IOWA STATE UNIVERSITY

AMES, IOWA

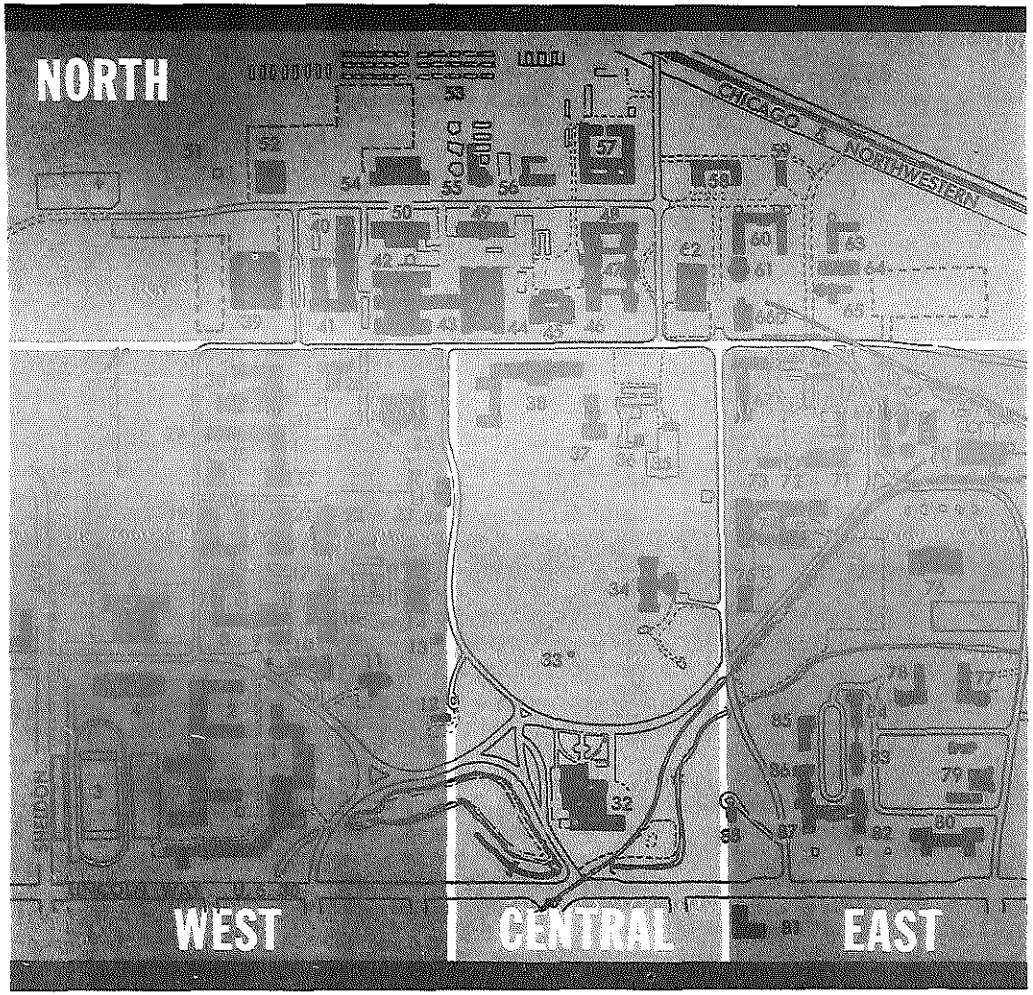
THE AMES / DES MOINES SITE

IOWA STATE UNIVERSITY
RESEARCH CAPABILITIES IN ELECTRONICS AND ELECTRONICS RELATED SCIENCES

Table of Contents

THE IOWA STATE CAMPUS

The University campus and adjacent recreational areas total about 1,000 acres, spreading over gently rolling prairie land which has been developed by careful plan into a naturalistic park.



WEST CAMPUS

1. Friley Hall
2. Helser Hall
3. Clyde Williams Field
4. State Gymnasium
5. Westgate Hall
6. Men's Physical Education
7. Naval Armory
8. Mechanical Engineering
9. Mechanics Laboratory
10. Hospital
11. Alumni Hall
12. Music Hall
13. English Office Building
14. Beardsheer Hall
15. Buildings E, F, G, H
16. Classroom Building
17. Aerospace Engineering
18. Engineering Experiment Station
19. Exhibit Hall
20. Engineering Experiment Station
21. Engineering Annex
22. Marston Hall
23. The Hub
24. Morrill Hall
25. University Library
26. Service Building
27. Chemical Engineering Laboratory
28. Chemical Engineering Laboratory (West)
29. Engineering Building
30. Computer Laboratory
31. Electrical Engineering

CENTRAL CAMPUS

32. Memorial Union
33. Campanile
34. Curtiss Hall
35. Horticulture
36. Botany Greenhouses
37. Botany
38. MacKay Hall

NORTH CAMPUS

39. Armory
40. Industrial Education
41. Agricultural Engineering
42. Chemistry
43. Atomic Research (Office and Laboratory Building)
44. Physics
45. Science Hall
46. Instrumentation Research
47. Veterinary Medicine
48. Veterinary Diagnostic Laboratory
49. Metallurgy
50. Research
51. Veenker Golf Course
52. Communications
53. Pammel Court Housing
54. Metals Development
55. Genetics Laboratory
56. Insectary
57. Veterinary Clinic
58. Horse Barns
59. Ruminant Nutrition Laboratory
60. Cattle Barn
61. Judging Pavilion
62. Animal Industries
63. Sheep Barn
64. Antigenic Laboratory
65. Hog Barn and Pavilion
66. Meat Laboratory

EAST CAMPUS

67. Agronomy
68. Agronomy Greenhouse
69. Central Stores
70. Power Plant
71. Press Building
72. Shattuck Theater
73. Landscape Architecture
74. Dairy and Food Industry
75. East Hall
76. Women's Gymnasium
77. Oak Hall
78. Elm Hall
79. Child Development and Home Management
80. Linden Hall
81. Graduate Residence Hall
82. Birch Hall
83. Barton Hall
84. Freeman Hall
85. Lyon Hall
86. Roberts Hall
87. Welch Hall
88. The Knoll

IOWA STATE UNIVERSITY
RESEARCH CAPABILITIES IN ELECTRONICS
AND ELECTRONICS RELATED SCIENCES

Preface

This information has been prepared in technical support of the Iowa proposal to locate the National Aeronautics Space Administration Electronics Center in Iowa.

Because an installation such as the Electronics Research Center needs to be located near a strong scientifically oriented university, we feel that Iowa State University of Science and Technology should be considered a very valuable asset to this area. Located at Iowa State University is the largest College of Engineering west of the Mississippi River with a total enrollment of 3,203 students, including 405 graduate students and 766 electrical engineering students. The third largest solid state physics research program in the nation is located at Iowa State; the graduate enrollment in physics numbers 137. The fourth largest Chemistry Department in the nation, with a graduate enrollment of 226 is also at Ames. The first Statistics Department in the nation is at Iowa State and has a graduate enrollment of 51 students. A large Mathematics Department supports the other sciences and grants more than 15 graduate degrees per year.

The Ames-Des Moines metropolitan area ranks first in the nation in number of Ph.D.'s granted per million population; the state of Iowa ranks third in the nation.

Iowa State University has had considerable experience working with industries through (1) its Affiliate Research Programs, including those in Electronic Control and Communications Systems, Solid State Electronics, and Electric Power; (2) its Center for Industrial Research and Service; and (3) its off-campus courses with such industries as Collins Radio and Maytag Corporation.

Located next to the Iowa State University campus is Bourns, Inc. with an electronics manufacturing plant producing potentiometer instruments and components. Bourns employs approximately 350 people at this plant.

The AEC has established one of its major research laboratories on the campus of Iowa State University. The Ames Laboratory of the USAEC employs more than 900 persons of which 450 are scientists and 225 are graduate students in physics, engineering, metallurgy, and chemistry. The research budget for this, a materials research laboratory, was nearly $7,000,000 for this fiscal year and is expected to increase to over $8,000,000 for the next fiscal year. The Ames Laboratory has more than 20 research groups in physics, 20 in chemistry, 10 in engineering, and 10 in metallurgy. New groups are also being formed in reactor technology; the five million watt research reactor will go into operation this year. (This will be the second reactor to be located at Iowa State University; the first is already in operation in the Department of Nuclear Engineering.)

