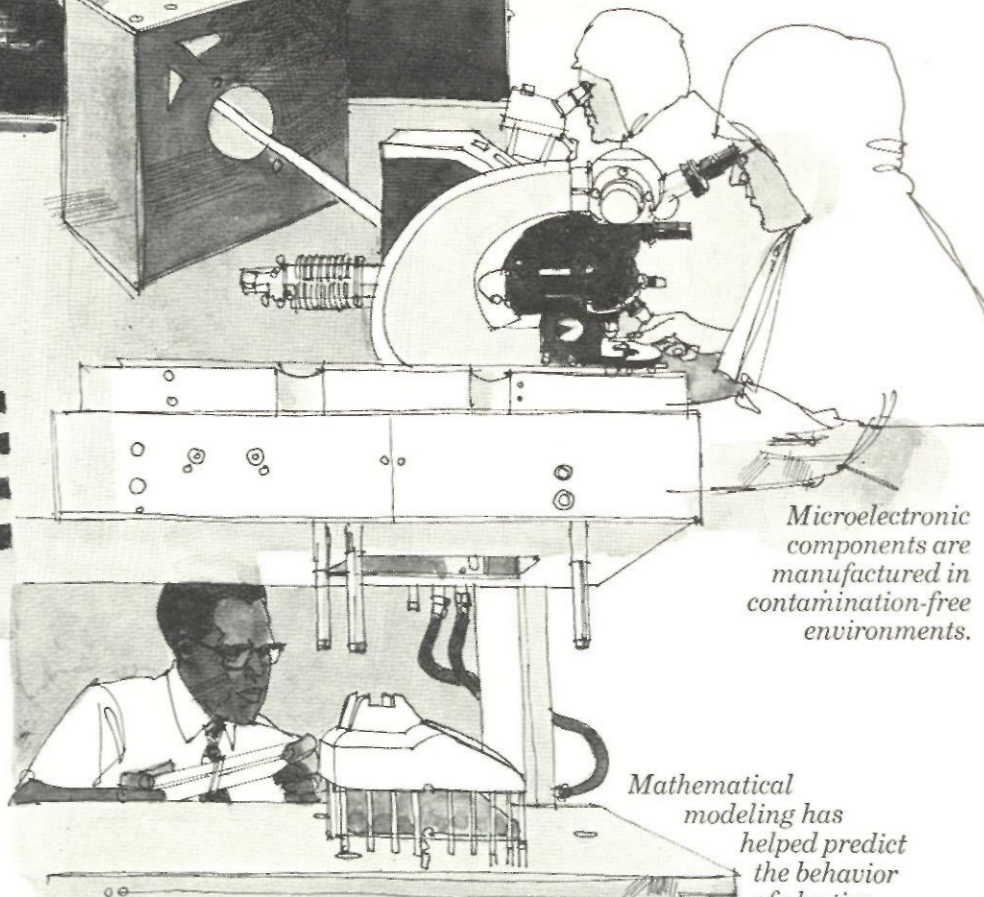
*Lasers are used
in a variety of ways—
from measuring
to drilling and welding.*



*The installation diagrams for
telephone switching centers have been
generated through computer graphics.*



*Like transistors
before them, integrated
circuits are spreading
into every nook and
cranny of the
Bell System.*



*Microelectronic
components are
manufactured in
contamination-free
environments.*

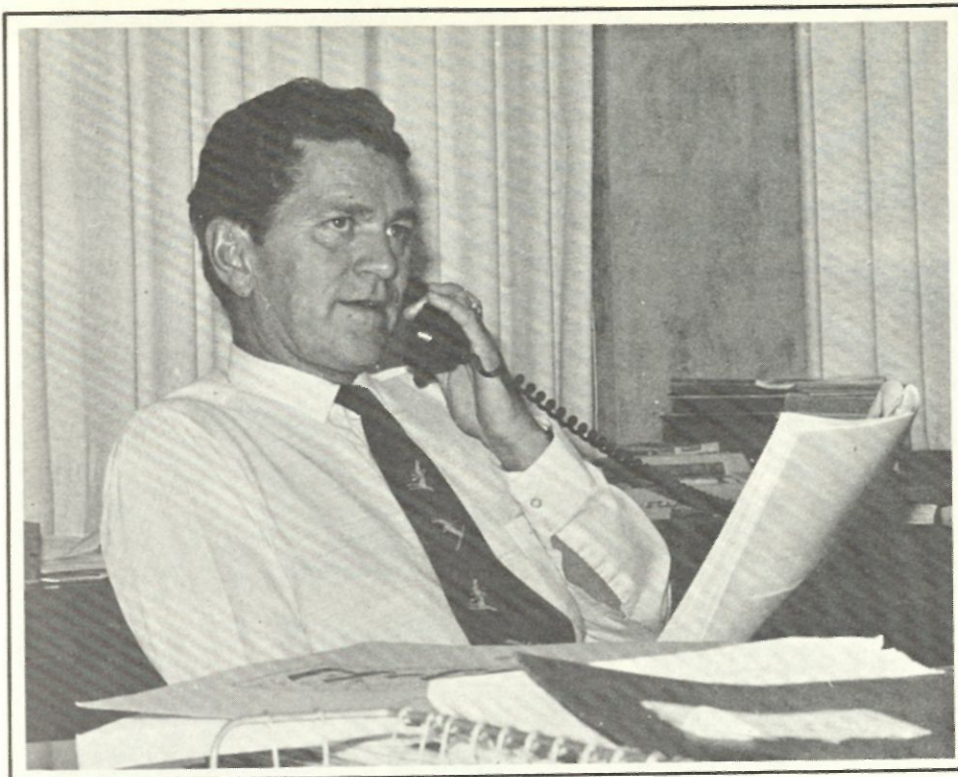
*Mathematical
modeling has
helped predict
the behavior
of plastics
in injection molding.*

Managing all this is a new breed of talented people. Whatever their specialties, they also have to be comfortable working in other fundamental disciplines once left only to "pure scientists". At Western Electric, we put science to work.



Western Electric

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Our school year is in full swing once more, and I am delighted to welcome all of you returning students. I am also pleased to welcome all of you who are new students. I hope you are finding our engineering program as challenging and as exciting as you had anticipated. If any of you are running into problems, please remember that our faculty is here to help you. To those of you who do not have a direct departmental contact: please do not hesitate to come to the Dean's office for conferences with our faculty and advisers there. We are anxious to help you, but we cannot do anything for you if you do not come to see us to let us know your situation.

I would like to especially encourage new students to get involved in college and university affairs in addition to handling your academic work. Particularly appropriate are activities in our student professional engineering societies on campus, including the Associated Engineering Students. Interviewers look for activities of this type as well as grade point averages when making decisions relative to possible offers for industrial positions. However, even more important, these activities are part of a university education and make your overall experience here more rewarding and more fun.

It appears that the demand for engineering graduates is going to be up again this year, with numerous offers and high salaries being available. It is nice to be in demand again, but let's not forget that the main thing we want to look toward is the career that will meet our own personal demands. For some of you, this means giving careful consideration to going on to graduate work even though there are many well-paying positions now available in industry. For others, it will mean moving directly into industry where I am hoping that each of you will recognize the key importance of continuing with your education through short courses, evening programs, and similar activities. For the person who is going to move forward in engineering — no matter what area he may be involved in — it is absolutely essential that education continue. So I now welcome you back to another year of study here at the University, and I immediately caution you that, if you are going to remain an engineer, study and continued learning will always be with you.

Good luck — learn a lot — be personally involved — and have a good year.

Max S. Peters

DEAN'S COLUMN



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If you like what you see and what you read, go to your Sylvania dealer. When you're there, you'll like what you hear.

*Manufacturer's suggested retail price.

GTE SYLVANIA

You are important. You, the engineering and science student at the University of Colorado are more important than any other single class of students on this campus. A rash statement? Perhaps. But the facts are painfully obvious. Fact: Your under graduate engineering education costs the University of Colorado fifty percent more than that of an arts and science humanities student. Apparently the regents and the state legislature think you are worth it or your tuition would not be the same as an arts and science student. Fact: The starting salaries offered to graduating engineering students continues to be higher than for any other graduate with a bachelor degree. Apparently, industry thinks you are valuable. Fact: By 1980 many sources are predicting a shortage of engineers. Apparently many people think that they will need you.

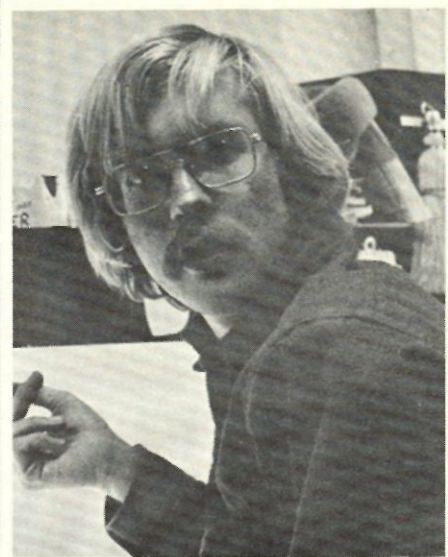
Society needs you because engineers scientists know how to make the world work. Engineers in particular are being educated in not only the *why* of the physical world but also in the *how*. In a time of economic uncertainty only engineers and scientists can keep industry going by developing new and better products and manufacturing them at a competitive price. Only engineers and scientists can take the theoretical fission and fusion processes (such as the ones described in this issue) and turn them into real power plants. Only engineering can design and construct the power systems necessary to deliver the energy that is produced. Only engineers can design and produce transportation systems and vehicles which are not fueled with scarce petroleum. The engineering profession obviously has its job cut out for it. If the human race is to survive and overcome the immense problems of the next fifty years; if the natural environment is to be made aesthetic and healthy again; if our cities are to be made livable again; if the third world nations are to feed and shelter their people; if all of every man's physical necessities are to be fulfilled, then engineering must accomplish the task. The revolutions of philosophers and political scientists probably will never occur. The revolution that is coming is one of technology.

The question then is: are you ready? Are you ready to not only engineer the physical systems required by society, but are you ready to deal with the most complicated system that exists — society and man himself? Are you ready for your role as a leader in the technological revolution? You take courses which teach you the fundamentals of math and science. You also take courses which apply this knowledge to nuts-and-bolts and engineering. You take humanities courses which teach you about man and society. You may also take courses in human relations and management, but how often do you work with people on a professional level? As a practicing engineer you will be required to work with your fellow engineers as a team in order to meet specified goals. As time goes on you may become the leader or manager of an engineering team. How much experience do you have in leading and motivating people? Quite often you will be required to make reports to your boss, your fellow engineers, or to laymen. How good are you at communicating your ideas?

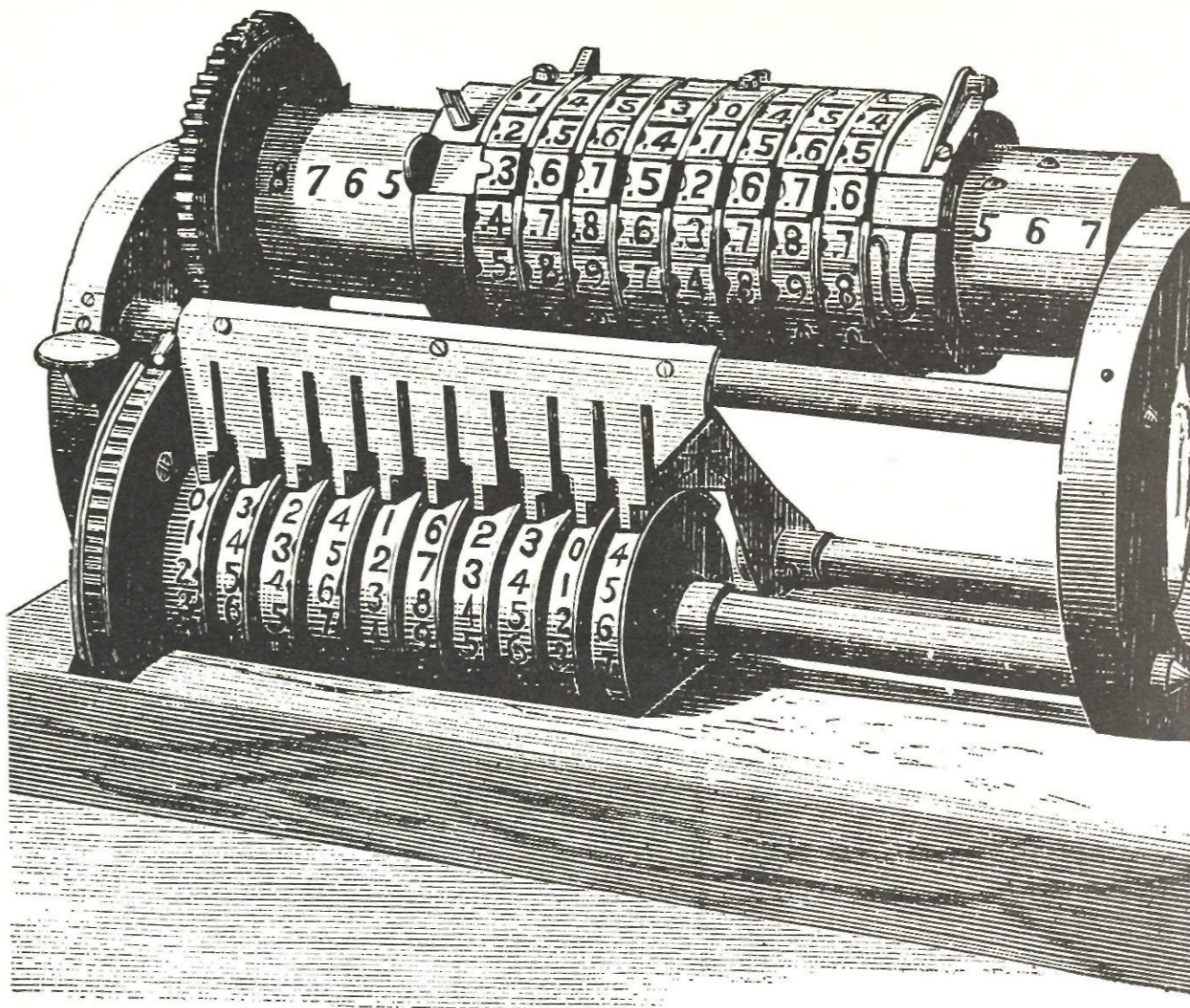
The time to get the experience is now and the place is the many extracurricular organizations on this campus. Clearing House, Colorado Student Lobby, Colorado Environmental Protection Agency, Rocky Mountain Rescue Group and service fraternities are only a few of the organizations which need your help and can give you experience in dealing with society and fellow workers. In your own college there are many organizations that need members. Groups such as the professional societies, this magazine staff and Associated Engineering Students need members. These organizations provide not only academic and professional development, but also provide a chance for personal growth through social interaction and leadership.

