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# RESEARCH SERVES COLORADO

EIGHTY-FIRST ANNUAL REPORT



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**ANNUAL REPORT  
1967-68**

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# RESEARCH SERVES COLORADO

EIGHTY-FIRST ANNUAL REPORT  
COLORADO STATE UNIVERSITY  
1967-68

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Honorable John A. Love  
Governor of Colorado  
Denver, Colorado

Dear Sir:

In compliance with the Act of Congress entitled "An Act to Establish Agricultural Experiment Stations," approved March 2, 1887, and with Acts supplemental thereto, I hereby present Colorado State University's Eighty-First Annual Report. This report encompasses research activities of the Colorado State University Experiment Station and of other major divisions of Colorado State University for the fiscal year 1967-68.

Respectfully,

A handwritten signature in cursive script, reading "Rue Jensen".

Rue Jensen  
Vice President for Research  
Colorado State University  
and  
Director, Colorado State  
University Experiment Station



### **The University and Research**

At Colorado State University research is an essential, practical, and integral function of all colleges and of most departments. These research activities generate new concepts and information; often they suggest significant modification of long existing concepts. Through application of the new, teaching programs remain dynamic and relevant to current circumstances. Furthermore, research findings help point the way to solution of complex problems in industry, in agriculture and in communities at home and abroad.

But research does more than solve problems and accumulate facts; its activity is integral with the learning process. Research, therefore, contributes substantially to the continuing education of students and teachers. By working with faculty on specific research projects, graduate students learn the nature of modern problems and the methods and techniques for obtaining solutions to them. Students also learn cooperation with other students and other scientists, and together they observe the benefits of concentrating the resources of many disciplines, such as biology, engineering and chemistry, in a single complex problem. Many research projects provide fellowships that enable students to pursue studies in the Graduate School. Without research, graduate instruction would become insignificant, and undergraduate teaching static and obsolete.

*W.E. Morgan*

William E. Morgan  
President  
Colorado State University

## Research at Colorado State University

Research and instruction at Colorado State University are fully integrated functions. In general, faculty members conduct research in their specialized fields and also teach classes of undergraduate and graduate students. As a result of this interaction of research and instruction, professors obtain new information for use in classes they teach, and students receive the benefits of up-to-date information and concepts. Frequently, the new information, because it has use beyond the classroom, helps in solving problems important to the economy of Colorado and other areas; for example, research information obtained in the Department of Agronomy by a scientist teaching a course in soil physics and studying the movement of fluids in soils may assist in water conservation and also become content for his lectures. In addition, the integration of research and teaching satisfies and encourages the demands and the pleasure of intellectual stimulation.

Although usually conducted by individual faculty members or by groups and their graduate students, the research is specifically administered by the University through three agencies: the Experiment Station, the Office of Water Resources Research, and the Office of Contracts and Grants. The Experiment Station receives aid from the Colorado State Legislature and from the United States Department of Agriculture, and it supports research on practical problems of the State in agriculture, natural resources, and community development. The Office of Water Resources Research, financed by money from the Colorado State Legislature and the United States Department of Interior, supports specialized research in all aspects of water management and use, including watershed development, ground water and surface water management, economics of water systems development, and political and legal aspects of project development. The Office of Contracts and Grants administers all agreements between Colorado State University and outside donor agencies for the conduct of specific research projects of potential mutual benefit to Colorado and the agency. Frequently, a major problem wide in geographic range and broad in effect (such as the study of air pollution along the front range of Colorado) may be supported by money from the Experiment Station and from a financial grant from a federal agency. Research scientists from each of several related departments may participate in the study of the problem and in seeking its solution.



Rue Jensen  
Vice President for Research  
Colorado State University



### **Office of Contracts and Grants Administration**

The acceptance of awards for research and other sponsored projects by an institution of higher education carries with it a definite responsibility. The University must agree to perform such functions as negotiation, administration, preparation of proposals and submission of reports on management of patent matters and others required by the sponsor. Only with the combined efforts of the principal investigator and the academic and business administrators can these responsibilities be fulfilled.

The Office of Contracts and Grants Administration has the responsibility for administering research projects which are supported by sponsors outside the University. The major sources of support are Federal and State agencies and industrial organizations. Formerly the responsibility for administration was one of the Colorado State University Research Foundation offices. Part of the personnel from the Foundation was organized into the Contracts and Grants Administration Office and became a unit under the Vice President for Finance.

Functions of the Contracts and Grants Administration Office include negotiating and administering research agreements, providing liaison between the principal investigator and the University on one hand and the sponsoring agency on the other, obtaining modifications to agreements, issuing subcontracts, and securing prior approvals on specified management and administrative matters. In order to meet the requirements, this office has available the manuals, letters, and other publications which govern the projects supported by different sponsors. Since there are wide variations among the policies of the various agencies, the Contracts and Grants Administrator maintains close liaison with other institutions having similar research activities and management problems.

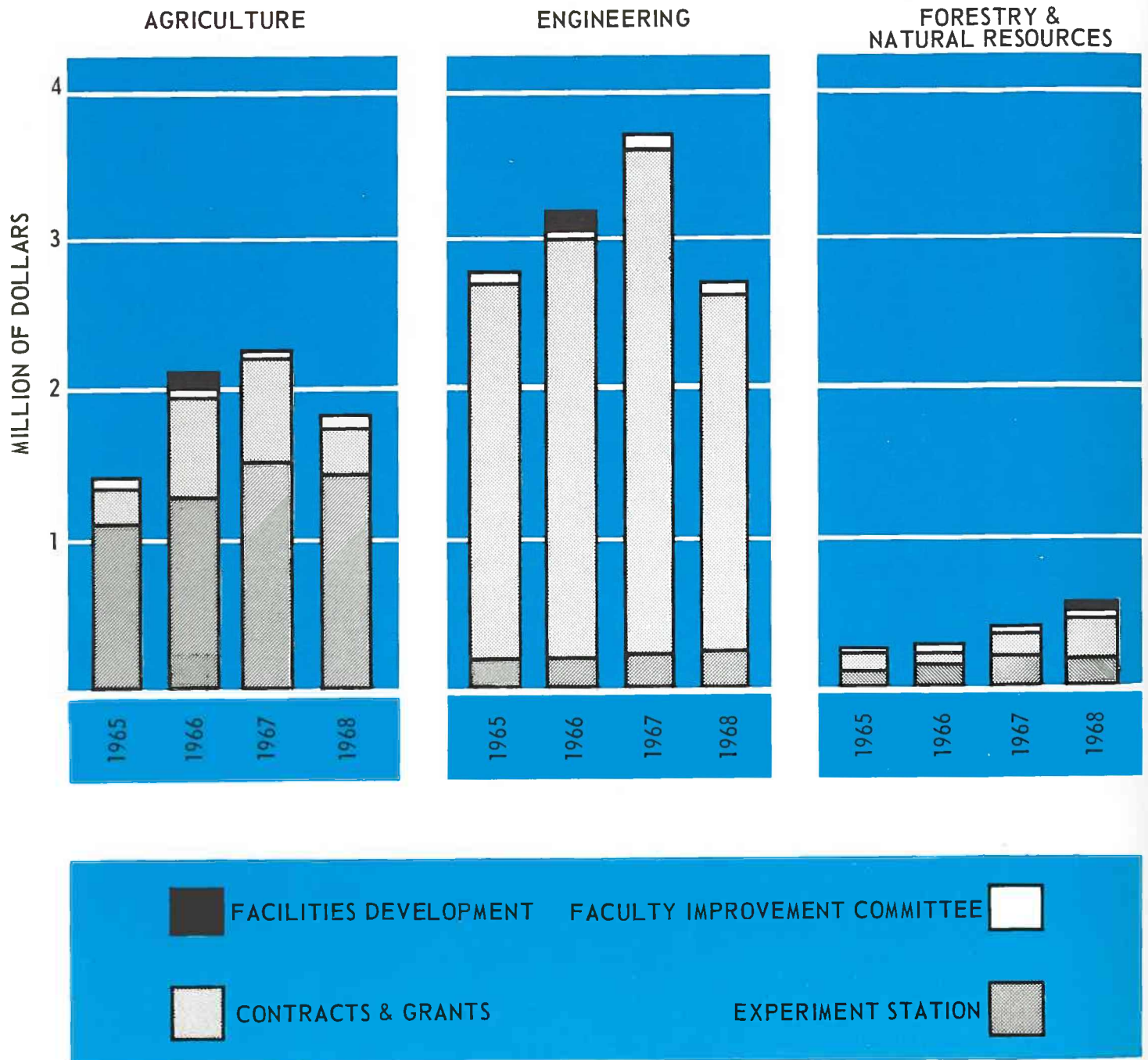
Accounting service for the sponsored projects is provided through the University Business Office.

Contracts and Grants Administration negotiates research awards to obtain the best possible terms for the University in such matters as budgets, patent and publication rights, and financial arrangements. It serves the principal investigator by handling the management problems of the contract or grant. Prosecution of the research, disclosure of inventions, and submission of technical reports are the responsibility of the principal investigator.

At the close of fiscal year 67-68 in excess of 550 projects worth more than \$25,000,000 were in effect.