I. Science and Engineering at Iowa State University

Iowa State has been long established as a school for graduate training; the first graduate degree was granted in 1877. This year 174 Ph.D.'s were granted by Iowa State. Of this number 43 were granted in engineering, 10 in physics (anticipate 25 Ph.D.'s per year by 1966), 38 in chemistry, 10 in statistics, and 6 in mathematics. This places Iowa State among the top 12 institutions in the United States granting Ph.D. degrees in the physical sciences. The university has a current enrollment of 11,517 of which 1,805 are enrolled in the graduate college. Current graduate enrollments include 405 in engineering and over 800 in sciences and mathematics. More than 90 per cent of these have the doctorate as a goal.

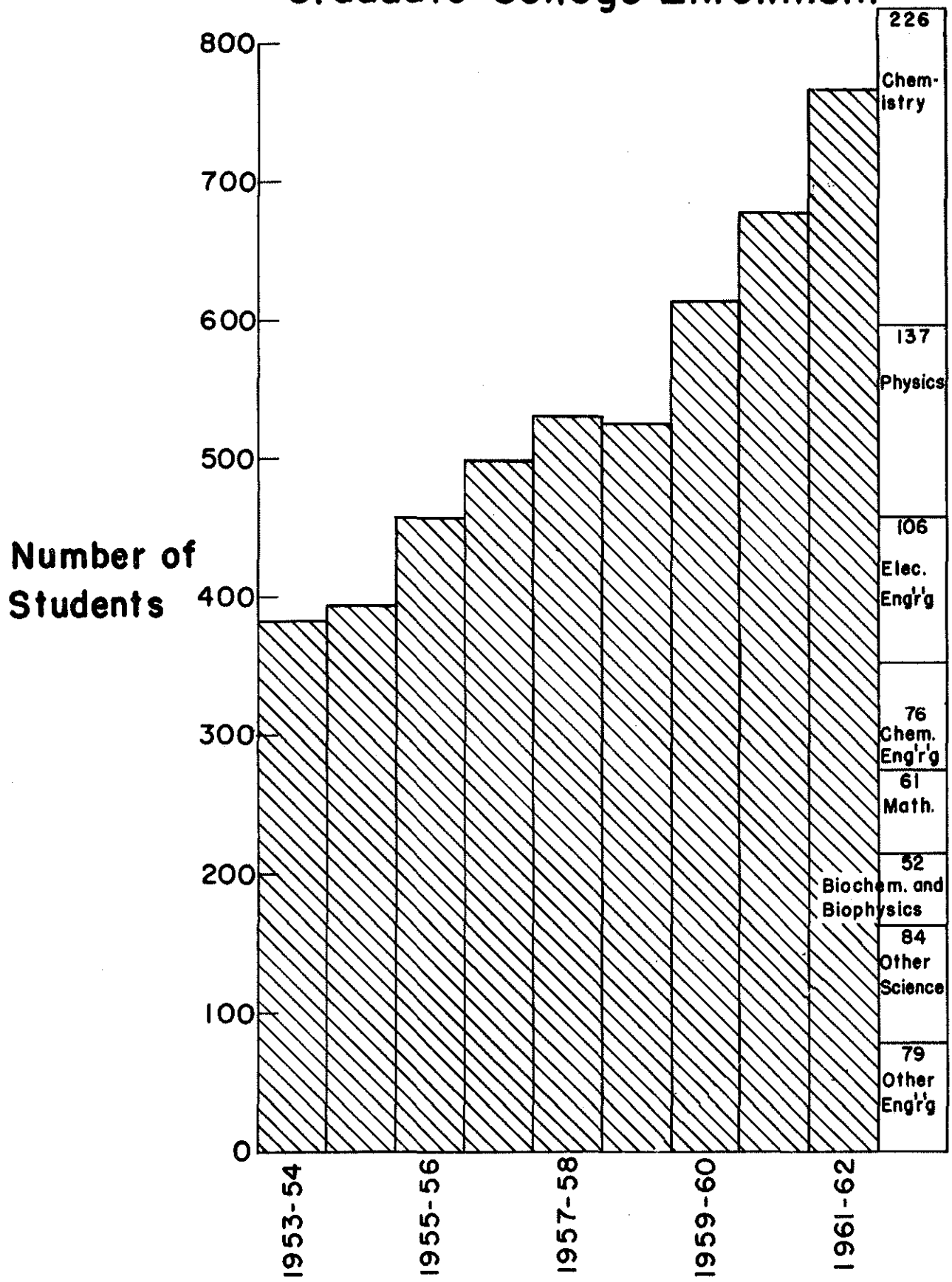
Iowa State University already plays a major role in providing the trained manpower in the sciences and engineering which this country needs to meet the challenge of our research and technology oriented society. All departments listed in Appendix A have strong well established doctorate programs and are already heavily engaged in research and training projects which directly support areas of great interest to NASA. Included in the list are the following departments: aerospace, ceramic, chemical, electrical, mechanical, and nuclear engineering; engineering mechanics; life and behavioral sciences, including bacteriology, bio-chemistry, bio-physics, botany, plant pathology, zoology, and entomology; chemistry, including analytical, radio, physical, organic, nuclear, and bio-chemistry; bio-medical electronics, supported by both the electrical engineering and veterinary medicine schools; mathematics; metallurgy; and statistics. Appendix B lists some specific research projects being carried out in many of these areas.

The Bio-medical Electronics Program at Iowa State University was the world's first formal academic program in this field. One of the most recent developments by this department is the respiratory

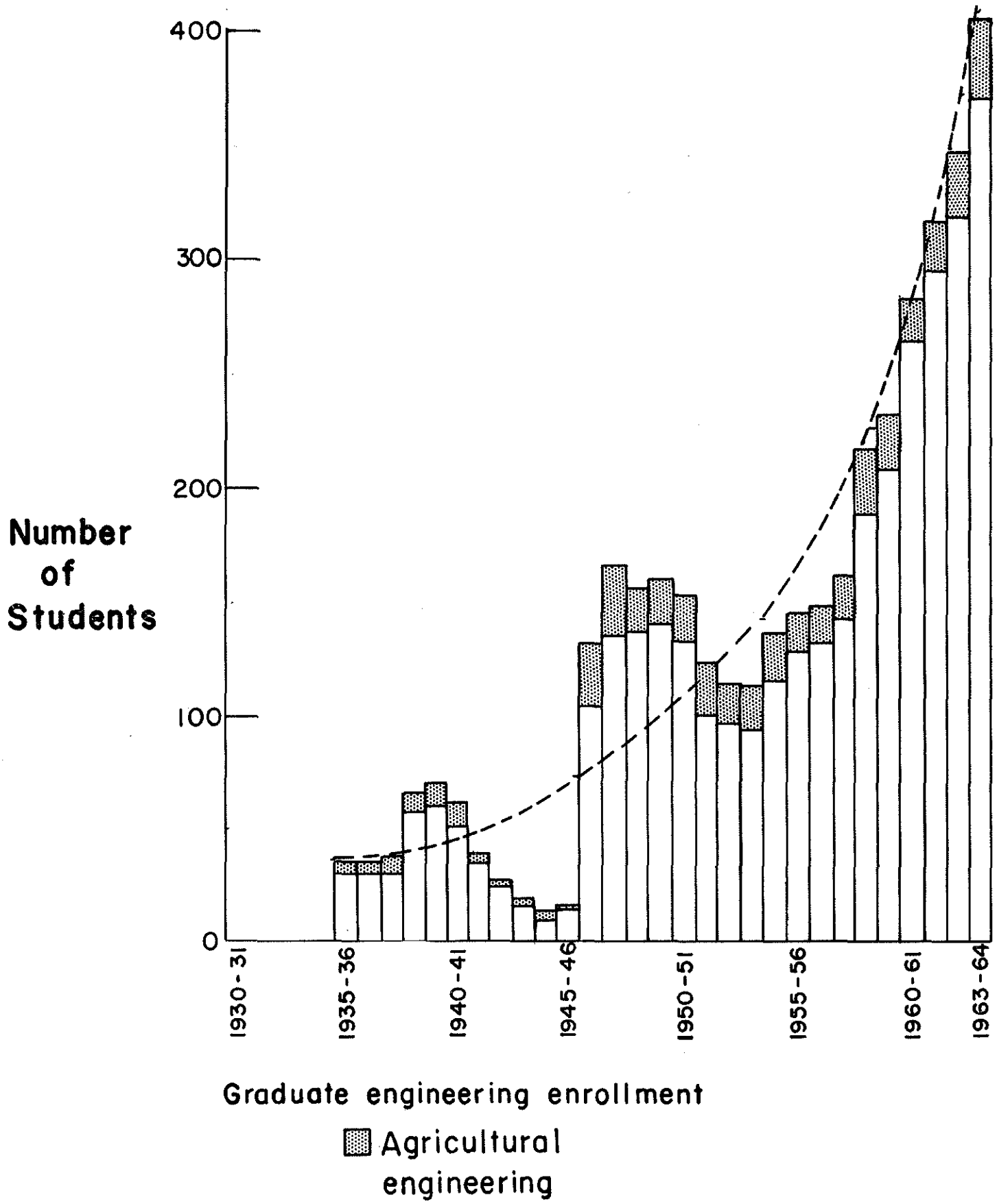
augmentor developed to help overcome respiratory syndrome disease among infants.