The engineer of the future will have to be a good leader and manager as well as an inventor and designer. As Dean Peters says on page 3, recruiters *do* look for extra-curricular activities on the record of a potential employee. Isn't it time you started relating to people on a professional level? Four years is too long to waste.

Gary Mills



FOUR
YEARS
IS
TOO
LONG
TO
WASTE



If you're like us, you don't like to work "by the numbers."

Some companies still start you off with a number of weeks of training courses. Then a number of months in one department. A number in another. And so on.

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LETTERS



UCSU?

The University of Colorado Student Union (UCSU) is continuing to pioneer its way as the student government. It is still in the process of defining everyone's function. UCSU consists of four units: the Joint Boards (Health, Recreation, Finance, Environment and the UMC); Executive, Judicial, and Legislative. The first three units remained essentially what they were in the old ASUC government. The major change was to the legislative unit and it has become more productive.

The legislative unit now consists of two ten-person councils. The first is called the Local Council. It is composed of one representative from each of the ten colleges on the university. They discuss problems within the schools and attempt to find solutions. The second is called the Representative Council and they are elected by an all-school election. Their purpose is to deal with campus input and problems and obtain a liaison between the students and the government. Twice a month the councils meet separately. For the other two weeks they meet as the twenty-member Executive Council and act on University wide student policies such as student funding and resolutions of support.

Presently, there are three Engineers in this government. Paul Hamilton (Civil) and Charlie Czarniecki (Chem E) are on the Representative Council, and Steve Schafenacker (ME) is the Local Council Representative.

The UCSU has spent much of its energies this semester on setting itself up. It is presently in the midst of several projects such as the bike problem, police in the dorms, finding a new student election commissioner, and finishing the By-Laws and Election Code revisions. It should be more productive than the old ASUC Senate

because its composition will not allow a party of students to direct or block its functioning. It would be very difficult to get a student party of four or five people elected to the Council, and even that small number would find a rough time in party politics.

The sad reality of student apathy, however, still exists. The old ASUC government would always create a crisis to get the students' interest. This Fall the Associated Engineering Students Control Board had different idea. As the student engineering government, AES receives over 2,100 dollars in student funding to maintain itself. To make the students aware of their active existence, and Engineering F.A.C. (Friday Afternoon Club), with non-student funding, was planned. It took three weeks to organize this function, which was held October 4th. Besides the free pretzels and beverages (over 800 cups were used), engineering organizations were present and had information about their activities. It was

a success in all aspects, which was the result of the efforts of Dana Gregory (President of AES), Dennis Wetterstrom (Civil AES Representative), Charlie Czarniecki, and Steve Schafenacker. They had a special assist from Dean Maler.

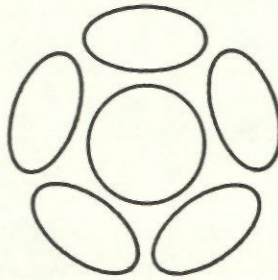
As a final note, the annual AES elections are held every Fall. The offices and positions are as worthwhile as the holders make them. AES can always use more people to help run it. From our experience in student government, we can say it is a very worthwhile activity — if you can keep your sense of humor.

Help direct your student government — get involved. You are always welcomed at an AES Control Board meeting.

Charlie Czarniecki
Representative Councilman

Steve Schafenacker
Local Councilman

ADL*

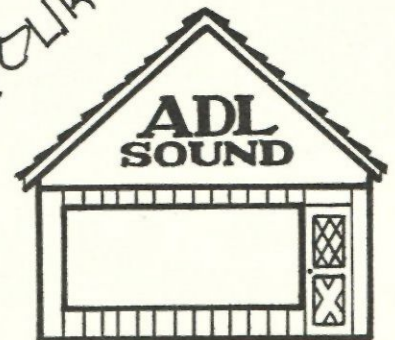


SPEAKERS

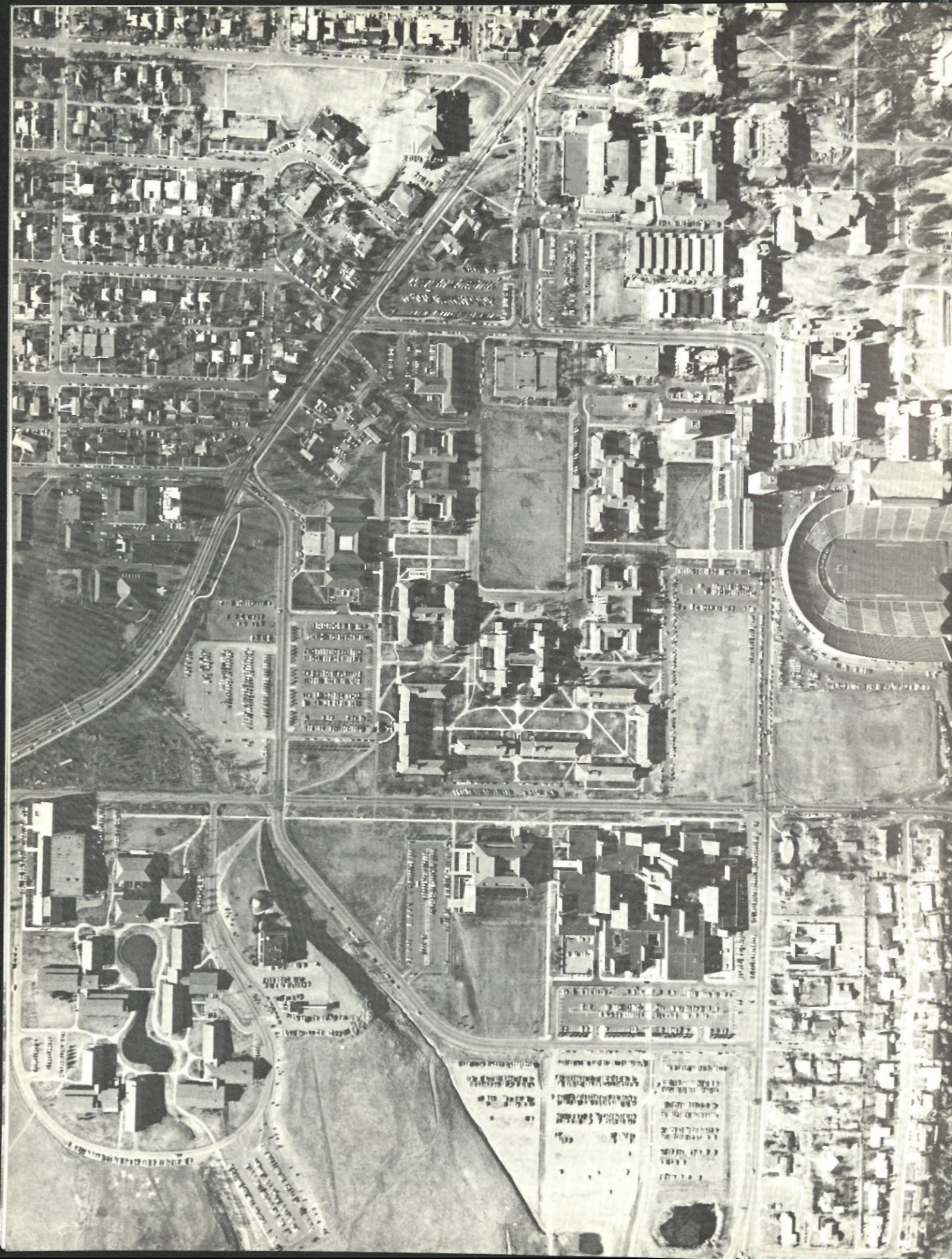
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CAMPUS PLANNING AT C.U.

THE MASTER PLAN FOR THE BOULDER CAMPUS PROVIDES AN INSIGHT INTO THE MANY FACTORS WHICH MUST BE ACCOUNTED FOR IN THE DESIGN OF FACILITIES FOR A LARGE UNIVERSITY

by Walt Cranor

In an era of overpopulation and urban sprawl, the need for planning in construction has become all too obvious. For C.U. students the problem is very close at hand, as can be seen at either the north or south end of the Boulder campus with the continuing construction of new facilities. "Problem" is the wrong word to use in describing the growth of the University of Colorado, since the campus construction is very carefully controlled by the 1963 Campus Development Plan, and more recently by the Interim Long Range Facilities Master Plan. It is the latter (herein referred to as the Master Plan) which deals with the siting of the new construction and updating of the utility systems. This Master Plan was based on three assumptions: 1) The time period covered by the plan would be five years (1973-1977), except for the utilities, which will be analyzed on a ten year basis. 2) The university would maintain an enrollment of approximately 20,000 FTE (Full Time Equivalent) students during this period. 3) During these years, the university would build the following new facilities: Computing Center, Events/Conference Center, Family Housing, College of Music Addition, Planetarium, and the Pharmacy Renovation and Addition.

This aerial photograph was taken in the fall of 1973 and shows most of the main campus south of Boulder Creek. West is toward the top, and 28th Street is at the bottom.

Perhaps it is best to first look at the role of the University of Colorado. The Colorado Legislature established a set of objectives for the university. According to a report prepared by the University Joint Planning Committee this role is interpreted as follows:

"The University of Colorado is devoted to: Education of able people, not merely by transmitting to them established knowledge and skills, but by helping them to experience with their teachers the actual processes of discovering new knowledge; Training for professional careers along with a general education in the arts and sciences and experience in the methods by which new knowledge is acquired; Research directed toward understanding the natural world, human society and the creative spirit; Various sorts of public service, bringing the skills and knowledge of the University to the people of the state through consultation services, extension courses, and continuation education programs for those who want to refresh and add to their education or professional skills."

Another feature which must be examined is the site of the University. The Boulder Campus is composed of three major parcels of land. The Main Campus is approximately 290 acres lying between Broadway, Baseline, Arapahoe, and 28th St. The East Cam-

pus lies slightly less than one mile to the east and contains 220 acres lying south of Arapahoe and east of 30th St. To the southeast of the intersection of Baseline and 30th is Williams Village on a site of 62 acres. These three areas and 18 small properties comprise the Boulder Campus. This land has been divided into six use zones, (as can be seen on the land use map on page 12) with two areas left as *unspecified facilities reserve*. The "core" area of campus is the *academic zone*. Obviously this area is singularly the most important, since it encompasses all instructional facilities such as classrooms, labs, libraries and faculty offices. Surrounding the academic zone are the *general support zone* and, to some extent, the *parking and housing zones*. The *general support zone* contains space for *administration, physical plant, student activities and recreation*. The parking zone does not include the small parking areas within the other use zones, but is only the major parking lots set aside solely for parking. The housing zone includes all of the dormitories and married student housing, both on the main and east campuses and Williams Village. Most of the area designated as *special support zone* lies outside of the ten minute walking distance from the campus core. This is primarily because the types of activities in this zone are dependent on nonstudent access. These activities include organized research, auxiliary services, extension and public service activities. The sixth zone is the *open space zone* which is: "those areas which are to remain permanently as open space having been so designated, including major landscaped areas on the central cam-

ENTER ↑

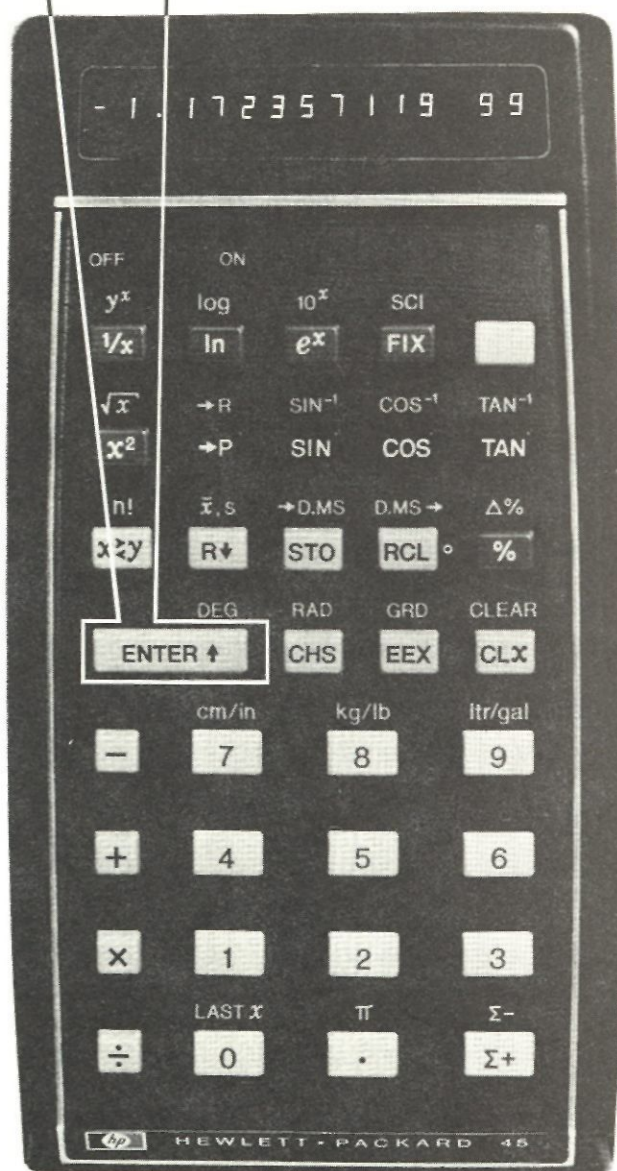
This is your key to unprecedented calculating power. Only Hewlett-Packard offers it.