# GROWTH OF RESEARCH

## RESEARCH FUNDS EXPENDED BY COLLEGE 1965-68



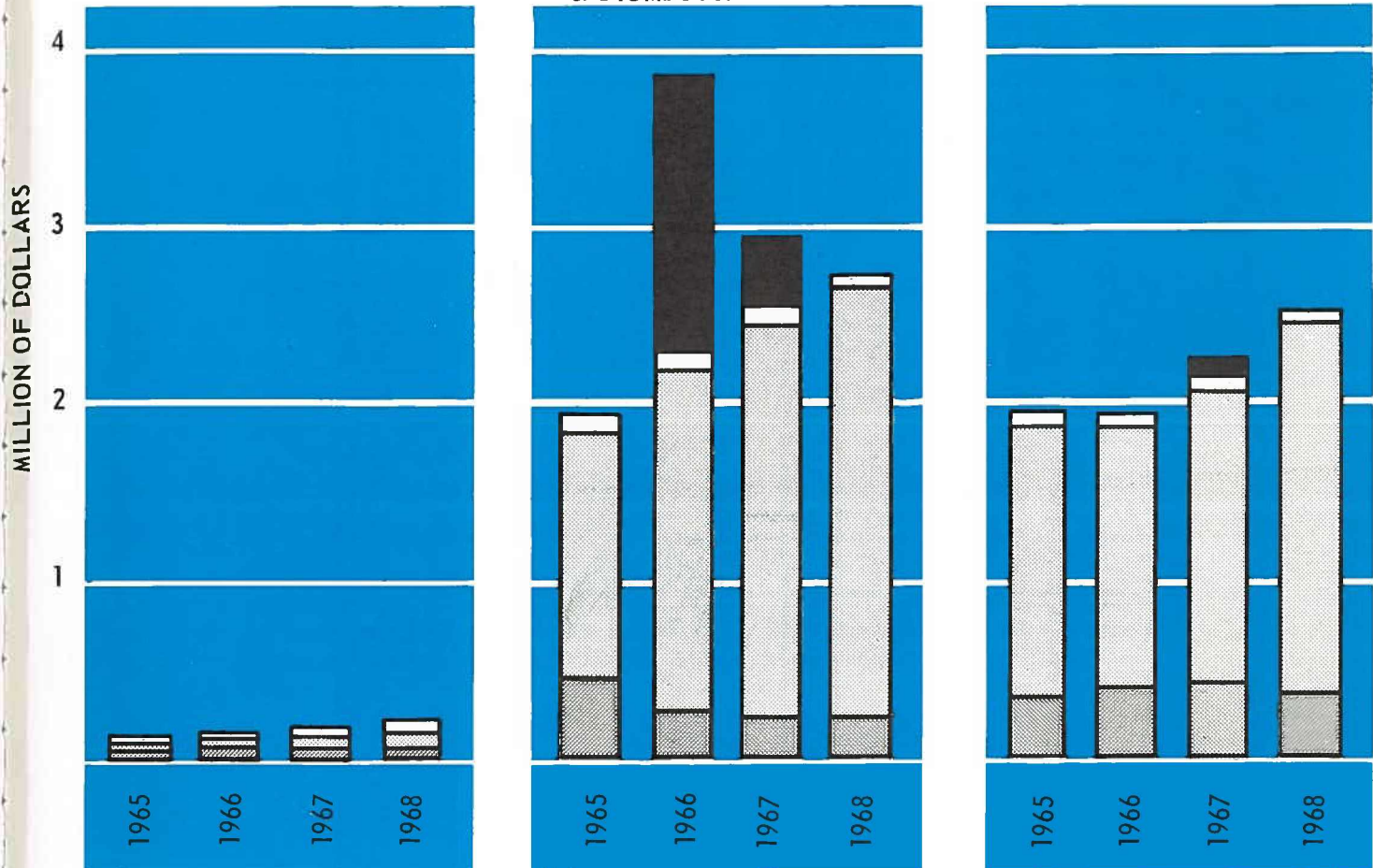
## GROWTH OF RESEARCH

### RESEARCH FUNDS EXPENDED BY COLLEGE 1965-68

#### HOME ECONOMICS

#### VETERINARY MEDICINE & BIOMEDICAL SCIENCES

#### ARTS AND SCIENCES



FACILITIES DEVELOPMENT

FACULTY IMPROVEMENT COMMITTEE



CONTRACTS & GRANTS

EXPERIMENT STATION





# FINANCIAL STATEMENT

COLORADO STATE UNIVERSITY EXPERIMENT STATION - FISCAL YEAR 1967-1968

	Hatch	RRF	McIntire-Stennis	Specific Research	State Approp.	Research Sales	Service Sales	Total
Carryover 7/1/67		1.00	15,008.79	2,829.05		5,802.69	1,644.47	25,286.00
Receipts, 1967-1968	489,242.00	276,432.00	59,896.00	19,300.00	1,944,687.00	387,698.98	202,766.02	3,380,022.00
<b>TOTAL: carryover and receipts</b>	<b>489,242.00</b>	<b>276,433.00</b>	<b>74,904.79</b>	<b>22,129.05</b>	<b>1,944,687.00</b>	<b>393,501.67</b>	<b>204,410.49</b>	<b>3,405,308.00</b>
<b>Disbursements:</b>								
Personal services	339,386.69	243,359.03	43,114.31	14,211.56	1,115,821.24	19,646.82	38,077.74	1,813,617.39
Labor	47,026.53	2,316.20	7,570.57	577.23	121,180.25	45,159.74	12,231.05	236,061.57
Travel	12,550.14	13,896.28	1,847.53	347.85	38,482.61	7,787.97	626.12	75,538.50
Equipment	10,745.07	2,789.59	1,997.59	3,594.00	43,089.60	57,796.29	8,490.64	128,502.78
Land and Structures	-----	-----	-----	-----	-----	-----	-----	-----
Personal benefits	-----	-----	-----	-----	76,946.13	923.60	2,164.73	80,034.46
Supplies and Materials	70,303.06	11,855.79	4,160.85	2,694.97	130,269.78	211,651.98	64,283.19	495,219.62
All other	9,230.51	2,216.11	1,296.80	205.66	90,964.57	23,057.08	103,676.95	230,647.68
Plant M&O	-----	-----	-----	-----	327,927.00	-----	-----	327,927.00
<b>Total Disbursements</b>	<b>489,242.00</b>	<b>276,433.00</b>	<b>59,987.65</b>	<b>21,631.27</b>	<b>1,944,681.18</b>	<b>366,023.48</b>	<b>229,550.42</b>	<b>3,387,549.00</b>
Balance 6/30/68	-----	-----	14,917.14	497.78	5.82	27,478.19	(25,139.93)	17,759.00
<b>Total Disbursements and Balance</b>	<b>489,242.00</b>	<b>276,433.00</b>	<b>74,904.79</b>	<b>22,129.05</b>	<b>1,944,687.00</b>	<b>393,501.67</b>	<b>204,410.49</b>	<b>3,405,308.00</b>

# COLORADO STATE UNIVERSITY

## STATEMENT OF EXPENDITURES FOR RESEARCH - FISCAL YEAR 1967-1968

College	Total	Contracts & Grants	Experi- ment Station	Faculty Improve- ment Committee	Facilities Develop- ment
Agriculture	\$ 1,898,019	429,820	1,464,334	3,865	—
Business	10,540	10,540	—	—	—
Engineering	2,754,631	2,485,482	262,455	2,960	3,734
Forestry and Natural Resources	591,526	293,437	225,452	340	72,297
Home Economics	208,697	125,628	81,534	1,535	—
Science and Arts	2,492,342	2,107,171	355,164	27,557	2,450
Veterinary Medicine and Biomedical Sciences	2,697,885	2,419,670	245,429	6,601	26,185
Other*	3,287,724	2,518,147	753,176	—	16,401
<b>Total</b>	<b>\$13,941,364</b>	<b>\$10,389,895</b>	<b>\$3,387,544</b>	<b>\$42,858</b>	<b>\$121,067</b>

\*Includes one or more of the following: Audio-Visual; Dean, Graduate School; Dean, Summer Session; Office of International Programs; etc.

### ADVANCED DEGREES AWARDED 1967-1968\*

College	Masters	Doctors
Agriculture	40	12
Business	17	—
Engineering	80	21
Forestry and Natural Resources	50	11
Home Economics	13	—
Science and Arts	346	42
Veterinary Medicine and Biomedical Sciences	23	19

\*includes August, 1968.

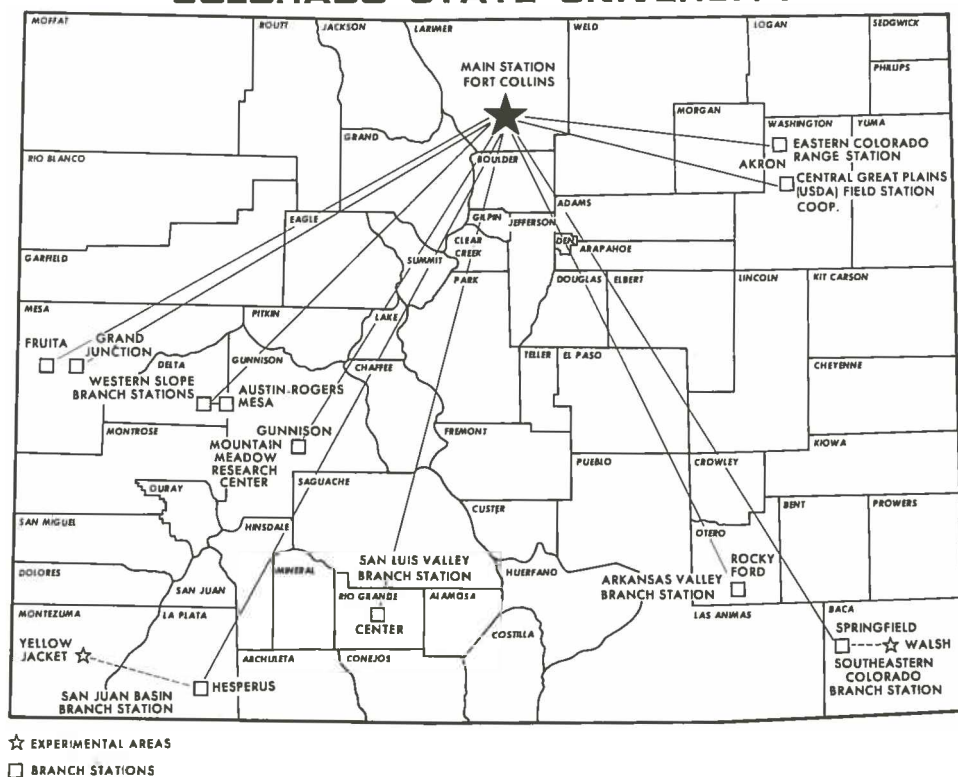
## Experiment Station

The Colorado State University Experiment Station is a complex of faculty, graduate students, technicians, laboratories, and field stations near the campus at Fort Collins and at nine other locations scattered throughout the state. Most of the scientists involved are both researchers and teachers.

The Experiment Station was created and funded in 1888 by passage of the Hatch Act. Like its counterparts in other land-grant colleges, it was enjoined as an integral part of the institution to promote investigation into the basic principles and useful applications of science relating to agriculture. In 1962 the McIntire-Stennis Cooperative Forestry Research Act expanded the efforts of experiment stations by providing new funding for research in forestry. Since both of these Acts require state matching funds, the Experiment Station is supported cooperatively by both state and federal governments. Over the years the program of the Experiment Station has broadened through contracts and grants to encompass research efforts in all eight colleges of the University.

Cooperative research is conducted with U. S. Department of Agriculture agencies on the main campus and at facilities located near Akron, Gunnison, and Grand Junction.

## Branch Stations and Experimental Areas





### **Natural Resources Center**

The Natural Resources Center coordinates education and research programs dealing with man's use and development of land, water, and atmosphere. These programs cut across departmental, college, and institutional boundaries. In addition, the Center administers a Federal program of water resources research funded through the Office of Water Resources Research (OWRR), U. S. Department of Interior. The missions of the Center are to stimulate more and better research on natural resources problems facing the State and Nation, train greater numbers of scientists and engineers for the task of natural resources development, and improve the flow of communication between those engaged in research and those engaged in application of research.

Five water research projects have been conducted under an annual allotment of \$100,000 funded by OWRR during the past year. Twenty-one professional research scientists or engineers representing 10 disciplines participated in 17 sub-projects. Five technical publications were produced with an additional 10 papers in process for future publication. Thirty-one students received advanced graduate training. Four graduate theses were completed.

An OWRR matching research grant program supported eight major research projects. A total of \$95,480.00 was provided in Federal funds matched by an equal amount from State sources. Thirty-four research scientists and engineers representing eight disciplines were engaged in these projects. Training of 22 students through participation in the research was provided. Nine theses were produced. Professional papers and reports published from the eight projects totaled three, with nine additional publications in process.

During the year, seven new matching research grant projects were authorized for Colorado by OWRR with \$124,674 of Federal funds to be matched by an equal amount of State funds.

The Center, through the activities of nine standing committees and several special committees, has been deeply involved in academic activities related to natural resources, regional planning for new research or educational programs, coordination of research programs with State and Federal agencies, and general public affairs concerning natural resources.

### Faculty Improvement Committee

The duties of the Faculty Improvement Committee (FIC) as stated in the CSU Faculty Staff Manual are:

*The Faculty Improvement Committee is composed of faculty representatives. The committee advises on matters of concern to the faculty, including such factors as working conditions, relationships, recognition, advancement, and other matters which may be recommended to improve effectiveness and welfare of the faculty.*

In addition, the FIC is responsible for a modest amount (\$42,858) in research funds. These funds are distributed by an ad hoc committee of five faculty members chosen by the FIC for their record in research. These research funds are granted to faculty members who submit proposals to this committee for the establishment of new research projects on the campus. Forty-nine grants were made to twenty-five departments for fiscal year 1967-68. The distribution of FIC funds by college in 1967-68 was as follows:

College	No. of Grants	Amount Granted
Agriculture	16	\$ 3,865
Engineering		2,960
Forestry and Natural Resources	6	340
Home Economics	—	1,535
Humanities and Social Sciences	49	13,273
Natural Sciences	3	14,284
Veterinary Medicine and	3	
Biomedical Sciences	1	6,601
	2	
<b>Totals</b>	<b>18</b>	<b>\$42,858</b>

The progress reports for these grants, which are on file in the Office of the Chairman of FIC, indicate that the distribution and use of these funds has contributed substantially to the increasing stature of research at CSU.