Since 1948 nearly 700 graduate students have received degrees in physics, engineering, metallurgy, and chemistry while employees of the Ames Laboratory. More than half of these received the Ph.D. degree.

Iowa State University
Graduate College Enrollment



Iowa State University
College of Engineering



IOWA STATE UNIVERSITY

College of Engineering

Department	1963 Total Enrollment	1963 Graduate Enrollment
Electrical Engineering	766	106
Mechanical Engineering	450	32
Architecture & Architectural Engineering	367	4
Aerospace Engineering	359	17
Civil Engineering	348	54
Chemical Engineering	332	76
Technical Institute (2-yr.)	211	--
Industrial Engineering	171	33
Agricultural Engineering	147	28
Engineering Operations	98	--
Ceramic Engineering	56	8
Engineering Science	44	--
Metallurgy	38	35
Nuclear Engineering	36	36
Specials	15	--
Engineering Mechanics	11	11
Engineering Graphics	--	--
TOTAL	3,449	440

GRADUATE COLLEGE ENROLLMENT IN SELECTED DEPARTMENTS

(Iowa State University, Fall Quarter)

YEAR	ENGINEERING					SCIENCE						TOTALS	New Students-- all fields	TOTAL Graduate College Enrollment During Academic Year
	Aerospace Engineering	Mechanical Engineering	Nuclear Engineering	Chemical Engineering	Electrical Engineering	Biochemistry & Biophysics	Botany	Mathematics	Chemistry	Physics	Metallurgy			
1954	0	13	0	26	19	0	29	20	204	59	12	382	246	1026
1955	1	9	0	22	29	0	30	21	201	63	16	392	256	1041
1956	1	9	0	23	29	0	33	33	242	68	18	456	280	1122
1957	6	7	18	31	29	0	34	33	243	76	21	498	278	1142
1958	8	21	30	36	39	0	33	33	230	80	20	530	269	1249
1959	9	15	31	38	48	0	38	43	211	75	17	525	295	1287
1960	10	25	36	45	75	22	37	55	202	83	22	612	412	1480
1961	15	40	38	54	77	35	43	58	199	87	31	677	391	1603
1962	21	34	40	56	87	41	43	60	221	134	28	765	453	1820
1963	17	24	37	76	106	52	52	61	226	137	34	822	585	1995

1963 FALL GRADUATE ENROLLMENT

Dept.	Grad. Stud.	Ph.D. Cand.
Aero. E.	17	13
Cer. E.	8	5
Chem. E.	76	40
Elec. E.	106	59
Mech. E.	32	19
Nuc. E.	36	22
Engr. Mech.	11	2
Metalgy.	34	25
Statistics	51	35
Chemistry	226	150
Physics	137	65

II. Research at Iowa State University

Iowa State University has long played a significant role in research in the various fields of science and technology. The university has a complete grouping of shops, including electronic installations, machine shops, instrument shops, carpenter shops, and glass shops, to cover the needs of its research programs. The Iowa State University library has strong scientific emphasis. It contains more than 510,000 volumes, subscribes to nearly 10,000 periodicals, and carries on an extensive exchange program. Physics and the other physical sciences have excellent coverage, and as an example of the scientific bias of the library, over 70 English translations of Russian scientific journals are received on a regular basis. The facilities of the library are made available to private industry.

Iowa State University's Computer Center includes the Cyclone digital computer which is an improved design of the Illiac and which contains a very large magnetic core memory, an IBM-7074-1401 complex with auxiliary equipment, an IBM-1401 (very large unit) with 1401-2-3 printer, an IBM-526, and an IBM-402. Other digital and analog computers are available on the campus for use with specific research projects, such as the 1401 computer located at the five million watt research nuclear reactor.

The Engineering Experiment Station is responsible for the research programs undertaken by the College of Engineering of Iowa State University. Recently the Engineering Experiment Station has done work and proposed NASA support in the following areas of interest to NASA:

Application of blade-element techniques to the design and performance prediction problems for axial-flow pumps.

Investigation of non-equilibrium of plasma flow behind an oblique shock.

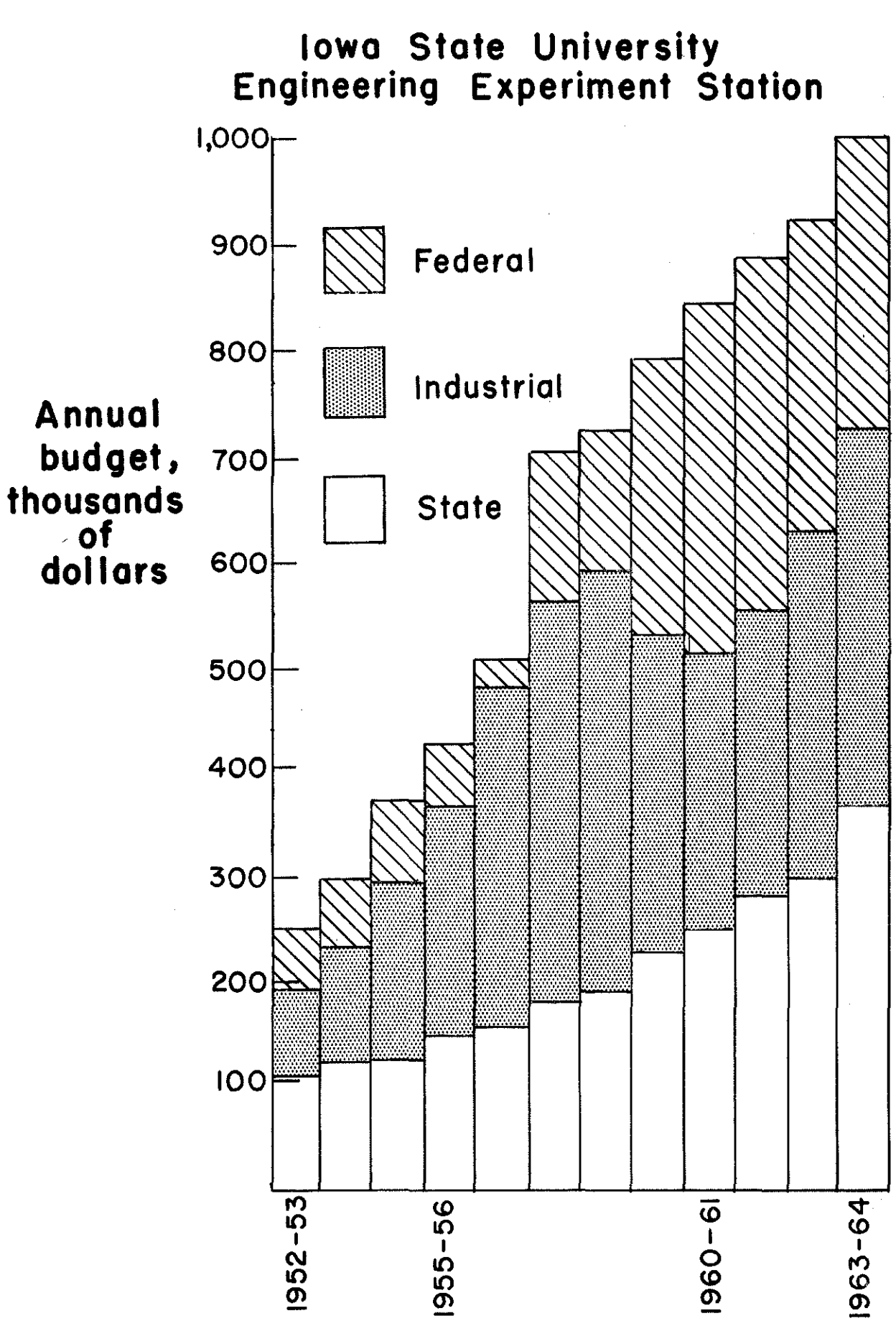
Theoretical investigation of non-equilibrium dissociating flow of a sharp-nosed or pointed body.