In 1928 a Polish mathematician, Dr. Jan Lukasiewicz, invented a parenthesis-free but unambiguous language. As it's evolved over the years it's come to be known as Reverse Polish Notation (RPN), and it's become a standard language of computer science.

Today, it's the only language that allows you to "speak" with total consistency to a pocket-sized calculator. And the only pocket-sized calculators that use it are Hewlett-Packard's

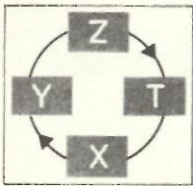
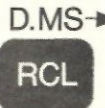
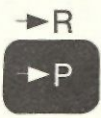
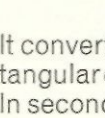
ENTER is the key to RPN because it enables you to load data into a 4-Register Operational Stack with the following consequences:

1. You can *a/ways* enter data the same way, i.e. from left to right, the natural way to read any expression.
2. You can *a/ways* proceed through your problem the same way. Once you've entered a number you ask: "Can I operate?" If yes, you perform the operation. If no, you press **ENTER** and key in the next number.
3. You can see *a/ll* intermediate data anytime, so you can check the progress of your calculations as you go.
4. You almost never have to re-enter intermediate answers—a real time-saver, especially when your data have eight or nine digits each.
5. You don't have to think your problem all the way through beforehand to determine the best method of approach.
6. You can easily recover from errors since each operation is performed sequentially, immediately after pressing the appropriate key, and all data stored in the calculator can be easily reviewed.
7. You can communicate with your calculator efficiently, consistently and without ambiguity. You always proceed one way, no matter what the problem.



The HP-45 uses RPN.

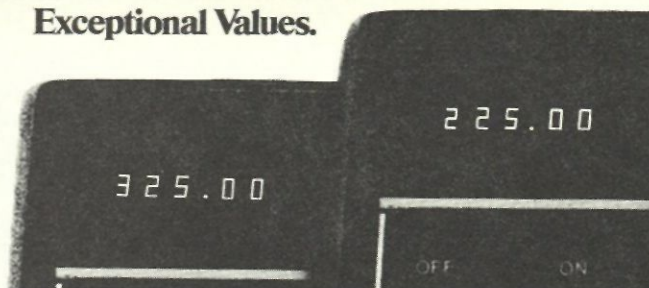
That's one reason it's the most powerful pre-programmed pocket-sized scientific calculator. Here are 8 others:

1. It's pre-programmed to handle 44 arithmetic, trigonometric and logarithmic functions and data manipulation operations beyond the basic four (+, -, ×, ÷).
2.  It offers a 4-Register Operational Stack that saves intermediate answers and automatically retrieves them when they are required in the calculation.
3.  It lets you store up to nine separate constants in its nine Addressable Memory Registers.
4. It gives you a "Last X" Register for error correction or multiple operations on the same number. If you get stuck midway through a problem, you can use the "Last X" Register to unravel what you've done.
5.  It displays up to 10 significant digits in either fixed-decimal or scientific notation and automatically positions the decimal point throughout its 200-decade range.
6.   It converts angles from decimal degrees, radians or grads to degrees/minutes/seconds and back again.
7.   It converts polar coordinates to rectangular coordinates...or vice-versa. In seconds.
8.  Its Gold "Shift" Key doubles the functions of 24 keys which increases the HP-45's capability without increasing its size.

The HP-35 uses RPN too.

If the HP-45 is the world's most powerful pre-programmed pocket-sized scientific calculator, the HP-35 is runner-up. It handles 22 functions, has a 4-Register Stack, one Addressable Memory Register and also displays up to 10 digits in either fixed-decimal or scientific notation.

Exceptional Values.

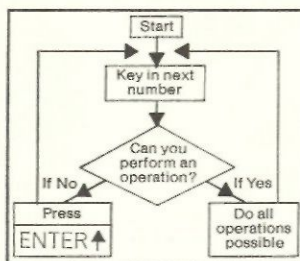


HP-45: \$325*

HP-35: \$225*

The exceptional value of these exceptional machines becomes even more apparent when you consider their prices. You can own the world's most powerful pocket-sized pre-programmed scientific calculator, the HP-45, for just \$325*. The HP-35 costs only \$225*.

Ask your dealer for our booklet, "ENTER vs. EQUALS."



It demonstrates the superiority of Dr. Lukasiewicz' language by comparing it to other calculators' systems on a problem-by-problem basis, and it explains the algorithm shown to the left which lets you evaluate any expression on a calculator that uses RPN and an Operational Stack. This booklet is

must reading for anyone seriously interested in owning a powerful pocket-sized calculator.

Available at leading department stores and college bookstores.

Stop in for a free copy of "Enter vs. Equals," detailed specifications on either the HP-35 or HP-45 and demonstrations of both machines. Call Hewlett-Packard Customer Service, (408) 996-0100 for the dealer nearest you.

Ask about our HP-65 and HP-70 while you're there.

Chances are, he'll also have our two newest pocket calculators on display—the fully programmable HP-65 that lets you write, edit and record programs on magnetic cards and the HP-70 business calculator that can help all business students to excel in their business courses.

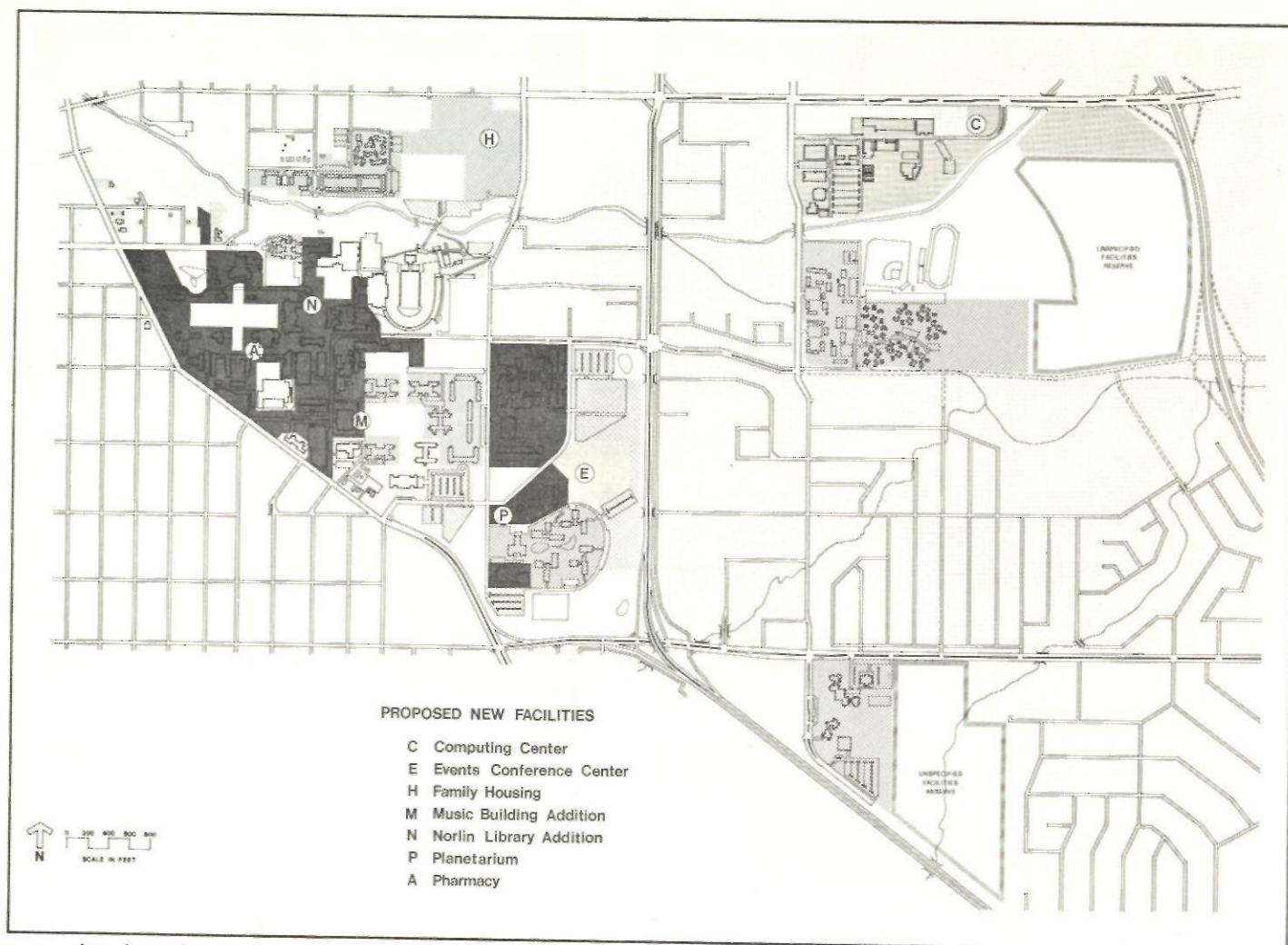
A Hewlett-Packard pocket calculator can help you in school today, on the job tomorrow.

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pus, developed recreation areas, playfields, informal recreation space, and areas which are to be preserved in their natural state."

Not only has some land been designated open space by the land use guidelines, control has also been placed on the density of buildings within the land zones. According to Article 5.3 of the Interim Master Plan, ground coverage within each zone shall not exceed 25%. This is based on one square foot of floor space for each square foot of land occupied at an average height of four stories. The ground coverage within the developed portion of the four major building zones is about 15%. Note that raising this density to 20% would allow for slightly more than two million gross square feet of new building space.

Planning must also consider private, public and university transportation for the campus, as well as internal circulation for parking areas and service access to the buildings. For these reasons, projections have been made

for 1977 actual daily volume of traffic, and planning has been made accordingly. The parking and circulation map shows circulation volume projected for 1975 as well as access routes to buildings, public and university transportation, and present or proposed parking areas.

The Interim Master Plan calls for steps to be taken to reduce the number of cars in the academic core and replace the lost parking spaces by adding to lots on the outlying areas. Parking space has been planned to handle the new demand created by the new construction, with approximately 6,166 spaces projected for main campus. The streets surrounding the campus provide for a large magnitude of traffic circulation to and around the university.

Within the considerations of planned growth, utility service is singularly the most concrete limitation on expansion. With the increasing demands of more modern equipment and more sophisticated environments required in buildings today, the utility systems seg-

ment of the Master Plan must have as its objective to "provide reliable utility service at the levels demanded." This requires the existing system to catch up to the present demands and continue improvement to meet the future demands. For the utility systems portion of the Interim Master Plan, the planning was based on the following assumptions:

1. Ten year planning horizon.
2. Stable enrollment at 20,000 FTE.
3. Increases in level and complexity of utility demands of more sophisticated equipment and environments required by the instructional, research, and public service programs of the University.
4. Detailed planning for future development of the east campus and Williams Village utility systems will be included in the final version of the Master Plan.
5. Detailed planning for irrigation

The new computing center shown here was recently completed and is located on East Campus. This building houses the computers and is located on Arapahoe just east of 30th St. in the Special Support Zone.

water, natural gas, storm sewers, and sanitary sewers is in progress and will be complete in the final version of the Master Plan.

The university owns and operates its own electrical distribution system. This system at present is somewhat inadequate and needs progressive modernization. The Interim Master Plan addresses itself quite comprehensively to the problems and solutions:

"The use of electricity at the University continues to grow and follows the same pattern as that for the rest of the country. Even though the academic floor space per student has remained fairly constant over the years, the kilowatt-hour (KWH) use per student has grown from 770 in 1955, to 1,318 in 1960, to 1,743 in 1965, and to 2,930 in 1970. From the above data it must be assumed that the electrical needs on the campus will continue to grow even though the student population may remain constant. Load growth will be slower than when the student population is increasing, but it will grow, and the distribution system must be capable of serving it."

The need for quality service is all too obvious — dark classrooms present a difficult place to hold classes, and dark or cold dorms are uninhabitable. The master plan has anticipated the present and future needs and planned accordingly. The first two of six phases have been completed to update and enlarge the electrical feed system.

The University also owns its own heating plant which provides high pressure, high temperature steam to all of the main campus buildings through a radial system of supply lines and con-

Replacing the out-of-date quonset huts which were serving as student housing, the new married student housing is under construction south of Arapahoe and West of Folsom. This complex should be completed during this academic year.



densate lines. Use projections for this facility indicate that here again the university is faced with the problem of existing equipment being undersize for the projected need, and thus the Master Plan had to address itself to the need for enlarging this portion of the utility systems, and modernization is continuing on the heating system.

The other utility of concern to the university planning staff was water. The history of water supply to the University is an unusual story.

"The Main Campus is supplied treated domestic water by the City of Boulder. Due to the wide variation in elevations in the City, the City's distribution system has been divided into four pressure planes. All of the Main Campus system was

designed for operation and served for many years at the high pressure plane (175 psi) until the construction of the Engineering Center and the Business School in the 1960's. These two buildings were supplied by a separate system from the City's medium pressure plane (75 psi)."

However, in 1972 it became necessary for the city to switch the university onto the medium pressure system entirely. This meant extensive changes in services for individual buildings and enlargement of mains in some areas to achieve adequate flow, and installation of new pumps in the heating plant to inject water into the boilers at high enough pressure. This change of pressure did have the good effect of providing for improved flow



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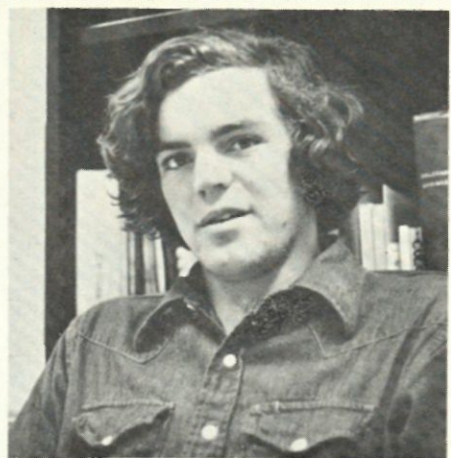
With a fairly workable background of the master plan presented, the actual process of siting can best be understood by following the Interim Master Plan summary of site evaluation and selection for some of the new construction. The recently completed computing center occupies a site in the special support zone. Because of increased remote terminal capabilities on the main campus, it was decided that the center need not be in the academic core area. Also, a high non-university personnel usage made access and parking prime considerations. Thus it was determined that a location adjacent to Arapahoe on east campus would maximize parking and access possibilities.