### University Planning Office

The Planning Office is responsible for the funding, programming, design, construction, space assignment, and space utilization of the total facilities program. During the last year the following facilities concerned primarily with development of research and graduate training facilities were either completed and occupied or placed under construction contract:

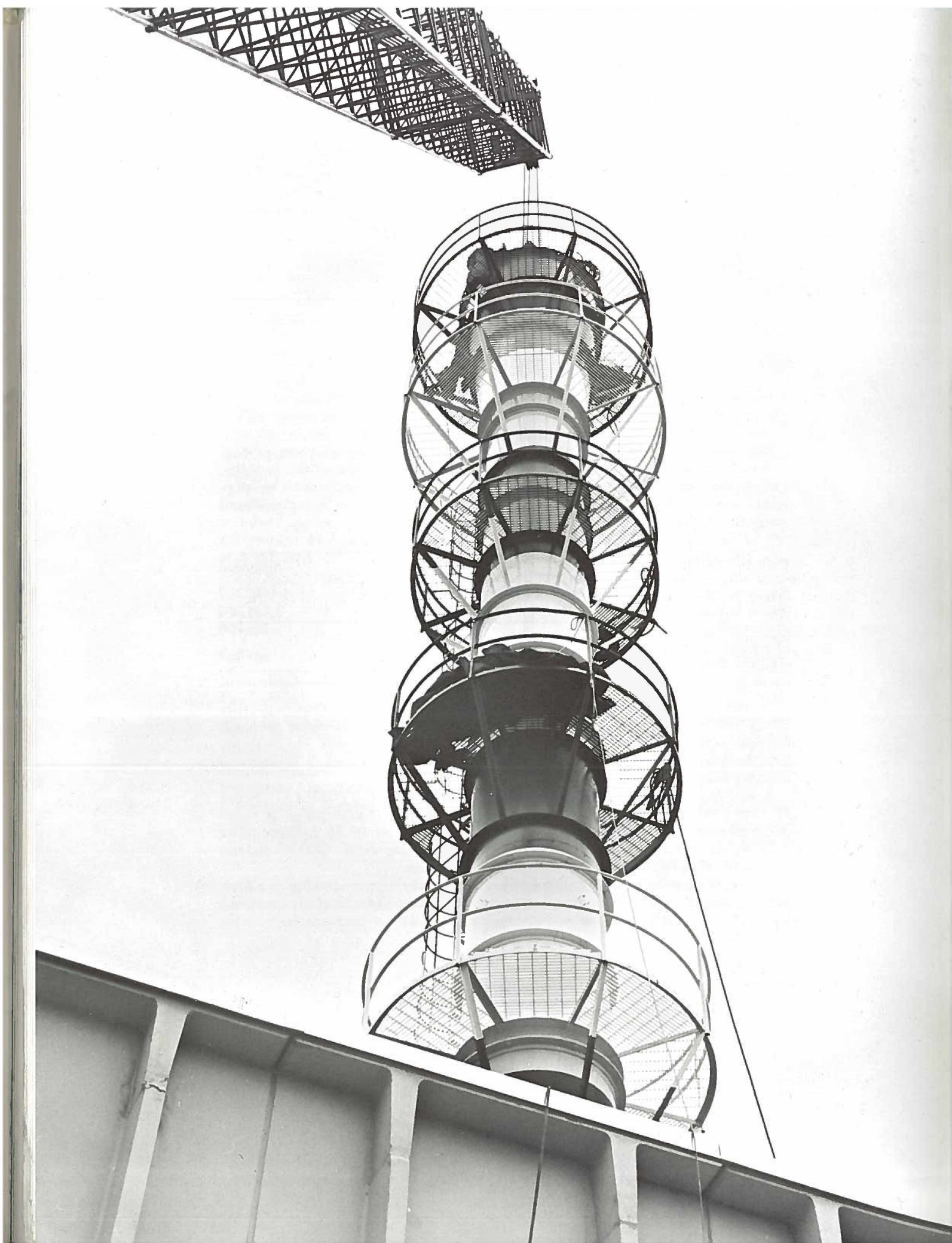
Facility	Sponsor	Amount
Engineering Research Center Addition	NSF <sup>1</sup>	\$ 608,350
Social Science	HEW <sup>2</sup>	1,745,000
Microbiology	HEW	335,000
<sup>1</sup> National Science Foundation		
<sup>2</sup> Health, Education and Welfare		

In addition to the construction program responsibilities the Planning Office works with departmental and administrative committees in developing proposals for additional research facilities and related research grant proposals. It also supervises facilities grant funds and administers proceeds from Research Foundation revenue bonds.

A new facility to house the Chemistry Department has been granted \$1,200,000 of Title I HEFA funds, and is in the final planning stage. Under design is a new Anatomy-Zoology facility with an anticipated project cost of \$5 million. The building of this facility will involve cooperation among NIH, HEFA, Bureau of Health Manpower, NSF, and the State of Colorado.

The University's present strong orientation to the upper division graduate training and research endeavors is reflected in a Five Year Program that calls for a 110 percent increase in existing research space.





## **Research Accomplishments**

### **Agricultural Mechanization**

Mechanical harvesting of potatoes in Colorado as well as other locations has suffered from the inability of present machines to satisfactorily sort stones and hard soil clods from the tubers. A new approach to this problem now underway in the Agricultural Engineering Department utilizes the different radiation reflecting abilities of these objects to control an automatic sorting mechanism.

The research involves a detailed study of the spectral diffuse reflectance characteristics of various varieties of potatoes, stones, and soil types and moisture contents, using a spectrophotometer capable of automatic recording of reflectance over a range of wavelengths extending from 200 millimicrons (ultraviolet light) to 2.7 microns (infrared). The detection mechanism being developed utilizes photo-conduct-

ing cells sensitive to monochromatic light at wavelengths where the reflectance of potatoes is markedly different from that of stones or soil clods. An electronic circuit translates this information into a signal which controls a rejection mechanism to remove the stones and clods.

Dr. Albert G. Story of the Agricultural Engineering Department is responsible for this project. Cooperating with him is Dr. Bruce Pollock of the USDA National Seed Laboratory who has made available and assisted in the use of the spectrophotometer used for the spectral reflectance studies.

Dr. Story plans further studies using light and infrared reflectance for the detection of fruit on trees and control of an automatic picking mechanism.

### **Analysis of Electric Sign Medium in Communication**

The electric sign medium has emerged as a significant form of communication in business. Dr. Robert Patty and Dr. Harvey Vredenburg of the College of Business are conducting a re-

search project to analyze the role of electric signs in a communication program. Specific objectives of the project are:

1. Define the function of electric signs as an

integral part of an effective communications program.

2. Develop a set of benchmarks for evaluating electrical sign display programs.
3. Develop more precise methodology for measuring the impact of electrical sign displays.
4. Determine consumer motivation of users

of electrical sign displays.

Results of the research project should be beneficial to both suppliers and users of electrical sign displays. The supplier will be able to design and distribute electrical signs more effectively. Users, on the other hand, will be enlightened in the utilization of electrical signs more efficiently.

### **Atmospheric Simulation Laboratory**

The program associated with this laboratory focuses on phase transitions in natural atmospheric clouds, particularly changes from the supercooled liquid phase to the ice phase since this process is primary in the precipitation process. Of particular importance is the change to the ice phase which is brought about by the presence of foreign particles on which ice may initially form from the supercooled water (heterogeneous nucleation). The foreign particles may be either natural or artificial, the latter being commonly referred to as cloud seeding agents.

The basic science of the behavior of these foreign particles is not well understood, nor are their effects in natural cloud processes. The major research mission in this laboratory is therefore to help ferret out some of the many unknowns concerning phase changes in natural clouds as well as to examine methods of economically producing various cloud treating agents.

A dynamic cloud chamber was completed this year to permit physical simulation of natural cloud processes. For example, a parcel

of a cumulo type cloud can be formed by simulating the lift of a parcel of moist air from ground level to altitudes as high as 65,000 ft. This then permits study of all of the phase transitions occurring in clouds of this type under controlled conditions. This facility is unique in the world.

Other facilities include a vertical wind tunnel with a 45" diameter by 60 ft. test section in which the velocity is variable from 10 to 200 ft sec<sup>-1</sup>. The tunnel is utilized to simulate the behavior of cloud treatment materials in the natural atmosphere. Other research apparatus includes a completely instrumented static cloud chamber and a wide variety of supporting apparatus.

The research activity is funded by NSF, USBR, ESSA, and USN. The interdisciplinary staff includes Roger L. Steele, Professor in Charge; Professors M. L. Corrin, Atmospheric Chemistry; U. Katz, Cloud Physics; and Research Associate J. E. Dye, Cloud Physics and C. I. Davis, Engineering—along with other supporting staff and graduate students.

### **Bighorn Sheep Ecology**

The history of the mountain sheep throughout the western states has often been a tragic one, and the problem cannot be better exemplified than by its history in Rocky Mountain National Park. With the arrival of early settlers in the area bighorn sheep were thought to be very abundant. Precise estimates do not exist, but it appears safe to say the total population may have exceeded 3,000 animals in and im-

mediately adjacent to what is now the National Park.

In the 1800's a severe decline was noted by residents of the area. The losses generally were attributed to diseases, some of which may have been introduced by domestic sheep. Around the turn of the century, and for a short period of time after that, a recovery in numbers was detected.



During this time, elk numbers were at an all time low because of uncontrolled hunting. With the establishment of the National Park in 1913, and subsequent protection afforded game accompanied with re-introduction of elk into the area, elk numbers soared.

By 1935 another bighorn decline was observed. From a study conducted in the late 1930's it was estimated that the Park population had dropped to slightly more than 300. Again, disease was blamed.

The current official estimate of mountain sheep (the symbol of Rocky Mountain National Park) is 200. At the same time elk have done remarkably well and have caused some dramatic changes in vegetation in key wintering areas. Park Service personnel have become extremely concerned with the problem of overabundant elk and a declining bighorn population.

Current studies are directed primarily at establishing elk-bighorn sheep range relationships

with the intention of determining the degree of competition between the two species. Information is being gathered on summer and winter distribution, numbers, food habits, range condition, and populations data. In addition, behavioral information is being obtained in an effort to determine social interrelationships between bighorn and elk.

Concurrent pathological studies have revealed that diseases may have some bearing on the problem, and an attempt is being made to evaluate the importance of several large mineral "licks" to the bighorn herd.

It is hoped that findings from this project will enable Park Service personnel to make specific proposals concerning the future management of bighorn sheep within the Park. Hopefully, we will be able to better evaluate the importance of the current elk populations on the bighorn sheep.

### **Bukharin and the Soviet Union**

The research of Professor Sidney Heitman of the Department of History is concerned with the political career of one of the most influential leaders and theoreticians of the Russian Communist movement, Nikolai I. Bukharin. Together with Lenin, Trotsky, and Stalin, Bukharin was one of the four major figures in the Bolshevik Party who were largely responsible for planning and carrying out the Russian Revolution of 1917 and shaping the early, formative history of the Soviet regime. As a leading organizer of the Party before and after the Revolution, as a dominant member of the most important political, economic, and cultural organizations in the USSR during the first two decades of Soviet rule, as the official head of the Communist International during the later nineteen-twenties, and as the acknowledged ideological successor of Lenin after his death in 1924, Bukharin played a dominant role in the formation and evolution of the Soviet system until his fall from power and execution by Stalin in 1938. Not content with his political victory over Bukharin, Stalin systematically suppressed and falsified the record of Bukharin's significant achievements, as well as that of other

purged opponents, and obscured the history of the Party to justify his bloody climb to power and the imposition of his totalitarian regime on Russia, an imposition that Bukharin tried in vain to prevent by advocating an alternative gradualist path to communism.