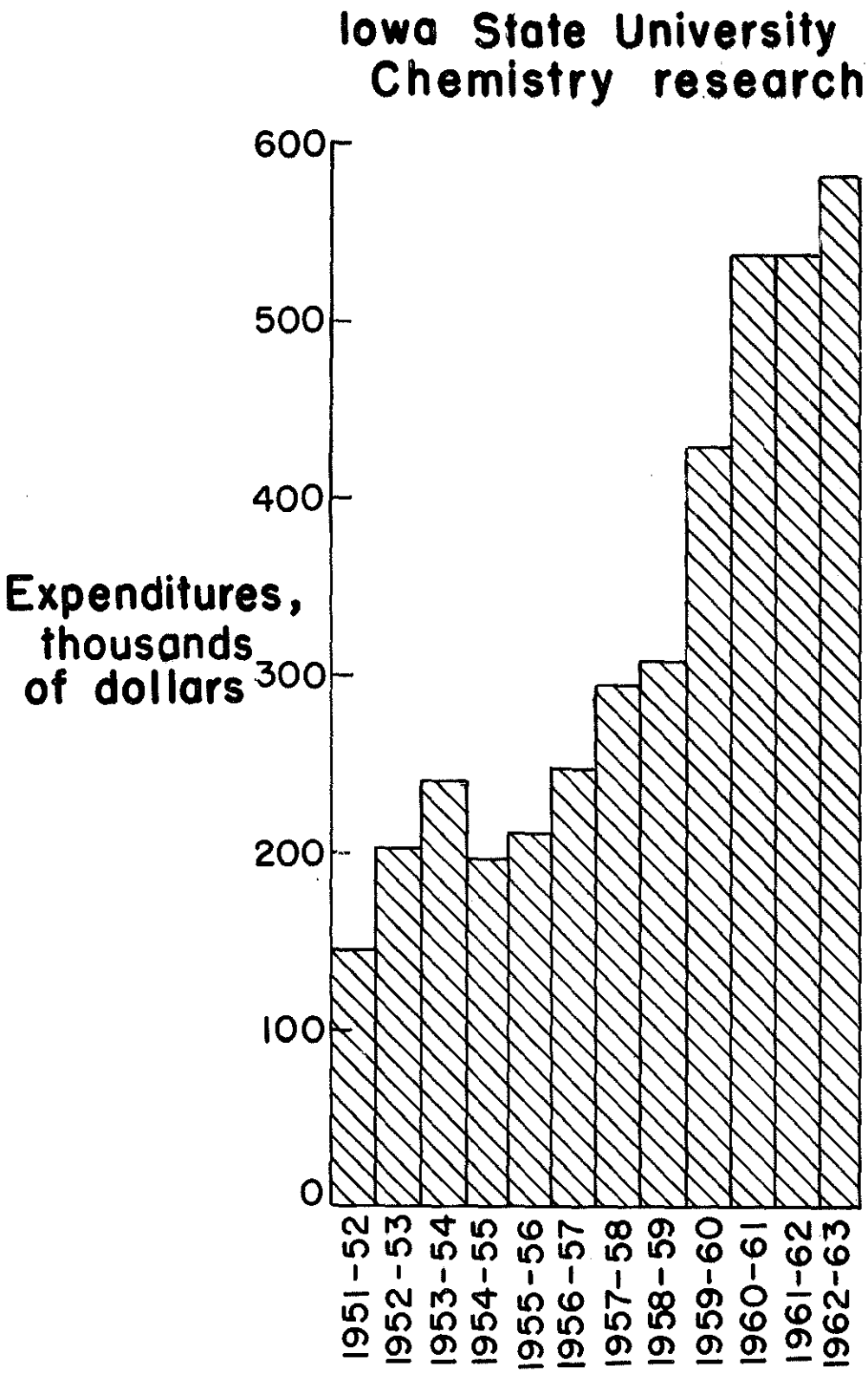
The study of process identification in the presence of noise.

In addition to the research being done in the Engineering Experiment Station, the Chemistry, Physics, Statistics, and Mathematics Departments are carrying on sophisticated research projects within their own departments. These departments are unusually well-equipped and have available through university sources and the Institute for Atomic Research (which is affiliated with the Ames Laboratory of the USAEC) unusually extensive facilities and research equipment. The Department of Statistics is one of the few in the United States which grants M.S. and Ph.D. degrees, and the department operates the Statistics Laboratory which is the first of its kind. Appendix B lists some specific research projects being carried out in many of the above areas.

The Bio-medical Electronics Laboratory is an inter-disciplinary facility operated by the Colleges of Engineering and Veterinary Medicine. The work includes the design of instruments for biological and medical measurements, application of advanced instrumentation techniques for studying biological and medical programs, application of feed-back control and system engineering theories to describe the physiology functions, and the application of biological concepts to the design of self-organizing data systems (Bionics).