The Fiske Planetarium is an educational and exhibit — oriented building. It serves primarily astronomy and related physical sciences, and was placed within the academic zone. Other considerations for this site were proximity to parking and the Summers-Bausch Observatory because it provided a visual complement. Also planned to be built on Observatory Hill is the Events/Conference Center. This building will house a variety of university related activities from sports events to conferences and lectures. Because it is planned to be a multi-purpose building, it was classified as general support. This site offers access to ample existing parking, and to an area where some additional parking may be constructed. Another consideration for this site was the proximity to the Kitzredge Complex which provides housing and food service in the summer for conferences.

Located north of Boulder Creek and adjacent to the Marine Court family housing, the new Married Student Housing Project offers 292 units in an area already zoned for housing. This area was previously occupied by the quonset huts which were sub-standard housing. The Music Building addition, the Norlin Library addition and the Pharmacy renovation have no effect on zoning, and the net effect of these is only a slight increase in density of land use, well within the guidelines set forth in the Master Plan.

In 1974 another step was taken in the long-range planning process: prepara-

Walter Cranor is a junior in Architectural Engineering. He hails from Gunnison, Colorado where he spends his summers ranching and building log houses. He wrote for the Colorado Engineer last year. He is managing editor this year. Walt is active in outdoor activities and two of his favorites are skiing with the ski patrol and being a volunteer fireman.



tion of the Centennial Redevelopment Plan for revitalizing the academic core of the Boulder campus. This document sets forth an eight-year plan for major renovation of older buildings and proposes several more new facilities. Tentative plans call for a new facility, the Centennial Building, to house audio-visual classrooms, language labs, and offices. This increase in office space will allow classrooms which were converted to offices in Ketchum to be restored to classroom use. This renovation of Ketchum is also covered in the Redevelopment Plan together with renovations of Hellems, Hale and Woodbury.

The redevelopment will also make minimal conversion of chemistry labs in Ekeley East for use as biology labs, and Ramaley will undergo a major renovation for Biology instruction usage. The north wing of the Fine Arts building will be improved to take advantage of space currently occupied by Fines Arts, Music and Museum areas. The plan also calls for demolition and removal of several temporary buildings.

The use of long range planning for construction provides the campus with an architectural and functional harmony which is unattainable by short-sighted planning, and if well conceived, gives the campus a quality which will be felt and respected long after the original planning has been forgotten. Such is the case here at C.U. where the university campus provides a robust and exciting atmosphere for the furthering of academic study. ■

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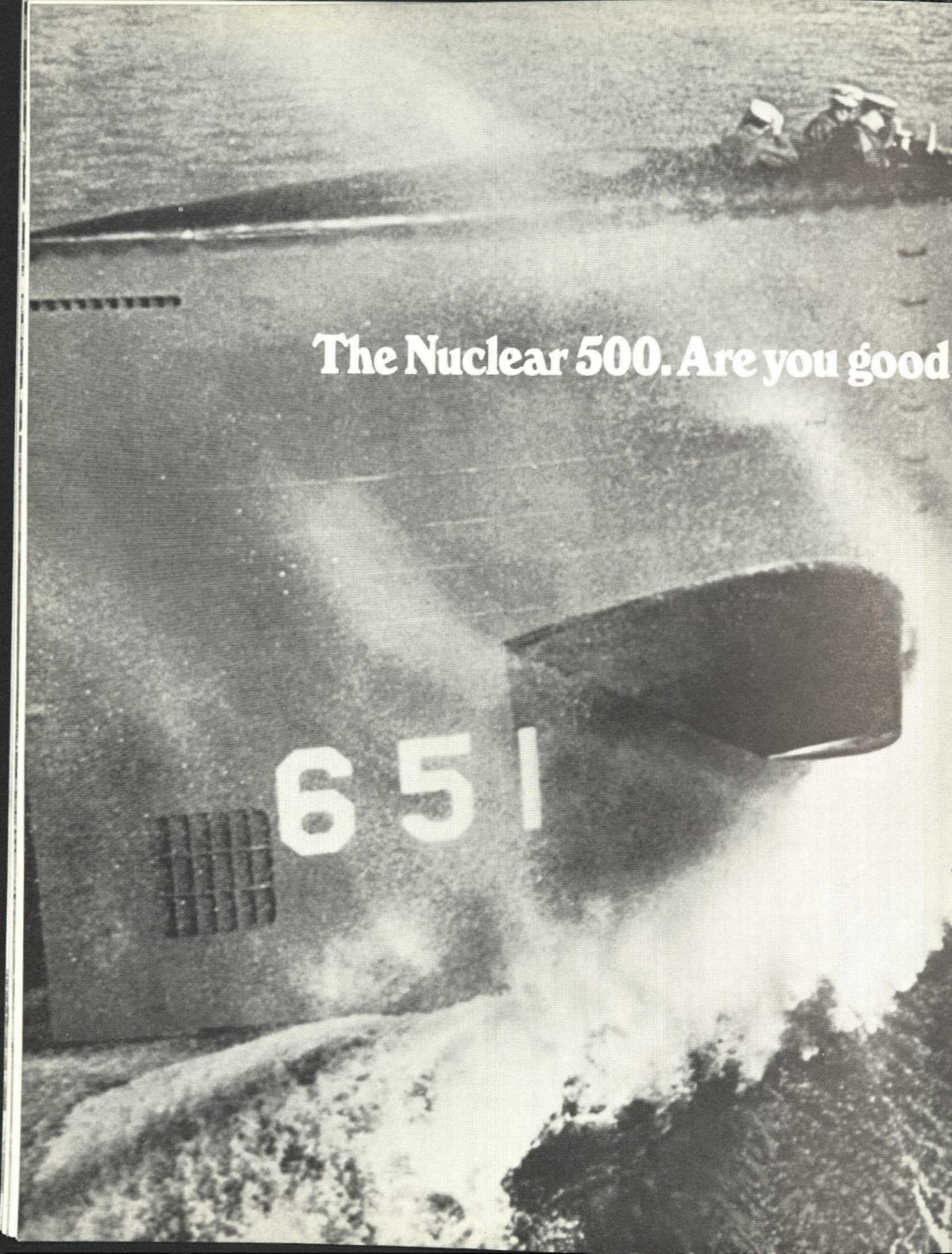
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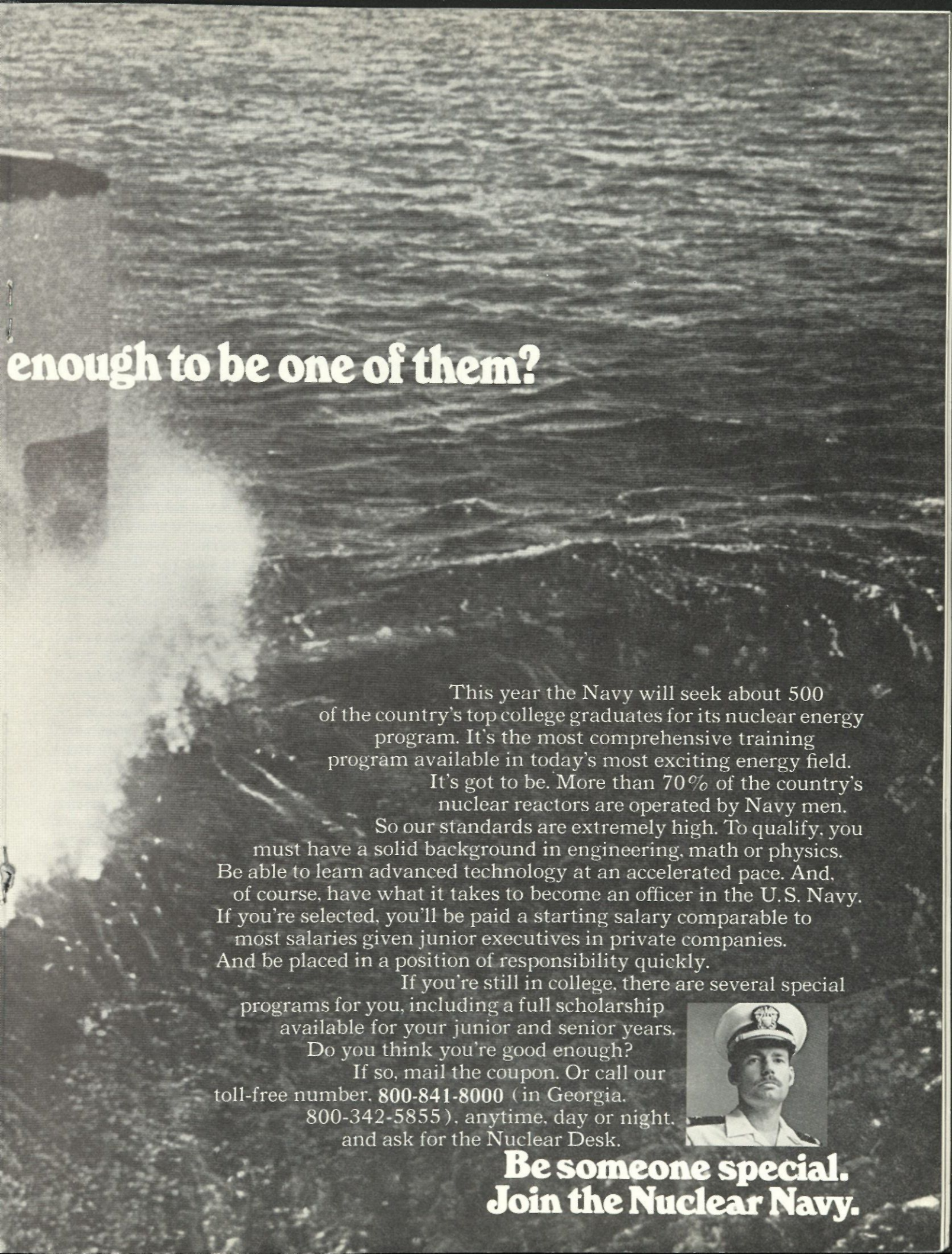
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A black and white photograph of the USS Zumwalt (DDG 50) underway. The ship's hull number '651' is clearly visible on the side. A large wake is being generated by the ship's movement through the water. In the background, a small boat with several people is visible on the horizon.

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LASERS AND NUCLEAR ENERGY

CURRENT RESEARCH
PROGRAMS ARE LINKING
LASERS TO POWER
PRODUCTION FROM
NUCLEAR FISSION AND
FUSION.

A GROUP IN THE C.U.
PHYSICS DEPARTMENT
IS CONTRIBUTING TO THIS
ENDEAVOR.

by Prof. James F. Scott

Ever since the first laser was demonstrated in 1960 these remarkable devices have found an increasingly wide range of applications. Recently however, it has been announced that lasers are being studied for application to their most unexpected and perhaps most important field — nuclear energy. New Atomic Energy Commission (AEC) programs at Los Alamos, Livermore, and Sandia Laboratories have coupled fission and fusion research to the laser. This new interest in laser technology has resulted in a sharp upswing in employment for laser physicists and engineers in a research and development area previously dominated by nuclear physicists and plasma specialists. Two separate programs account for the surge in laser physics programs sponsored by the AEC. The first is the program on laser induced fusion. This project, first announced publicly by Dr. Edward Teller in 1972 at the Montreal Quantum Electronics Conference in a lecture he whimsically titled "Internal Combustion Engines", has recently been summarized in a very readable review in *Scientific American*: 230, 24 Emmett et al., June 1974.

The basic idea in laser induced fusion is to fire a short pulse (1 nanosecond or less — 10^{-9} seconds) of very intense laser light (several terrawatts or more — 10^{12} watts) at a small droplet a tritium-deuterium mixture which has been cooled to a liquid state. The laser pulse is focused onto the droplet from several directions at once, so that the droplet is violently compressed. The compression does not arise from the direct radiation pressure of the laser beam, but indirectly; the laser pulse causes an explosive ablation of the outer surface of the droplet similar to the ablation experienced by the outer surface of a space craft during re-entry. Newton's Third Law produces a reactive compression of the inner part of the droplet which increases its density to approximately 10,000 times the density of water. At very high densities the critical mass for thermonuclear fusion is very small.

Thus one may hope to produce a hydrogen bomb which goes "pop" instead of "BANG" and drive a steam engine with it to produce electric power.

The job for physicists and engineers is to design and develop new lasers to do the implosion job. The desired parameters make this a formidable task. In order to show feasibility, that is, to demonstrate laser induced fusion in the laboratory, existing lasers such as neodymium-doped glass systems will probably suffice. With a suitable chain of glass laser amplifiers they can produce incredibly intense pulses of energy. Unfortunately, they are very inefficient, putting out much less than 0.1% of their input energy into light. It is unlikely that a power plant using glass laser-pumped fusion for energy could ever produce enough power to even run its own lasers! In other words, break-even appears unlikely.

A second laser system under active study for laser induced fusion is that of CO_2 . The carbon dioxide laser operating at $10.6 \mu\text{m}$ can function in a short pulse mode with power and pulse lengths comparable to those of neodymium-glass. In addition, its operating efficiency is approximately 4%, which makes it sound like a more realistic choice for break-even operation. However, for technical reasons, its long wavelength may make it much less efficient at the task of pellet compression. One of the jobs of laser physicists in the fusion project is to invent a new laser which will combine the efficiency of CO_2 systems with the shorter wavelength of neodymium-glass. An active program exists in the area of chemical lasers, particularly those operating in the near ultraviolet.