Until recently, Bukharin's role in the early history of Soviet Communism and the importance of his alternative to Stalinism have been only little known or understood in the West because of the suppression of the record of his career in the Soviet Union. During the past ten years, however, Professor Heitman has recovered from libraries and archives in this country and abroad the documentary and published accounts of Bukharin's thought and acts, making it possible now to study his contribution to Soviet history and to re-examine the current interpretations of that history in the light of Bukharin's contribution to it.

With the assistance of grants from the Ford Foundation, the Social Science Research Council, the Rockefeller Foundation, the American Council of Learned Societies, the Honor Institution of Stanford University, and Colorado State University, among others, Professor Heit-



man has completed a comprehensive historical bibliography of Bukharin's works, which will be published in 1968 by the Hoover Institution; several studies of Bukharin's career and thought which have been published in books and journals in this country and abroad; and edited, annotated editions of Bukharin's major works, which have been or will soon be published to make them available to other scholars for study.

Presently in progress are two major studies by Professor Heitman—an analysis of Bukharin's political thought and a comprehensive biography of Bukharin, which will be published by the Stanford University Press and which are intended to dispel the obscurity surrounding his life and career and his significant contributions to modern Communism.

### **The Carrying Capacity of Parks**

Yellowstone National Park and other nationally significant parks of grandeur and outstanding beauty exist because of a long and continuing effort to protect them from uses which would have greatly reduced, or even destroyed, their scenic and scientific values. An additional type of protection is necessary today if these areas are to retain the attributes for which they are valued. In one sense, the parks have become too successful. They attract a growing number of visitors each year and even under the best of circumstances it is increasingly difficult to maintain the health and vigor of vegetation, to keep the intrusion of asphalt, concrete and other material to a minimum, and to provide visitors an opportunity to enjoy a visit without the frustrations and tensions produced by crowds and crowding and the disillusionment of entering an area which reflects in many different ways the fact that large numbers of visitors have used the area.

The ability of a park or recreation area to absorb people is ultimately limited by a lack of space to accommodate anyone else; but long be-

fore that, various thresholds in terms of volume of use are reached. Permitting additional visitors to use the area after a given threshold has been reached is equivalent to providing a different type of experience to visitors than that which was previously experienced.

The National Park Service is particularly concerned with finding criteria which can be used to determine the thresholds of use of a particular area, methods which can be used to determine when a given threshold has been reached, and methods which can be used to evaluate the losses which occur as a threshold is crossed.

Stanley Brickler, a graduate student in the Department of Recreation and Watershed Resources and Dr. Joseph Sardo, a staff member of the Department of Sociology, have made field observations in Rocky Mountain National Park in an effort to find answers to these questions. The project, under the direction of Drs. Arthur T. Wilcox and R. Burnell Held, is continuing with an initial report to be made in 1969.

### **Colorado's Water Problems**

Colorado Water Law is based upon the Appropriation Doctrine which guarantees the right of any person to divert the unappropriated waters of any natural stream for beneficial use. Priorities are defined chronologically. Over the years economic and growth pressures have caused an increasing number of citizens to divert water by pumping the underground supply. Only recently were the depleting effects of this on sur-

face water supply discovered. The situation has worsened to the extent that some surface users have been unable to satisfy their historic water rights due to underground pumping. *De jure*, any pumping or diverting of water that is detrimental to an earlier right is illegal. Yet to administer wells on this basis would call for a shutdown of the wells and the economy of at least one valley would be deprived of its lifeblood.

General opinion is that strict application of the Doctrine of Prior Appropriation is unacceptable.

We have developed to such a point that we have concepts of the law which make it impossible to get the best use of water . . . The only way around the problem is for the conservancy district to control, on a local level, most of the water resources so that they have greater flexibility in the delivery of water, that it can be delivered upon demand at a time when people need the water. (Colorado Water Conservation Board, Minutes, December 1966, pp. 45)

There are economic-engineering propositions which call for the re-regulation of existing water supplies to effect a more efficient distribution of the resource. The feeling is that the only solution is voluntary collusion and consensus among the well and surface users within an

area of common management of the water.

New techniques have been developed but the problems of implementing these and incorporating them into the community are immense. Profound resistance is being met. A major task is to persuade water users that re-regulation can occur consistent with (rather than against) the basic system of property and other constitutional rights; that cooperation for mutual benefit replace a system of total win or loss.

The research study in progress focuses on the problem of community acceptance and incorporation of these new ideas of social organization. The particular task of the study is to ask what are the prerequisites for institutional change. It attempts to pinpoint the crucial factors upon which social change depends. Social and private attitudes, ways of thinking and prediction, use of information all become important in studying this aspect of the development process.

### **Concepts of Authority**

Authority is a fundamental concept of management operations. Effectiveness of management operations is highly dependent upon the manner in which authority is allotted and applied. Dr. Ron Wiggins of the College of Business is conducting a study of concepts of authority. The work thus far has been concerned with definitions and meanings of authority within the classical framework, i.e., the "management

process" school. A number of related terms occur and have been considered.

Another phase of the investigation has been concerned with the applications of the classical ideas of authority in conjunction with the classical principles of "Unity of Command" and "Unity of Direction." This has involved the relationship of ideas and principles within the field of Industrial Relations.

### **Control of the Sugar Beet Root Maggot**

The sugar beet root maggot is a serious insect pest of sugar beets grown in Colorado. While this pest can be held in check with soil applications of aldrin or other chlorinated hydrocarbon insecticides, the use of these chemicals results in undesirable residues in the processed sugar. It has thus become necessary to find other means of controlling this pest.

Insecticide trials in 1968 at planting time and as post-emergence applications indicate that stand loss and root damage due to the sugar

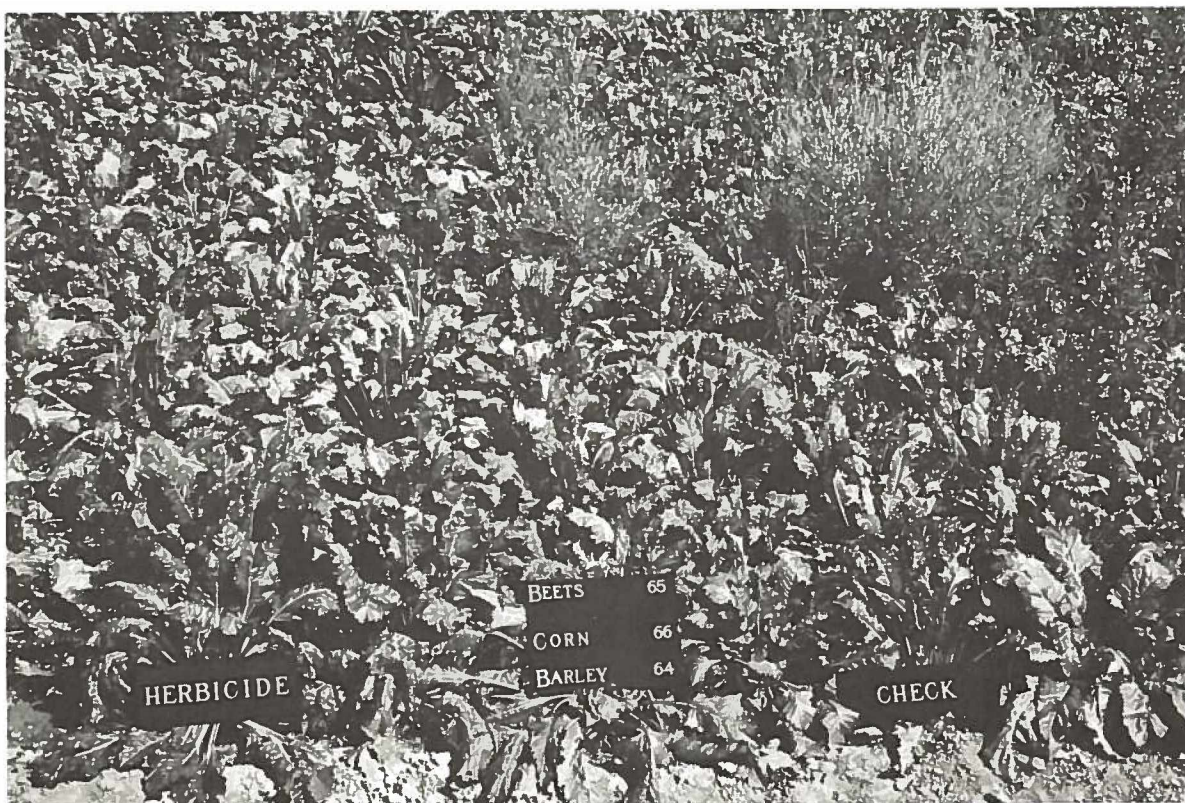
beet root maggot can be reduced when the time of application provided a maximum amount of toxicant present in the plant row at the time the eggs are hatching.

The insecticide was not effective when applied as a band over the beet row within one week after adult flies were first observed to be emerging. The insecticide was so placed that the young maggots contact the poison as soon as they emerge from the eggs. Insecticide applications made after the eggs started hatching were

N. I. BUKHARIN, father of the Russian Revolution



The detection of herbicides in soil requires advanced analytical instrumentation.





not satisfactory. In Colorado the time of adult emergence varied considerably. Near Prospect Valley, Platteville, and Berthoud the adults, depending on prevailing weather, emerged as early as the third week in April. On the northern edge of the infested area near Fort Collins, Wellington, Black Hollow, and Ault, the adults emerged the first week of May.

The insecticides were applied as granules and spray concentrates. Granules were applied with an applicator equipped with spreader fans to provide a six to eight inch band. In cases where this coincided with first cultivation, the cultivator tools were adjusted to cover the granules with a small amount of soil and thus protect them from sunlight and wind.

Some applications were made at the time of planting. Satisfactory control of flea beetle and sugar beet maggot was obtained with materials applied at planting time. However, when maggot emergence was more than thirty days from this time, a second application had to be made.

The most effective materials tested were Diazinon, Disyston and Thimet. Diazinon granules applied at a rate of 1.5 pounds actual toxicant per acre as a band over the plant row appeared to be satisfactory this year. Disyston and Thimet at a rate of 1 pound actual toxicant per acre as a band also were satisfactory. The use of higher rates caused some plant damage to appear, but in most cases the plants recovered.

### **Crop Management Systems—Weed Control and the Fate of Herbicides**

The complex problems of labor and rising costs have increased the urgency to find the best combination of production systems to control weeds while maintaining crop yield and quality and minimizing pollution of the soil and environment. The use of crop rotation systems together with herbicides markedly reduces weed populations without any detrimental effect on yield and quality of crops. Selective herbicides are providing effective methods of control; crop growers can no longer afford to control weeds in one crop while allowing them to grow and produce seed in other crops.

Research conducted at the Agronomy Research Center has shown that weeds can be effectively controlled through use of crop rotation systems and supplemental use of herbicides. Where sugar beets followed beans in a crop rotation system, all weeds were significantly reduced even where herbicides were not used. Where sugar beets followed corn and barley, greater weed populations were noted and certain weeds such as Kochia were not controlled even where the herbicide was applied. This points out the value of a crop rotation system. The use of both pre- and post-emergence herbicides significantly reduced weed populations in all crops of the crop rotation (beans, beets, barley, and corn), increased yields, and did not affect crop quality.

The control of weeds through crop rotation with chemical herbicides is another step toward complete mechanization of sugar beet production.

Studies of the fate of herbicides in the soil environment have been undertaken as part of a regional research project involving scientists in seven western states. This cooperative research program has shown that pesticide movement and persistence in soil are influenced by rainfall, soil properties, soil environment, microbial activity, and characteristics of pesticides such as solubility, leachability, and absorption to soil colloids. Such information is necessary in order to obtain maximum benefits from the use of herbicides without at the same time contributing to soil and groundwater pollution. Studies conducted in the Department of Agronomy under the direction of Dr. K. G. Doxtader have shown that some herbicides are rapidly decomposed by soil microorganisms; some compounds show measurable decomposition in just a few days after being applied to soil. Such herbicides should present no problem from the standpoint of the accumulation and carry-over of residues from one year to the next. Other herbicides, however, appear to be very resistant to microbial attack and unless degraded by some other means may result in the pollution of soil, as well as groundwater.