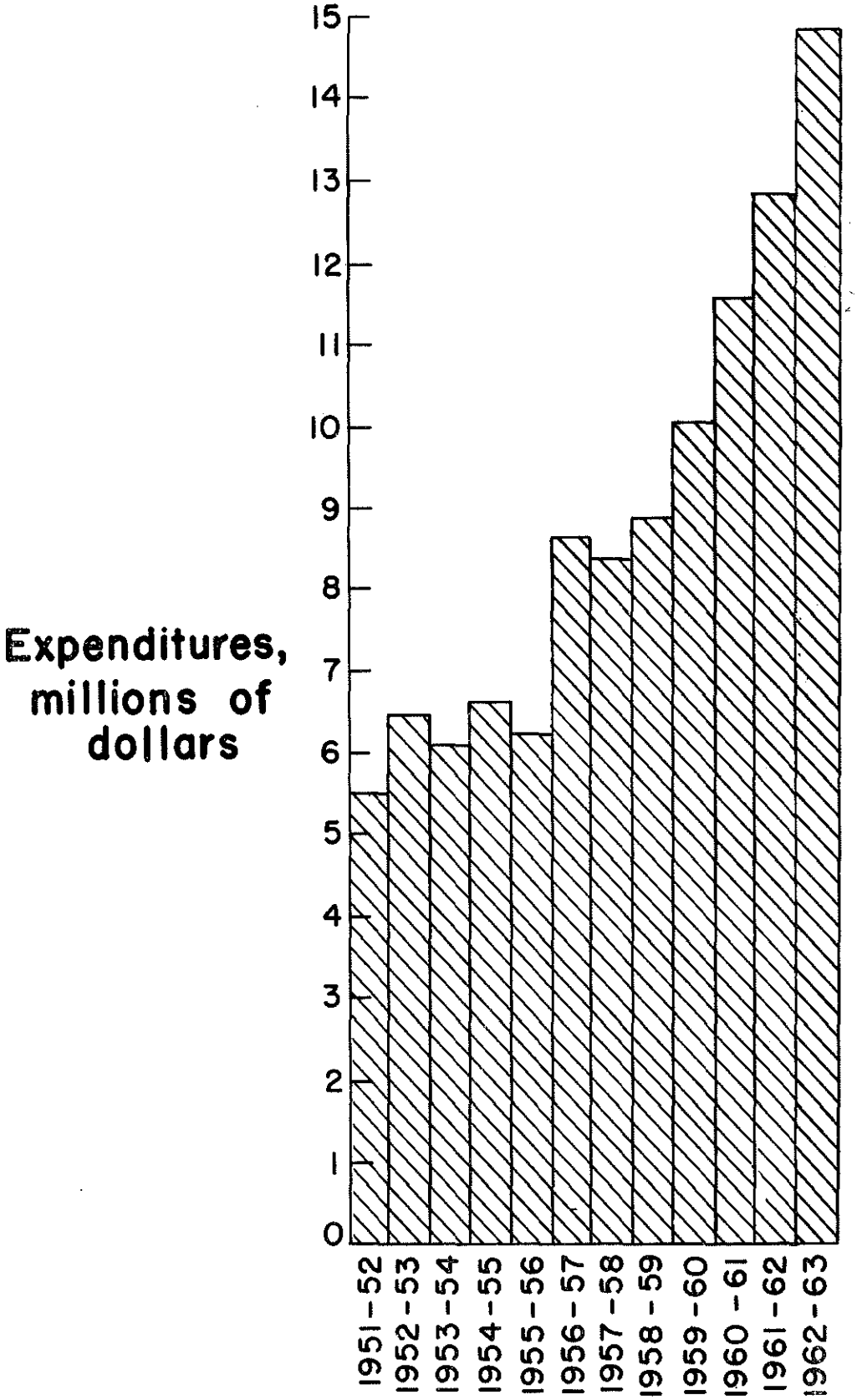
The excellent research facilities located at Iowa State University have been largely responsible for the success the school has experienced in attracting scores of scientists of world-wide reputation. The attitude of the university and the city of Ames toward research type installations is probably best indicated by the enthusiastic acceptance of the Ames Laboratory and the National Animal Disease Laboratory and by the way in which scientific personnel employed by these facilities have been integrated into the community. The entire Ames community is strongly oriented toward academic and research activities. It is a community with an exceptionally large number of scientists, engineers, technicians, and research workers. The community is demonstrating the ability to absorb the type of growth and to provide amenities required by these two research facilities and their 1500 employees.


Iowa State University
Engineering Experiment Station
Annual budget, thousands of dollars
1,000
900
800
700
600
500
400
300
200
100
Federal
Industrial
State
1952-53
1955-56
1960-61
1963-64



Approximately 3.0 million dollars additional was budgeted in 1963 for research in Chemistry in the Ames Laboratory of the U.S.A.E.C. located at Iowa State University.

Iowa State University
Total research



III. Iowa State University Affiliate Research Programs

The rapid advancement of science and technology has led to the need for more sophisticated research. One method of putting such research on a continuing basis is a cooperative industry and university effort; many types of research can best be performed in a university atmosphere. The Engineering Experiment Station at Iowa State University has therefore initiated affiliate research programs in several fields including Electronic Control and Communications Systems, Solid State Electronics, and Electric Power.

Although many industrial concerns have their own research programs in the above fields, most of these programs are limited to those topics which are of immediate company concern and have a relatively good chance of commercial success. As a consequence, many fruitful ideas must be overlooked and fundamental investigations bypassed. University programs can carry out fundamental research and at the same time provide basic training for the next generation of scientists. Iowa State University has also gained considerable experience in working with industry through these programs.

The industrial affiliate research programs at Iowa State University have been created to provide industry with the opportunity to support research in areas of mutual interest and provide protection for the industry in terms of patents. Each industry participating in each affiliate program pays to the Engineering Experiment Station $5,000 annually.

The affiliate program in the Electronic Control and Communications Systems includes five major areas of investigation: (1) control systems, (2) wave propagation research, (3) information theory, (4) data processing, and (5) bio-medical systems.

The affiliate research program in Solid State Electronics includes four major research areas: (1) materials, (2) devices, circuits, and components, (3) energy conversions, and (4) devices and transducers for bio-medical instrumentation.

The affiliate research program in Electric Power includes three major areas of interest: (1) power system engineering, (2) power utilization, and (3) energy conversion.

Among the industrial companies supporting these affiliate programs are: Texas Instruments Incorporated; Control Data Corporation; Fabri-Tex, Inc.; IBM Corporation; Minneapolis-Honeywell; and the Boeing Company.

IV. Technical Institute

In addition to the research capabilities and standard academic programs of Iowa State University, we should include Iowa State's Technical Institute which is training engineering technicians in electronic, mechanical, construction, and chemical technologies. The first three curricula are accredited by the Engineering Council for Professional Development, and the fourth, being newly established, awaits this accreditation. The rapidly expanding program of the Technical Institute is already contributing greatly to the industrial growth of Iowa. The programs in electronics, mechanics, and chemical technology should have direct applications to NASA's fields of interest. Collins Radio Company, for example, is already making excellent use of Technical Institute graduates in their NASA contract work.

This two-year training program for technicians for industry has been widely acclaimed by those industries which have hired its graduates. By 1967 we anticipate 75 technicians per year to complete the course in electronics technology. Approximately the same number will also be certified in mechanical technology per year by 1967.

The importance of this availability of technicians to the Electronics Research Center is emphasized by the recent statement by Mr. Robert Tiemann, Professional Relations Section, National Aeronautics and Space Agency, when he emphasized the role of the technician in the research and development effort of eight NASA field centers. Mr. Tiemann said, "We have no choice but to increase the effectiveness of the engineer through expanded use of technicians. A trained and experienced technician performs his specialized duties in a far more superior manner than would the fresh graduate engineer, in fact better than a mature engineer. In recent years we have increased the percentage of technician support and have observed improvements in operations. But we have only begun to exploit the potential usage of technicians, and we plan to further expand our current admittedly inadequate ratio of technicians to engineers."

V. Center for Industrial Research and Service

The Center for Industrial Research and Service (CIRAS) is an important new program established at Iowa State University to provide engineering and technical assistance to Iowa's growing industry. CIRAS assists industrial growth in Iowa (1) by coordinating industrial needs with the technical capabilities and specialties available in the State, (2) by using full time staff to assist with special problems facing industries in Iowa, and (3) by publishing technological information from research and extension activities relating to Iowa's industrial climate and growth. CIRAS helps Iowa business and industry to improve old products, to develop new products, and to help find new uses for old products.

Through CIRAS, counselling and advice is provided directly to industry to help solve specific problems in such areas as production, management, marketing and quality control. Actual solutions may be developed by Iowa State University, other State agencies, Federal government agencies, or private organizations. Assistance by Iowa State University is provided by employing specialists on the University staff as consultants, by initiating research projects in established research groups or Experiment Stations, and by organizing or developing educational programs under the various Extension services.

In addition, the full time CIRAS staff undertakes formal research programs or furnishes specialized assistance in surveys, reports, or organizational studies. It acts as a clearing house for efforts to help Iowa business and industry improve.

Technological information specifically for Iowa industry is published to show the State's potential for industrial growth. These publications describe the capabilities and activities of personnel and organizations in the State, potential raw materials and industrial processes, and results of research and extension programs.

The industrial climate of Iowa can benefit greatly from direct aid and technological assistance by the University through CIRAS.

Evidence of the need for such aid is shown by several successful arrangements presently underway between research teams of Iowa State University staff members and various Iowa industries.

The purpose of CIRAS is service to the industries of Iowa.