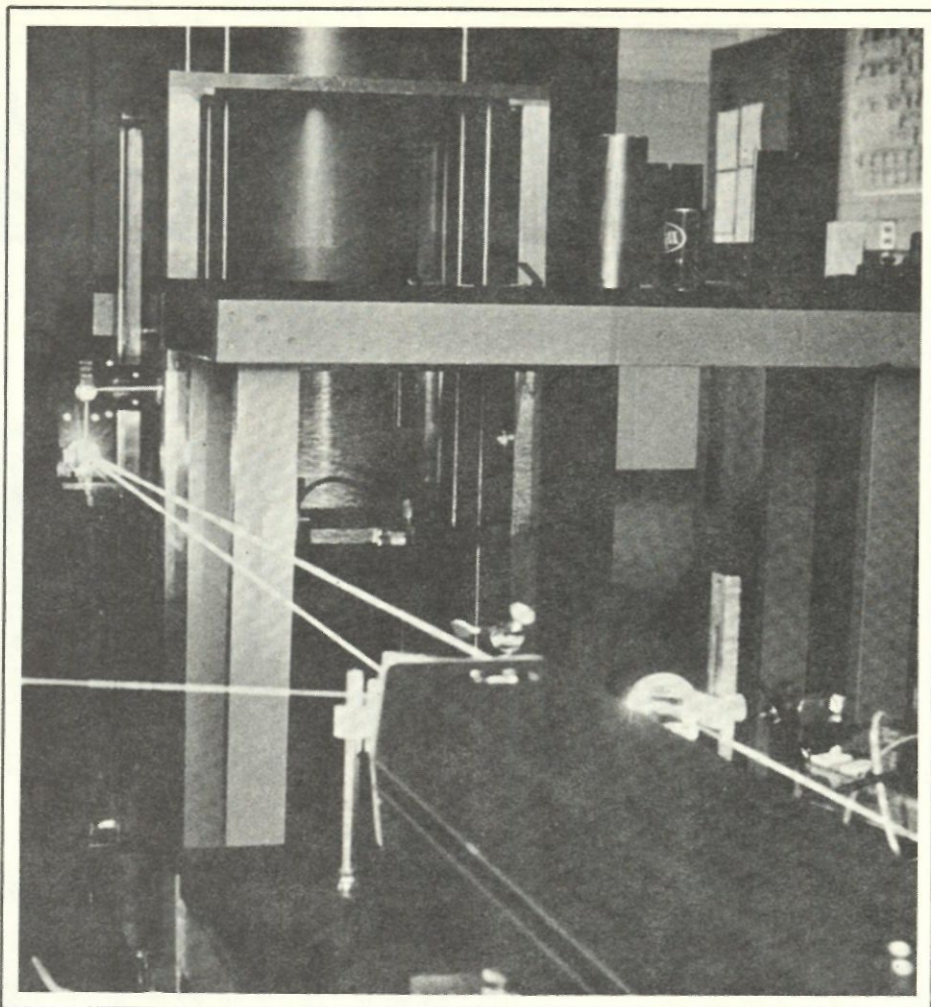
There are a number of ways university scientists, including those in Colorado, contribute to this program. Although the prototype laser fusion devices under construction at Los Alamos and Livermore are multi-million dollar systems beyond the size of most universities' capabilities, the search for new kinds of high-efficiency, high-power lasers goes on at the University of Colorado and at many other U.S. universities. In addition, some of the subtleties of laser fusion can be tackled with the computers and laboratory equipment available in most

physics or engineering departments. For example, the efficient compression of a tritium-deuterium pellet requires a very curious pulse shape. One must tailor the shape of this nanosecond burst of light in such a way that it delivers most of its energy in the last fraction of the pulse. Theoretical and experimental efforts to achieve optimum pulse shape have occupied many university physicists and engineers during the past two or three years. University participation in these efforts has been facilitated by the fact that nearly all aspects of the laser fusion program are unclassified.

The second main program in which the AEC utilizes laser relates to fission and the program is still somewhat classified. In contrast to the fusion program, lasers are *not* directly involved in the fission process itself. Lasers contribute in an indirect way, in the process of isotope separation. The usual way of producing high grade fuel for either reactors or weapons involves either gaseous diffusion or centrifuging. For example, uranium may be reacted with fluorine to produce uranium hexafluoride. A sample of this gas will contain both U^{235} and U^{238} . The U^{238} hexafluoride molecules weigh about 1% more than those of U^{235} , and when spun rapidly in a centrifuge, will drift to the outside of the chamber, where they can be separated from the U^{235} material. Unfortunately, this is a terribly inefficient process, since the isotopic mass differences are small. In fact, a reasonable fraction of all the electric power produced in the United States is used for centrifuging and gaseous diffusion of uranium hexafluoride! In view of the present energy crisis, this is hardly desirable.

It has been known for a long time that lasers whose wavelength or color could be carefully tuned could be used to selectively photo-excite different isotopic varieties of molecules. This is because different isotopic forms of the same molecule, such as $U^{235}F_6$ and $U^{238}F_6$ have slightly different absorption wavelengths. Thus a high-power, tunable laser might be employed to separate U^{235} and U^{238} , or some other isotopes of interest, in an optical way, without the need for any centrifuging.

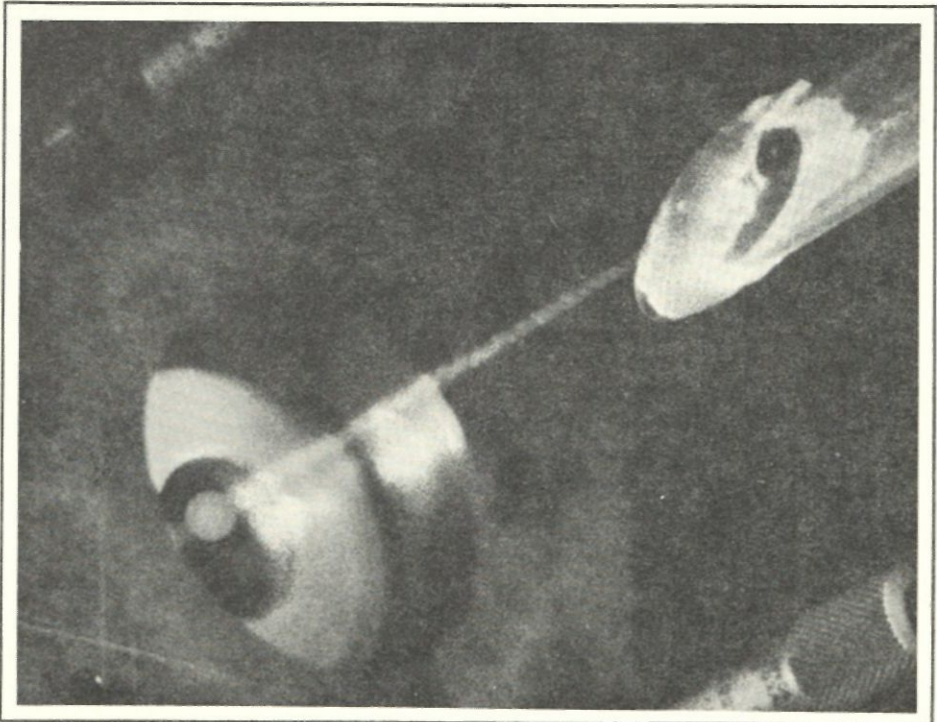
Over the past five years several kinds of tunable laser have been developed.



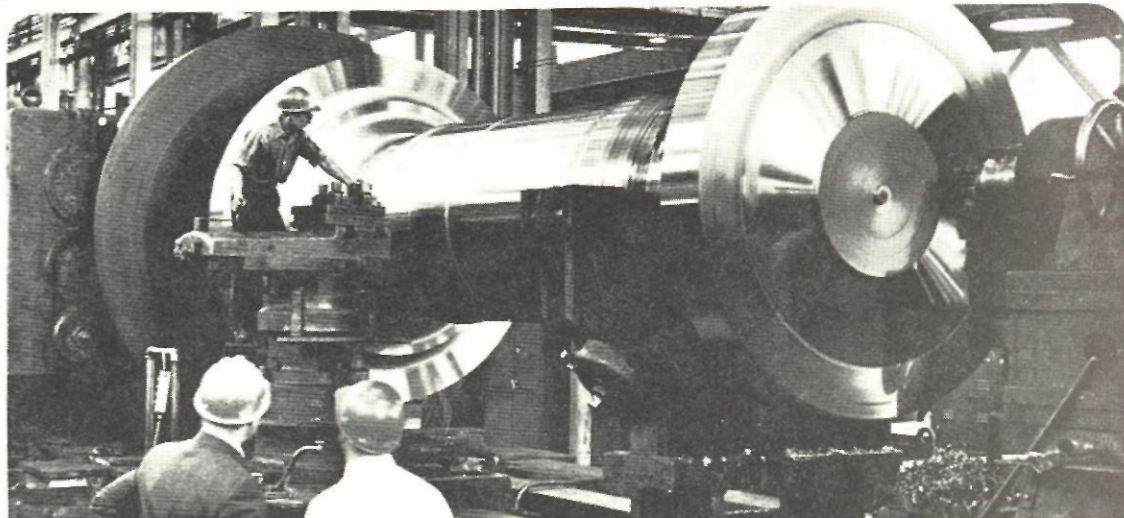
ABOVE: The author's laboratory in Duane E-0028.

The argon and krypton laser beams can be seen being relected into the large dewar which holds the super-conducting magnet at 2° K.

BELOW: Inside view of argon ion laser. The laser beam is emerging from the argon gas through a Brewster-angle window and is reflected from output mirror.



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By far the most common are the chemical dye lasers, which work over the entire visible spectrum and into the near infrared and ultraviolet. In the medium infrared region of 3 to 20 μm , however, the only tunable lasers are semiconductor spin-flip lasers. These solid state devices emit intense, coherent light whose wavelength can be tuned by increasing or decreasing the magnetic field in which they are placed. So far, two spin-flip lasers have been developed which have practical importance. The first employed indium antimonide, a common semiconductor, as the active medium and could be pumped with CO_2 lasers at 10 μm or CO lasers at 5.3 μm . The newest spin-flip laser employs indium arsenide and can be pumped with HF or DF chemical lasers at slightly shorter wavelengths.

There is an active research program on InSb spin-flip lasers in Boulder at the National Bureau of Standards under the primary direction of Dr. Joseph Wells, who is also an adjunct professor in the department of physics and astrophysics at the University of Colorado. In addition, Prof. James F. Scott in the same department at CU has an NSF-sponsored research program on spin-flip devices. The Department of Physics and Astrophysics at CU has almost unique high-field facilities; its 152,000 gauss super-conducting magnet is the highest continuous field facility in the United States outside of the National Magnet Laboratory in Cambridge, Mass. This high-field magnet has allowed the group under Prof. Scott's direction to undertake a research program aimed at

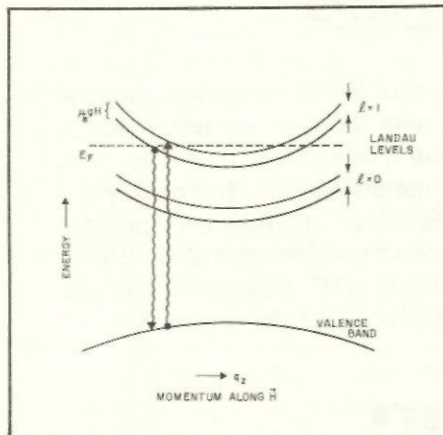


FIG. 1: Energy level diagram for electrons in a semiconductor in a high magnetic field. E_F is the Fermi surface.

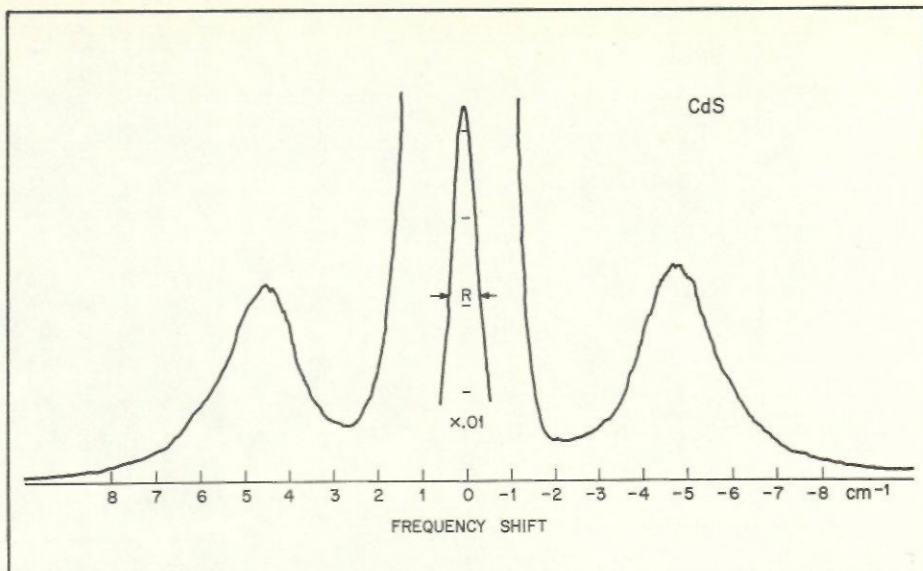


FIG. 2: Power spectrum of a cadmium sulphide spin-flip oscillator. Vertical scale is power out; horizontal scale is frequency shift in cm^{-1} (1 cm^{-1} is about $0.2 \text{ \AA}$ at $5000 \text{ \AA}$; 1 cm^{-1} is about 0.1 meV). Zero frequency shift is the frequency of the argon "pump" laser.

developing new kinds of spin-flip devices. Recently this group (R.L. Hollis, D.J. Toms, J.F. Ryan, and J.F. Scott) reported the first observation of spin-flip scattering in a p-type semiconductor; their work appeared in *The Physical Review Letters*, Vol. 31, p. 1004, 1973. The basic idea in spin-flip lasers is that in the presence of intense laser light the electrons in a semiconductor are made to flip their spins from along the direction of an applied magnetic field to the opposite, antiparallel direction (or vice versa). The emitted light from the semiconductor is shifted in energy from that of the pump laser by an amount proportional to the magnetic field. In some spin-flip lasers conversion efficiencies of over 80% can be obtained, and the output can be tuned over most of the range from 3 to 20 microns by employing various schemes.