## **Design of Subsurface Drains**

At the present time, the depth and spacing of subsurface drains are determined on the basis of theory which is unrealistic in concept. The reason usually given for the use of this theory is that more realistic theory is too complex for practical application. Model studies conducted at Colorado State University have proved the inadequacy of present drainage theory. They have also demonstrated the feasibility of using models to obtain more adequate design criteria.

Since the installation of subsurface drainage systems continues on a large scale and involves the expenditure of enormous funds, the Agricultural Engineering Department has undertaken a program of model studies to obtain improved methods of design. The research has

reached a stage such that it is known that the techniques of modeling are valid. Work is continuing to develop methods of measuring the soil parameters needed to characterize the soil for model studies and to determine the degree of sensitivity of drainage systems to the significant soil parameters.

Work is also underway to develop mathematical models involving computer solutions to supplement design information obtained with the physical models.

The research group responsible for these studies includes Dr. A. T. Corey, Professor of Agricultural Engineering, and H. R. Duke, Agricultural Research Service, USDA.

## **An Economic Analysis of the Pet Food Industry**

The pet food industry is one of the more dynamic industries to evolve in the past ten years. Annual sales have grown from approximately \$500,000,000 in 1963 to approximately \$843,000,000 in 1967, and are expected to reach one billion dollars in 1969. The industry caters to owners of approximately 60 million dogs and cats, representing in excess of one-third of the households of the United States. Product and packaging innovations have been numerous in the recent past. Canned foods represent about 50% of total sales, while dry foods have been steadily increasing to 46% of sales; semi-moist foods have also been growing in popularity. The market for cat food is growing even faster. Dr. Val F. Ridgway and Dr. George Kress of the College of Business are making an economic

analysis of the pet food industry.

The industry is composed of the major food companies, some major meat-packing firms, and some companies whose sole activity is pet foods. Among the larger firms competing are Armour, General Foods, General Mills, Ralston-Purina, and Calo Pet Food Company. In addition, there are in excess of 2,000 smaller producers.

Many of the producers of pet foods are meat packers. Entry into the pet food field enables them to make more profitable use of many of their by-products. Since meat packing is one of Colorado's major industries, an investigation into the feasibility of pet food production by Colorado packers could lead to more profitable utilization of their by-products and an addition to the Colorado economy.

## **Economics of the Medical-Health Industry**

Applying economic principles to the administration of society's scarce resources is of increasing concern to many groups. There is a growing awareness that the science of allocating resources and efficient decision-making has almost limitless applications. This movement toward applied economic analysis is occurring on

several fronts, notably in air pollution, education, space exploration, urban housing, and water resources. To illustrate, it was previously not a primary goal to economize in national defense but to appropriate as many resources as could reasonably be marshalled to this area. The present basis for allocating resources to de-

fense is a detailed analysis of alternative courses of action. Recently, the medical-health area has come under intensive scrutiny, not only by academic economists, but by various government agencies and legislators who want to understand forces associated with the cost-price structure of medical care. For example, the relationship between the cost of medical equipment and the price of health care may be an important one to establish.

The purpose of this study is to describe structure, conduct, and performance in the medical equipment industry, then to determine if they have any bearing on the composition of health-care costs. Essentially, the study focuses on examining whether concentration of economic power exists among firms in various medical equipment lines and, if present, whether it is associated with increasing prices of medical services. The project is primarily an industry study in which the tools of the industrial organization economist are being used to examine characteristics of groups of firms producing medical apparatus which are sold to health care institutions. Sources of information include price lists and magazines and direct mail advertisements of medical equipment firms, personal interviews with medical equipment salesmen, financial data from annual reports and trade publications, and questionnaire returns from mail surveys of medical equipment firms and

from personnel in health care institutions. Several topics on the general organization among medical equipment firms are being explored: their relation to suppliers and buyers, seller concentration, entry conditions, product diversification, vertical integration, product differentiation, price and nonprice competition, and efficiency and performance.

Under the project seven working papers and three Master's theses have been prepared. Findings to date are as follows: medical electronics, surgical tables, and hospital room furniture are representative product lines to form a proxy for the medical equipment industry; much product differentiation characterizes this industry, both from the standpoint of physical output variation and selling efforts; buyers of medical equipment are quite knowledgeable about these products; economic performance in the medical equipment industry is acceptable generally; personal selling effort by medical equipment firms is very well organized according to the nature of the market; and the extent of vertical integration is apparently not very significant in the medical equipment industry.

Additional work is contemplated for this academic year to include studies of the government as a buyer of medical equipment, innovation and development of new products, turnover of companies in various lines, and pricing practices and policies.

### Emphysema

Domestic cattle have difficulty in adapting to sudden changes in diet. One example of this is observed when animals grazing on dry summer mountain ranges are suddenly moved to lower elevations and placed on recently-mown, lush irrigated pastures. Many of them will develop acute pulmonary emphysema and die within two days to a week. This disease syndrome is first characterized by labored breathing, and is more commonly observed in pregnant cows running with a nursing calf. Death is sudden.

The disease has been studied at Colorado State University since 1960 when Dr. Lynn Griner, in cooperation with workers at the University of Wyoming, studied light microscopic

pathology of the disease.

Cooperative studies with veterinary scientists from Montana, Washington, Utah, Nevada, Wyoming, and Colorado have continued from 1960 to the present. G. P. Epling of the Department of Anatomy is representing Colorado State University in this collaboration.

Knowledge presently accumulated indicates a probable cause of the disease. When cattle change pastures from dry, aged plants to rapidly growing, recently mown, and irrigated plants at least two differences become significant—the nutrients contained within the plants are different, and the protozoa and bacteria on those plants are different. Cattle have a digestive system which provides a big soaking vat for plants





Part of a lung from a cow with emphysema,  
magnified 53,000 diameters.



immediately upon swallowing; this soaking vat (the rumen) provides an opportunity for the protozoa and bacteria to "pre-digest" cellulose of plants for absorption in the cow's intestine. Because the microorganisms on rapidly growing plants are different types than those on dry, aged plants, and because they are exposed to different chemical masses in the two types of plants, different "byproducts" are produced as the cellulose is pre-digested. Some of the by-products produced by rapidly growing plants are poisonous until the cow learns to adapt to them. When the accumulation of poisons is massive and sudden, one reaction of the body is to produce pulmonary emphysema—a rupturing of the walls of small air spaces in the lungs, to eventually create large cavities in the lungs and thus prevent normal lung function.

Current research efforts are directed toward identifying the poisons produced in the digestive

system, and toward determining how the poisons cause lung damage. It is possible that poisonous gases produced by the protozoa and bacteria in their pre-digestion of cellulose may be belched and inhaled by the cattle to produce lung damage, or that poisons may be absorbed into the blood from the digestive tract and circulated to the lungs to cause the damage.

Electron microscope studies of tissues from cattle with pulmonary emphysema are in progress at Colorado State University to help answer these questions. At the present, evidence favors the implication of a poisonous gas which when belched and inhaled could cause lung damage. The nature of the gas is not yet known.

Dr. Epling's work on this project has been sponsored by grants from the National Institutes of Health and by Colorado State University funds.

### Energy Losses from a Solar Dryer

Green lumber from trees in the Central Rocky Mountain region contains 700 to 800 pounds of water for each 1000 board feet. At least 500 pounds of this water must be removed in order for wood to perform well in service without excessive dimensional change. Removal of this water requires an input of energy in excess of 400,000 British thermal units.

One commercial means of supplying this energy is through kiln drying. In this process energy is supplied by using gas, oil, electricity, or other fuel to heat air in the kiln. A second method—air seasoning—utilizes the sensible heat from the sun available in the outdoor atmosphere. On cool and cloudy days very little drying is accomplished. A relatively new and experimental method of drying wood is termed solar drying. In this method radiant energy from the sun is used to evaporate water from wood in a confined space.

Recent work in the field of solar drying has called attention to the need for providing a more efficient and economical process. The current study was conducted by Eugene M. Wengert, a graduate student working under the direction of Dr. Harry E. Troxell, in the solar

dryer constructed on campus in 1962. The principal objective of this study in the Department of Forest and Wood Sciences in cooperation with the U. S. Forest Service and Colorado State Forest Service was to determine the magnitude of energy losses in the dryer. Previous studies by Dr. Troxell and L. A. Mueller had demonstrated that, compared with air seasoning, drying time could be shortened through use of the solar dryer.

In the operation of a solar dryer, incoming radiant energy is absorbed by surfaces inside the dryer, although some energy is reflected from these surfaces and lost by transmission through the walls of the dryer. Other sources of energy loss include conduction through the floor and loss of heated air from the dryer through ventilation. The energy that is absorbed by objects inside the dryer is used in several ways: some is used to heat the object; some is used to heat and evaporate water; some is lost by convection to the surrounding air; and some is lost by infrared longwave emission.

Through measurement of energy gains and losses in operating the solar dryer fully charged with green lumber, five major losses were shown



to account for about 84 percent of incoming energy: convection from walls and roof 29 percent, reflection and transmission of solar energy 17 percent, ventilation 14 percent, new longwave radiation 13 percent, and conduction through

the floor 11 percent. Further work is planned in an attempt to reduce these losses through improved design of the dryer and to determine the economic feasibility of solar drying in the Central Rocky Mountain region.

### **Financial Management Analysis of Colorado Flower Growers**

Nearly every decision that managers make will affect the cost-income structure of a firm. Every account and dollar balance that appears in the financial statements of a firm is a reflection of the over-all decision-making ability of management even though it may represent a series of good and bad decisions. Financial account balances should not only provide an evaluation of the past decision-making performance of management but should provide management with an informational basis for making future decisions.

Dr. John L. McKeever of the College of Business is conducting a study to determine the nature and intensity of managerial problems of a sample of firms in the Flower Growers' Association, utilizing financial data as the determining factor.

This study will provide valuable information based on a financial analysis of the *average* or *typical* firm in the area. The financial analysis of the *average firm* can serve as the yardstick against which every other firm can measure its operational efficiency.

In addition, the financial analysis of the aver-

age firm derived from the study can (1) serve as the basis for future action in developing training programs to improve the decision-making ability of management, (2) identify the need for acquiring immediate consultation services to avoid a crisis, and (3) pinpoint areas for continuing research.

The study procedure that Dr. McKeever has followed involved collecting financial information from a representative sample of firms in the Colorado Flower Growers' Association, determining the policies and procedures used by the sample firms in order to classify the financial accounts, determining a series of financial ratios that would clearly and precisely reflect the decision-making ability of management in utilizing the firms' resources, preparing the financial information of the sample firms for programming on a computer, and from the computerized information preparing a report setting forth the sample average for the series of key ratios when available.

Research results should assist individual flower growers in providing better service and encourage successful development.

### **Fish Talk**

Can fish communicate? This is a question that has long interested ichthyologists and laymen alike. Attempts to gather hydronic signals from fish with conventional hydrophones or similar equipment have all met with failure.

The rather recent discovery of "tensor" type signals from fish by researchers in Florida and Colorado has suggested that a breakthrough may have occurred. The use of simple submerged dipole antennae has been the key to the discovery of the "fish sound."

Dr. Harold K. Hagen of the Department of

Fishery and Wildlife Biology has been one of the leaders in the new area of research. Preliminary work supported by a CSU faculty improvement grant has resulted in the development of some better equipment and techniques needed to clear background noises from the tapes of electroacoustical fish signals.