VI. Staff Consulting

Staff members of Iowa State University may consult on a fee basis, carefully avoiding conflict of interest. It is the policy of the Engineering College to "encourage a reasonable amount" of ~~research~~ consulting by staff members so long as it contributes to professional development and does not interfere with other responsibilities.

VII. Engineering Extension Service

In addition to the wide variety of advanced study made possible by the research and graduate school facilities of the university, there is also an extensive program of short courses, seminars and workshops. The Engineering Extension Service has a full-time staff of 25, and utilizes the academic staff of the College of Engineering. The College of Engineering and other segments of the university conduct courses on the Ames campus and at other locations across the state wherever demand is sufficient. In the academic year 1962-63, enrollment was about 12,000 in such varied fields as Power Network Analyzers and the application of the data resulting therefrom, Operations Research, Public Utility Valuation and Rate Making, and Work Management.

APPENDIX A

THE ROLE OF

IOWA STATE UNIVERSITY

IN RESEARCH AND GRADUATE EDUCATION

The Iowa State University of Science and Technology was the first Land-Grant College; it has long played a significant role in research and graduate education in the various fields of science and technology. Work at the university is fully accredited by all of the pertinent regional and national organizations. Iowa State University is a member of the Association of Graduate Schools, the forty members of which collectively confer over 75 percent of the doctoral degrees granted in this country. The university currently has an enrollment of 11,500 of which approximately 2,000 are enrolled in the graduate college. The university confers about 165 Ph.D. degrees a year; most of these are in the science and engineering areas closely related to the program activities of the National Aeronautics and Space Administration. Current graduate enrollments are 330 in engineering and 625 in sciences and mathematics. More than 90 percent of these are working on the doctorate.

Iowa State University already plays a major role in providing the trained manpower in the sciences and engineering which this country needs and will need to meet the challenge of our research and technology oriented society. All departments listed below have strong, well-established doctorate programs and are already heavily engaged in research and training projects which directly support areas of great interest to NASA.

AEROSPACE ENGINEERING - Staff: 12 members, 6 full-time, 5 one-half time, and 1 one-quarter time. All engaged in research. Seventeen graduate students are majoring in Aerospace Engineering, 13 of these are working on Ph.D. programs, the rest on M.S. programs (several of these plan ultimately to work for the Ph.D.).

Present research activities: Modes of vibration of an inflatable delta wing; structural vibration of long, slender missiles; nozzle study on jet mixing characteristics of multi-rocket nozzles in close proximity to each other (optimum design of rocket nozzles by the method of three dimensional characteristics and calculus of variations--the study is both mathematical and experimental); magnetohydrodynamics; gas dynamics; rendezvous and de-orbit studies including minimum single impulse trajectory, first order error analysis, elliptical initial orbits, multiple impulse de-orbit trajectories, effect of a finite burn time, cross-range errors; GEM (ground effect machine); boundary layer control; bioastronautics.

LIFE AND BEHAVIORAL SCIENCES include the departments of Bacteriology, Biochemistry and Biophysics, Botany, Plant Pathology, Psychology, Zoology and Entomology. These five departments have had 211 graduate students over the past ten years. The departments have graduated an average of 28 Ph.D.'s annually. There are nine post-doctoral associates in these departments. These departments are very well equipped including their own electron microscopes, controlled environment chambers, complete laboratory facilities, and strong

supporting departments. Bacteriology emphasizes particularly microbiophysiology, ecology and controlled environments, and identification and classification of unusual microorganisms. Biochemistry and Biophysics conducts a wide variety of research activities including metabolic and stress studies with microorganisms, plants and animals, and an investigation of photosynthetic anaerobic autotrophs. Research in the Department of Botany and Plant Pathology covers a broad area but includes specifically: evolutional relationships between plants and environment, electron microscopy of the fine structure of chromosomes, suspension of life by dry storage (world leadership on seed research of potential value in space studies using seeds for food sources), photosynthesis, potability of water as affected by algal concentrations, behavior of protoplasm confined in chambers with controlled environmental conditions and radio tracer studies of food translocation. Department of Psychology stresses research in psychological measurement and in personnel, comparative developmental and social psychology. It includes integration of psychophysical measurement and psychometric theory, biochemical concomitants of stress, instrumental communication by members of two-person teams and degree of acquaintanceship and need for cognitive clarity on cooperative tasks of varying duration. Research in Zoology and Entomology is very extensive. Included are: problems in toxicology, cytology, effects of food additives, effects of radiation on parasitic organisms, population dynamics, biological control and protozoan physiology.

CERAMIC ENGINEERING - Staff: 7 members; 2 full time, 1 one-half time, 4 one-quarter time. Eight graduate students are enrolled in the department, 5 are Ph.D. candidates. All of the research programs are in the area of materials. The department is well equipped and has available the unusual resources of the departments connected with the Ames Laboratory of the Atomic Energy Commission.

Current graduate programs involve: ductility of cubic ionic ceramic crystals as evidenced by variation of grain boundary orientation, ductility of ionic ceramics as evidenced by electron microscope studies, grain growth mechanism in UO_2 at elevated temperatures, uranium glasses and their behavior, hafnium oxide in zirconium oxide as high temperature refractories, and thermal properties of high temperature materials (above 1500^{o} C).

CHEMICAL ENGINEERING - Staff: 6 professors, 4 associate professors, 4 assistant professors, all holding the Ph.D. degree, 3 instructors holding the M.S. degree. Current graduate enrollment: 76, of which 40 are Ph.D. candidates.

Among current research projects of probable basic interest to NASA are both fundamental and applied studies on the transport of heat, mass, and momentum in reacting and non-reacting turbulent systems (this work is of importance in rocket and missile design because of its applicability to flow and combustion problems) and measurement and correlation of the radial and axial components of the eddy diffusivity tensor which is used to predict the flux of heat or mass in a turbulent stream.

CHEMISTRY - Staff: 35 senior members, 26 postdoctoral associates, 226 graduate students, and 199 undergraduate majors.

The department is unusually well equipped and has available through university sources and the Institute for Atomic Research (which is affiliated with the Ames Laboratory of the Atomic Energy Commission) unusually extensive

facilities and research equipment. The department also has available access to the university synchrotron and a 5 million watt reactor which will be in operation in 1964. A fine group of mass spectrometers are in operation; the atomic weights for nitrogen and chromium recently adopted by the International Union of Chemistry were based on data obtained with these instruments. Iowa State is a world center for work on the chemistry of the transuranium elements and for the rare earths.

A large amount of specialized research equipment is available. This includes a wide range of optical instruments such as several high resolution grating spectrographs, Raman spectrograph and fluorescence spectrophotometers using visible and ultra-violet light and X-rays. Carey and Beckman spectrophotometers are also available. Intensively used are a Model 21 Perkin-Elmer infrared spectrometer, an HR-60 nuclear magnetic resonance spectrometer and a 100 kilocycle electron spin resonance spectrometer.

An excellent complement of X-ray diffraction equipment and a precision electron diffraction apparatus is intensively used for studies of molecular structure and of the surface structure of solids.

Radio chemistry equipment is available in a wide variety of machines and includes a "Hot Canyon". Mass spectrographic equipment is intensively used.

Adjacent to the Chemistry Building is the Physical Sciences Reading Room which is generally restricted to staff and graduate student use. The main library was recently enlarged and air conditioned. It has an excellent collection of reference books and complete sets of all bound journals in the field of chemistry.

A large addition to the Chemistry building is under construction. This addition, including equipment, will amount to over $3,100,000 and will be about 91,500 gross square feet in size.

Since July 1, 1950, the Department has granted degrees to 943 persons as follows:

		Year ending June 30													
		51	52	53	54	55	56	57	58	59	60	61	62	63	Total
Degree	PhD	24	34	24	29	24	31	25	36	25	32	35	43	33	395
	MS	15	21	21	13	16	21	17	25	42	29	22	13	22	277
	BS	29	23	13	13	16	18	16	22	17	17	21	28	38	271
Totals		68	78	58	55	56	70	58	83	84	78	78	84	93	943

Iowa State has one of the top four graduate schools in chemistry in the nation.