Present research in the C.U. physics department group on spin-flip devices includes both theoretical and experimental efforts. Through Prof. Scott's participation as a consultant to the Los Alamos Scientific Laboratory a theoretical program has been initiated at C.U. to understand the intrinsic limitations on output power from spin-flip lasers, and to try to understand (and remedy!) an anomalous effect characteristic of all spin-flip lasers which distorts the output pulse shape and wastes 50% or more of the potential output power. This work is being carried out as a collaboration with Dr.

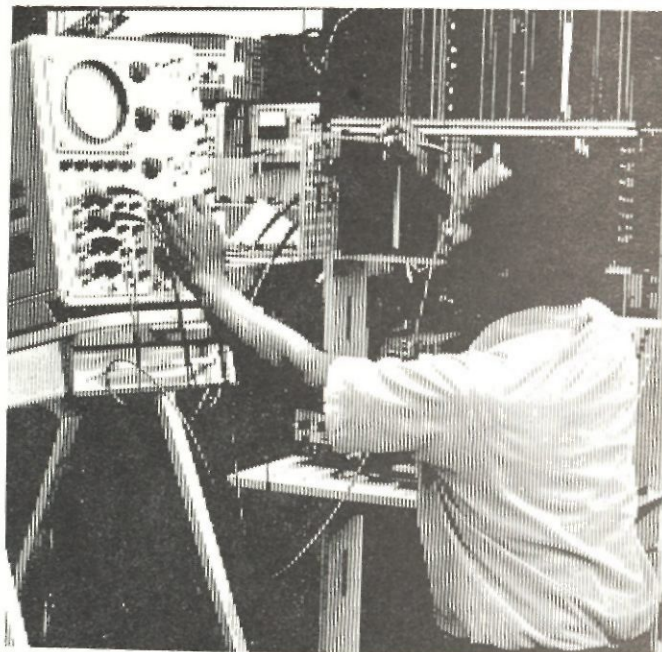
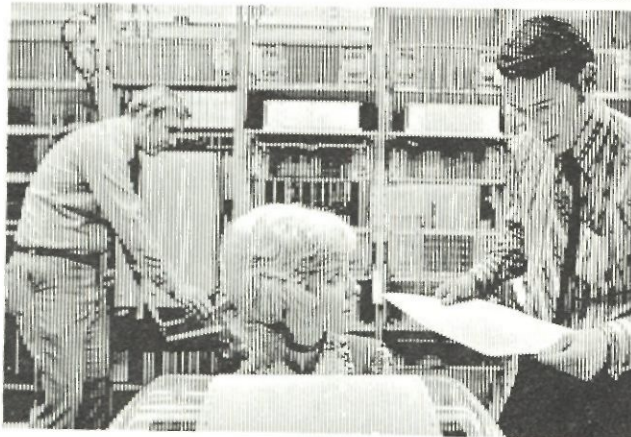
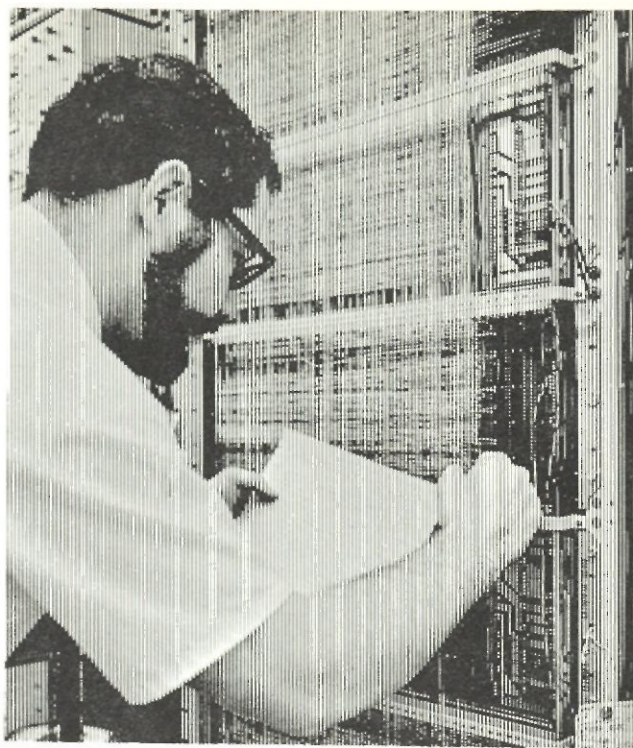
C. Cantrell of Los Alamos Scientific Laboratories.

Very recently some cooperative efforts between Prof. Wells at NBS and Prof. Scott have been initiated which should place the Boulder scientific community in a more active role in spin-flip laser R&D. Of particular interest are spin-flip amplifiers for diode lasers and pulsed field spin-flip lasers operating at 300,000 gauss and above. The less device-oriented work on spin-flip scattering mechanisms is carried out in room E-0031 in the basement of Duane Physics Building at CU; interested students and others in the Boulder scientific community can see these facilities by appointment.

From a technical point of view, spin-flip devices are easy to understand. An electron has spin $1/2$, and in a magnetic field its energy levels are quantized into spin up and spin down ($+1/2$, $-1/2$). These levels are split by an amount $\mu g H$; where μ is the Bohr magneton; g , the electron gyromagnetic ratio; and H , the magnetic field strength. The spin-flip process is diagrammed in Fig. 1. An electron is excited from the valence band to an empty state in the conduction band above the Fermi surface. At the same time another electron drops down from the conduction band to fill the hole. A net amount of energy $\mu g H$ is thereby extracted from the system.

Fig. 2 shows the power spectrum resulting from this process. The

Continued on page 24



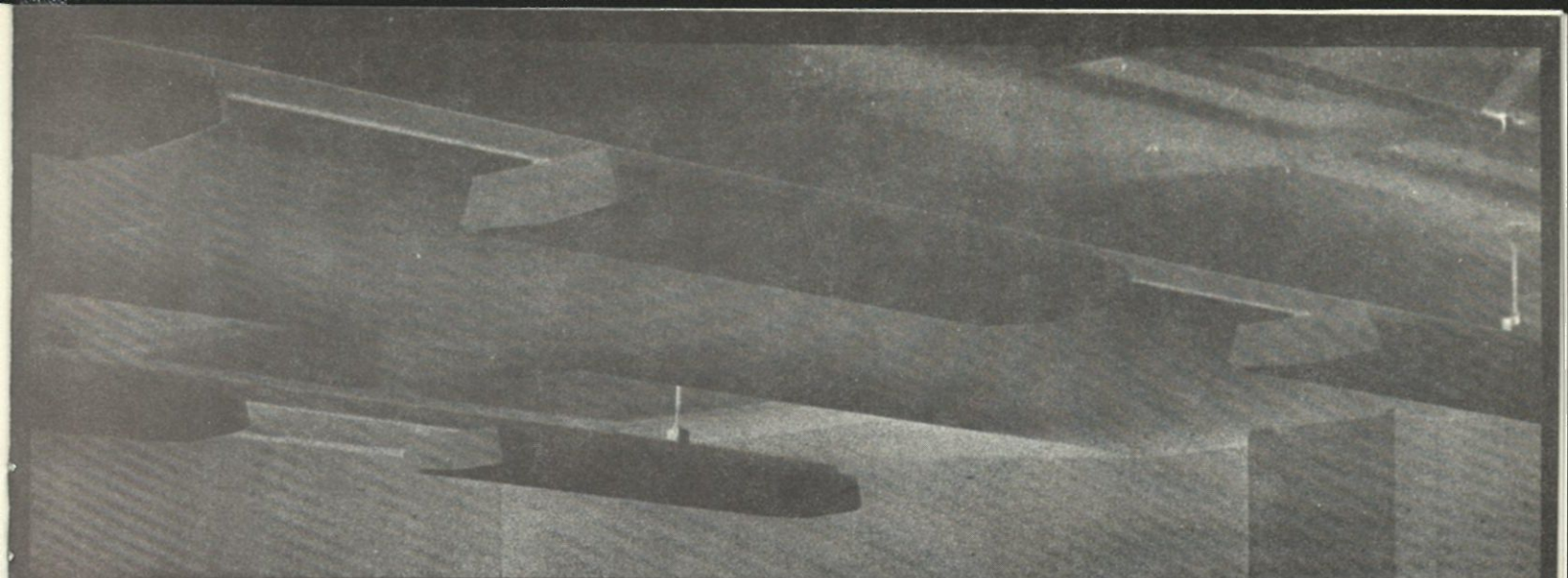
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LIGHT AND THE HUMAN BODY

RECENT RESEARCH HAS BEGUN TO SHOW THE SUBTLE RELATIONSHIP BETWEEN THE FUNCTIONING OF LIVING ORGANISMS AND THE LIGHT THEY RECEIVE.

by John McGovern

Ever since man moved indoors, artificial light has become of prime importance for continued functioning. Engineers and scientists have devised a variety of light sources from the incandescent bulb to the high intensity Mercury Vapor Lamps. With these illuminants we are able to preceive, but more needs to be learned about how well we perform, and what other effects on the human body artificial light has. For cons, man's only sources of light were the sun and fire. Did man evolve with a dependence on sunlight? With our predominately indoor life under artificial light sources this becomes an important question that needs to be answered.

An example of the possible need for sunlight is shown in an experiment performed at Cornell University with students studying under two different sources of illumination. After 4 hours of studying under a high-color-rendering sunlight-simulating source the students had significantly better visual acuity and less eye fatigue than the group studying under the standard cool-white fluorescent. A high-color-rendering source has a smoother spectrum distribution. It was noted that there was no significant difference between the groups at the start. It is possible, then, that the headaches and eyestrain that all CU students seem to

suffer at one time or another is caused by the cool-white fluorescent lamps used here.

It was felt that the better visual acuity and decrease in fatigue under the sunlight simulating source is not only due to the effect on the visual processes but also on the metabolic processes. This has not been tested to date but other evidence does show that light effects metabolic processes. Probably the most widely known and best documented effect is the sunlight conversion of 7-dehydrocholesterol in the skin to vitamin D3. The body's need for vitamin D was discovered during the industrial revolution in Britain when there occurred an epidemic of rickets (faulty formation of the bones) among children. It was discovered that a lack of vitamin D was the culprit. Subsequently, vitamin D was introduced into foodstuffs such as milk. At the time it was not known why there was a deficiency, only that there was one. Later research found that the formation of vitamin D took place in the skin due to stimulation by sunlight. It was then that the real cause of the epidemic of rickets was found. In the urbanized society, pollution and continued living indoors prevented the required amount of sunlight, particularly ultraviolet light, to synthesize a sufficient amount of vitamin D.

Another metabolic effect of sunlight

found has been the reduction of serum bilirubin in premature babies. Excessive levels of bilirubin causes jaundice and brain damage which will lead to death if allowed to continue for some time. To reduce the levels of bilirubin, phototherapy under high intensity illumination is prescribed. Although it is not fully understood which wavelength is involved or the mechanism involved it is known that fluorescent light from a pure blue spectrum to a sunlight-simulating spectrum works to reduce the levels of bilirubin until the liver can take over its natural job.

One of the most interesting effects reported has been that of ultraviolet radiation on black lung disease in miners in Russia. Russian literature tells that they now require miners to have a daily dosage of ultraviolet light which they have shown reduces the incidence of black lung disease. These results have been substantiated by tests on rats here in the U.S. The investigator found that the ultraviolet increased the rats' capability to remove the coal dust particles from their lungs. Further testing on humans has not been done in the U.S., but if it is found to be true of the human respiratory system, the United States' number one industrial disease could be cured.

These are only a few of the documented effects that light has on

our body, but they all point out that sunlight is necessary for good health. With a decrease in sunlight due to air pollution, combined with the fact that we spend more of our time inside, adequate exposure to sunlight becomes a design criteria for planners and engineers. There is a definite need for sunlight simulating light sources in hospitals, nurseries, factories and offices. With proper reserve and planning man's need for sunlight may again be fulfilled. ■

Laser Continued

"pump" laser frequency is designated as zero frequency shift but actually is high frequency visible light. In the device illustrated, the output signal is shifted by only a few angstroms — an amount which can be varied by changing the magnetic field. The undetected "idler," in the language of electrical engineering, would lie in the millimeter wavelength microwave region.

A primary aim of the spin-flip studies of Prof. Scott's group is to understand the changes in the power spectrum shown in Fig. 2 as functions of temperature, carrier concentration, mobility, and magnetic field strength.

The approach taken to understand the power spectrum of a spin-flip oscillator is that of response functions. The fluctuation-dissipation theorem (or, in its more familiar electrical engineering form—the Nyquist Theorem) proves that the power dissipated by any system is proportional to the imaginary part of the susceptibility for the system. For example, the simply damped harmonic oscillator has an equation of motion given by

$$m\ddot{x} + \Gamma \dot{x} + kx = eE \quad (1)$$

John McGovern is a graduate student in Architectural Engineering specializing in visual perception and illumination. He is Vice-President of the Student Chapter of the Illuminating Engineering Society and President of Chi Epsilon honorary fraternity.



where x is the displacement and E is the driving field. When we combine this equation with the definition of susceptibility $X(\omega)$:

$$x = X(\omega) E(\omega) \quad (2)$$

and assume sinusoidal solutions for $x(\omega, t)$, we obtain

$$X(\omega) = \frac{\omega_0^2}{\omega_0^2 - \omega^2 + i\gamma\omega} X(\omega = 0) \quad (3)$$

where $\gamma = \Gamma/m$.

The imaginary part of this susceptibility gives us a power spectrum which is Lorentzian in shape.