Although much work needs to be done, the results are both encouraging and exciting. It seems very probable that fish signals can be separated according to species, size, and stress of the animal at the time of production. This

has been demonstrated on oscillographs and on the Sanborn recording permapaper. It might be possible to locate and follow specific groups of fish at great distances. It is also possible that fishes can be attracted to a desired area by transmission of signals on a frequency known to produce a response in fish. Dr. Hagen is currently

studying the use of fish tensor signals to indicate the limits of tolerance of fish under the stress of thermal pollution. It would be highly desirable if a fish could communicate his abilities to thrive under various levels and types of pollution; we might not then have to depend upon the arbitrary standards of man.

### **Hydrogeologic Relationships**

Groundwater is an important resource in Colorado, and recent years have brought increasing problems of groundwater management. Colorado legislators have authorized the designation of "groundwater basins" in the state so that equitable water management policies can be formulated. Fundamental to the concept of a designated basin is the isolation of water. That is, neither surface water nor ground water should flow from one basin to another.

Water in these natural basins is contained in unconsolidated sands and gravels which have been deposited in relatively recent geologic time. At the base of these loose sands and gravels lies the older consolidated "bedrock." Although saturated with water, the bedrock is generally less permeable than the younger sands and gravels, and is considered a boundary for water movement within a designated groundwater basin.

A hydrogeologic investigation of the Kiowa-Bijou area has been conducted by the Geology Department of Colorado State University under

the supervision of Dr. James Waltz. A graduate student, Alan Kuhn, received financial support for his work on this project from private citizens in the study area and from the firm of Telson, Haley, Patterson, and Quirk, Consulting Engineers, Greeley, Colorado.

Hydrogeologic data, water quality data, and information on geologic structure which were collected for this study indicate that a bedrock sandstone stratum, known as the Fox Hills Formation, is contributing water into the alluvial valleys over distances in excess of 100 miles. Thus, one of the fundamental bases on which the concept of a designated groundwater basin is founded has been proven to be invalid for the case of the Kiowa-Bijou Groundwater Basin.

Continuing research, under the direction of Dr. Waltz, has as its objective the development of techniques which can be used to locate and evaluate other areas where bedrock formations affect the groundwater which is stored in alluvial aquifers.

### **International Biological Program Launched**

June, 1968 marked the beginning of the International Biological Program (IBP) at Colorado State University. This program is an international effort to bring the skills of a great many scientists to bear on the relationships between man and the biological world which supports him. The first part of Colorado State University's participation in IBP was made possible by a \$400,000 grant from the National Science Foundation. Officially, Colorado State University's participation is known as The Analysis of Ecosystems, Grassland Biome Subprogram.

The site for the grasslands study is near Nunn,

Colorado, about 38 miles from Colorado State University. It was chosen late in 1967 after a series of meetings which reviewed the results of an eight day airplane survey made of the Great Plains from Canada to Mexico by a team of scientists. Pawnee, as the site is called, is located on the 15,000-acre Central Plains Experimental Range of the U. S. Agricultural Research Service. In addition 110,000 acres of the nearby western portion of the Pawnee National Grasslands operated by the U. S. Forest Service will be used for some of the studies.

Characteristic of many millions of acres

throughout the Great Plains, the principal vegetation at the site includes blue grama grass—often referred to as the “queen of the prairie” because it is so prevalent and hardy—buffalo grass, snake-weed, and two species of cacti, the prickly pear and nipple varieties. Animals range from cattle and sheep to pronghorn antelope and bison; from jackrabbits and prairie dogs to ground squirrels and kangaroo rats. Birds such as the lark bunting and horned lark are abundant along with many varieties of insects.

The overall plan for research on the grassland site involves four components: 1) the abiotic factors such as soil, climate, and water; 2) the “producers,” the plants which manufacture food; 3) the “consumers, the animals that eat plants and each other; and 4) the “decomposers,” bacteria and fungi which break down waste products and tissues and regenerate the soil. A comprehensive network of researchers will soon be organized to look at similar problems throughout the Great Plains and other grasslands and coordinate their studies with those at Pawnee.

During the first year, 11 research projects in-

volving 26 investigators will be started. These encompass aspects of all four major areas: climatology, hydrology, meteorology, photosynthesis, herbage dynamics, large consumers, small animal diets, grassland birds, insects, decomposers, and soil and the nitrogen cycle.

An interesting question that will be investigated in the study of the large animals is whether the species native to the grasslands such as the bison and antelope are more efficient and better adapted to it than those species — cattle and sheep — imported by man. Alteration of the vegetation by the imported groups will also be studied.

This program is only the beginning of a vast amount of multidisciplinary research needed to analyze ecosystems properly. But, with adequate support, this and the other five biome studies of the Analysis of Ecosystems program of the IBP could provide some answers in the near future to the very disturbing problems man is faced with today concerning the maintenance of environmental quality.

### Low Temperatures and Plant Tissues

Many plant tissues are injured by low temperatures considerably above the freezing point: avocado growers advise consumers not to refrigerate the fruits, and mature green tomatoes will not ripen properly after exposure to temperatures under 50°F; there are many other examples. In addition many of the large-seeded legumes (southern pea, lima bean, snap bean) are injured by low temperatures in the early stages of germination.

Work at CSU in this area has used as the subject southern peas, which show injury at temperatures even as high as 59°F. This injury resembles to some extent the chilling injury of tomato or banana or avocado fruits. In both cases the respiratory rate, essential to all life processes, decreases and the cell membranes become more permeable, allowing vital cell contents to leak out.

Injury to germinating seeds can occur in the first six hours after the seeds begin to take up water. If the initial water taken up is at a higher temperature, there is much less damage

later from low temperatures. Early exposure to chilling temperatures shows up as reduced growth of the seedling plants many days later, even if the plants have been at favorable temperatures in the meantime. Early chilling also results in slower and poorer emergence of the seedlings.

Experiments have shown that one of the factors influencing sensitivity to low temperatures is the moisture content of the seed at planting time. In general, the drier a seed is, the longer it can be stored with good viability. However, it appears that the best seed moisture content for good storage is not necessarily the best for good planting results.

Experiments are continuing to find out how low temperature injury occurs, what factors other than seed moisture content influence its severity, and what steps can be taken to avoid or prevent this injury in field plantings. This research is partially supported by a grant from the American Seed Research Foundation.

## **Lunar Volcanoes**

With time drawing near for the landing of manned spacecraft on the Moon, a major concern of the N.A.S.A. has been the stability of the lunar surface. A controversial aspect of this problem is the possible occurrence of active volcanoes. Many astronomers have reported flashes of light and gas clouds, or so-called lunar transient phenomena, suggesting the presence of volcanic activity. These observations, difficult to substantiate, are discounted by many space scientists.

The thousands of photographs taken by the lunar orbiter series provide detailed close-up

photographs of the lunar surface unobtainable by earth-bound telescopes. Dr. S. A. Schumm of the Department of Geology in studying the department's collection of these photographs noted flow patterns resembling terrestrial lava flows. The lava flows were identified on the rim of the Crater Aristarchus, which is the site of the greatest number of "transient phenomena" observations. Identification of these lava flows strongly supports the hypothesis that volcanic activity has occurred recently on the moon.

## **Measuring Textural Quality of Fruits and Vegetables**

Maintenance of high quality as fruits and vegetables move from the farm through marketing channels to the consumer is of vital economic importance. Household interviews conducted in Pueblo County revealed that texture was one of the main quality factors important to consumers. Texture of fresh fruit and vegetables changes during growth, maturation, and handling. Taste panels are currently used as the most reliable research tool to predict consumer acceptance; however, this procedure is expensive and time-consuming. Development of chemical

and physical methods for measuring texture of fruits and vegetables which correlate highly with panel scores for texture could result in saving both time and money. Preliminary examination of the data collected in 1968 using 28 replicates of three varieties of apples (Red Delicious, Golden Delicious, and Winesap) indicates that both chemical analysis of pectic substances and shear force values are correlated with panel scores for texture of apples. Use of the shear apparatus for rapid estimates of texture in the field shows promise.

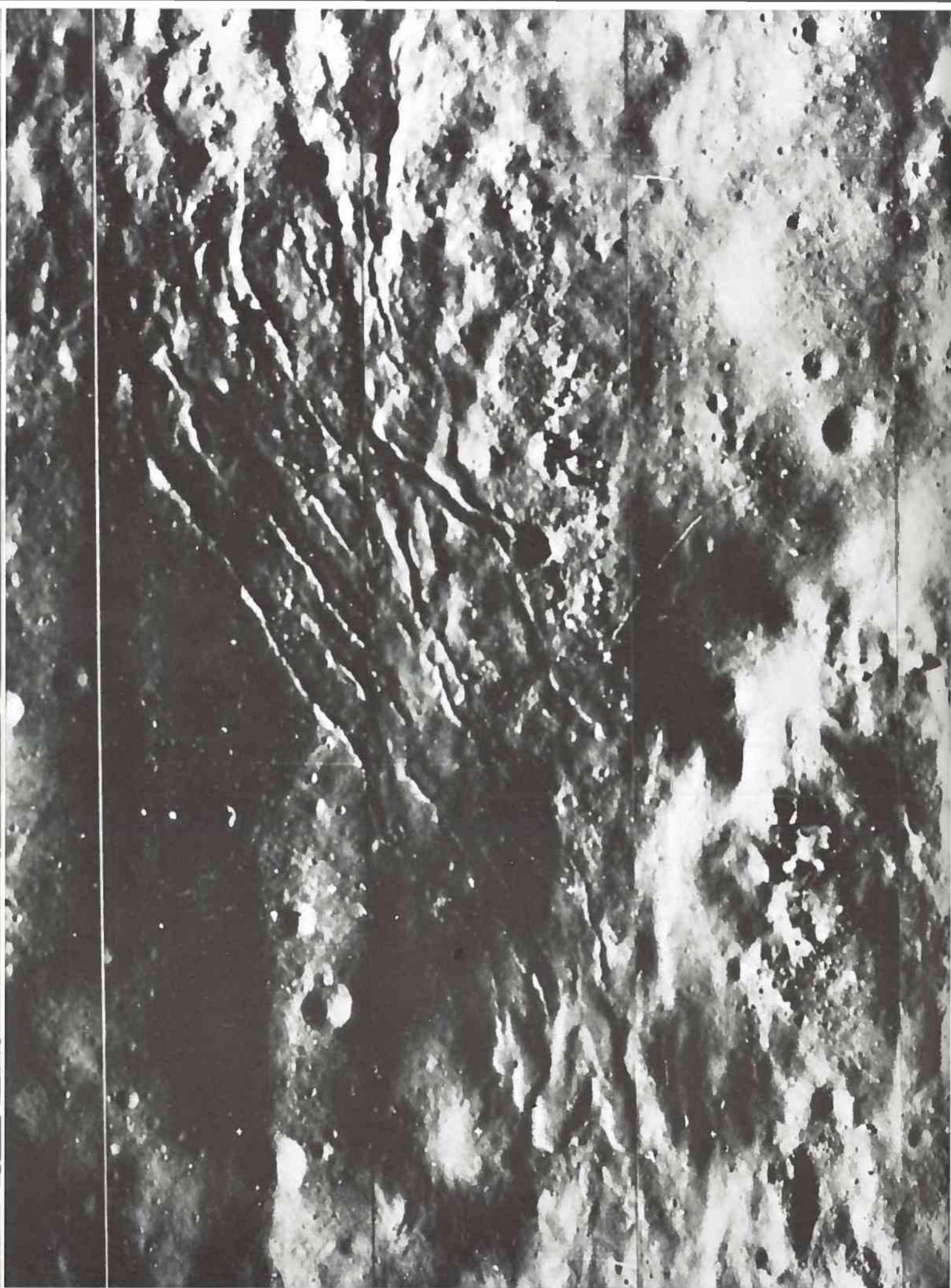
## **The Microbiology of Poultry Products**

The product phase of our research program has become more involved in the microbiological aspects of poultry science. Food product microbiology has become one of the primary concerns of food-regulating agencies in recent years, and the poultry industry has frequently been a target for their complaints.