About one-third of the Chemistry Ph.D. alumni of Iowa State University are in academic positions--8 are deans, directors, or presidents of colleges and 25 are department heads. Eleven (11) are presidents or vice presidents in industrial firms. Fifty-five (55) are directors or managers of research or production divisions in industry.

ELECTRICAL ENGINEERING - Staff: 14 full professors, 8 associate professors, 11 assistant professors, and 15 instructors. Currently, 47 students are pursuing the M.S. degree and 59 students (all beyond the M.S.) are pursuing Ph.D. programs in Electrical Engineering. About 5 Ph.D. degrees a year have been granted in the department.

One of the first degree-granting Biomedical Electronics programs in the country was established in 1957 as an inter-disciplinary program between the Colleges of Engineering and Veterinary Medicine. A half-million dollar building to house this activity has just been completed. Several Ph.D. programs have already been completed. The work includes the design of instruments for biological and medical measurements, application of advanced instrumentation techniques for studying biological and medical programs, application of feed-back control and system engineering theories to describe the physiological functions, and the application of biological concepts to the design of self-organizing data systems (bionics).

The Department of Electrical Engineering is particularly strong in solid state work with research being conducted in magnetic and non-magnetic thin film materials and devices, thermoelectric materials and devices, and semi-conductor conjunction materials. As a result of work done in this department a number of unique parametric devices have been proposed and experimentally demonstrated. Among these have been the magnetic film parametric amplifier, magnetic film balanced modulator, the magnetic film parametron and certain logic elements. Work is being done on application of semi-conductor diodes VHF and UHF as high power switches, as varactor amplifiers and infrared detecting systems. Research with thermoelectric energy conversion is being carried on. The department has designed, built, and operated since 1959 a Cyclone computer (modeled after the early Illiac) which now has a memory capacity of 16,384 forty-bit words. This has been augmented by acquisition by Iowa State of an IBM 7074-1401.

MATHEMATICS - Thirty of the staff of 46 hold the Ph.D. degree; 13 are full professors, 7 are associate professors, 15 are assistant professors, and 11 are instructors. Current graduate enrollment is 60. Fifteen Ph.D.'s on the Mathematics staff are carrying on mathematical research related to problems of interest to NASA. These include the following.

Applied Mathematics, covering elasticity, plasticity, plates and shells, fluid dynamics, partial differential equations, and boundary value problems, integral equations, and integral transforms treated from both theoretical and practical point of view. Nonlinear Differential Equations including qualitative behavior of systems, existence of almost periodic and periodic solutions, stability of solutions, Liapounov's second method in stability problems. Numerical Analysis including work on solution of linear systems and solution of linear and nonlinear differential equations.

MECHANICAL ENGINEERING - Staff: 5 professors, 6 associate professors, 10 assistant professors, 6 instructors, and 36 graduate students.

National Aeronautics and Space Administration and its predecessor, the National Advisory Committee for Aeronautics, have supported during the past several years a research program in the fluid mechanics of axial-flow turbomachinery. This program has been carried out under NACA contracts NAW-6506 and NAW-6518, as well as NASA grant NsG-62-60 and a supplement. The investigations supported have been directed toward improvement of methods for predicting performance characteristics of axial-flow compressors and pumps. Both analytical and experimental approaches to the problem have been found necessary and are in progress at present with four staff members of the Mechanical Engineering Department participating. Three men have prepared dissertations based on their work under the NASA grant. Two are doctoral dissertations and one is an M.S. thesis. A number of recent graduates of the Mechanical Engineering Department have become members of the NASA Lewis Research Center staff on completion of their programs of study.

METALLURGY - The entire staff of the Metallurgy Department devote their research efforts to basic and pioneering research on materials, particularly high temperature materials. Staff: 6 full professors, 4 associate professors. There are 34 graduate students enrolled in metallurgy, 25 are Ph.D. candidates.

The following equipment is presently available for use in metallurgical research: Testing equipment including tensile, creep, fatigue and impact machines; complete x-ray diffraction equipment including high temperature cameras, Weissenberg and precision cameras; electron microscope; nuclear reactor for neutron diffraction or radiation damage studies; complete metallographic equipment; arc induction and electron beam melting furnaces; zone refining furnaces of various types; fabrication equipment including swaging, drawing, rolling and extrusion equipment; electron microprobe analyzer; spark cutter for machining single crystal specimens; magnetic susceptibility apparatus; ultrasonic equipment for measurement of elastic constants.

Research activities and interests of present staff: Study of bonding interactions in metals by determining the crystal structures, electromagnetic, elastic and thermodynamic properties; high temperature chemistry (pyrometallurgical reprocessing of reactor fuels); high temperature properties of materials including phase relationships, electrical resistivity, specific heats and thermal expansion; solid state transformations in metals and alloys; equilibrium and kinetic properties of metal-non-metal reactions; physical metallurgy and mechanical properties of thorium; gas-metal reactions at high temperatures; phase equilibria in rare earth systems, nuclear metals and refractory metal alloys; preparation and purification of the less common metals, specifically Cr, V, Y, Sc, Th, Nb, U, Ca, Ba and the rare earths; physical properties of the rare earths, e.g. vapor pressures, allotropic transformation, crystal structures; effect of impurities and alloy additions on the brittle-ductile transition of body centered cubic metals; strain aging in vanadium and chromium; corrosion problems and transport properties of liquid metals; nucleation and growth in solid solutions; relation of structure of alloys to physical and mechanical properties.

NUCLEAR ENGINEERING - Department of Nuclear Engineering is responsible for two activities--the M.S. and Ph.D. programs in Nuclear Engineering and the M.S.

and Ph.D. programs in Engineering Mechanics. Because of this unusual combination of areas of activity, the department is in a unique position to contribute in teaching and research in space-oriented programs. Nuclear Engineering - Iowa State University was the second university in the United States to offer a graduate program in Nuclear Engineering. The interest of graduate students in this field has increased steadily. This fall 40 regular graduate students are majoring in Nuclear Engineering and two more are in divided major programs. Of these, 18 are working on the M.S. degree and 22 on the Ph.D. degree. Approximately one hundred graduate degrees have been granted with a major in Nuclear Engineering.

The program in Nuclear Engineering is well supported scientifically by the Ames Laboratory of the Atomic Energy Commission and by the Departments of Chemistry, Mathematics, Physics, and Statistics.

ENGINEERING MECHANICS - This was authorized as a field for major graduate study nearly thirty years ago. Currently, eleven men are working on the Ph.D. degree and two on the M.S. degree with a major in Theoretical and Applied Mechanics. About sixty graduate students have received degrees with a major in this field. They are about equally divided between the M.S. and Ph.D. degrees.

Staff: 6 professors, 3 assistant professors and 2 instructors.

Facilities include: A 10-kw, multipurpose nuclear reactor with extensive radiation and shielding facilities; a graphite moderated subcritical assembly; a 5-c Cobalt-60 source; an extensive collection of counting and scaling equipment; an analog computer; materials testing equipment (conventional); science of materials laboratory equipment. In addition, facilities of the computing center are available. A second reactor (5 tMW) is under construction for the Ames Laboratory.

Research areas: The department combines teaching and research activities in the areas of Nuclear Engineering, Engineering Science and Engineering Mechanics. In addition, the head of the Department of Nuclear Engineering was for three years the head of the Department of Aeronautical Engineering and is a member of the Institute of Aerospace Sciences and an Associate Fellow in the Royal Aeronautical Society.

There are two areas in which training and research are of interest to NASA. They are: concepts of propulsion of deep space vehicles by nuclear devices and materials problems of space vehicles.

The department possesses the capabilities to investigate materials problems along three lines:

1. The interaction of materials and radiation. A more complete understanding of these phenomena are important from the standpoint of (a) structural materials used in conjunction with nuclear propulsion devices, (b) effects induced in vehicles and contents resulting from radiation in space, and (c) devices and techniques for detecting radiation in space.

2. Surface phenomena. Problems of ablation upon reentry, cohesion and adhesion of metal surfaces (cold welding) under the high vacuum encountered in deep space, surface stability in space environments.