The equation of motion for spins is quite different than that given in Eq. (1), however. Spins in a magnetic field obey a first-order differential equation, unlike the second-order equation in (1) above. In linearized form these equations may be written as

$$\frac{dM}{dt} i = -\mu g \hbar (\vec{M} \times \vec{H})_i + \frac{X_0 H - M}{T_i} \quad (4)$$

where M is the magnetization; H is the applied magnetic field; μ , the Bohr magneton; g , the gyromagnetic ratio; $\hbar$, Planck's constant divided by 2π ; X_0 , the static susceptibility; T_i , a relaxation time; and $i = x, y$, or z . Equations of the form in (4) are generally called "modified Bloch equations" after Felix Bloch, who won the Nobel Prize in 1952 for his work in magnetism. Eq. (4) yields a susceptibility [defined as $M = X(\omega) \cdot H(\omega)$] given by

$$X(\omega) = \frac{\omega_0 + i\Gamma}{\omega_0 - \omega + i\Gamma} X(\omega = 0) \quad (5)$$

where $\Gamma = 1/T_i$. This susceptibility is quite different from that given for the simply damped harmonic oscillator in Eq. (3) and has been used by Prof. Scott's group to analyze spin-flip power spectra like those shown in Fig. 2. Emphasis has been placed upon understanding the characteristics of the damping term Γ in Eq. (5). It is found that it varies linearly with temperature, as $n^{2/3}$ at low temperatures (where n is the carrier concentration), linearly with mobility of the electrons in the semiconductor, and approximately as the square of the scattering angle between the incident "pump" laser beam and the spin-flip output beam. All of these phenomena have been explained in terms of a simple theory of electron diffusion with no adjustable parameters. Interested readers may refer to Scott et al., Phys. Rev. B6, 3856 (1972) for a more complete analysis.

To summarize, the spin-flip laser works as follows: another laser is used to shine monochromatic light on a semiconductor. Let us say this light is green. When this happens, some of the electrons in the semiconductor flip their spins from up to down (along the applied magnetic field). When the electrons flip spin they take energy out of the system, or put some in. The amount of energy taken out (or put in) is $\mu_B g H$ and thus changes with magnetic field. The light which comes out of the semiconductor is shifted down in energy toward the yellow by $\mu_B g H$, or up in energy toward the blue by $\mu_B g H$. These two shifted emissions are the two peaks in output shown in Fig. 2. Spin-flip lasers working in the visible region of the spectrum are not very practical, since tunable liquid dye lasers do a

Continued on page 31

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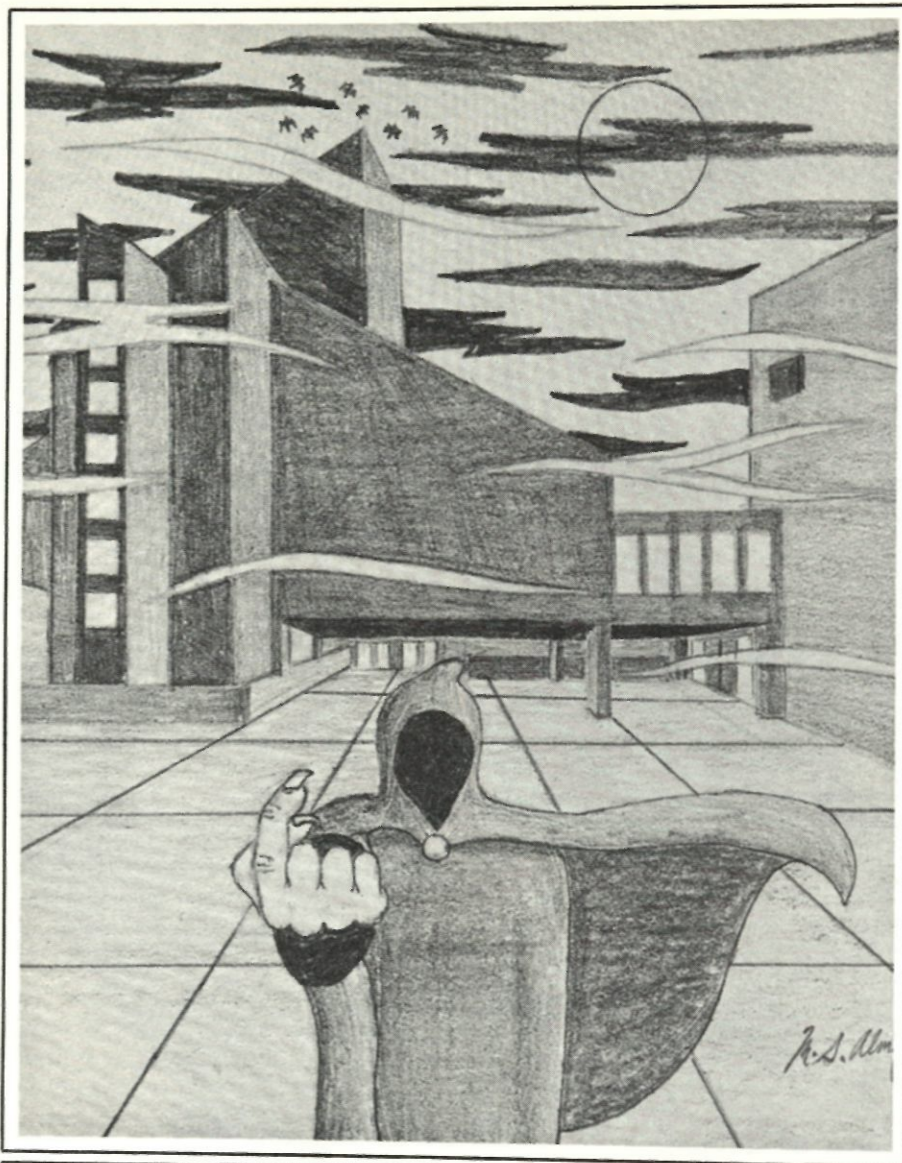
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TURN BACK, IT'S A TRAP!

A MATH-PHYSICS MAJOR
LOOKS AT ENGINEERING
STUDENTS

by Chris Claudio

As you gaze about, and see what were once confident, upstanding engineering students committing mass academic harakiri, you can't help but surmise that perhaps there is something incredibly wrong with the College of Engineering and Applied Science. I truly hate to pop your bubble, but you are grossly incorrect. Although that august institution is certainly not without sin, the despicable culprit that sends herds of first and second year engineers down the tubes every semester, is that hapless fool himself, the beginning engineer. Take yourself back to the foggy edges of your memory, back to that bastion of morality and mom's apple pie, high school (those of you who find this beyond your mental capabilities will just have to take my word for things). Yes, where you made that witless immortal decision that you too, shall

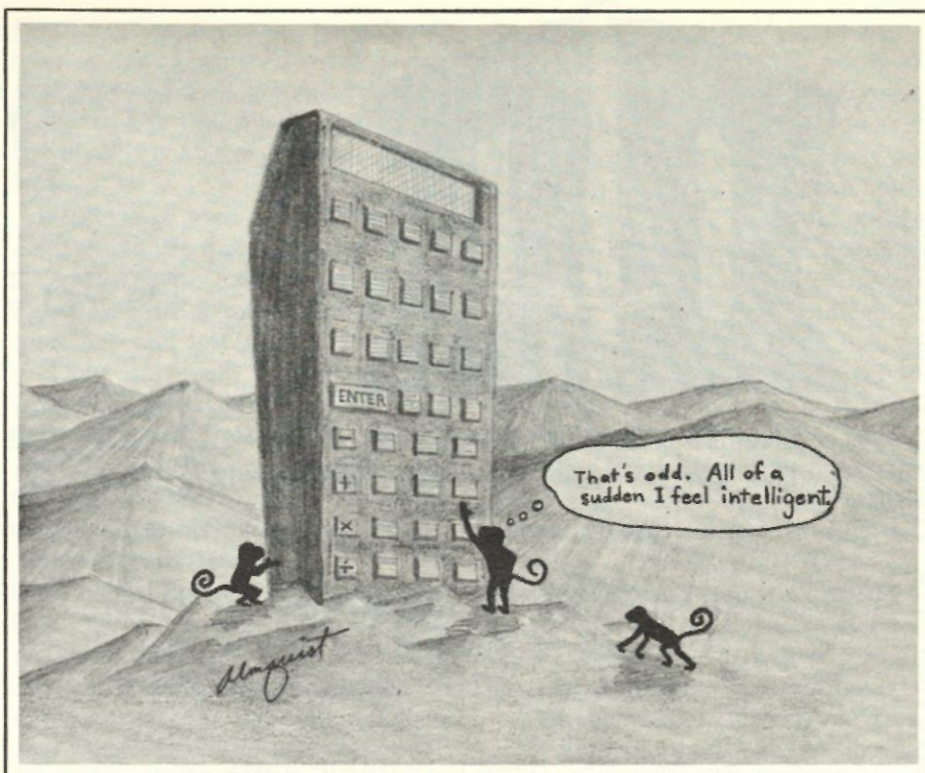
push the forefront of man's knowledge and be an engineer. You realize, of course, that instead of being the grand waste of national resources, termed a flunking student, you could be an up and coming bag boy or at least the hottest gas station attendant in town. Why? What influenced the brainless choice leading straight down the path to either total academic demise or, what's worse, that heart rending last minute transfer to the School of Business? Maybe it was because you astutely noticed that the College of Arts and Sciences requires three years of high school foreign language, and again taxing those fifty cubic inches of fatty tissue, realized that your chances in a college language course could be roughly equated with a trip over Niagara Falls in a plastic bag. Or maybe you're one of the lucky few who came to engineering through inheritance, and since you know those before you are no mental wizards, you can see no trouble in gliding through college on your way to big, big pay (after all, if they can do it, I sure can).

As a joke, mention the words "math background" to the unfortunate beginning engineer and you're going to hear a tale of woe that won't leave a dry hanky in the house. While the mood is set, try the noun "physics" and see the look of utter ignorant terror that passes over the young, tearful face. After all, what does all that stuff have to do with engineering? Engineers don't use math and physics. They use slide-rules and calculators.

Take a second to reach into the dust ridden waste paper basket and pull out your College of Engineering Handbook. Believe it or not it's all there, in very legible black and white and perfectly good English. Nineteen, count them (you've got enough fingers and toes), 19 of the thirty-one hours suggested for freshmen are none other than no hold barred basic math and physics. Only to be followed by the coup de grace' of twelve more big hours in your sophomore year. But take heart, chances are most of you bumpkins will never come face to face with those demons. This program, you see, certainly was not designed by idiots, the math and physics courses are completely interrelated with a masterful system of prerequisites and core-

quisites that put *Catch 22* to shame and accelerate your movement to the Business Building, banishing all hope of recovery in less than six years. It's all in that innocent looking thin, red booklet, and assuming that reading is one of the talents you picked up between Romper Room and Baili High, you can't claim ignorance. You knew the job was dangerous when you took it.

You know deep down where it really counts. I, for one, am overjoyed that in this age of great engineering disasters, C.U. is weeding out the dummies. But you guys insist on turning this academic mercy slaying into slow and painful torture. Look at the recent trend to what fellow engineers revere as the much beloved H.P. Without a thought that there might be a demand for engineers who are mentally sharp enough to be capable of rudimentary arithmetic, the dense engineer flocks with his cohorts to purchase one of Hewy's high priced idiot boxes. Someone ought to get on the President's toll free drug hotline as these instruments are clearly addicting to the feeble minded. Have you ever



seen an engineer with his H.P. in the shop? It's horrible, the poor devil's suffering through withdrawal. His hand moves involuntarily to the right side of his belt, addition sends noticeable

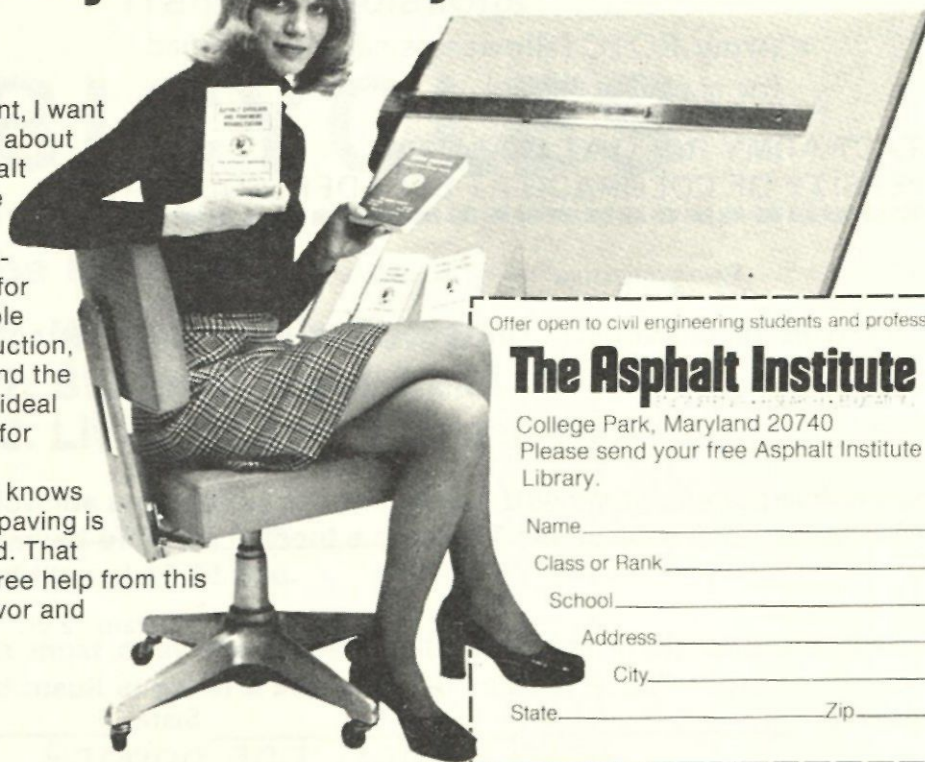
shutters as he finds he's run out of appendages, a square root sees a whimpering mass searching desperately for anything with buttons and lights. Think of it, our young button pushers

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can go through their short academic lives never really knowing what a log is, other than a designation for a button or a large cylindrical shaft of wood. See for yourself, ask one of these bright lads what the natural log of "e" is, and watch the fastest draw in the west followed by a puzzled expression while his eyes nervously scan the digits for an "e". Frankly, I view the purchase of one of these little black brains as a sure fire indication that the purchaser is well on the way out. It is often very difficult to discern whether the center of intelligence is encased in an ugly black pouch which never leaves the waist, or is resting lopsidedly above the neck.