We are presently conducting research to develop a commercially applicable in-process method of reducing the microbial contamination on poultry carcasses. A "skin removal and dilution method" for quantifying the bacterial population on poultry carcass skin was compared to the "cotton swab technique." Dry swabs picked

up 1% of the count estimated by the skin removal method; wet swabs picked up 29% of skin-sample count. Wet-swabs removed a larger percentage of bacteria for enumeration before a hot water skin-surface treatment (71°C., 15 sec.) than after the heat treatment. Heat treatment reduced the bacterial population by 3,100 bacteria per sq. in. of skin. Bacterial kill after carcass heat treatment was 79% by the wet-swab method, but only 31% by the skin removal method. The swab sampling method leads to the erroneous conclusion that the heat treatment was more effective than it actually was. Hot-water pasteurization of the whole carcass





surface is being tested with the primary objectives of eliminating pathogens from the finished product and extending its shelf life.

Much of our recent research has involved refinement of the microbiological methodology for determining the number of bacteria on poultry carcass skin. The method developed is being

used in our present research on poultry carcass pasteurization.

An expansion of research efforts is planned toward developing effective and practical methods of microbial control in all phases of poultry food product production, from the farm to the consumer.

### **Nutritional Requirements for Horses**

With the more affluent society the importance of the horse as a pleasure animal has increased significantly in the past decade. Horse populations are increasing in every state and particularly in Colorado. Because of this the horse is becoming an increasingly important part of the agricultural industry.

Most of the research concerning nutritional requirements for horses was aimed at draft animals being used as a source of power during the early part of this century. The pleasure horse of today is being used for an entirely different purpose; we are now most interested in adequate nutritional status, life span, and performance in these animals. Unfortunately most of the information collected on draft horses does not apply to today's pleasure horse.

Dr. Kirvin Knox of the Department of Animal Science at Colorado State University has recently initiated a research project to determine the energy and protein requirements of light pleasure horses under several conditions of exercise or work. His studies so far have shown that commonly recommended levels of feed intake are inadequate to maintain good condition in light-weight pleasure horses receiving minimal exercise. His data further suggests that this may also be true for performing horses and those used for recreation.

It is anticipated that these studies will yield valuable information on the nutritional requirements of pleasure horses, enabling the individual horse owner or the commercial breeder to more effectively care for his animals.

### **Performance of Permanent Press Garments in the Western Region**

Members of the Staff of the Department of Textiles and Clothing are participating in a regional study of men's white permanent press shirts. Ten men on the campus have volunteered to wear the shirts provided for this study. Equal numbers of 100% cotton and of 65% polyester/35% cotton shirts, all with permanent press and soil release finishes, are being studied. Laundering is done in the research laboratory with special attention being paid to stain removal, selec-

tion of optimum washing and drying temperatures, and handling to prevent undue wrinkles. At selected intervals, shirts will be evaluated by a panel of judges for whiteness retention, wrinkle resistance, and absence of signs of wear. Upon completion of the wear study, precise objective measurements will determine the extent to which these shirts fulfill expected performance requirements.

### **Potato Research**

Low value per acre crops, when infested with soil-borne plant diseases, are not economically treated by chemical methods. There are, however, fruitful methods of treatment by incorpora-

tion of various soil amendments under study. Dr. Monty Harrison, supervising research of the Department of Botany and Plant Pathology, has shown that the fungus which causes the Verticil-



lium Wilt disease of potatoes can be inactivated by amending infested soils with mature barley straw and other organic materials.

The Verticillium fungus previously has been considered long-lived in the soil and very resistant to treatment. However, reductions of this

fungus as much as 80-90 percent have been demonstrated within two weeks of incorporation of 4-16 tons of barley straw per acre of soil. Concomitantly with this reduction of the soil fungus, there was a 25 percent increase in the size of potato tubers produced.

### **The Presidential Press Conference**

A two-part summary of a study of the performance of the presidential press conference as a medium of information between the president and the nation through the mass media has resulted from a two-year investigation, including one month in the White House press room and a survey of selected newsmen and representatives of the administration, by Dr. Delbert McGuire of the Technical Journalism Department.

Sixty newsmen were selected at random from a list of 500 members of the White House press corps with 10 representatives from each of six areas of the media: foreign press, radio-television, newspapers, wire services, news magazines, and news bureaus. Nine representatives of the administration cooperated, including President Eisenhower.

Each respondent from the news media was given a 36-item questionnaire covering 12 aspects of press conference techniques. Three questions dealt with each aspect—one to the "left" of the current practice, one representing current practice, and one to the right." Administration

representatives were interviewed with a tape recorder on the 36 questions.

The results were analyzed by a modified Q-sort, using a computer ANOVA program, which placed respondents in clusters as to their opinions and recommendations on press conference practices. (It was found that the clusters did not coincide with the respondents' specialties.)

The study concluded, among other things, that two new techniques of fairly recent origin brought major problems and dissension: The televising of conferences (begun during Eisenhower's administration) and the practice of the president using the first half of the average 30-minute conference period for general statements before questioning (begun by Johnson).

Recommendations included a suggestion that newsmen spend more time in preparation for each conference; that the conferences be scheduled on a regular basis to allow for such preparation logically; and that some of the conferences be given wholly to one important topic of the day.

### **Radioecology of Natural Systems**

Radioactive fallout produced by the testing of nuclear devices has been dispersed by air currents and other natural forces throughout the world. Certain native plants and animals in Colorado have accumulated readily measurable amounts of this radioactivity as a result of a combination of climatic and ecological factors. These facts raise several important questions. To what extent does fallout radioactivity accumulate in natural organisms? What processes and conditions control the distribution and movement of the radioactivity? What levels of radioactivity would be required to cause harm-

ful changes in the structure and function of our natural resources?

An initial attempt to answer the first question was made possible through a contract with the U. S. Atomic Energy Commission in 1962 to investigate levels of radioactive cesium, iodine, and strontium in deer, vegetation, soils, precipitation, and air. Subsequent studies led to more emphasis on mechanisms of fallout accumulation in vegetation and in deer, using the laboratory to augment field sampling. In 1967 funds were granted to expand the research to cover radionuclide accumulation in aquatic sys-

tems and to investigate the effects of radiation both on natural grassland and on the pika, a small mammal that lives in the alpine zone.

Results to date indicate that fallout radioactivity in various plant and animal samples, although measurable, has not been high enough to cause any detrimental effects. However, sufficient data have been gathered to establish relationships between the intensity of nuclear fallout and the radiation doses that many native plants and animals would receive. Data indicate that trout from some alpine lakes concentrate considerably more fallout than other native animals which are consumed by humans.

This research is also increasing our knowledge of several biological and ecological attributes of native animals. For example, from the levels of fallout in trout and deer and in their respective food sources it is possible to estimate feeding rates of these animals under the complex and varied conditions of nature.

This research is being directed by Dr. F. W. Whicker and Dr. A. H. Dahl of the Department of Radiology and Radiation Biology. Individual projects are being carried out by several graduate students who will report the results of the research in theses and dissertations.

### Religious Language

Dr. Donald A. Crosby, in a book to be published soon called *Horace Bushnell's Theory of Language (in Its Connection with Other Nineteenth Century Philosophies of Language)*, offers an intensive study of a central feature of the thought of an American theologian and philosopher whose influence was far-reaching in the nineteenth century. Dr. Crosby examines Horace Bushnell's theory of language from a variety of perspectives; its relation to the rest of Bushnell's thought; its integral connection with the development of formulation of his overall viewpoint; its relation to the background of other nineteenth-century theories of the origin of language and of the relation between language and thought, particularly those espoused by variety of perspectives: its relation to the rest Americans; and from the larger context of American culture through an exhibition of its ties with Puritanism, the thought of Jonathan

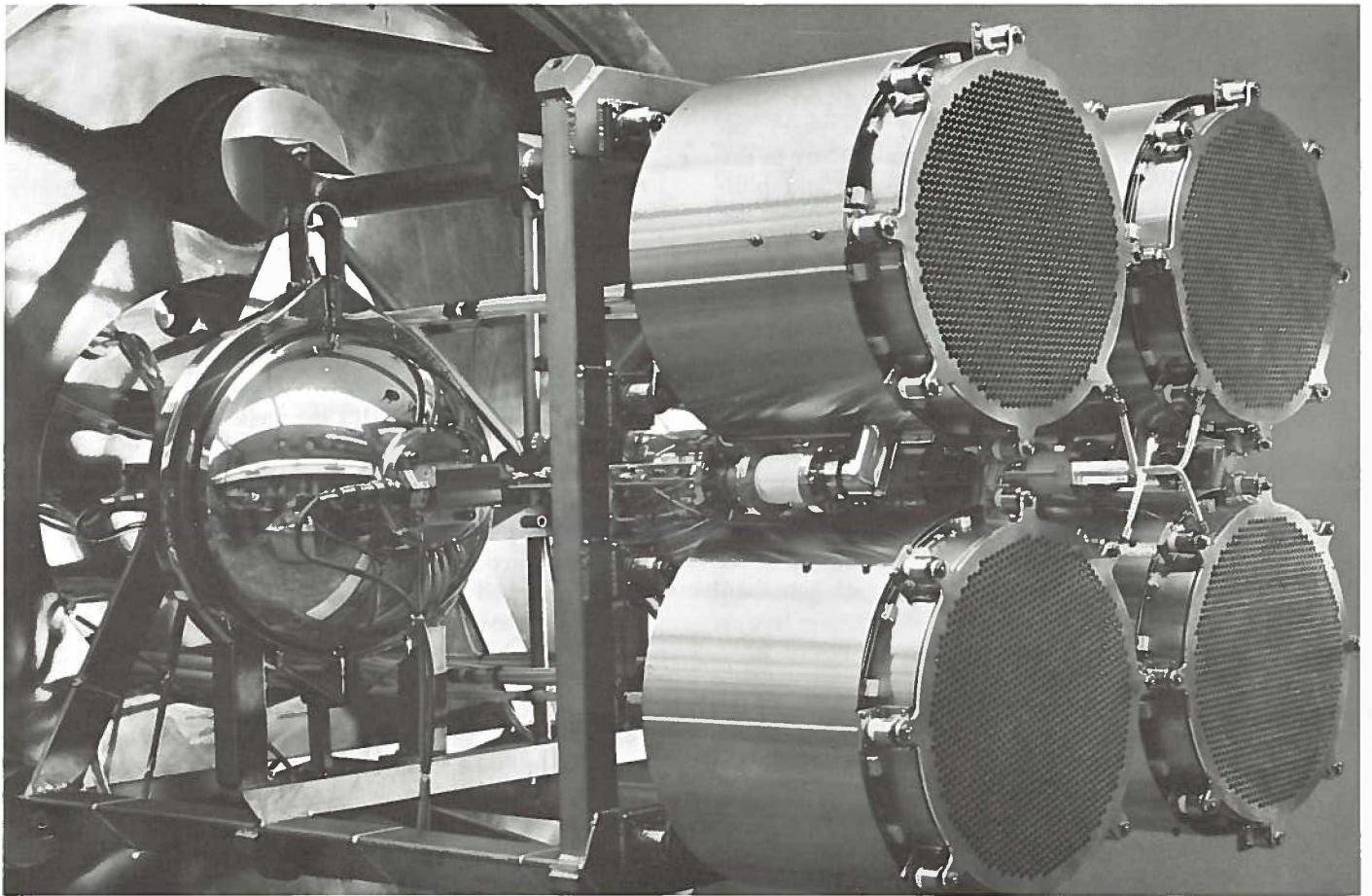
Edwards, the post-Edwardian theology, and New England Transcendentalism. He enquires into its use as a theological method, devoting a separate chapter to the way in which Bushnell's language theory influenced his explication of the doctrine of the Trinity, and the way in which Unitarian and orthodox reactions to that same doctrine were shaped by a different conception of language owing its impetus to Locke and the Scottish Common Sense philosophers. Finally, Dr. Crosby brings out its role in the controversy that swirled around Bushnell at mid-century. Criticisms of his views on language set forth by Bushnell's theological enemies become a springboard for philosophical commentary on the strengths and weaknesses of the language theory, particularly in terms of its implications for the philosophical analysis of religious discourse.