3. Shock and vibration characteristics. An extensive research program is in progress in the department on resistance to shock loading. Duration of maximum strain, in particular, appears to be a significant parameter.

PHYSICS - Present staff: 17 professors, 5 associate professors, 11 assistant professors, and 2 instructors. About two-thirds of the personnel are concerned with solid state physics, and one-third with nuclear physics. In solid state physics, the department is among the top three departments in the country. In nuclear physics, it is within the top dozen. Graduate student enrollment, 137. Graduates last year: 12 M.S.'s and 10 Ph.D.'s. A 2.5 million dollar physics research laboratory will be constructed this year; 1.1 million dollars was granted by the National Science Foundation for this structure.

The major direction of expansion at present is in high-energy nuclear physics. The department is beginning cooperative experiments in bubble chamber analysis with the Wisconsin group, and are planning an emulsion experiment at Brookhaven in cooperation with the Tufts University group.

Another area of expansion will be in astrophysics. The department will work in studies of planetary atmospheres, energy production in stars, and allied topics.

A project which may be of considerable interest to NASA is a thesis project which has as its object the analysis and construction of an "image intensifier" tube, which should yield a million-fold increase in brightness of an optical image too weak to see with the naked eye. The work so far has been mostly theoretical, but the idea appears to be sound.

STATISTICS - The staff of the Department of Statistics is made up of 32 people: 6 full professors and 1 visiting professor, 7 associate professors and 1 visiting associate professor, 7 assistant professors, and 10 associates or instructors. This department has long been a world leader in development of statistics both in theory and application.

The Department of Statistics offers work toward the B.S., M.S., and Ph.D. degrees, as well as minor work for students majoring in other fields.

There are 51 graduate students majoring in Statistics; 36 others are undergraduate majors, and 5 are special students.

Research projects include one for NASA, "Reports and Study of Statistical Correction Model". The object of this study is to test by numerical evaluation a new technique of improving the current barotropic short range weather forecasts made by the Joint Numerical Weather Prediction Unit (J.N.W.P.U.) of the National Weather Bureau at Suitland, Maryland. The study involves the classification of the approximately 2000 forecast "grid-points" of the northern hemisphere into "regions" which are "meteorologically homogeneous" for the purpose of the short term weather prediction technique. Particular attention is paid to the region which includes Cape Kennedy, Florida.

Other major projects on which graduate programs are based: Reports and study of statistical correction model, training program in biometry, unequal probability sampling theory and the time series aspects of panel surveys, research on analysis of variance procedures, the relation between statistical estimation and mathematical programming, problem of relevant reference sets in statistical inference, methods of finding optimum operating conditions, the properties of computed residuals in randomized experiments, design and interpretation of experiments using crosses of genetic material, role of errors of parameter estimation in index selection, Monte Carlo studies of genetic selection.

APPENDIX B

SOME IOWA STATE RESEARCH PROJECTS IN ENGINEERING, PHYSICS, CHEMISTRY AND STATISTICS

Aerospace Engineering - Wave propagation in a fully ionized plasma with uniform initial velocity and externally applied magnetic field.

Application of the method of characteristics to the optimized design of E-D, plug, and laval nozzles.

An investigation of simultaneous and short time-interval launching of two or more satellites into the same circular orbit from a common launching platform or from separate platforms.

Study of forced convection of heat from a wire located near a solid boundary (Using Iowa State's low turbulence wind tunnel).

Ceramic Engineering - Studies underway include: self-diffusion coefficients for single-and polycrystal yttrium oxide from 1400 - 1800°C, spectral emissivity of refractory oxides as a function of temperature, heat capacities of refractory ceramic oxides at temperatures above 1500°C, mechanisms of sintering and grain growth correlated with elasticity in polycrystalline yttrium oxide, and refractory protective coatings for metals.

Ceramics for structural use - a fundamental study of the plastic properties of cubic ionic materials in the transition from the monocrystalline to the polycrystalline state.

Thermal properties of high temperature materials (1500-3000°C).

Chemical Engineering - Laminar - turbulent transition in magneto-hydrodynamic flow.

Heat transfer studies and mathematical analysis of single-phase cryogenic storage system at zero-G environment.

Heat and mass transfer in tubular reactors.

Molecular distillation of metals at non-equilibrium (extreme high vacuum conditions).

Electrical Engineering - Control and information processing systems research includes: digital filtering in navigational control systems, analogue - digit system interface, adaptive linear decision systems, and information processing.

Macro and microelectronic devices, circuits and materials research includes magnetic thin films and computer memory and components.

Quantum electronics, communications and propagation research includes: scatter propagation, atmospheric turbulence, and ionosphere scatter.

Engineering Mechanics - Determination of the transient and oscillatory motion of solid bodies immersed in viscous fluids.

Unsteady motion of a fluid due to a random pressure disturbance.

Mechanical Engineering - Effects of free-stream turbulence on heat transfer from a flat plate.

Effect of shock wave - boundary layer interaction on heat transfer to a flat plate in high-speed flows.

Heat transfer rates at the stagnation point of blunt bodies in the presence of an applied magnetic field.

Effect of nose shape on stagnation-point heat transfer.

Development of methods for prediction of the flow patterns in the bladed passages of axial-flow pumps and compressors.

Metallurgy - Relationships of crystalline imperfections to the deformation characteristics and other mechanical and physical properties of metals and alloys are being studied.

Alloy theory investigations include: the nature of the metallic bond; structure determination of alloy phases and calculation of bond strengths from elastic constant measurements; and thermodynamic properties of alloys and intermetallic compounds.

Development of methods for the preparation of ultra-pure metals, and research in zone and electron beam refining techniques.

The study of the physical properties, mechanical characteristics and phase relationships of the rare-earth metals and alloys; preparation of rare-earth metals.

Nuclear Engineering - Unique competence in use of scale distorted and dissimilar models in analysis and design of all types of nuclear engineering and radiation systems; superior competence in analysis of data from fluctuating systems, stochastic methods.

Chemistry - Research in analytical chemistry includes: organic analytical reagents, spectroscopy, nonaqueous systems in analytical chemistry, phenanthroline-type organic reagents, and electro-analytical methods.

Inorganic chemistry research includes: radio chemistry, molten salts, unfamiliar oxidation states of metals, use of semi-micro techniques, coordination chemistry, reaction mechanisms, and reaction kinetics.

Organic chemistry research includes: organo-metallic chemistry, stereochemistry-reaction mechanisms, physical organic--free radicals, natural products -- synthesis and biosynthesis, photochemical effects, troponoid systems, carbanions, and organic synthesis.

Physical chemistry research includes: rare earths-theories of solution, electron diffraction molecular structure, surface chemistry, rare-earth separation, mass spectroscopy, radio chemistry, chemical and physical metallurgy, x-ray structure computer programming, low temperature chemistry, and high temperature chemistry.

Analytical spectroscopy of the rare-earth elements.

Mathematics - Non-linear ordinary differential equations.

Physics - Solid state research includes: magnetic resonance, nuclear magnetic resonance; semiconductors, high temperature properties, electronic properties, non-stoichiometric compounds, anomalous Hall effect in ferromagnetics, superconductivity; Fermi surfaces, de Haas-van Alphen effect, nature of ferromagnetism; surface ionization effects; and properties of magnetic materials below $1^{o}K$.

Low energy nuclear physics research includes: experimental nuclear physics, photonuclear reactions; nuclear spectroscopy; and positron annihilation--angular correlation.

High energy nuclear physics research includes: relativistic coulomb wave functions and asymptotic forms; and theory of elementary particles and their interactions.

Heat capacity lag in heavy gases at room and elevated temperatures.

Theoretical astrophysics, study of planetary atmospheres.

Statistics - The professional staff of the Statistics Laboratory has made notable research contributions in general theory and methods and in the theory and methodology of experimental design, survey sampling, numerical analysis and programming, econometric statistics, genetic statistics and biological statistics, including bioassay.

Included in the thirty statistical research projects last year was a study for NASA of a statistical correction model.