This epidemic of unsightly black bulge dangling from engineering hips, leads me to the firm conclusion that all engineering students are independently wealthy. Not only are you constantly throwing good money after bad with tuition, but there is not one of you mental wonders out there that does not possess some kind of electronic aid or at least a high priced slide rule. Now I am fully aware that there may be someone who has been slighted by this sweeping generalization, so I cordially invite all who are in their third year of engineer-

ing and juniors, possessing only a sharp mind, a sharp pencil, a cheap plastic slide rule, and an empty wallet, to gather in the janitorial closet at the basement of Duane for my public apology.

If you have been around engineers directly after the answers to the physics test have been passed out, you've probably noticed that those who are conscious and not screaming uncontrollably or falling quietly on their freshly sharpened pencils, are shaking their heads and ironically remarking that it is not fair, we're not going to use this stuff as engineers. What I can't believe is that this mental giant actually is keeping a straight face! Let me clue in all of you up and budding flunkies. In a way you're not going to be using this elementary stuff. What you will be using (if by some miracle you make it), will put what you can't grasp now to utter shame. Engineers apply science to the real world (do I detect a look of sudden enlightenment?) and even those of you who aren't passing probably have realized that you are not living in a world that is flat, has no mass, doesn't spin, is airless, has no friction, is at sea level on the equator, is basical-

ly two dimensional, and keeps a constant temperature of 0°C, when the situation decrees. Isn't it a crying shame that the world you will be hopefully working with is actually very messy, and it doesn't really care about your situation. So, if you're an Aero who has trouble with fluid dynamics, or an E.E. who can't grasp Ampere's Law, or a Civil, Mechanical, or Architectural protege who is bent out of shape by forces and torques; run, do not walk, to pick up a Business catalogue—someday soon you're going to find it handy. If simple integration refuses to yield areas, differential equations are exposed to the hard vacuum between your ears, and Taylor's Formula is to you a good way to see that your clothing fits, hang up your calculator. They give grocery clerks *big* machines with buttons.

The engineer of tomorrow is going to be applying the science of Einstein, Heisenberg and Max Plank and will have to feel very much at home with quantum theory and the uncertainty principle, cryogenics, and high energy plasmas. No one ever told you that when you attempt engineering at C.U.

Continued on page 30

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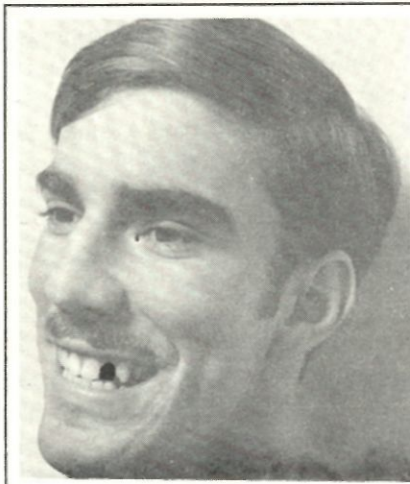
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you are going for what academic thermodynamisists call just about the highest energy level on campus (outside, of course, of Math/Physics) and your fate is predicted by the second law of thermodynamics as you all head irrevocably to the lower academic energy states. The fact that somewhere out there, there may exist an engineer who is well on his way to graduation in less than five years, and those disturbing rumors that someone actually transferred successfully from Business to Engineering does not dissuade me from being a member in good standing of this school of thought.

For all your haphazard bumblng, I have to credit you with rawly ignorant courage. I also fervently hope that you keep inanely trying—or I will lose my modest benefits as a tutor. As for those who finally resign to fate, I sincerely wish you the best of luck with your gas

stations in which you proudly display that business degree. The few who actually make it, in whatever time it takes, have earned a small measure of my respect as well as the simple request that you try to forget the math and physics you so painfully learned. If you

don't, I along with a few other Math/Physics majors may find ourselves out of a job, and I would be stuck weeding out the dummies at some educational institution. Something I'm sure none of you would wish for your kids. ■



Chris Claudio is a junior in Math-Physics who sometimes attempts to tutor freshman engineering students. He does own a sharp pencil, a cheap plastic sliderule, but not necessarily a sharp mind. Chris can sometimes be found in the Math-Physics library memorizing five-place log. and trig. tables. It has also been rumored that he has on occasion made passionate love to sheep.

***The Colorado Engineer* presents an article competition**

general topic: Solar Energy

possible article topics:

- 1) Solar energy systems that work and how. (heating and cooling)
- 2) Solar energy systems that are being sold but don't work and why. (this must be well documented)
- 3) Research on possible solar energy systems.
- 4) The economic feasibility of solar energy.

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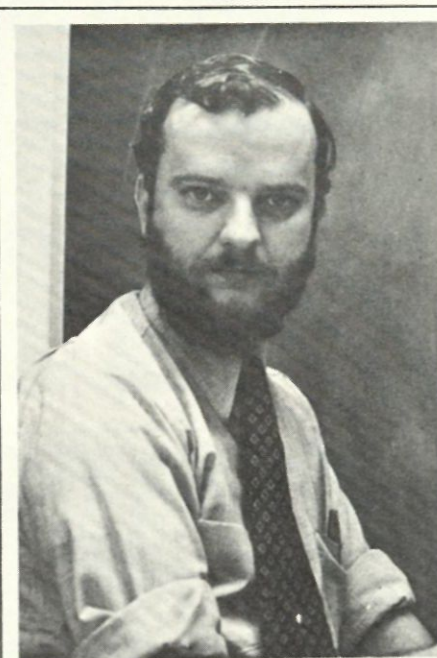
- 1) All entry articles must be in *The Colorado Engineer* office (ESOT 1-7) by 5 P.M. Friday, November 29, 1974.
- 2) Entries must be typewritten, double-spaced, on 8½ by 11 inch paper and must be free from spelling and grammar errors.
- 3) Articles must be between 1500 to 3000 words in length. (5-10 typewritten pages).
- 4) Articles will be judged on originality, conciseness, research done, style and technical quality.
- 5) Photographs and drawings will be considered in the final awards.
- 6) The entries will be judged by staff of *The Colorado Engineer* and their decision is final.
- 7) All entries will be returned and can be picked up after January 20, 1975 in ESOT 1-7.

prizes! \$40 first prize \$20 second prize \$10 for any other article published.

Contestants are urged to contact the editorial staff of *The Colorado Engineer* (in ESOT 1-7; phone: 492-8635) for additional information.

better job there. However, dye lasers don't work very far into the infrared. In the infrared spin-flip lasers give tunable, coherent, high power output from about 3 to 15 microns. And this region of the spectrum is quite useful for isotope separation programs.

Spin-flip laser technology is thus viewed as an important phase in the development of economical isotope separation. In light of the increasing demand for nuclear energy the advantages of an isotope separation process which uses less money and energy are obvious. The experimental and theoretical work carried out in the CU Physics Department should yield a better understanding of the power output characteristics obtainable with these exotic new devices. ■



James F. Scott is presently Professor of Physics and Astrophysics at CU. Before being appointed to that position in 1971 he was a member of technical staff in the Quantum Electronics Research Department of Bell Telephone Laboratories for six years. While at Bell, he acquired one of the early patents on spin-flip lasers. Professor Scott received his B.A. from Harvard in 1963 and Ph. D. from Ohio State in 1966. He was appointed Senior Visiting Fellow at the University of Edinburgh from 1970-71, and has been consultant to the Los Alamos Scientific Laboratories since 1973. Research interests include lasers, semiconductors, and solid state phase transitions. Professor Scott lives in Boulder with his wife Carol and two children: Michael, 8, and Lisa, 6.

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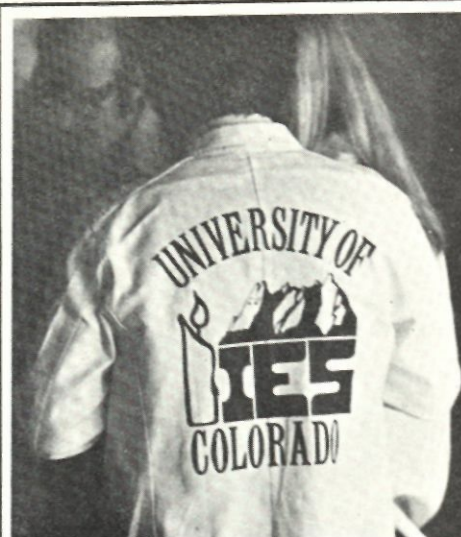
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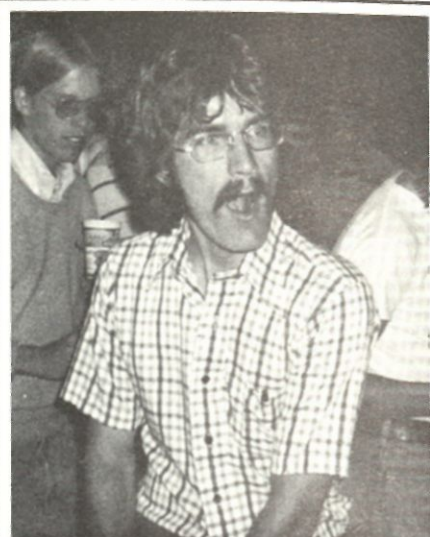
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F.A.C.

The first Annual Engineering Friday Afternoon Club (F.A.C.) was held October 4th, beneath the Engineering Deans' offices. It consisted of seven kegs of Oly (over 800 glasses were used), boxes of pretzels, three hours of music, and large mass of students and instructors. The F.A.C. achieved its purpose, that being to introduce engineering students to the engineering student government and student groups in a social atmosphere. The event was sponsored by the Associated Engineering Students (AES) with non-student fee monies.



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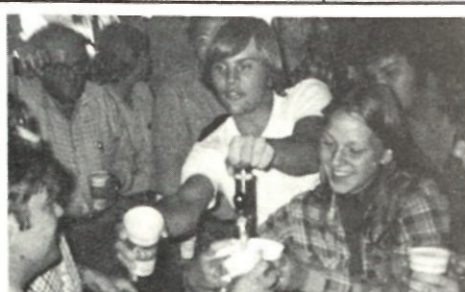
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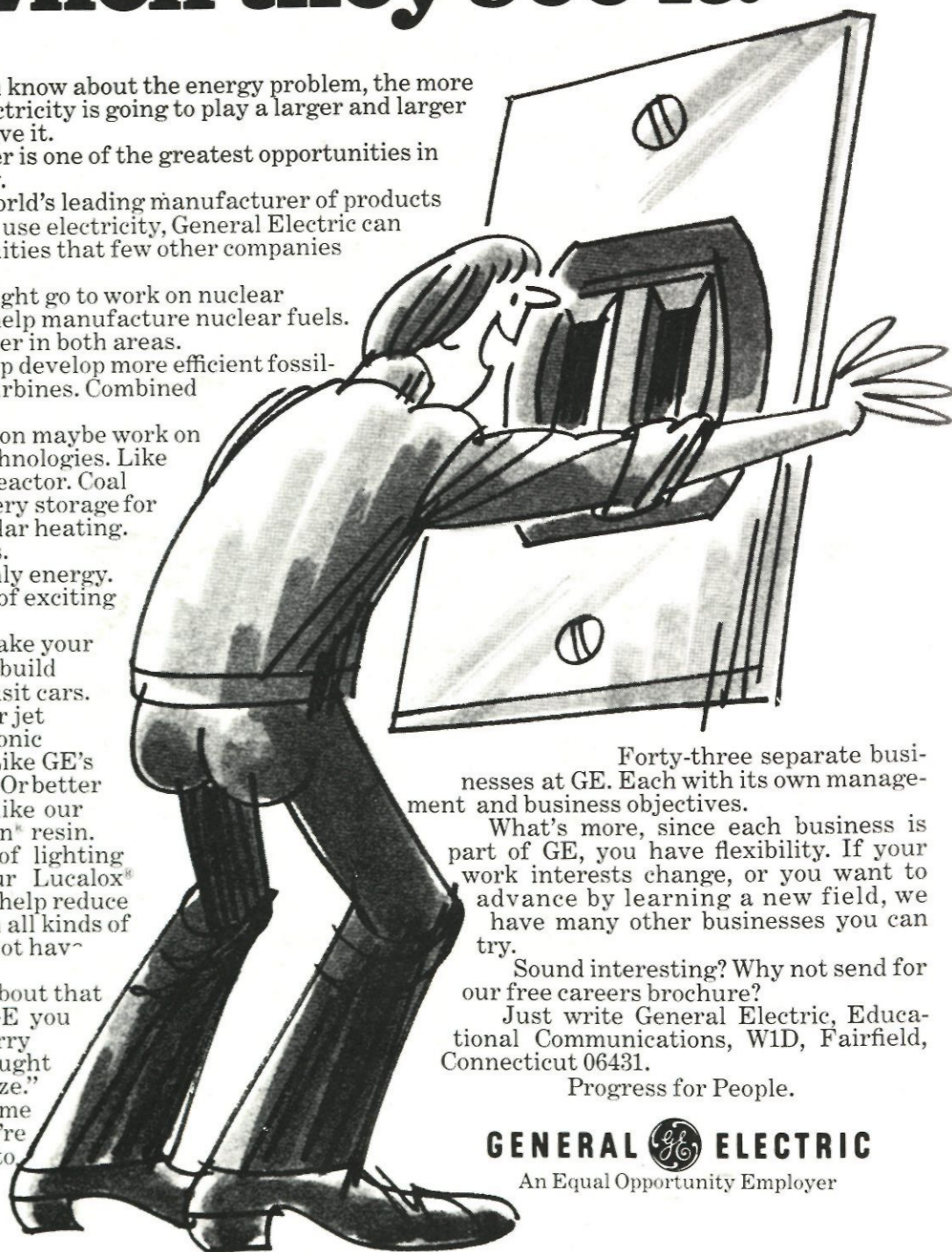
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