### Role of Promotion in Business Firms

Promotional activity is a fundamental marketing function in business competitive strategy. Dr. Harvey Vredenburg of the College of Business has underway a project to study promotional activities and to determine their role in business operations. The basic objective of the

project is to develop a working definition of promotion which will permit measurement of (1) the promotional effort business firms in the U. S. employ in the conduct of business, (2) the contributions made to consumer welfare, and (3) the contributions made to the business firms.





Electric thruster system under development.

## Space Propulsion and Energy Conversion

Man's exploration and development of uses of space has encountered a number of new and difficult problems in propulsion and energy conversion. Solutions for these problems require imaginative combinations of basic science and sophisticated engineering. Research in these areas is being done in a three-year-old program in the Department of Mechanical Engineering for the National Aeronautics and Space Administration.

Primary emphasis in this program has been given to electric space propulsion in which propellant is accelerated rearward by electric power instead of by a combustion process as in conventional chemical rockets. With very light-weight electric powerplants, electric propulsion is much more effective than conventional rockets for the positioning and precision attitude control of long-life satellites and for long-distance space propulsion.

Research topics in this program have ranged from engineering comparisons of the various types of electric propulsion systems to an examination of the theory of relativity for possible future utility in space propulsion.

A project presently underway is the investigation of the control characteristics of the most efficient present-day electric thruster and development of improved components for that thruster. This project is in support of the Jet Propulsion Laboratory thruster system. Detailed measurements are made of the ionized gas

(plasma) within the thruster; these will contribute to a better understanding of plasmas in general.

Another type of electric thruster also under study involves the electrostatic spraying of sub-microscopic droplets. In addition to improved thruster performance, the basic information gained in this study may have a direct application to industrial processes.

Significant advances in methods for heat addition to supersonic vapor flows have also been made in this program. Although this research is intended to extend the performance range of electrothermal thrusters, this new knowledge in fluid dynamics certainly will be important in many other applications such as the generation of electric power.

Experimental work in this program is done in a high-vacuum facility which is four feet in diameter and fifteen feet long. Vacuums of 0.000000001 of atmospheric pressure are regularly attained in this tank with the aid of liquid-nitrogen cooling. Electric power sources of up to 150,000 volts and numerous special instruments are parts of the facility.

Leader of this program is W. R. Mickelson, Professor. Other faculty members contributing to the program are Professor V. A. Sandborn; Associate Professors G. W. Tompkin, Jr., and H. E. Wilhelm; and Assistant Professors C. E. Mitchell and P. J. Wilbur.

## Thyroid Hormone Toxicity

Research during the 1940's established that oral administration of thyroid hormone could in some circumstances bring about more efficient production of meat, milk, and eggs. The practice proved to be hazardous, however, because thyroid hormone is toxic at levels slightly above requirements for optional production. Protection or sensitivity depends on the nutritional state of the animal and in particular the intake of the amino acid methionine. Dr. L. W. Charkey, directing research in the Department of Biochemistry, has demonstrated that glutathione, produced when methionine is utilized by

the animal, is the active protector against thyroid hormone toxicity.

Dr. Charkey's group is further studying the actual location within the cell of glutathione protection and its relationship to the energy conversion ability of the cell. This will more clearly establish the biochemical relationships for the function of thyroid hormone on an animal's metabolism. His study will further reduce the guesswork in practical applications of thyroid hormone in medical, veterinary, and animal production problems.

## Urolithiasis

Urolithiasis, a disease associated with the presence of calculi (stones) in kidney, bladder, urethra, and ureter, is common to both man and animals. In man, the most frequently occurring calculi are oxalates, followed by phosphates and uric acid. Among cattle and sheep on range the calculi are mainly silica, while among those in the feedlot, calculi are mainly phosphates of magnesium and magnesium ammonium. In spite of the fact that the composition of calculi may be different, all calculi consist of two components: (1) the matrix, an organic part of proteinaceous matter, and (2) an inorganic part of sparsely soluble salts.

Although urolithiasis has plagued man for a long time, many questions as to the cause, prevention, and treatment of this disease are still unanswered. For the past decade, the disease has been studied by Drs. R. H. Udall, F. H. Chow, and D. W. Hamar in the Department of Pathology at Colorado State University. Two phases of study have been conducted by this research group.

One phase of the study has been the development of dietary control in producing and preventing phosphate calculi in cattle, sheep, and rats. When animals are fed diets containing a high percentage of fattening ingredients such as milo, sorghum, and corn and a low percentage of alfalfa hay or an experimental feed containing high phosphate and low chloride, calculi are produced. When a chloride in the form of

sodium, ammonium, potassium, or calcium is supplemented to the diet, the incidence of calculi can be reduced.

The other phase of the research has been the study of the urine mucoproteins, proteins, and peptides and their possible role as matrix of the calculus. The results of this investigation have shown that the calculus matrix may not consist of preformed compounds, but an array of aggregated molecules of mucoproteins, proteins, and peptides present in urine. In the presence of magnesium or calcium, the mucoproteins, proteins, and peptides can be cemented together and can form an insoluble mass to provide sites for crystallization of inorganic salts.

Therefore, the formation of calculus appears to relate to the type of urine which will cause association of the organic molecules offering loci for salt crystallization and which will supply sufficient ions of the essential kind to form insoluble salts. One of the methods of preventing calculus formation appears to relate to the type of urine which furnishes inorganic ions converting the less soluble salts to the more soluble salts, i. e. magnesium phosphate to magnesium chloride. Until more is learned about the chemical and physical property of urine and of urine organic compound, the answers to many of the questions concerning the cause, prevention, and treatment of the disease will not be fully understood.

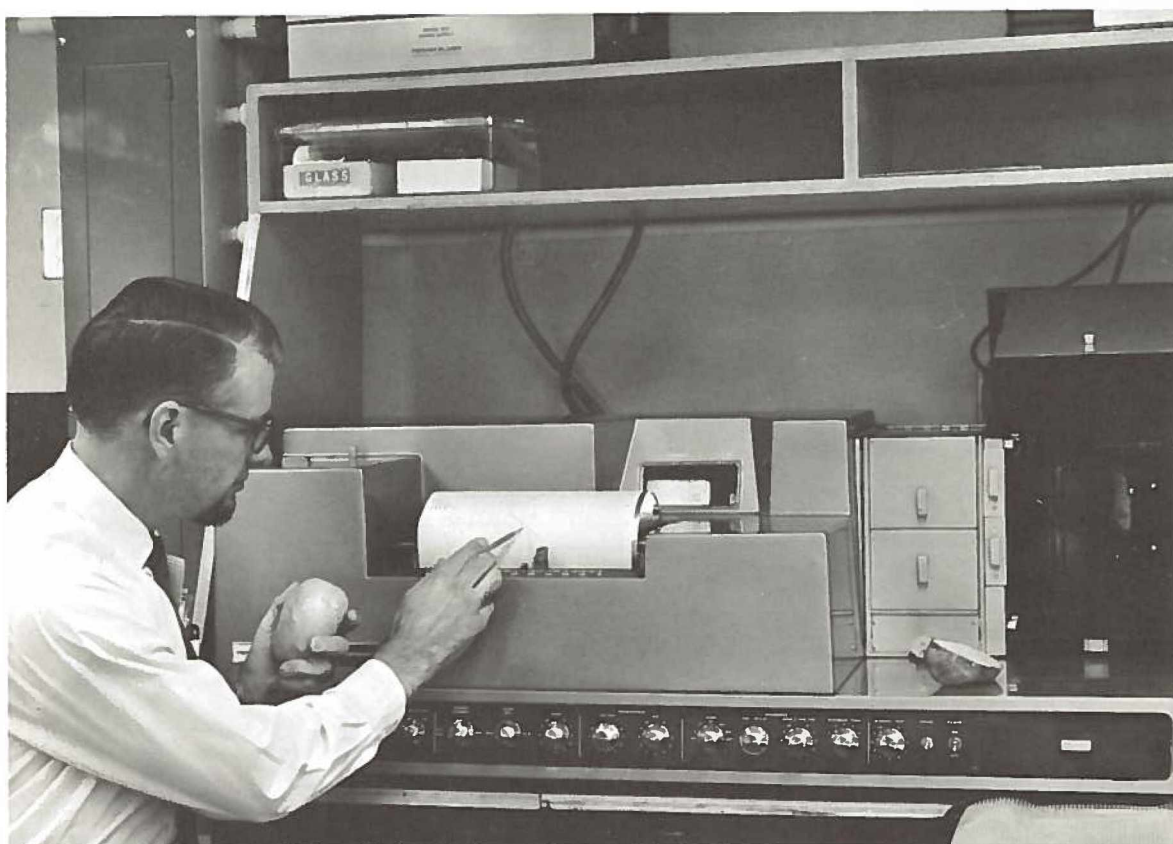
## Vitamin A and Photoreceptors

It is well known that vitamin A deficiency in man can result in a form of "night blindness" in which a person's visual sensitivity is greatly reduced under conditions of low illumination. This impairment in vision is attributed to a failure in the regeneration of the photosensitive pigment located in the visual receptors associated with "night" vision. The receptors functional during "night" vision are generally called rods while those responsible for "day" vision are termed cones.

Other laboratories experimenting on rats have shown that the rod receptors will actually de-

generate under conditions of severe vitamin A deficiency. However, the effect on the cone receptors has not been studied as extensively. Since the chicken eye contains rods as well as several subtypes of cones, it is an appropriate animal to use to study the effects of vitamin A deficiency on both types of photoreceptors.

We are currently investigating the consequences of various degrees of vitamin A deficiency in chickens. By means of electrophysiological measurement of the eye's sensitivity to light, light- and electron-microscopic observations of structural changes, and biochemical



Spectrophotometer used for spectral reflectance measurements on potatoes, stones and clods.



analysis, we are attempting to trace the course of the pathological conditions which result in disruption of structure and function of the photoreceptors. The utilization of a combina-

tion of techniques and measurements should result in a better understanding of the underlying mechanisms.

### **Workable Rehabilitation**

Dr. E. R. Oetting and Dr. Charles W. Cole of the Department of Psychology have just concluded a four year study of the rehabilitation of mental patients from the Fort Logan Mental Health Center in Denver. Their research was designed to find out why former mental patients failed on jobs and to study the effect of providing special forms of follow-up support after the patient leaves the mental health center. During this study over 500 patients were provided with counseling and placed on jobs.

Their findings indicate that about 20 percent of patients can succeed if they have help in finding a suitable job, whereas others need special assistance. For example, patients often fail because of inability to handle a crisis, even as small as criticism. If an employer understands this problem, the hospital can provide help in this crisis, and the patient can learn to deal with the situation appropriately. Where the patient's

problems of adjustment were relatively mild, follow-up support by an individual counselor helped keep him employed.

Patients with more severe problems could still succeed if they were provided group therapy directed at adjusting to the work situation. The study also showed that some patients could succeed only if a sheltered environment could be created. Even though they are not dangerous in any way, some patients continue to behave in peculiar and bizarre ways that keep them from working directly with the public.

Though rehabilitating former patients is difficult and time consuming, the cost of mental illness is so great that such efforts pay for themselves. Dr. Don Rhody of the Department of Economics directed studies that show that if only one former patient in fifty can be returned to the national average income, he will earn back the costs of rehabilitating all fifty patients.

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